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The Varga Site: A Multicomponent, Stratified Campsite in the Canyonlands of Edwards County, Texas

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Authors

J. Michael Quigg, Jeffrey D. Owens, Paul M. Matchen, Grant D. Smith, Robert A. Ricklis, Mercedes C. Cody, and Charles D. Frederick

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EXECUTIVE SUMMARY

Data recovery excavations at the Varga Site were conducted in two phases during 2002 by archeologists from the Cultural Resources Department of TRC Environmental Corporation's (TRC's) Austin office under contract to Texas Department of Transportation (TxDOT) Scientific Service Contract No. 572XXSA004. This mitigation program was necessitated by the proposed reconstruction of the crossing of a Ranch to Market Road over Hackberry Creek, immediately south of the site in northeastern Edwards County. These archeological investigations were conducted as part of the responsibilities of TxDOT under existing federal and state legislation for the protection of cultural resources.

Geoarcheological trenching and hand-excavations within the existing 31 m wide road right-of-way of 7- m-wide paved Ranch to Market Road focused on the alluvial fines in the first terrace overlooking Hackberry Creek immediately adjacent to a spring. The southern edge of the terrace contains relatively fine-grained sediments ranging from 15 to 150 centimeter (cm) thick that overlie coarse stream gravels that extend to an unknown depth. The modern ground surface had been impacted by road construction and maintenance activities, as well as by light erosion.

Block Excavations were conducted on both sides of the pavement and resulted in the hand-excavations of a total of 207.75 square meters (m^2), including 83 m^2 (66.2 m^3) in Block A on the western side and a 124.75 m^2 (38.26 m^3) area in Block B on the eastern side. Archeological deposits in the investigated part of the site extend to the southern lip of the first terrace and extend about 50 m to the north. The excavations yielded evidence of a multiple component campsite with three distinct and a fourth less

distinct prehistoric components. In Block A, the 100 to 150 cm thick fine-grained sediments yielded four intact cultural components. Block B only targeted the youngest, Toyah component. The fine-grained alluvial sediments that comprise the first terrace contain discrete occupations radiocarbon dated to the Late Prehistoric period Toyah phase (ca. 290 to 660 B.P.), the Late Archaic period (ca. 1,700 to 2,300 B.P.), and the Early Archaic period (ca. 5,200 to 6,300 B.P.). A Middle Archaic period (ca. 3,900 to 4,800 B.P.) component was also recognized, but was not as clearly defined as were the other three components. Krotovina disturbance was relatively extensive in parts of the investigated site area. Nevertheless, the archeological deposits exhibited a high degree of contextual integrity.

The Toyah phase component contains a rich assemblage of cultural material (ca. 65,000 pieces), including lithic debitage (ca. 26,000), quantities of highly fragmented bones (ca. 18,700), small burned rocks (ca. 16,000), formal and informal stone tools (ca. 1,850), scattered ceramic sherds (ca. 100), and 11 burned rock features. This component was radiocarbon dated by 14 accepted dates to between 290 and 660 B.P. Preservation was generally good, but mixing and probable overprinting contributed to poor horizontal patterning and an inability to identify discrete activity areas.

The Late Archaic period component consists primarily of a large, nearly 6 m diameter lens of burned rock that is interpreted as an incipient burned rock midden with an indistinct central pit oven. This feature was associated with a buried A horizon and exhibited a high degree of stratigraphic integrity. However, beyond the ill-defined boundaries of this burned rock feature,

the Late Archaic period component yielded a limited lithic debitage assemblage (ca. 1,800), a few mussel shell fragments, five isolated burned rock features, scattered burned rocks, and occasional chipped stone tools (ca. 30) totaling less than 6,000 pieces. Identified dart point styles associated with this midden include Frio, Marcos, Ensor, Castroville, and Edgewood. This component was radiocarbon dated by 11 accepted dates to a 600-year period between 1,700 and 2,310 B.P.

The Middle Archaic component was not well-defined, but definitely present and dispersed below the Late Archaic component and above the Early Archaic component. These materials were vertically distributed over a 20 to 40 cm thick zone that lacked completely sterile levels or visible breaks in the stratigraphy between the other cultural events. Lithic debitage (ca. 4,400) dominates the recovered assemblage (ca. 6,000), with limited burned rocks (ca. 3,000), a few formal chipped stone tools (ca. 25), and moderate frequency of vertebrate remains (100 g) also present. Two poorly organized burned rock features were also identified and documented. Five Early Triangular projectile points and one Carrizo point fragment occurred within this component. Two wood charcoal assays and one radiocarbon date on a deer bone directly date this Middle Archaic component to ca. 900-radiocarbon year period between 3,910 and 4,820 B.P. These three absolute dates are stratigraphically in order compared to the radiocarbon dates from the cultural components above and below.

The Early Archaic component was defined by quantities of dense cultural debris (ca. 135,000) within a roughly 30 cm thick zone directly on top and mixed into coarse river gravels and below the Middle Archaic component. The cultural material varied in depth from a shallow 50 cm below datum (bd) at the north end to a much deeper 120 cmbd in the southern end of

Block A. The recovery of a robust assemblage of dart points (170 specimens) that consisted of Group 2—Early Corner-Notched, Bandy, Martindale, Gower, and Merrell dart points indicates that this zone represents many occupations that occurred over a relatively broad time frame. The dart points were associated with a diverse tool assemblage (ca. 1,300). Organic preservation was poor in this lower stratum, but occasional fragments of animal bone, plant seeds, and wood charcoal were recovered. Fifteen organic samples of diverse materials yielded radiocarbon dates that document a minimum use period of 1,080-radiocarbon years from 5,200 B.P. to 6,280 B.P.

Greater insight and understanding of each of these four components represented was made possible through the employment of numerous technical analyses, including the radiocarbon dating of 66 samples, six optically stimulated luminescence dates, use-wear analysis and organic residue identifications on 156 stone specimens, petrographic analyses on 18 pottery and one local sediment samples, pollen and phytolith analyses on 25 paired samples, instrumental neutron activation analysis on 261 chert samples and 18 pottery sherds, fatty acid composition on eight pottery sherds and 94 burned rocks, stable carbon and nitrogen analyses on 112 samples, macrobotanical analyses on 44 float and 75 individual charcoal samples, and granulometric and compositional studies on 10 sediment samples. The combined results have contributed significantly to a greater understanding of the Varga Site as a whole and documented specific information concerning the behaviors of the people who occupied the site. These and other technical analyses are urged for other excavated sites in the future to continue to broaden our understanding of the human behaviors at specific sites and throughout the broader region. This will add to a growing database that will foster a better understanding of prehistoric lifeways across Texas.

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Individuals from TxDOT district offices in San Angelo and Junction, Texas, also provided invaluable assistance during the fieldwork for this project. Ms. Nancy Fisher, Environmental Coordinator of TxDOT's San Angelo District Office, helped set up meetings, directed TxDOT personnel, and provided useful background information. A number Gradall® and backhoe operators provided much needed assistance during both phases of the data recovery operations, including initial removal of overburden and ongoing movement of backdirt piles away from the excavation areas and roadway as they became increasingly voluminous.

The hard-working field staff from the Cultural Resources Department of TRC's Austin and El Paso, Texas, offices completed the two phases of data recovery excavations at the Varga Site, making significant contributions to the timely and efficient completion of the fieldwork. During the initial (Phase I) data recovery investigation, conducted from January 14 to

February 10, 2002, the field crew was directed by Dr. Chris Lintz (Principal Investigator). Ms. Elia Perez, served as Project Archeologist, and supervised the crew of archeological technicians, which included Mr. Don Badon, Mr. Steve Baird, and Mr. Roman Clem. Mr. Grant Smith, TRC's geoarcheologist, conducted the in-field stratigraphic documentation of alluvial terrace sediments on the site and in the surrounding environment through backhoe trenching and profile recording. Dr. Lintz assisted by Roman Clem prepared the interim report from the Phase I investigations. The second stage (Phase II) of data recovery investigations conducted between July 22 and October 9, 2002, was directed by Mr. J. Michael Quigg (Principal Investigator) who planned the fieldwork, directed the data analyses, coordinated with the various technical analysts, managed the budget, and guided this project to its conclusion. Mr. Jesse Owens served as Project Archeologist, overseeing a field crew composed of Mr. Badon, Mr. Ron Charles, Mr. Clem, Mr. Steven Schooler, Mr. Jason Smart, Mr. John Spencer, and Ms. Sylvia Reyna. Again, Mr. Smith conducted geomorphological investigations on the lower terrace adjoining the deeply stratified cultural deposits on the site and in the immediate area.

The fieldwork was made much more enjoyable through the kindness and hospitality of the Varga family, in whose honor this site has been named. Mr. Todd Varga and family provided several home-cooked feasts for the field crew in the summer of 2002. Mr. Varga continually stopped by to see the excavations in progress and to visit with the field crew, asking many questions and providing many insights regarding artifact discoveries and other archeological sites in the immediate vicinity. He also conducted a tour of local upland settings, facilitating the collection of local upland chert samples used in this study. Mr. Varga allowed Dr. Lintz access to his extensive artifact collection for initial

identification and recording, which helped to refine early interpretations of the sequence of prehistoric occupations in the vicinity of the Varga Site. Mr. Varga also provided the picture of the recent flood event that destroyed the road (Figure 2-2).

Upon completion of the Phase I excavations, Mr. Clem processed the collections from the site, helped assemble the initial database, and contributed to the Phase I interim report submitted to TxDOT in April 2002. After the Phase II field investigations were completed, all materials collected from the Varga Site were transported to TRC's laboratory in Austin, Texas. There, Mr. Smart and Mr. Clem sorted, washed, and catalogued artifacts and input data; and they are thanked for their hard work. Mr. Clem also conducted the flotation of the sediment matrix samples. Ms. Mercedes Cody coded and entered data on dozens of attributes on hundreds of artifacts under the direction of Mr. Owens, with technical assistance from Mr. Shane Pritchard in 2003 and 2004. Ms. Cody is thanked for her attention to detail in cleaning up and maintaining the database, searching for and resolving errors, correcting and ensuring that all paperwork was correct and properly labeled, and maintaining the database and artifact collections throughout the analysis, reporting, and curation processes. Mr. Pritchard produced the initial drafts of cultural feature drawings and site maps, and Ms. Cody was responsible for producing some of the remaining figures and illustrations in this report. Ms. Cody also conducted the analyses on the chipped stone tools, managed the data base entry, conducted the curation preparation on the artifacts, notes, records, and photographs, helped with many of the tables and ran a very controlled laboratory. Mr. Owens performed statistical analyses of artifact distributions and stone tool attributes, photographed most artifacts, and was responsible for the technical editing and initial production of the draft report. Mr. Owens wrote

several chapters including the Introduction, much of the Methods chapter, the Research Design that guided the analyses and interpretive effort for the project, the majority of metric analyses of the projectile points presented in Appendix A, conducted the spatial analyses, and wrote the interpretations of those analyses that are integrated into the component chapters, and formatted and edited about half the draft document. Mr. Smith wrote the geoarcheological portions of this report. Dr. Charles Frederick contributed the comparison of the Varga Site stratigraphy to other regional stratigraphic sequences. Mr. Eric Oksanen helped to complete and interpret the quantitative results of the projectile point analyses in Appendix A. Mr. Paul Matchen helped to answer and address the various comments provided by the TxDOT following their review of the draft document and was a major contributor to Chapter 19 that addresses the various research questions presented in the Research Design. Dr. Robert Ricklis stepped in during the final stages and conducted a thorough edit of the entire report and his broad knowledge of Texas archeological and editorial skills made a significant contribution to the readability of the final report. Dr. Lintz assembled the data from the Phase I investigations, directed the analyses of the unknown mineral deposits initially believed to be possible human bones, prepared the public information brochure on the Varga Site used in the public outreach programs, and co-authored the interim report describing the results of the Phase I data recovery excavations. That report provided the recommendations, scope of work, and general research direction for the subsequent Phase II effort. Ms. Marie Archambeault also helped in enumerable ways from December 2004 on through the submission of the draft report to TxDOT with the extensive reporting process, creating illustrations, inserting the figures, formatting and editing of about half the draft document, helping in final stages of

laboratory analyses, and providing quality control of the draft report. Mr. Ben Herdeman did the final editing of the final report and is thanked for his attention to detail.

Dr. Darrell Creel, Director of the Texas Archeological Research Laboratory (TARL) in Austin, Texas, visited the site during the field investigations and provided insightful comments and welcome levity. Ms. Laura Nightingale, Head of Curation at TARL, provided assistance in locating ceramic artifacts from other archeological sites in southwest Texas and in checking out other material requested for loan by TRC during the course of this research. Dr. Charles Frederick provided valuable insights into the optically stimulated luminescence (OSL) dating technique and provided directions as to which processes were likely to yield the best results. Ms. Margaret Howard, Ms. Amy Ringstaff, and Ms. Aina Dodge of the Texas Parks and Wildlife Department, Public Lands Division, Cultural Resource Program were helpful in obtaining recent publications and providing lithic materials from the Devil's Sinkhole area investigations (sites 41ED54, 57, 58, and 141) to be used in instrumental neutron activation analyses (INAA). Ms. Susan Snow of the National Park Service office in San Antonio, Texas, facilitated the process of obtaining permission for Mr. Quigg to use Native American ceramic materials from Mission San Juan for analyses. Ms. Marybeth Tomka, Head of Curation at the Center for Archeological Research (CAR) at the University of Texas at San Antonio found, selected, and documented the ceramic sherds from the Mission San Juan used in the analyses. Ms. Tomka also helped various TRC personnel in the preparation of the materials and records for curation at CAR.

We would also like to thank the many professional individuals and facilities whose technical expertise provided valuable contributions to interpreting the data sets that

allowed us to provide greater and more in-depth insights into the prehistory of the Varga Site. Mr. Elton Prewitt lent his vast experience in Texas projectile point typology to the task of identifying the suite of projectile points collected during this mitigation project. Mr. Prewitt also provided insights into the research conducted at Devil's Rockshelter Site. Ms. Mary Jo Schabel, owner and operator of the Soils & Physical Geography Laboratory in Milwaukee, Wisconsin, conducted the chemistry and texture analyses of the site sediments. Dr. Bruce Hardy, previously Professor in the Department of Anthropology, Grand Valley State University, Allendale, Michigan conducted high-powered-microscopic use-wear and residue analyses on a sample of stone tools from the site. Dr. Hardy's ability to detect, identify, and interpret use-wear and residues have greatly advanced our understanding of the function of many tools and our overall assessment of site structure and function. Mr. Eric Schroeder of Paul Price Associates, Inc., of Austin, Texas, decalcified many sediment matrix samples before their submission for stable carbon and nitrogen isotope analyses. Dr. David Harris of the Stable Isotope Facility at the University of California at Davis provided the stable carbon and nitrogen isotope data together with insights and direction for interpreting the data. Dr. J. Philip Dering of Shumla Archeobotanical Services in Comstock, Texas, identified and interpreted a sample of macrobotanical remains from the site. Dr. Mary Malainey and Dr. K. L. Malisza conducted the lipid residue extractions and analyses on a sample of burned rocks and ceramic sherds. Dr. John Jones of the Palynology Laboratory at Texas A&M University conducted the pollen and phytolith extractions from sediment samples, which were subsequently sent to Dr. Richard Holloway of Quaternary Services in Flagstaff, Arizona, for analysis. Dr. Holloway lent his extensive experience to the task of interpreting and

documenting the pollen and phytolith data. Dr. Lee Bement of the Oklahoma Archeological Survey in Norman identified about one-half-dozen animal bones whose species could not be positively determined. Dr. Marvin Kay, Associate Professor of Anthropology at the University of Arkansas in Fayetteville, Arkansas, conducted high-powered-microscopic use-wear analyses and provided technical expertise in use-wear analysis to the interpretation of two Toyah-aged stone tools from the Varga Site that were believed to have special functions. Dr. Michael Glascock of the Archaeometry Laboratory at the University of Missouri Research Reactor Center, in Columbia conducted the instrumental neutron activation analysis on cultural and natural chert samples from the Varga Site and surrounding southwest and central Texas locales. Dr. David Robinson of Austin, Texas, undertook petrographic analyses of a sample of ceramic sherds from the Varga Site and other Late Prehistoric to Protohistoric period sites to provide information on the technical manufacturing attributes of Toyah Phase ceramics. Geochron Laboratories, a division of Krueger Enterprises, Inc., of Cambridge, Massachusetts, provided the carbon, nitrogen, and bioapatite isotope data on a bone sample from the Toyah component. Dr. James Feathers, Professor of Anthropology at the Luminescence Dating Laboratory of the University of Washington in Seattle, conducted the single-grain optically stimulated luminescence dating of six sediment samples from the Varga Site for comparison with the standard radiocarbon dates from each of the main components.

The mineral deposits, originally suspected to be possible human remains, collected during the Phase I investigations and labeled Feature 6 were carefully scrutinized by various experts to provide interpretations of this material. Dr. John Kappleman, a consulting anthropologist in Austin, Dr. David Glassman a physical

anthropologist at Texas State University in San Marcos, Dr. Robert R. Paine a physical anthropologist at Texas Tech University, Dr. Gary W. Rutenberg of Anthropos, in Austin, and Mr. Greig Parker an anthropologist in California all provided expert opinions concerning the questionable materials.

To all the above people and institutions I am grateful and appreciate their individual expertise and contribution to the multi dimensional aspects of this mitigation project. Thanks to all.

Mike Quigg
Project Manager

1.0 INTRODUCTION

Jeffrey D. Owens

This report describes the results of two phases of data recovery excavations at the Varga Site (41ED28), a multicomponent prehistoric archeological site in Edwards County, Texas (Figure 1-1). The first phase of data recovery operations occurred from January 14 to February 10, 2002, and the second phase was conducted from July 22 to October 9, 2002. These cultural resource investigations were carried out by personnel from the Austin and El Paso, Texas, offices of TRC Environmental Corporation (TRC) on behalf of the Texas Department of Transportation (TxDOT), Environmental Affairs Division, Archeological Studies Program under Scientific Services Contract No. 572XXSA004. The cultural resource study was necessary due to the proposed reconstruction of the crossing of the Ranch to Market Road over Hackberry Creek in northeastern Edwards County, Texas, and was carried out as part of the responsibilities of TxDOT under existing federal and state guidelines, including Sections 106 of the National Historic Preservation Act (NHPA) of 1966 (P.L. 89-665; 80 Stat. 915; 16 USC §470 et seq.); and the Texas Antiquities Code (Texas Natural Resource Code of 1977 [revised 1987], Title 9, Chapter 191, VACS, Art. 6145-9).

Data recovery excavations were conducted in two separate phases. The first phase of fieldwork included mechanical stripping and trenching as well as manual excavation of a small part of the potentially affected part of the site. Upon completion of the first phase of

fieldwork, TRC submitted an interim report to TxDOT that summarized the archeological and geoarcheological investigations conducted to date (i.e., February 2002) and presented a preliminary tabulation and limited analysis of artifacts and feature data recovered from the site (Lintz et al. 2002). This report documented the significant research potential of the site, recommended a second phase of data recovery excavations to mitigate the proposed construction impacts, and presented a data recovery plan that guided the second phase of excavations.

A second interim report described the second phase of fieldwork, which included manual excavation of a large part of the potentially affected part of the site as well as additional mechanical trenching (Owens et al. 2002). It also presented a preliminary tabulation and assessment of the entire assemblage of data recovered from both phases of excavations as it applies to the research design outlined in the data recovery plan. Following a brief description of the natural setting and history of archeological investigations at the Varga Site, this second interim report briefly summarized the archeological and geoarcheological investigations conducted by TRC personnel. Then, the report presented an overview of the site's stratigraphy and a preliminary summary of the assemblage of cultural material (including artifacts and feature data) recovered from both phases of data recovery excavations. Finally, the data assemblage was critically evaluated for its potential to address selected major research domains.

This document begins with a brief introduction to the archeological investigations at prehistoric site 41ED28. Chapter 2.0 provides a general environmental background that briefly discusses the physiographic setting, geology and geoarcheology, climate, and economic resources in the region. Chapter 3.0 provides a general

Figure 1-1. Varga Site (41ED28) Location Map

cultural background for the Lower Pecos and Central Texas archeological regions that focused on the four main time periods: Early, Middle, and Late Archaic, plus the Toyah interval represented at the Varga Site. Broad theoretical perspectives and specific research orientations

are presented in Chapter 4.0. Chapter 5.0 describes the field and laboratory methods used to obtain and analyze the cultural materials recovered. The geoarcheological investigations, results, and interpretations are presented in Chapter 6.0, which provides the context for

enabling understanding of the recovered archeological materials. Chapter 7.0 introduces the archeological results and provides the discussion of the analytical components to be presented in the following chapters. Chapters 8.0 through 11.0 present the detailed descriptions, analysis results, and interpretations of the cultural materials recovered from the four identified components. Chapter 12.0 provides the data descriptions of the materials that for one reason or another were not assigned to one of the identified components. Chapters 13.0 through 17.0 utilize the recovered data from across 41ED28 to address the major research issues and specific research questions presented in Chapter 4.0. Chapter 18.0 presents a broad view of the human ecosystems represented at the Varga Site. Chapter 19.0 evaluates and assesses the multiple analytical techniques used in our analyses. Management considerations and recommendations are presented in Chapter 20.0. Chapter 21.0 lists the references cited throughout the body of the report. A glossary of technical terms is presented for the reader in Chapter 22.0.

The glossary is followed by 15 appendices labeled A through O that provide detailed data and analyses primarily from outside technical laboratories. These specific data sets include the projectile point analyses in Appendix A, detailed laboratory data concerning the radiocarbon dates in Appendix B, the high-powered use-wear analyses and interpretations in Appendix C, the petrographic analysis and results in Appendix D, pollen and phytolith analyses and interpretations in Appendix E, instrumental neutron activation analyses (INAA) is presented in Appendix F, lipid residue analysis is presented in Appendix G, stable carbon and nitrogen isotope data on cultural and modern plant and animal resources appears in Appendix H, macrobotanical identifications are discussed in Appendix I, the expert opinions concerning the unknown material are presented in Appendix J,

the granulometry and chemical analyses are presented in Appendix K, the optically stimulated luminescence (OSL) data are presented in Appendix L, high-powered use-wear analyses on two unique chipped stone tools is presented in Appendix M, and INAA on ceramic sherds is presented in Appendix N. Appendix O is on a Compact Disk – read-only memory (CD-ROM) that contains individual tables with the individual metric and non-metric data for each stone tool by tool categories from the four defined components and the entire database for these investigations.

1.1 PROJECT LOCATION

The Varga Site (41ED28) is in southwestern Texas near the western edge of the Balcones Canyonlands, a physiographic and ecological subdivision of the Edwards Plateau Natural Region. Deep, rugged, parallel canyons that formed as southward-flowing streams characterize the Western Balcones Canyonlands where rivers cut through the limestone formations that compose the Edwards Plateau (Decker et al. 2000:1-2). Below the Balcones Escarpment and fault zone at the southern edge of the Edwards Plateau, these streams flow across the nearly level Rio Grande or Gulf Coastal plains, eventually discharging into the Gulf of Mexico.

The Varga Site is about 3.1 kilometer (km) (5.0 mile [mi]) below the rim of the Edwards Plateau in the dissected canyonlands associated with Hackberry Creek, a tributary of the Nueces River (Figure 1-2). Topography in the vicinity of the site is moderately strong, with variations of up to 136 meter (m) (ranging from 644 to 780 m above mean sea level [amsl]) across a distance of 3.1 km (5.0 mi). These dramatic changes in topographic relief are due to the entrenchment of Hackberry Creek and its tributaries into the local Cretaceous limestone

Figure 1-2. Overview of Varga Site Looking North

deposits. Local exposures of these limestone deposits include the chert-bearing limestone of the Segovia member, which is exposed on the ridges and upper slopes, and the underlying Fort Terrett member limestone of the Edwards Group, which is exposed along the lower valley walls (Barnes 1981).

The Varga Site is situated in the T1 terrace on the north bank of Hackberry Creek, overlooking the current stream channel from a height of about 6 m (19.7 feet [ft]). In the vicinity of the investigated part of the site, Hackberry Creek has three prominent alluvial terraces that form a broad, gently sloping, lowland landform that measures about 430 m (1,410 ft) in maximum width (i.e., north to south along the route of a Ranch to Market Road). The T1 terrace is a fill terrace that contains relatively fine-grained sediments ranging from 15 to 140 centimeter (cm) (1.3 to 11.7 ft) in depth. These fine sediments in turn overlie rounded to subrounded

limestone stream gravels and boulders that were deposited under high-energy fluvial conditions. Archeological deposits in the investigated part of the site extend to the lip of the T1 surface and an undetermined distance to the north.

A deposit of coarse limestone gravel and boulders dominates the T0 terrace below the T1 terrace lip. These gravels are the result of the floodplain surface being scoured of its uppermost fine-grained sediments by high-energy flood events, the two most recent of which occurred in the winters of 2000/2001 and 2001/2002. These extremely coarse gravel deposits are similar to those beneath the fine-grained sediments of the T1 terrace, which were probably deposited under analogous high-energy alluvial regimes in the past.

The T2 terrace hugs the base of nearby upland formations. The edge of the T2 terrace is

located about 270 m (886 ft) north of the investigated part of the site.

The gross boundaries of the Varga Site were determined when the site was initially documented during a cultural resource reconnaissance more than 30 years ago (Marmaduke and Whitsett 1975:92; Texas Archeological Research Laboratory [TARL] Archeological Site Atlas). These boundaries describe a site that extends about 780 m (2,558 ft) along the north terrace of Hackberry Creek, varying in width from roughly 60 m (197 ft) near the site's center to 20 to 25 m (66 to 82 ft) at either end. TRC's investigations were limited to the part of the site that lies within TxDOT's right-of-way flanking the Ranch to Market Road, near the western end of the documented site area. TxDOT's right-of-way is about 31 m (102 ft) wide as it emerges onto the T1 terrace from the creek crossing, including roughly 7 m (7.6 ft) of existing pavement and associated road shoulders that bisect the right-of-way. The investigated part of the right-of-way therefore includes two 12 m (39.4 ft) wide tracts on both sides of the pavement, defined on the inside by the existing roadway and on the outside by adjoining property fencelines.

The area of potential effect associated with the construction project extends northwards only a short distance onto the T1 terrace. Although Marmaduke and Whitsett (1975:92) reported that the northern boundary of the site was not determined when the site was originally discovered. The site files indicate that the northern edge extends about 65 m (213 ft) north of the T1 terrace lip within the right-of-way of the Ranch to Market Road. Based on TRC's investigations, cultural debris extends northwards from the terrace edge minimally 40 m (131 ft [i.e., to the northern limit of TRC's excavations]), and quite possibly farther. In fact, the mapped northern boundary of the site

probably under represents the true extent of the debris scatter, at least in the western part of the site. In any event, TRC's investigations cover and can be considered to have mitigated any construction-related impacts to a horizontal area of about 1,240 m² (4,067 ft²) within TxDOT's right-of-way (40 m [131 ft] north-south by 31 m [102 ft] east-west [including the existing pavement]).

1.2 PREVIOUS INVESTIGATIONS

The Varga Site was originally documented during a cultural resource reconnaissance of the upper Nueces River Natural Area near the Devil's Sinkhole (Kennard 1975; Marmaduke and Whitsett 1975). Although the original site forms are missing from TARL files, the survey report briefly describes site 41ED28 as a 250 m (820 ft) long site of undetermined width that extends along a terrace on the north side of Hackberry Creek (Marmaduke and Whitsett 1975:92). The recorders identified two "burned rock middens" on the highest part of the terrace as well as several additional "fire hearths" on the lower parts of the terrace. Burned rock and lithic artifacts were observed scattered across the entire surface of the site (see Marmaduke and Whitsett 1975:107, Fig. 5). Following its initial discovery and documentation, no further cultural resource investigations occurred at the Varga Site until the current TxDOT undertaking.

1.3 DATA RECOVERY EXCAVATIONS— PHASE I

These archeological investigations were initiated in response to the planned reconstruction of a Ranch to Market Road crossing over Hackberry Creek immediately south of the site. The existing low-water crossing had washed out twice during severe flooding in the winters of 2000/2001 and 2001/2002. At the time that archeological investigations were begun, final decisions had not yet been made regarding the

long-term solution for repairing the creek crossing, but either a bridge or a reinforced low-water crossing were considered to be options. Either way, the part of the Varga Site lying within the existing road right-of-way on the north terrace of the creek would be impacted by construction activities, so TxDOT initiated cultural resource investigations of the potentially affected part of the site.

In 2001, TxDOT's Environmental Affairs Division personnel contracted with TRC to investigate the part of the site that lies within TxDOT's right-of-way. TRC's scope of work was originally quite limited; it was designed to exhaust the information potential of a purported burned rock oven feature located at the surface near the rim of the first terrace of Hackberry Creek on the west side of the Ranch to Market Road (Lintz et al. 2002). During a field inspection of the damage to the low-water crossing following the most recent flood event in 2001, TxDOT archeologists noticed a low topographic mound within the right-of-way on the west side of the existing road. This apparent topographic anomaly was reported to be covered with lithic debris, burned and unburned rocks, and animal bones, and was suspected to be a prehistoric burned rock oven "midden." Local informants apparently reported that this "midden" had been subjected to repeated collecting and digging activities over the years, though no obvious potholes were evident (the authors presently believe that these reports of pothunter excavations apply to other burned rock midden features located elsewhere on the site, beyond TxDOT's right-of-way). As this "midden" was located within the area of potential effect, regardless of the manner of highway repair construction of the low-water crossing, investigations of the area were warranted as required under Section 106 of the NHPA.

In an effort to streamline the regulatory procedures of NHPA Section 106, TxDOT archeologists entered into consultation with the Texas Historical Commission (THC). Based on these consultations and available information about the site, it was determined that any archeological testing of that part of the site within TxDOT's right-of-way would most likely result in the determination of the "midden" feature as eligible for inclusion in the National Register of Historic Places (NRHP). Consequently, the parties agreed that data recovery investigations should be initiated in the "midden" feature without implementing a formal testing phase.

In consultation with TxDOT, TRC developed a scope of work that employed mechanical stripping and trenching and manual excavation of up to 10 m³ (7.65 ft³) of the potentially affected part of the Varga Site to efficiently extract data from the intact parts of the purported "midden" feature. A work authorization for these investigations was issued to TRC under an existing statewide contract for general cultural resource services. TRC archeologists and geoarcheologist performed data recovery fieldwork between January 14 and February 10, 2002, under Texas Antiquities Commission Permit 2779. During these investigations, our understanding of what the site contained changed considerably and necessitated contract modifications to reallocate the 10 m³ (7.65 ft³) excavation area to examine the archeological potential on both sides of the Ranch to Market Road near the lip of the first terrace.

The initial plan for investigating this site was developed by TxDOT archeologists specifically to document what was thought to be an isolated burned rock "midden" exposed at the surface, to identify any intact cultural deposits, and to extract information from any intact portions of the feature (Lintz et al. 2002:6). Consequently,

the initial work authorization called for TRC archeologists to restrict excavations to the “midden” feature. First, the assumed disturbed surface sediments overlying the “midden” feature on the west side of the road, which was described as being “armored” with lithic debris, burned and unburned rocks, and animal bones, were mechanically stripped using a Gradall®. Next, a north to south oriented trench was excavated west of a small concentration of burned rocks revealed during the stripping. This trench exposed a 5 to 6 m (5.5 to 6.5 ft) long burned rock lens (designated as Feature 1) in a shallow basin completely buried under 30 cm of fine sediments and overlying about 60 cm (30 in) of fine sediments on top of a coarse gravel deposits. In accordance with the contract, a second, east-west-oriented trench was excavated perpendicular to the first trench through the northern half of the shallow burned rock lens. This trench reaffirmed the scarcity of burned rock in most of the deposits; the evidence clearly indicated that the topographic mound feature did not represent a burned rock midden (Figure 1-3). Subsequent manual excavations along the edges of the backhoe trenches documented the occurrence of elevated quantities of lithic debris in the fine sediments above the burned rock lens and again just above the basal gravels (Figure 1-4). The recovery of diagnostic projectile points dating to the Early Archaic and Late Prehistoric periods, multiple concentrations of artifacts above and below the thin, buried rock lens, and an overall lack of evidence for the reported vandalism of the site, all indicated that this part of the first terrace contained stratified cultural occupations with considerable integrity. Furthermore, the cultural deposits appeared to be intact and have the potential to extend laterally beyond the vicinity of the topographic mound.

Upon consultation with TRC, TxDOT altered the scope of work to include the investigation of deposits on both sides of the road to ascertain

the geometry of the terrace deposits and the extent of archeological remains. TRC archeologists were asked to monitor additional backhoe trenches north of the original target area on the west side of the road as well as on the east side. TRC personnel were also granted latitude of professional judgment in the placement and distribution of 0.5-by-0.5 m and 1-by-1 m manual excavation units. However, the level of effort expended to examine both sides of the road was restricted to the original excavation volume cap of 10 m³. During this first phase of field investigations, four backhoe trenches were excavated on the west side of the road and three additional trenches were excavated on the east side (Figure 1-5). Eight 0.5-by-0.5 m (1.5-to-1.5 ft) units were hand-excavated along the edges of the deeper backhoe trenches (five on the west side and three on the east side of the road), a scatter of five 1-by-1 m units was hand-excavated on the east side of the road, and two 1-by-2 m units were hand-excavated on the west side of the road near the initial backhoe trenches. Manual excavations were conducted using hand tools (i.e., picks and shovels), and all sediments were screened through various combinations of 6.4 mm (1/4 in) and 3.2 mm (1/8 in) mesh. Clusters of artifacts, such as faunal bone or burned rocks, and ashy stains were designated as cultural features. Seven features were originally documented in the field, though three were later attributed to natural causes (i.e., two burned root casts and one cluster of mineral deposits originally believed to possibly be decomposed human long bones). Documented cultural features included the buried burned rock lens (Feature 1), two sparse scatters of burned rock, and one bison and deer bone dump associated with burned rocks. All hand-excavated units were terminated upon reaching culturally sterile gravel deposits. In addition, soil samples were collected from various strata observed in the backhoe trenches to aid in preliminary geoarcheological

Figure 1-3. East to West and North to South Trenches Through Low Mound Area at South End of Site (Subsequently Block A Area)

Figure 1-4. Phase I Hand-Excavations Along Initial Trenches with Burned Rock Lens Exposed in Profiles at South End of First Terrace (Eventually Block A Area)

Figure 1-5. Varga Site (41ED28) Phase I Investigation Areas In Impact Area

interpretations of site stratigraphy and terrace formation processes. The first phase of fieldwork was halted upon meeting the contractual excavation limit of 10 m³.

All lithic and ceramic artifacts, pieces of burned clay, and charcoal were collected. Excavators compiled preliminary field counts of collected materials to facilitate the compilation of information about material distributions. Laboratory work associated with the first phase of fieldwork, however, was limited to assessing the completeness and accuracy of field records and collected materials; no cleaning or cataloging of artifacts occurred at this stage. All material classes were examined, counts and weights were compiled for the unwashed artifacts, and an effort was made to identify the types of projectile points and pottery recovered from the excavations.

The results of this initial phase of fieldwork were summarized in an interim report (Lintz et al. 2002) and served as the basis for designing a second, more robust phase of data recovery excavations. The first interim report documented that the archeological setting and context were quite different than originally expected, and a second phase of fieldwork was recommended to fully investigate the dense and stratified cultural deposits within the area of potential effect.

The first phase of fieldwork established that thick (70+ cm) deposits of stratified fine sediments containing predominantly Late Prehistoric, Late Archaic, and Early Archaic archeological materials exist on both sides of the pavement within TxDOT's right-of-way. Despite some variability in depositional packages across the site, two major and one minor occupation zones were documented. The uppermost major occupation zone, attributed to the Late Prehistoric period (Toyah phase), was present in the uppermost 20 to 30 cm of deposits

on both sides of the road. Large quantities of artifacts were recovered and the preservation of bone and organic remains was excellent in these upper sediments. Several associated cultural features (i.e., debris clusters) were documented.

The minor occupation was associated with the large, thin lens of burned rock (Feature 1) buried at depths of 30 to 60 cm below surface (cmbs). This occupation was tentatively assigned to the Middle Archaic period based on the presence of a possible Pedernales/Martindale point (subsequent investigations established that this feature and the surrounding cultural component actually date to the Late Archaic period; consequently, this cultural component will be referred to as Late Archaic throughout the remainder of this document). Even though associated artifacts were not abundant, this occupation zone was marked by superb stratigraphic clarity on both sides of the road (although high burned rock densities were limited to the immediate vicinity of Feature 1).

Finally, a substantial Early Archaic period occupation zone was identified at depths ranging from 60 to 80 cm east of the road and from 60 to 110 cm west of the road, near the base of the excavations above and just into the basal gravel deposits. Preservation of organic materials was not perceived to be especially good in these lower zones, and no associated features were found during the first phase of fieldwork, but artifact densities were extremely high.

Based on variability in artifact densities, the most productive areas to be examined in the second phase of fieldwork appeared to include all occupation zones on the west side of the road, including the Late Prehistoric, Late Archaic, and Early Archaic period occupations (as well as any general Middle Archaic components that may occur between the Early and Late Archaic period occupation zones), but only the Late Prehistoric occupation was

targeted east of the road. Older occupations were documented on the east side, but the preservation appeared to be poor and temporal and cultural diagnostics and features appeared to be rare. Thus, the first interim report recommended that the second phase of fieldwork target all three components on the west side of the Ranch to Market Road and only the Late Prehistoric component on the east side of the road. The report presented a data recovery plan that guided the proposed second phase of excavations and outlined eight primary research domains to be addressed with the data recovered. Upon consultation with THC, TxDOT concurred with TRC's recommendations and issued a work order to proceed with the proposed second phase of data recovery excavations.

Before the second phase of excavations could begin, however, TxDOT entered into consultation with any interested parties (per Section 106 of the NHPA) regarding the possible human remains recovered during the first phase of fieldwork. At TxDOT's request, a sample of the possible human remains was examined by three physical anthropologists. The physical anthropologists concluded that the materials could not be assigned to a species, though one concluded that the size and position of the materials were consistent with human leg bones. Given the inconclusive results, TxDOT submitted a sample to a bone histologist for examination of the cellular structure of the material. The histologist and his academic advisor both concluded that the material was not bone. The histology information was also submitted to an osteologist in California who reaffirmed the conclusion that the material was not bone. After all opinions were gathered, TxDOT's archeological staff, TRC archeologists, and the THC concluded that the material was not human in origin (these materials are currently believed to be sediment cavities, probably root casts, that were

subsequently filled with carbonates, see Appendix J). Based on this conclusion, it was determined that the second phase of data recovery excavations could proceed.

1.4 DATA RECOVERY EXCAVATIONS— PHASE II

The goals and methods applied during the second phase of data recovery excavations were based on the insights gained from the first phase of investigations (Lintz et al. 2002). The first phase of excavations clearly indicated that the stratigraphic structure of the first terrace of Hackberry Creek and the variety and extent of archeological deposits present were considerably more complex than originally expected. TRC's investigations demonstrated that the Varga Site contains stratified deposits with minimally three well-defined prehistoric occupation zones. The uppermost and lowest occupation zones contained abundant materials associated with the Late Prehistoric period (Toyah phase, ranging from 300 to 600 years ago) and one or more Early Archaic period components (ranging from 6,000 to 8,000 years ago). A buried 5-to-6 m diameter burned rock lens (Feature 1) denoted a third, intermediate, Late Archaic period occupation zone. Remains from other (presumably Middle Archaic period) components were suspected to exist, but associated features, tools, and other diagnostic materials were too sparse to confidently correlate the materials into meaningful analytical units.

The artifactual, ecofactual, feature-related, and geoarcheological data recovered during the first phase of investigations indicated that the Varga Site contained important information about the prehistoric past (Lintz et al. 2002; also see Chapter 4.0—*Research Design*). Therefore, a second phase of data recovery excavations was conducted to mitigate the proposed impacts from road replacement, to recover relevant data from

minimally three clearly defined cultural components represented (as well as from any additional, less well-defined components that

may occur), and to obtain additional geoarcheological information about the age and structure of the Hackberry Creek terraces.

2.0 ENVIRONMENTAL BACKGROUND

J. Michael Quigg and Jeffrey D. Owens

2.1 PHYSICAL ENVIRONMENT

The Varga Site lies 0.8 km (0.5 mi) below the rim of the Edwards Plateau in the dissected canyonlands associated with Hackberry Creek, a headwater tributary of the Nueces River. Topography in the vicinity of the site is moderately pronounced, with local relief of up to 136 m (ranging from 644 to 780 m above mean sea level [amsl]) across a distance of 0.8 km (Figure 2-1). These dramatic changes in topographic relief are due to the entrenchment of Hackberry Creek and its tributaries into the Cretaceous limestone deposits.

The Varga Site lies within the T1 on the left (north) bank of Hackberry Creek, overlooking from a height of approximately 8 m and is about 30 m from the current stream channel. In the site's vicinity, Hackberry Creek has three prominent alluvial terraces that form a broad, gently sloping, lowland landform that measures about 430 m in maximum width (i.e., north to south along the route of the Ranch to Market Road). The T1 is a fill terrace that contains relatively fine-grained sediments ranging from 15 to 150 cm in depth. These fine sediments in turn overlie rounded to subrounded limestone stream gravels and boulders that were deposited under high-energy fluvial conditions. Archeological deposits in the investigated part of the site extend to the lip of the T1 and an undetermined distance to the north.

Channel deposits of coarse limestone gravel and boulders measuring at least 2.5 m in thickness dominate the T0 below the T1 lip. Based on one humate date from just above the gravel deposit, these T0 gravels were deposited before ca. 6,300 B.P. The floodplain surface was subsequently scoured of its uppermost fine-grained sediments during high-energy flood events between 6,300 and 2,000 B.P. The upper 1.5 m of fine-grained sediments, which overlays these gravel deposits were laid down over the last 2,000 years. The two most recent flood events occurred in the winters of 2000/2001 and 2001/2002 (Figure 2-2). The lower coarse gravel deposits on the modern Hackberry Creek floodplain (T0) are similar to those beneath the fine-grained sediments of the T1 and probably were deposited under analogous high-energy alluvial regimes in the past.

The limited T2 is restricted to the outer margins of the valley and lies at the base of steep valley walls. The southern edge of T2 is approximately 270 m north of the investigated part of the Varga Site. Only a very limited part of T2 lies within the TxDOT right-of-way.

2.1.1 Physiography and Topography

The Varga Site is near the western edge of the Balcones Canyonlands, a physiographic and ecological subdivision of the Edwards Plateau. Southward-flowing rivers and streams cut through the limestone formations that compose the Edwards Plateau thereby creating deep, rugged, parallel canyons that characterize the Western Balcones Canyonlands (Decker et al. 2000:1-2). Below the Balcones Escarpment and fault zone at the southern edge of the Edwards Plateau, these streams flow across the more nearly level Rio Grande or Gulf Coastal plains, eventually discharging into the Gulf of Mexico.

Figure 2-1. Overview of the Varga Site (41ED28) Looking North

Figure 2-2. Road Damage Following Recent Flood Event

2.1.2 Hydrology

The Varga Site is approximately 3.1 km south of the upland divide that separates the southward-flowing waters that drain into the Nueces River catchment from those that flow eastward into the Llano River basin. The site is near the headwaters of Hackberry Creek; about 12.5 km east of its drainage divide near the eastern margin of Edwards County. Hackberry Creek flows southward into the Nueces River roughly 12.1 km south of the site. The Nueces and the West Nueces rivers parallel one another and then merge in southern Uvalde County. The Nueces River parallels several other major rivers that lie to the east that also flow southwards out of the Edwards Plateau, winding across the Gulf Coastal Plain and ultimately discharging into the Gulf of Mexico at Corpus Christi, Texas. United States Geological Survey (USGS) topographic maps indicate (and field observations confirm) the presence of three active springs in the vicinity of the Varga Site. One is located immediately downslope from the project area on the west side of the road crossing over Hackberry Creek (Figure 2-3). Two additional springs are 175 and 280 m east of the project area (i.e., along the eastern part of the site). These three natural springs are the northernmost sources of permanent water along Hackberry Creek. Brune (1981:175) references a spring labeled “Hackberry Springs” in this approximate location. According to local lore, these springs are connected to the underground water channel in the Devil’s Sinkhole, which is approximately 5.3 km northwest of the site. Six additional active springs issue along the 5.4 km long segment of Hackberry Creek south of the project area. The water flow from these springs is strong, ranging from 72 to 180 liters per second during the period from 1939 to 1954 (Brune 1975:41, 1981:175). Large pools of water currently stand immediately upstream and downstream from the site. This abundance of

water contrasts markedly with the scarcity of natural water resources farther upstream.

Figure 2-3. Spring Pool Near Varga Site

2.1.3 Geology and Soils

The dissected escarpment of the Edwards Plateau in the vicinity exposes Upper Cretaceous period Buda Formation limestone. These exposures occur at the highest elevations and are more prominent to the north and northwest of the project area. In this region, the Buda limestone forms the flat-lying portions of the plateau, such as those in the vicinity of Rock Springs, Texas. Underlying the Buda limestone is the chert-bearing limestone of the Segovia Member of the Edwards Limestone of the Lower Cretaceous, which is exposed on the ridges and upper slopes. The Segovia Member limestone in turn overlies the Fort Terrett Member limestone of the Edwards Group. The Fort Terrett limestone is exposed along the lower valley walls and dates to the Lower Cretaceous period (Barnes 1981). The Edwards Formation extends over a broad area of Texas and extends northward to Fort Worth. The Edwards Formation limestone is present in both the Central Texas and Lower Pecos regions and contains quantities of chert-bearing locations. Silicified wood also occurs in basal Edwards Group deposits in southern Real County (Sellards et al. 1990). Microscopically, the

Edwards Group limestones show much diversity. The formation is from 159+ m (520+ ft) thick within the area represented on the Uvalde, Texas, U.S.G.S. quadrangle. The Lower Cretaceous formations continue to the southwest into Mexico. The geological deposits of this region are identical to deposits farther west in northern Val Verde County and adjacent counties, indicating geological continuity across these regions.

The natural chert outcrops associated with the Edwards Formation limestone were valuable resources throughout prehistory for native populations, who used these cherts for tool manufacture. Frederick and Ringstaff (1994) identified the broad horizontal distribution of the Edwards Formation and its chert-bearing deposits. The “Edwards chert” is a component of Lower Cretaceous limestones throughout Central and West Texas and northern Mexico. Frederick and Ringstaff (1994) also developed an initial taxonomy of 16 distinct types of “Edwards chert” from Fort Hood, which is located near the eastern margin of the Edwards Group. The 16 defined types of “Edwards chert” show a wide range of physical variability within the bedrock. These initial 16 types have since been expanded to include more types and variations within the region, including river-transported gravels. To obtain a general understanding of the chemical variability within “Edwards chert,” instrumental neutron activation analysis (INAA) was conducted on 121 samples representing six bedrock sources within the Edwards Group at Fort Hood (Frederick et al. 1994). The results indicated that 21 of the 31 measured elements were potentially useful in pattern recognition. The bivariate plots indicated some overlap in characteristics among the six Fort Hood chert types, but a general chemical separation was detected between the Edwards cherts and other analyzed sources north of Texas. Apparently, varying concentrations of metals and rare earth elements occur in Edwards

cherts that can be used to distinguish cherts from different regions across the Edwards Formation.

Recent Holocene alluvial deposits occur immediately adjacent to most of the narrow stream channel margins within the river basins of the Balcones Escarpment. As discussed above in the Hackberry Creek section at the Varga Site, at least three alluvial terraces are represented in some parts of the valleys. Coarse gravels with considerable chert nodules, some of sufficient size for use as tool stone, dominate the streambed of Hackberry Creek adjacent to the Varga Site.

The northern part of Edwards County is dominated by Ector-Rock Outcrop-Real soils. These are very shallow, undulating to very steep, stony loamy soils underlain by limestone or marl and limestone outcrops on uplands. The Ector soils are typically grayish brown stony loam over fractured limestone. Real soils have dark grayish brown gravelly clay loam surfaces over weakly cemented limestone. The soils in the alluvial terraces are mostly Nuvalde-Del-Frio soils. These are deep, nearly level to gently undulating loamy and gravelly soils with slopes less than three percent (Soil Survey Staff 1982).

2.2 THE BIOTIC ENVIRONMENT

2.2.1 Floral Communities

The plant and animal life of the western portions of the Edwards Plateau and Balcones Escarpment are sufficiently diverse that they defy simple characterization. Blair (1950:112-114) characterizes this region, which he includes within his Balconian biotic province (which includes the Edwards Plateau and some of the surrounding areas), as an intermixture of floral and faunal elements of other major provinces, including woodland, plains, and desert. As such, the Balconian province can best be characterized as a broad ecotone (Johnson 1994:8-9; Odum 1959), offering a complex cross-section of floral

and faunal resources adapted to different ecological niches. The western half is semiarid, whereas the eastern half is a dry, subhumid zone. The Tamaulipan biotic province lies south of the Edwards escarpment and the Chihuahuan biotic province lies to the west near the Pecos River. These nearby provinces potentially contributed various plants and animals to this region in the past depending upon the changes in the past climates and environments.

Kuchler (1964:86) classifies the regional vegetation as a juniper-oak savannah, with a dense to open canopy of broadleaf deciduous and needleleaf evergreen shrubs and low trees. Dominant vegetation throughout upland settings includes little bluestem grass (*Andropogon scoparius*), mountain juniper (*Juniperus* sp.), and live oak (*Quercus virginiana*). Mesic forests that include several species of oak (*Quercus* sp.), elm (*Ulmus* sp.), pine, (*Pinus* sp.), hackberry (*Celtis* sp.), pecan (*Carya illinoensis*), walnut (*Juglans microcarpa*), and various berry-bearing shrubs cover stream floodplains. Other economically important xeric plants in parts of the region include lechuguilla (*Agave lechuguilla*), sotol (*Dasyllirion wheeleri*), beargrass (*Nolina* sp.), and prickly pear cactus (*Opuntia* sp.). Vast expanses of the native vegetation have disappeared as the result of overgrazing by sheep and goats throughout historic and modern times.

Auken et al. (1980) discovered that the density, dominance, frequency, and importance of trees and shrubs covering the Edwards and Glen Rose Limestone formations were similar near San Antonio. In all, they identified 24 woody species. Twenty-nine percent occurred exclusively on the Edwards Formation, 42 percent were common to both areas, and 29 percent occurred exclusively on the Glen Rose Formation. Both areas were dominated by juniper (*Juniper ashei* [52 percent]), live oak

(*Quercus fusiformis/virginiana* [15 percent]), and sotol (*Diospyros texana* [11 percent]).

In vegetation studies in the Balcones Scarp zone near Waco, Gehlbach (1988) found that fire promoted the sprouting of Texas oak (*Quercus texana*), live oak, flameleaf sumac (*Rhus copallina*), skunkbush sumac (*Rhus flabelliformis*), and redbud (*Cercis* sp.) Fire killed the juniper. Thus, fire may be the natural cause of oak dominance over juniper.

The aboriginal use of many native plants is well documented for the southwest (Castetter 1935; Castetter and Opler 1936), with specific references to lechuguilla and agave (*Agave neomexicana* [Castetter and Bell 1937; Castetter et al. 1938; Castetter and Opler 1936]), yucca (*Yucca* sp.), sotol (*Dasyllirion wheeleri*), beargrass (*Nolina microcarpa* [Bell and Castetter 1941]), mesquite (*Prosopis* spp.), and screwbean (*Prosopis pubescens* [Bell and Castetter 1937]). Duisberg (1952) also discusses desert plant utilization, including such species as Candelilla (*Euphoria antisyphilitica*), beargrass, creosote bush (*Larrea divaricata*), jojoba (*Simmondsia chinensis*), gourds (*Cucurbita foetidissima*), and devils claw (*Martynia parviflora*). Yanovsky (1936) provides a thorough compilation of food plants used by the aboriginal populations across Canada and the United States. An in depth discussion on yucca is provided by Webber (1953) and should be consulted for background.

The following examines a few selected plants in detail and focuses on ethnohistorically documented strategies of gathering and preparing these food resources since the resulting burned rock cooking features are commonly found in the region. Most plants with rosette foundations are commonly called mescal in the early literature. For clarification, the term “mescal” refers to the crowns of agave and similar plants. However, this should not be

confused with mescal beans that are derived from a Texas mountain laurel tree (*Sophora Secundiflora*). This tree is part of the Leguminosae (Fabaceae) family. The native use of mescal beans is documented for a very broad region that includes the Varga Site project area (Merrill 1977). The mountain laurel is a perennial herb with dense, alternate, dark green leaves on smooth stems that grow as shrubs or small trees. The fruit is a woody seedpod 2 to 12 cm long that is moderately to strongly constricted between seeds. The pods contain one to several dark red seeds (Correll and Johnston 1979). The seeds are ovoid in shape, and range in size from 8 to 20 millimeter (mm) long and 5 to 15 mm wide, with a distinctive seed scar deeply impressed on one side. The seeds range in color from maroon to orange-red through yellow. The bright red seeds or beans are hallucinogenic and are used in ceremonies and as decorations (Merrill 1977).

Yuccas are among the most valuable plants of the southwestern desert (Bell and Castetter 1941). They provide food, shade, and wind protection for many desert species. They are distributed over vast areas of the southwest, plains, valleys, and mountains and occur in all types of soil, but are more common in sands and gravels. Soap-tree yucca (*Yucca elata*) and Great Plains yucca (*Yucca glauca*) commonly occur in extensive belts that extend for kilometers and are particularly common on more compact sandy soils (Webber 1953). Humans have relied on this plant for thousands of years. The uses include food, beverages, medicines, and clothing. In general, the yucca plant consists of long, narrow, rigid leaves that extend outwards from a central crown. A stem or stock grows from the base and yields a fleshy fruit and seeds. The seedpods were prepared in a variety of ways, including boiling and roasting (Bell and Castetter 1941).

Sotol (*Dasylirion* spp.) has a rosette-leaf base surrounding the center or heart of the plant. These bases contain sugar. The leaves, up to 100 cm long and 4 cm wide, are narrow, linear, elongated, rigid, and pointed at the end with small, claw-like teeth 1 to 3 cm apart along the leaves. The plant develops a tall, leafy, flowering stem terminating in a stout, cylindrical stem. The stem can reach up to 5 m in height. The plants primarily grow on limestone or granite slopes in the Trans-Pecos region, the Edwards Plateau, West Texas, and into Mexico (Correll and Johnston 1979:404-405), but they tolerate a wide range of moisture conditions. Sotol hearts are most tender and contain their highest food value in the spring, but they can be gathered and cooked at any time. The seeds on the stalks usually ripen in August.

Lechuguilla (*Agave lechuguilla*) is a century plant commonly found throughout the Chihuahuan Desert. It is generally thought to be rare east of the Devils River. It often occurs in light-colored, highly calcareous, limestone-derived soils with a current range in extreme southern New Mexico continuing southward into Mexico across western Chihuahua and Durango provinces, throughout Coahuila, and continuing to the south (Freeman 1973). Like other agaves and sotol, it has a rosette-leaf base radiating outwards from the center or heart of the plant. It produces large numbers of capsules along a spike-like panicle, with each capsule producing up to several hundred seeds. It germinates readily over a wide range of conditions, even under water stress, not from the seeds but almost entirely by rhizomes (Freeman 1973). These are perennials with May through June as the primary reproductive season and flowers when there is sufficient rainfall. This plant contains a toxin called sapogenin that requires breakdown through cooking to make it edible.

The importance of these plants can be distilled from the following passage from Castetter and

Opler (1936:35-37) concerning the gathering of agave by the Mescalero Apache. Agave was usually collected in the spring for roasting when the stored sugars made it sweeter.

“The crowns of the mescal plants were dug out with three-foot sticks cut from oak branches and flattened at the end. This end, when pounded with a rock into the stem of the plant just below the crown, permitted the crown to be removed readily. A broad stone knife was used to chop off the leaves, two being left for trying the crown together, and making transportation move convenient. The naked crowns were bulbous, white in color, and one to two feet in circumference.

“Pits in which the crowns are baked are about ten to twelve feet in diameter and three or four feet deep, lined with large flat rocks. On the largest rock, which is placed in the center, a cross is made with black ashes. Rocks are piled on the flat stones, but care is always taken that the top level shall be level. Upon this, oak (*Quercus* sp.) and juniper wood (*Juniperus* sp.) are placed. Before the sun comes up this is set on fire and by noon the fire has died down.

“On these hot stones is laid moist grass, such as bunch-grass (*Sporobolus airoides*), side-oats grama (*Bouteloua curtipendula*), texan crab-grass (*Schedonardus paniculatus*), big blue stem (*Andropogon furcatus*), mesquite grass (*Muhlenbergia wrightii*), marsh foxtail (*Alopecurus aristulatus*), Muhlenbergia neomexicana, or the leaves of bear grass (*Nolina microcarpa*), but bear grass is usually preferred since it does not burn readily. The largest mescal crown is selected and a cross made on it with tule or cat-tail pollen (*Typha latifolia*), when this is available, the pollen always being placed on the crown from east to west and north to south. The Indians then pray. Holding the large crown toward the opening of the pit four times, they toss it in and throw the other crowns in after it. Next they have the youngest child present stand at

the east of the pit and throw four stones into it. After the mescal has been covered with the long leaves of bear grass and the whole with earth to a depth sufficient to prevent steam from escaping, the crowns are allowed to bake the rest of the day and all night. Early in the morning the pit is opened and a crown examined and eaten. The pit is again closed and the Indians refrain from drinking until noon of this day so as to prevent rain. The following morning all the mescal is removed.

“The pulpy centers of the black, crowns are released from their charred leaf base and pounded vigorously into thin sheets on a rock. This brown, juicy pulp is spread out to dry on “mescal cradles”, very loosely woven shallow or tray baskets made from the leaves of *Yucca elata*, and in these the prepared mescal is carried home. Unfermented mescal juice is often sprinkled over mescal when being dried. This gives it a glaze, which aids in preserving it. It may be eaten as soon as baked or dried and stored for future use in hide containers (parfleches). When wanted, the desired amount is cut off, soaked in water, and when softened the water is squeezed out and the mass eaten without further preparation. A piece of crown is cut off and chewed and the inner side of the leaves chewed and scraped, much as we eat globe artichokes. When the pithy center of the leaf is reached it is discarded. Mescal is sweet, having an agreeable taste somewhat like molasses, and a mild laxative effect.

“Many are the combinations in which mescal is used. After the dried product has been softened by soaking it is kneaded together with ground pinon seeds or walnuts (at present peanuts may be used) until the whole is of a doughy consistency; it is then ready for consumption. Mescal mixed with juniper berries (*Juniperus scopulorum*) is another favorite food, whereas the fruits of the three-leaved sumac (*Rhus trilobata*) are

also ground with mescal and the mixture dried and stored for future use.”

In discussing the Maguey (*Agave americana*) plant, Castetter and Opler (1936:38) state “[T]hey prepare it by boiling it until it is soft, then mash it into a paste.... Another well known desert plant, sotol (*Dasyllirion wheeleri*) was utilized in much the same way as mescal.”

The following quote is from Bell and Castetter (1941:19) and concerns an ethnographic account of *Yucca elata* being roasted by the Chiricahua and Mescalero Apache in New Mexico.

“The crowns of *Y. elata* were gathered any time from the middle of March until the end of summer and the portion of the stem between the ground and the leaves was peeled and baked overnight in an underground oven in a manner similar to that in which the mescal was prepared. The yellow or brown product was then fried in the sun, broken into pieces, and after softening in water the rather sweet product was ready to be eaten. The tender central leaves of *Y. baccata* were cooked in soups, boiled with meat, or used in various other similar combinations.”

In addition to the edible hearts of these plants, the stalks and fruits were also used as foods (Castetter and Opler 1936:38-39).

2.2.2 Fauna

Faunal resources include 57 species of mammals, 36 species of snakes, 15 species of frogs and toads, 16 species of lizards, and one species of turtle. Minimally 65 species of birds and three species of mussels, as well as a considerable variety of crustaceans, are also present (Blair 1950:133, 115; Kennard 1975). The dominant economically important indigenous game animals presently available include whitetail and mule deer and javelina. Bison also roamed this area periodically in early historic times.

2.3 CLIMATE

2.3.1 Modern Climate

Regional climatic variability in Texas is quite high. Southwest Texas is typified by a semiarid climate. Modern climatic data show that the average annual precipitation ranges from 20.3 cm (8 in) in extreme West Texas to 142.2 cm (56 in) in east Texas (Bomar 1983; Larkin and Bomar 1983). The Lower Pecos region receives an average of about 48 cm (18 in) per year, whereas the Varga Site area receives about 61 cm (24 in) per year, and at the eastern side of the Edwards Plateau near Austin, the precipitation is about 81 cm (32 in) per year. This reveals a clear increase in the amount of rain from the dry west Texas to the wet east Texas, which has a strong influence on the type and growth of vegetation.

Rainfall in nearby Junction, Texas, averages 57.20 cm (22.52 in) per year, with two dominant rainfall periods occurring in spring (April through June) and fall (August through October). Average monthly rainfall during the spring rainy season varies from 5.41 to 8.33 cm (2.13 to 3.28 in), with May generally being the wettest month at 8.33 cm (3.28 in [Bomar 1983:221-222, Table C-2]). Average monthly rainfall during the fall rainy season ranges from 5.99 to 7.32 cm (2.36 to 2.88 in), with August generally having the most rainfall at 7.32 cm (2.88 in). Snowfall in Edwards County averages only 2.5 cm (0.98 in) per year, and annual potential evapotranspiration ranges from 60 to 90 cm (24 to 36 in [Geraghty et al.1973]).

Average annual low temperatures range from 4° to 19°C (40° to 65°F), and average annual highs range from 21° to 30°C (70° to 86°F), increasing along a gradient from north to south (Decker et al. 2000:39). The coldest months currently occur from December through February, with average low temperatures ranging between 0° and 2°C (31.7° and 35.4°F), as documented for

the nearby town of Junction, Texas (Bomar 1983:212-213, Table B-5). January is the coldest month, with an average temperature of 0°C (31.7°F). The warmest months occur from June through August, with average high temperatures ranging between 34° and 36°C (93.3° and 95.9°F [Bomar 1983:215-216, Table B-7]). July is the warmest month, with an average temperature of 36°C (96.7°F). Extreme temperatures beyond these ranges are common, ranging from -22°C (-7°F; January 31, 1949) to 43°C (110°F; July 27, 1954), as documented for the nearby city of Kerrville, Texas (Bomar 1983:214, Table B-6). The Varga site area has an average of 20 days with temperatures over 38°C (100°F).

Relative humidity has a daily average range of 73 to 74 percent in the morning to 36 to 48 percent in the afternoon from January to April, while the daily range in humidity is slightly higher from July to October, with ranges of 75 to 82 percent in the morning and 36 to 50 percent in the afternoon, as documented for the nearby city of San Angelo, Texas (Bomar 1983:234, Table F-4).

Wind velocity comes from the Arctic Air Mass of the north during October through January with an average speed of 14.5 km per hour (9 mph), but summertime winds (i.e., during April through July) are dominated by the Maritime Tropical Air Mass and come from the Gulf of Mexico to the southeast and south/southeast with an average speed of 16 km per hour (10 mph).

2.3.2 Paleoenvironment and Indications of Paleoclimate

The Varga Site is near the western end of the Edwards Plateau, but only about 50 km from the Lower Pecos region. These two archeological regions are discussed as separate and distinct regions in the literature and therefore, their respective paleoenvironments may also be

different, as implied by Bryant and Holloway (1985). Interpretations of paleoenvironments in these two regions differ somewhat from each other, and it is not clear which paleoenvironmental interpretation is more appropriate for the Varga Site area. It is also possible that paleoenvironments at certain times in the past were very similar in the two regions. The following discussions summarize current reconstructions of paleoenvironments in the Edwards Plateau and the Lower Pecos regions.

2.3.2.1 Central Texas Paleoenvironments

In Central Texas, across the Edwards Plateau, and along its eastern margins in the adjacent Post Oak Savanna region, the paleoclimate records are somewhat better known. Many pollen cores from bogs in the Post Oak Savanna (Larson et al. 1972; Bryant 1977b; Holloway et al. 1987), some data from geomorphic investigations of river valleys (Blum 1987; Blum and Valastro 1989; Toomey et al. 1993; Nordt 1992; Johnson 1995; Johnson and Goode 1994; Mear 1998), and cave deposits (Toomey 1993) provide a variety of proxy data for reconstructing paleoenvironment. These proxy data have been summarized several times and much of the discussion that follows has been extracted from the overviews by Bryant and Holloway (1985) and the more specific trends observed by Bousman (1998).

Bousman (1998), using secondary counts, requantified the pollen results from Boriack and Weakly bogs just east of the Edwards Plateau. These two bogs provide a 16,000-year sequence of fluctuations between grass and arboreal pollen that indicate shifts between forest, woodland, and open plant communities. Bousman's interpretations of his recalculations indicate that open vegetation communities were present during the Late Glacial Maximum and between 13,000 and 12,000 B.P., 10,000 and

9,000 B.P., and 8,000 and 2,500 B.P. (Figure 2-4). A key factor in understanding these shifts in vegetation is that the mesic woody species invaded grasslands during the moist climates intervals, but woody species died during droughts (Coupland 1958). Apparently, between 8,000 and 7,000 B.P. the region became grassland. The phytolith data from the Wilson-Leonard Site also supports a grassland composition similar to today during the period from ca. 8,700 to 6,000 B.P. (Fredlund 1998). Along the Texas Gulf Coast, it appears that, between about 6,700 and 6,000 B.P., the sea level was rising rapidly (Ricklis and Blum 1997). A two-phased, mid-Holocene dry interval occurred, with extremes recorded at 6,500 B.P. and 5,000 B.P. (Bousman 1998). Alternatively, Johnson and Goode (1994) see no long-lasting, dry hypsithermal climate in the eastern Edwards Plateau; consequently, little change occurred in the climate between the Early and Middle Archaic cultural periods. Johnson and Good (1994) do acknowledge, however, that some drying occurred in late Early Archaic times.

The faunal record from Hall's Cave near the center of the Edwards Plateau indicates conditions that were dryer than modern from ca. 5,000 to 2,500 B. P. (Toomey et al. 1993). About the time of this dry interval, the upland soil mantles in Central Texas were being rapidly stripped (Toomey et al. 1993), as Nordt (1992) interpreted for the Fort Hood area. Fredlund (1998), using phytolith data, sees the overall vegetation composition of Central Texas reach its modern balance of woodlands and grassland by about 4,000 B.P. Between 4,000 and 3,200 B.P. was a period of rapid sea level rise (Ricklis and Blum 1997). Johnson and Goode (1994) propose that a dry Edwards Interval lasted from about 5,000 to 3,000 B.P.

For the last 3,000 years of the Weakly Bog sequence, grass and oak pollen are equally

represented. Starting at roughly 3,000 B.P., the pollen frequencies indicate that oak woodland was followed by oak-hickory woodland. Bousman (1998) interprets this change to indicate that the climate became progressively moister through the Late Holocene. This is in direct contradiction to the interpretation offered by Holloway et al. (1987) on the same bog pollen. Toomey et al. (1993) also appear to differ in that they see drier conditions culminating between ca. 5,000 and 2,500 B.P. To date, research has not definitively proven whether flood plain aggradation is related to dry periods or to moist conditions (Johnson and Goode 1994). Toomey et al. (1993) see more mesic conditions from about 2,500 to 1,000 B.P., with modern conditions predominating from 1,000 B.P. to the present. The phytolith assemblage from the Wilson-Leonard Site indicates that local conditions became less open after 2,000 B.P. (Fredlund 1998).

Two significant grass spikes occurred in the Weakly Bog data, one dated to 1,500 B.P. and the other estimated at 500 to 400 B.P. (Bousman 1998). These grass spikes are linked to alluvial pedogenesis in floodplain deposits during these periods in Freestone and Leon counties to the east of the Edwards Plateau. This point is significant to the extent that grassy intervals can be associated with alluvial stability, but not all researchers agree on this issue. As an outgrowth of his Quaternary work in the upper Sabinal River valley, Mear (1998) believes that downcutting and deposition can occur simultaneously along a stream during both dry and humid climate regimes.

Caran (1998) provides a cautionary note to interpretation of data used in the reconstruction of paleoenvironments and reminds us that the data generally represent second, third, or higher-order extrapolations from the database. This might account for some of the differing

Figure 2-4. Comparison of Multiple Interpretations of Changing Environments in Central Texas Using Different Data Sets

interpretations together with multiple causes for end product. Currently, it appears that Johnson's and Goode's (1994) projection of temperature shifts is out-of-step with Bousman's (1998) canopy cover estimates and the phytolith assemblage at Morgan Playa (Fredlund et al. 1998) in the Rolling Plains to the north of the Edwards Plateau. Fredlund's (1998) results from the Wilson-Leonard Site indicate that phytolith analyses for the Texas region are warranted.

2.3.2.2 Lower Pecos Paleoenvironments

The Pecos River divides the Edwards Plateau from the Stockton Plateau to the west. The Varga Site is near the boundary of three major biotic provinces and therefore, exhibits considerable ecological diversity. The Lower Pecos region has received extensive excavations of large rockshelters, but has not yielded a detailed paleoenvironmental history. Bryant

(1966, 1969, 1977a) has led the way with several site-specific pollen investigations directed at reconstruction of the paleoenvironment (i.e., at Arenosa Shelter, Hinds Cave). Several factors contribute to a lack of pollen data. First, pollen is generally poorly preserved in the rockshelters and the deep alluvial terraces. Second, considerable mixing of the deposits has caused context concerns. Other approaches and techniques, such as phytolith and isotope studies, have not been attempted. What has come from the rockshelter deposits are considerable plant remains (Dering 1977, 1979) and human coprolites (Bryant 1974; Williams-Dean 1978) that can be used as proxy data to extrapolate past environmental conditions.

The pollen evidence from the Lower Pecos region is quite spotty, but provides general trends presumably reflecting the regional record and not just the local conditions. Some cultural activities in these archeological sites potentially skewed concentrations of certain pollens. For the period between 10,000 and 7,000 B.P., Bryant and Shafer (1977), Dering (1979), and Bryant and Holloway (1985) interpret the decreases in fossil pine pollen coupled with the rise in pollen from herbaceous plants and grasses as indications that the previous Late Glacial Period mosaic vegetation of woodlands, parklands, and scrub grasslands was being gradually replaced by expansion of scrub grasslands. The pine pollen was thought to reflect relic stands of pinyon pine in some of the protected canyons.

From about 7,000 to 4,000 B.P., the pollen records are incomplete and inadequate (see Johnson 1963; Bryant and Holloway 1985). The evidence from Hinds Cave reflects decreases in the percentages of grass pollen, rises in the percentages of pine pollen, and an overall increase in arboreal pollen between 7,000 and 6,000 B.P. that may reflect the beginning of

widespread soil erosion (Dering 1979; Bryant and Holloway 1985). Although it is not clear what the specific paleoclimatic conditions were between 7,000 and 4,000 B.P., this was a period of erosion and severe flooding along the Rio Grande, as evidenced at Devil's Mouth Site (Johnson 1964) and Arenosa Shelter (Dibble 1967). Between about 6,700 and 6,000 B.P. is a time of rapid sea level rise (Ricklis and Blum 1997) that indicates a general global warming trend. In the Southern High Plains at Lubbock Lake, the Firstview Soil formed during a period between 8,500 and 6,300 B.P. (Holliday 1985). The Yellowhouse Soil developed between 6,300 and 5,000 B.P.

The last 4,000 years indicates a gradual and continual trend towards increased aridity (Bryant and Holloway 1985). Apparently another period of sea-level rise occurred between 4,000 and 3,200 B.P. (Ricklis and Blum 1997), again, that indicates a general global warming trend. One brief reversal in this drying trend was identified around 2,500 B.P. from pollen at Bonfire Shelter and Devil's Mouth, which shows a marked increase in the percentage of both pine and grass pollen. This has been interpreted as a brief return to somewhat cooler and more mesic conditions (Bryant 1969; Bryant and Shafer 1977; Bryant and Holloway 1985).

Looking further west across the American Southwest, the evidence from packrat middens has provided vast assemblages of plant remains that have been used to interpret past vegetation sequences (Van Devender and Spalding 1979). After 11,500 B.P. in the Guadalupe Mountains, a Douglas fir/southwestern white pine forest at 2,000 m amsl was replaced by a juniper grassland community (Van Devender and Spalding 1979). In general, the middle Holocene woodland species migrated northward, retreating to elevations in the mountains and disappeared in the lowlands. Desert-adapted species increased in abundance and dispersed

into new areas (Van Devender and Spalding 1979).

From the packrat evidence in the American Southwest, Van Devender and Spalding (1979) believe that the present climate and vegetation regimes of the modern Chihuahuan Desert were established after about 8,000 B.P. Winter precipitation was reduced in or withdrawn from much of the Southwest, whereas summer monsoons expanded. Middle Holocene wet climates probably favored development of grassland. However, widespread loss of well-developed mature soils on bedrock during the middle and late Holocene probably augmented the development of xeric microhabitats and desert vegetation. Van Devender and Spalding (1979) also demonstrated that the desert succulents coexisted with the juniper-oak and pinyon woodlands in the Trans Pecos region.

Precipitation reconstruction from dendrochronology in the American Southwest, specifically for the southern Rio Grande Basin in southeastern New Mexico, reveals that the most severe long-term drought during the last 1,373 years occurred between 1,010 and 910 B.P. (A.D. 940 and 1040 [Grission-Mayer et al. 1997]). Following this drought was a wet period that lasted to about 740 B.P. (A.D. 1210). However, within this wet period was a short-term drought of about 15 years from 825 to 810 B.P. (A.D. 1125 to 1140). A second drought period occurred between 740 and 645 B.P. (A.D. 1210 and 1305). In general, the dendrochronology reveals major swings in precipitation over the last 1,400-year period. In fact, the drought history from old post oak trees in Texas reveals oscillating precipitation levels across South Texas (Stahle and Cleaveland 1988).

Plant remains provide direct evidence of the paleoenvironment and are well-documented from many archeological sites in the Lower

Pecos region. In the period radiocarbon dated from 9,120 $\pm$ 90 B.P. (Tx-2866) to 6,750 $\pm$ 100 B.P. (Tx-2316) at Hinds Cave, Dering (1977, 1979) has identified many plants from Analysis Unit 7. These include oak (*Quercus*), juniper (*Juniperus*), walnut (*Juglans*), mesquite (*Prosopis*), hackberry (*Celtis*), coyotillo (*Karwinskia humboldtiana*), onion (*Allium*), lechuguilla (agave lechuguilla), yucca, sotol (*Dasylirion*), *Condalia* sp., grasses, and prickly pear (*Opuntia*), all of which are thought to have been exploited by the early inhabitants. These data, together with the drop in percentages of arboreal pollen below the herbaceous pollen frequencies, were interpreted to represent a reduction in the pinyon pine stands in northern Val Verde County (Dering 1979). Dering also believes that juniper tree was abundant in the area.

The short interval between 6,540 $\pm$ 70 B.P. (Tx-2744) and 6,160 $\pm$ 80 B.P. (Tx-2735), in Analysis Unit 6, exhibited these same plants with the addition of acacia, yucca, chenopodium, buffalo gourd (*Cucurbita foetidissima*), sumac (*Rhus virens*), and Texas mountain laurel (*Sophora secundiflora*). Shortly thereafter, between 4,990 $\pm$ 70 B.P. (Tx-2743) and 4,410 $\pm$ 70 (Tx-2749) in Analysis Unit 5, these same plants together with beargrass (*Nolina*), redbud (*Cercis*), yaupon (*Schaefferia*), and dominated by lechuguilla, continue in the archeological record. At this time, a sudden drop in pine pollen occurred, but several factors could have contributed to this drop and one explanation is not sufficient. Apparently, major vegetation changes occurred in the Lower Pecos region between 5,000 and 4,400 B.P.

After 4,000 B.P. (Analysis Units 2, 3, and 4), the record at Hinds Cave was again rich in plant macrofossils. Radiocarbon dates of 2,280 $\pm$ 60 B.P. (Tx-2746) and 3,780 $\pm$ 70 B.P. (Tx-2741) document this period. In general, the same suite of plants continued in the

archeological record with the addition of a grassland component that contained bristlegrass (*Setaria leucopila*) and tanglehead (*Heteropogon contortus*). The major differences in plant content during this period are the drop in lechuguilla and the increase in sotol (Dering 1979). Dering proposed two possible

explanations for this shift: (1) a change in the prehistoric technology or (2) a change forced by a shift in the distribution and abundance of sotol and lechuguilla. Dering (1979) argues that the environment of the Lower Pecos has not changed as drastically as had been previously thought (Bryant 1977a).

3.0 CULTURAL OVERVIEW

J. Michael Quigg

3.1 INTRODUCTION

The Varga Site lies in eastern Edwards County towards the western end of the Edwards Plateau physiographic region, which is generally considered part of the Central Texas archeological region (Prewitt 1981a, 1985; Figure 3-1). However, the site lies only 50 km (80 miles) east of the heart of the Lower Pecos archeological region (see Perttula 1995: Figure 1 for proposed archeological regions). The geographic position of the Varga Site within the southwestern dissected plateau region may lend itself to cultural influences and/or specific uses by human populations from either or both of the Central Texas and Lower Pecos cultural areas.

This chapter provides a general overview of what is known about the cultural history of the Edwards Plateau and Lower Pecos cultural areas. In general terms, human occupation in the region spans some 13,000 years, but there are key differences in the tool assemblages and other aspects of the cultural systems among the different areas that form the basis for defining different chronological sequences. Prehistoric sites with rich and diverse assemblages, such as the Varga Site, have potential for the examination of prehistoric human adaptation to this complex ecological setting through time and investigation of the relationships with adjacent culture areas.

This chapter presents the relevant cultural background for the general

cultural/chronological units pertinent to the major components discovered as a result of data recovery excavations at the Varga Site. The three principal chronological units upon which this discussion focuses are the Early Archaic period, the Late Archaic period, and the latter part of the Late Prehistoric the succeeding Protohistoric period (i.e., the Toyah phase or horizon). The site also contains a diffuse Middle Archaic period component marked by Early Triangular projectile points, but is not as well-defined as the three primary components. Brief background statements concerning the Middle Archaic are also presented. Available information on the three principal cultural periods provides a broad foundation upon which to build. It is anticipated that the materials recovered from the Varga Site excavations, the results of the various analyses, and the presentation of component and artifact data will significantly advance our understanding of the Early Archaic, Late Archaic, and Late Prehistoric periods and contribute to a greater understanding of human adaptations to this complex and poorly understood region.

3.2 ARCHEOLOGICAL BACKGROUND

The western edge of the Edwards Plateau has received relatively little archeological attention and archeological knowledge of the area is correspondingly rather poor (Decker et al. 2000). However, some sites in this region, most of which are located just south of the escarpment, have undergone archeological excavations (e.g., the La Jita Site [41UV21; Hester 1971], the Leona River watershed [Lukowski 1987], the Smith Site [41UV132; cited in Mueggenborg 1994], the Blue Hole Site [41UV159; Mueggenborg 1994], the Heard Schoolhouse Site [41UV86; Goode 1991; Black et al. 1997], the Woodrow Heard Site [41UV88; Decker et al. 2000], the Anton Site [41UV60; Goode 2002]) in Uvalde County. However, with

Figure 3-1. Prewitt's (1981a) Central Texas Archeological Region Overlaying Physiographic Regions

the exception of the Nueces River Natural Area survey (Marmaduke and Whitsett 1975) and the Devil's Sinkhole State Natural Area survey (Howard et al. 1996), relatively few systematic surveys or recent excavation projects have been completed in this region. As of January 2003, slightly more than 200 archeological sites have been recorded in Edwards County. The site types include open upland camps, terrace camps, lithic scatters and workshops, lithic procurement areas, rockshelters, burned rock middens, sinkholes, and pictographs. Howard et al. (1996) provides histories of the archeological investigations in Edwards, Real, Uvalde, Kerr, Kimble, and Sutton counties, which will not be repeated here.

The survey at Devil's Sinkhole provides an indication of the site types and densities for the uplands in the immediate canyonland region (Howard et al. 1996). The 736.3 hectare (ha) (1,827 acres [ac]) survey revealed the presence of 21 prehistoric sites, or one site per 35 ha (1 site/87 ac). Of the 21 sites recorded, 43 burned are burned-rock middens and another 15 are burned-rock scatters. Natural chert outcrops occur at 38 percent of the sites. Most burned rock middens are circular and have maximum diameters of 20 m or less. Over half the sites yielded diagnostic projectile points (a total of 45 specimens). Only about nine percent were arrow points and the rest were dart points, with a majority of those representing the Late Archaic period.

Although the region lacks systematic surveys, a sample of 106 sites listed in the vicinity of the Varga Site and adjacent to Hackberry Creek and the Nueces River represents diverse site types situated on different landforms (Table 3-1). Sites include rockshelters, burned-rock middens, lithic scatters, lithic procurement areas, and buried camps. These prehistoric sites occur on/in terraces (58 percent), in the uplands (38 percent), and in the intervening slopes

(4+ percent). Campsites buried in depositional sediments are limited to the alluvial terraces, whereas rock shelters and lithic procurement sites are found primarily on slopes. Burned-rock middens have been found in both upland and the terrace settings.

Archeological investigations have been spotty in both the Central Texas and the Lower Pecos regions, with excavated sites yielding cultural materials that are quite variable in time, context, and artifacts. Most excavated sites lack one or more key data sets that would contribute to broad comparisons. For example, some site-specific investigations have yielded very limited cultural assemblages containing few diagnostic artifacts (e.g., Devils Rockshelter [Prewitt 1966], Camp Pearl Wheat [Collins et al. 1990], Turkey Bend Ranch [Treece et al. 1993a], 41TG309 [Quigg et al. 1996], Cibolo Crossing [Kibler and Scott 2000]), limited numbers of, or no radiocarbon dates (e.g., Youngsfort [Shafer 1963], Landslide [Sorrow et al. 1967], Devils Mouth [Sorrow 1968], Camp Pearl Wheat [Collins et al. 1990], Devils Rockshelter [Prewitt 1966], Eagle Cave [Ross 1965], Sleeper [Johnson 1991]), have not been fully reported (e.g., Arenosa Shelter, Hinds Cave), have compressed stratigraphy (e.g., Barton Creek [Ricklis and Collins 1994], Camp Pearl Wheat [Collins et al. 1990], Sleeper [Johnson 1991], Wilson-Leonard [Collins 1998], Woodrow-Heard [Decker et al. 2000]), or have yielded hundreds of specimens from mixed context (e.g., La Jita [Hester 1971], Panther Springs [Black and McGraw 1985], Barton Creek [Ricklis and Collins 1994], Woodrow-Heard [Decker et al. 2000]).

As a result, our understanding of the different time periods and associated assemblages is quite limited. Even the ages of relevant cultural/chronological units are not clearly defined in most cases. Some sites provide better context and more information than other sites.

Table 3-1. Archeological Sites in the Vicinity of the Varga Site in Northern Edwards and Western Real Counties

Time Period	Upland Setting	Canyonlands Rock Outcrops	Alluvial/Colluvial
Paleoindian			
Early Archaic			
Middle Archaic	2 middens – ED50 (Pandale)		
General Archaic	3 middens – ED147 (dart)		2 middens – ED141 (dart)
	2 middens – ED141 (dart)		
Late Archaic	1 midden – ED67 (Pedernales)		9 middens + procurement – ED58 (Pedernales)
	4 middens – ED65 (Pedernales)		4 middens + procurement – ED54 (Pedernales)
	4 middens – ED55 (Arenosa)		1 midden – ED78 (Castroville)
	1 midden – ED74 (Marshall)		1 midden – ED83 (Montell)
	2 middens – ED39 (Pedernales)		1 midden – ED70 (Frio)
	1 midden – ED75 (Frio)		2 midden – RE23 (Frio)
	1 midden – ED76 (Frio)		2 middens – RE26 (Bulverde)
	1 midden – ED81 (Bulverde)		
	1 midden – ED44 (Darl/Marshall)		
Late Prehistoric	Lithics – ED145 (arrow)		
	4 middens – ED65 (dart)		
	Camp – ED40		
Unknown	Lithics – ED149	Procurement – ED146	Buried camp – ED25
	Lithics – ED148	Procurement – ED144	1 midden – ED26
	1 midden – ED143	Lithics – ED140	Buried camp – ED29
	Lithics – ED142	Rockshelter – ED24	1 midden – ED31
	1 midden – ED56	Rockshelter – ED85	Lithics – ED32
	Lithics – ED30		Lithics – ED33
	Procurement – ED41		Buried camp – ED34
	1 midden – ED43		Lithics – ED35
	Procurement – ED46		Buried camp – ED36
	1 midden – ED47		Buried camp – ED37
	Procurement – RE41		Lithics – ED38
	1 midden – ED51		2 middens – ED45
	2 middens – ED71		1 midden – ED48
	1 midden – ED72		1 midden – ED49

Table 3-1. Archeological Sites in the Vicinity of the Varga Site in Northern Edwards and Western Real Counties (Continued)

Time Period	Upland Setting	Canyonlands Rock Outcrops	Alluvial/Colluvial
			Buried midden – RE46
			Buried camp – RE47
Multicomponent	6 middens – ED53		Buried camp – ED23
	4 middens – ED52		Buried camp – ED27
			Buried camp – ED28
			3 middens – RE30 (Clifton)

ED = Edwards County, RE = Real County, 2 middens = the number of middens per site, (Pandale) = point recovered at site
Site 41ED58 presently encompasses 58, 59, 60, 61, 62, 63, 64; Site 41ED65 presently encompasses 65 and 66; ED88 farmstead;
Number refers to site number

and those with larger data sets have provided the bulk of currently available information. Sufficient time and space is not available to review all sites or components that have been investigated; therefore, this presentation mainly relies upon the more complete data.

In 1995, the Texas Archeological Society (TAS) published a comprehensive volume that summarizes much of what is known about Texas prehistory. Many papers in that volume provide excellent background information for the current study, specifically those by Collins (1995) on Central Texas and by Turpin (1995) on the Lower Pecos region. Other key and relevant publications from which chronological information has been extracted include Turpin's (1991) synthesis of the Lower Pecos chronology, earlier work by Prewitt (1981a, 1985), the Wilson-Leonard Site report (Collins 1998), Johnson and Goode's (1994) reevaluation of the Eastern Edwards Plateau climates and archeologically defined culture periods, and the Woodrow-Heard Site report (Decker et al. 2000), which includes a comprehensive summary of excavated sites in the region surrounding the Varga Site. These publications

provide much of the background information presented in this chapter.

Archeological investigations have not produced many well-stratified sites that exhibit good context with tool types and/or cultural assemblages that have been securely radiocarbon dated to the Early Archaic period. McKinney's (1981) assessment of early Holocene adaptations lists only 45 Early Archaic sites for Central and Southwestern Texas, and his discussion is based on materials from surface contexts for nearly half of his sites ($n=21$). Preliminary assessments of the Early Archaic projectile point types recovered from the Varga Site generally indicate occupations post-dating components containing Angostura projectile points and associated assemblages. Recent assessments of the terminal age for Angostura points provides a reasonable chronological baseline for the earliest (post-Angostura) occupations at the Varga Site.

The Angostura interval has been radiocarbon dated to roughly 8,900 to 7,900 B.P. (Decker et al. 2000) at sites including Woodrow Heard, Richard Beene, Wilson-Leonard, and Armstrong (Schroeder and Oksanen 2002). In Central Texas, the Middle Archaic period begins at approximately 5,500 B.P. (Johnson and Goode

1994). Therefore, the Early Archaic period horizon at the Varga Site must generally fall between 8,000 and 5,500 B.P. The following discussion centers on this later part of the Early Archaic period for both the Central Texas and Lower Pecos archeological regions. The two regions have many similarities. As archeological research has progressed in each region over the years, chronological information from one region has often been transposed to the adjacent region based on new findings (e.g., Sorrow et al. 1967). However, McKinney (1981) argues that these two areas represent distinctive adaptations that are not readily equated.

3.2.1 Burned Rock Midden Research

Massive accumulations of burned rocks were recognized very early in Texas archeology. In 1919, Pearce had excavated burned-rock middens and presented a model of their construction. He suggested that burned rocks had accumulated around a “central feature” or hearth, and that as hearth rocks became fractured from use they were tossed out and replaced with new rocks. The continued use of the hearth over time resulted in a massive accumulation of burned rocks around the hearth. He also suggested that the central hearth was used for cooking or boiling various foods. Since the beginning, and over the course of nearly 50 years of intermittent investigation, the age of these middens was established by estimating the ages of the various types of projectile points found mixed with the burned rocks (Wilson 1930; Huskey 1935; Pearce 1938; Kelley and Campbell 1942; Kelley 1961; Hester 1970, 1971). In 1935, Huskey, reporting on middens in the upper Nueces Canyon of Edwards, Real, and Uvalde counties, had documented that one group, or “Type A”, middens was most often associated with various Archaic projectile point types. A second group, “Type B” middens, contained only arrow point representing later

cultures. He thought that the “Type B” middens were relatively few (often only one per site), and generally smaller in size and thinner (often consisting of only a single stratum of burned rocks).

Most early archeological work emphasized establishing the relative age of the burned-rock middens/mounds via correlations of associated point types with estimated ages. Thus, there was only limited documentation of the physical form/structure of burned-rock deposits, and little concern with their function. Consequently, early publications provide cursory descriptions of the features themselves, making it difficult to ascertain what the features actually looked like. Currently, it is unclear if investigated features fall into more than one formal category. The terminology used over the years, in referring to these as mounds or middens, was also a concern and led to ambiguities, as some researchers tended to associate specific forms of human behavior on the basis of the terms used (Wilson 1930; Krieger 1945; Suhm et al. 1954; Kleinback et al. 1995).

For example, although Wilson (1930) had accumulated no direct evidence, he related the distribution of mounds to the distribution of sotol as the primary food being cooked in these features, and used ethnographic data to propose that these features were functionally similar to earth ovens. As more work was done on burned-rock middens, Kelley and Campbell (1942) presented an alternative to Pearce’s (1919) “central feature” idea, suggesting that the middens accreted through construction of “intersecting hearths” over a long span of time, with redundant use of these areas for cooking accounting for middens lacking central features and/or clear stratigraphy middens. Kelley and Campbell (1942) thought most of the hearths were used for baking and roasting. As research evolved over time, several different suggestions were offered to explain midden formation.

Greer (1967), working in far west Texas and southern New Mexico, distinguished subtle differences in the doughnut-shaped (ring) middens, those with subsurface pits (“mescal pits”) and those with surface hearths (“midden circles”). His mescal pits were the remains of earth ovens, and he inferred that the others were represented some other use. Another hypothesis concerning the development of middens was presented by Sorrow (1969) who believed these features were simply dump areas where various kinds of cultural debris were discarded, accounting for all the different types of materials discovered in some cases.

Weir (1976:35-40) established four types of burned rock middens to account for the variations observed in the field. Burned rock midden (BRM) Type 1 was “oval and mounded in shape with no surface indications of any subsurface feature.” Often these had a high artifact content. Type 2 was a “circular aggregation of burned rocks around a central pit” that was generally smaller, in the range of 7 to 15 m in diameter. Also these were generally associated with more charcoal and fewer artifacts than Type 1. Burned rock midden Type 3 was generally a ring of burned rocks around a central slab-lined subsurface pit. Type 4 was a general scatter of burned rock with no obvious shape or form and generally only one rock thick. In addition to the visual differences and the establishment of different types of middens, Weir also noted that the observed types showed differential distribution across the landscape. Type 1 middens were dominant in Central Texas. Type 2 middens were mostly in western and northwest parts of Central Texas. Type 3 middens were mostly along the western edge of Central Texas and toward the southwest. Weir (1976) also believed that most of the middens were of Archaic age, ranging in age from 5,000 to 1,800 B.P.

Projectile points were still being relied upon for age determination of middens when Weir (1976) provided his midden typology. Over the years researchers had recognized that there were different types of middens, some were of different ages, and variability in contents was noticed as some contained many stone artifacts and others reflected plant processing.

After the late 1970s, interest and excavations continued to increase and were directed towards these controversial and frequently occurring cultural features (Weir 1979; Peter 1982; Howard 1983; Black and McGraw 1985; Creel 1986; Gearhart 1987; Lukowski 1987). Researchers generally referred to two primary types of middens in the literature, the domed form, or Type 1 (Gearhart 1987) and the ring/annular midden, or Type 2 (Treece 1992).

In a synthesis of Central Texas archeology, with over 200 burned rock middens having been excavated in the region (Howard 1991), Prewitt (1981a, 1985) incorporated burned rock middens into his formulation of culture chronology as key index markers of different cultural phases. Following the lead of Weir (1976) Prewitt also believed that the most intense use of middens was during the Archaic, beginning in the Early Archaic and continuing throughout the Middle Archaic (Prewitt 1981a). However, few burned rock features had been directly radiocarbon dated, so most middens were assigned an approximate age based on the extrapolated and general age of projectile points collected from them. As recently as 1991, Prewitt stated that “the general age range of Central Texas burned rock middens is fairly well established to be Middle Archaic, or roughly 5,000 to 2,250 B.P.” however, the full age range has yet to be precisely defined (Prewitt 1991:26).

In a 1988 symposium on burned rock middens, five authors attempted to provide a synthesis of investigations and results, as well as directions

for future work (Hester 1991). The general consensus was that very little new had been learned about burned rock middens over the previous years and innovative field methods would be necessary to generate new and more informative results. Work continued on burned rock middens across Central Texas (Treece 1992; Treece et al. 1993a; Collins 1994; Mueggenborg 1994, Black et al. 1997; Black et al. 1998). One testing and excavation project in Bexar County employed the use of an experimental approach in excavation and field-recording strategy (Black et al. 1998).

Analyses of data from testing and data recovery at five burned rock midden sites across the Edwards Plateau provides an in depth view of these features and brought new insights to their age and function (Black et al. 1997). A compilation of data centering on burned rock middens was conducted and presented for an 18 county area in Central Texas. A total of 156 radiocarbon dates from 36 middens at 29 sites (Decker 1997) yielded results that indicate that just over 80 percent of the radiocarbon dates fall after 2,000 B.P. (A.D. 1) and 53 percent fall after 1,150 B.P. (A.D. 800)(Black and Creel 1997:273). Although the bulk of the dates represent the last 2,000 years, radiocarbon dates are as old as 8,500 to 9,000 B.P. (6,500 to 7,000 B.C.) at 41BL598 (Quigg and Ellis 1994; Black and Creel 1997). However, the number of radiocarbon dates shows an essentially logarithmic increase toward the present, suggesting that the observed pattern may be more a function of limited long-term preservation of datable charcoal than a real indication of an actual long-term increase in the use/creation of burned rock midden deposits. Thus, while the tendency for the radiocarbon dates to cluster toward the more recent end of the chronological spectrum does contrast with earlier-stated suggestions that most middens

were used in the Middle Archaic, this may be more apparent than real.

Recent testing at 16 sites containing burned rock middens in Bowie County, on the northern edge of the Central Texas archeological region has, to a degree, elucidated midden development. Several characteristics were noted: middens represent re-use and maintenance of a central feature; rock sizes in middens are not random, but rather appear to be patterned; the presence of bone and mussel shell in low frequencies is consistent with the use of earth used to cap a cooking feature or oven; the primary food cooked in such earth ovens consisted of geophytes (i.e., bulbs and tubers); the most intensive use of the Bowie middens occurred between 500 and 1,200 B.P. (A.D. 750 and 1400) (Mauldin et al. 2003). Investigations like this one are documenting particular characteristics of the middens in one localized area, but there is still need for similar detailed investigation in middens in other parts of Texas. It cannot presently be assumed that the information from these middens is representative of all other middens. In a broad encompassing midden distribution study by Mauldin et al. (2003), Edwards, Real, Val Verde and Crockett counties formed one of three high-density areas. There is mounting evidence that these high-density areas may be related to the distribution of different types of food resources. The more northern areas may be related to geophytes, whereas the more southwestern areas may be related to sotol, agave, and lechuguilla.

After nearly 90 years, where does burned rock midden research presently stand, and what are the key questions still in need of answers? The ideas for future investigation strategies presented by Collins (1991) in the symposium volume have only been applied in a few instances since their publication. In most instances those investigative methodologies have brought about a greater understanding and have raised more

questions that require considerably more data to address. This does suggest that progress is being made to understand these features. Obviously, much remains to be learned and certainly more specific data are required to address the more specific questions, and determine the cultural and social implications of these features.

3.2.1.1 Burned Rock Midden Ages

Most burned rock middens were assigned a general age based on estimated projectile point ages, that placed these features during the Early, Middle, and Late Archaic periods. More recently, in Central Texas, the primary use period is presently radiocarbon documented to the Late Prehistoric period from about 500 to 1,250 B.P. (A.D. 700 to 1450) (Treece 1992; Treece et al. 1993b; Quigg and Ellis 1994; Black and Creel 1997; Decker 1997; Mauldin et al. 2003), though, as already noted, this impression may be an artifact of the limited preservation of datable charcoal. Thus, as revealed by the data from the five investigated middens at O. H. Ivie Reservoir, the diagnostic projectile points recovered from the middens indicate ages are slightly too considerably older than the ages indicated by the radiocarbon dates (Treece 1992). In the Trans-Pecos region, the annular or ring middens have also been documented to the Late Prehistoric period, 400 to 1,400 B.P. (A.D. 630 and 1559) (Young 1981, 1982; Wiseman 1999). Wiseman (1999) points out that of the 18 dates obtained from middens in the Guadalupe Mountains only three date earlier than 1,450 B.P. (A.D. 500). He also documents one site in Eddy County, New Mexico that radiocarbon dates a 250- to 300-year period of use during the Late Archaic, between 2,900 and 3,100 B.P. (900 and 1,150 B.C.), based on nine charcoal dates that represented the horizontal and vertical breath of the midden.

Only a relatively small percentage of investigated middens have been radiocarbon

dated, and there is a definite need to radiocarbon date many more middens across broad regions of Texas. To highlight this point, well over 200 middens have been excavated in Central Texas (see Howard 1991), but Black and Creel (1997) only employ 141 dates from 35 middens (about 18 percent of those investigated) in their assessment of the age of these features.

To address the length of midden use it is also important to run many radiocarbon dates on each midden to gain a complete understanding of the use period. The dated samples must represent a broad horizontal area of each midden as well the vertical height of the midden to enable one to address this complex accumulation of cultural debris over time. However, the above-mentioned problem of limits to charcoal preservation, and its potential to provide misleading assessments of site/feature ages, must be kept in mind as we continue to attempt to better define the temporal range of Texas burned rock middens.

3.2.1.2 Function of Burned Rock Middens

Profusions of highly fractured rocks at prehistoric archeological sites are primarily the result of localized cooking activities, and probably represent a suite of recurrent human activities. It is still debated if cooking activities are represented only by the remains of earth ovens, or if some middens represent a variety of other types of cooking and discard activities. Even in the more rigorous investigations, the analyses of artifacts and residues generally reveal ambiguous results. Most middens lack the direct botanical remains to indicate one or more specific functions, whereas others provide limited evidence for processing of a variety of resources. Most research in Central Texas has been focused on the small domed middens, and it is conceivable that the very large middens/mounds at places like Fort Hood

represent a variety of other activities. Over the years and across broad parts of Texas, burned-rock midden excavations have yielded different frequencies of cultural debris associated with the burned rocks. Some features have yielded considerable quantities of other material, whereas other features have produced little in the way of other classes of debris. Although differences in midden form and contents have been documented, few researchers have paid serious attention to the likely hood that more than one type of midden probably exists (Peter 1982; Kleinbach 1995). In some instances the lack of camp debris around a midden is indicative of localized processing activity, and some middens document long use-life indicating the resource was available for long periods.

3.2.1.3 Foodstuffs Processed in Burned Rock Middens

A whole variety of foods are thought to have been cooked in the central earth ovens including, but not limited to, sotol, yucca, prickly pear, acorns, seeds, onions, camas, tubers, and animal meat (Wilson 1930; Creel 1986, 1991, 1997; Hines 1994; Dering 1998a; Decker 1997; Black and Creel 1997; Mauldin et al. 2003). However, in most cases, such assumptions are not empirically based, and only in the last 10 to 15 years have some specific plant remains actually been documented from middens. Potential food resources that have recently been documented on a rather consistent basis include eastern camas and onion bulbs. These bulbs have been recovered in direct association with burned rock features that date back to least 8,000 years at the Wilson-Leonard Site (Collins 1998; Dering 1998b) and were being cooked in middens dated to the Late Prehistoric in Bowie County (Mauldin et al. 2003). The postulation that acorns were one of the resources processed in the middens (Creel 1986, 1991) has recently been questioned by Mauldin et al. (2003), who suggests that the few recovered pieces of of

burned acorns may be linked to the oak wood that was employed as fuel wood. In far West Texas, several middens have yielded a range of charred plants including pinyon nutshell, yucca fruit, prickly pear fruit, agave fibers, juniper fruit, and hedgehog cactus spines (*Echinocereus*) (Bohrer 1994). Flotation of matrix from the central cooking features in middens is definitely one of the principal means of recovering charred food remains. However, the older middens may not have good organic preservation; and therefore, there is a need to continue other lines of investigations such as identification of phytoliths, and chemical residue analyses of the rocks and matrix.

3.2.1.4 Burned Rock Midden Formation

Many burned rock middens are documented to have been the result of a central-feature cooking apparatus—postulated as an earth oven. Hypotheses for other types of midden construction—the communal dumps or the intersecting hearth models—are still discussed, but have very little direct empirical support. Apparently most middens formed over relatively long periods of time, but in some cases there were periods of peak use represented in the formation process. The specific processes in construction/formation have not often been studied in great detail and much remains to be learned about the sequences of heating, cooking, and discard of the burned rocks. The annular form of the five investigated middens at Ivie Reservoir narrowed the use of those structures but, with the exception of the midden at 41RN169, no central hearth/pit features were located (Treece 1992; Treece et al. 1993a). Several investigations have identified what are referred to as incipient middens, such as Feature 7 at 41CC167 and 41CN95 (Treece et al. 1993a). With continued use of some annular middens and debris filled the central basins, smaller pits were excavated into the midden

matrix (Treece 1992). Experimental earth-oven and hot-rock have contributed to an understanding of the process and such experimentation will continue to play a role in functional interpretations (Witkind 1977; Bond 1978; Lintz 1989; Stark 1997; Lucas and Frederick 1998; Leach et al. 1998; Jackson 1998; Leach et al. 2001; Stark 2002).

3.2.1.5 Distribution of Burned Rock Middens

Mauldin et al. (2003) documents that burned rock middens are largely confined to the Edwards Plateau and West Texas. The sites in West Texas are in proximity to sotol, yucca, and lechuguilla, and those middens across the Edwards Plateau, in some instances, have been documented for the cooking of geophytes. One recognized high frequency of middens is centered in the Real, Edwards, Val Verde, and Crockett counties (Mauldin et al. 2003). Now that there appears to be some apparent linkage between different foods in different regions, this association requires exploration and documentation to determine if this is real or related to some other phenomenon.

Although the answers have come slowly over the years, recently the more thorough midden investigations and more detailed analyses of midden debris have just began to shed light on these more obvious cultural features. Still, the unanswered questions remain much the same, with some more specific questions added to the list. What was the midden construction process, and is there just one process to account for the types of middens? What is the temporal span of the burned rock middens, and is it the same across Texas? Were there peak periods of use in the past, and, if so, how should this be explained? What are the landscape conditions that cause the placement of burned rock middens within a specific region and across Texas? Are regional differences present in types of middens

and foods cooked in the middens? Can middens be attributed to one specific season of procurement of certain foods? Are the peak periods of use of middens linked to fluctuating resource availability of environmental changes? Is the dominance of Late Prehistoric radiocarbon dates reported by Black and Creel a real reflection of the history of burned-rock midden use intensity, or is it rather merely a bias introduced by preservation factors? If the middens are in fact largely of Late Prehistoric age, how can we account for the profusions of earlier Archaic dart points found therein? How or why do the older dart points get into the Late Prehistoric middens? Do middens reflect only earth oven cooking? What other camp activities may the middens reflect?

3.3 THE EARLY ARCHAIC PERIOD (8,800 TO 5,500 B.P.)

3.3.1 Central Texas

In the Central Texas archeological region, the Early Archaic period is thought to date from ca. 8,800 to 5,500 B.P. (Johnson and Goode 1994; Collins 1995; Table 3-2). The specific beginning and ending dates are still unclear, and these ages may fluctuate as more radiocarbon dates from good contexts are presented. We may expect to see slightly different beginning and ending dates for this cultural period in different parts of Central Texas as archeological assemblages are further reported. Recently published syntheses of Early Archaic period archeology in Central Texas, such as those for the Sleeper (Johnson 1991) and Woodrow-Heard (Decker et al. 2000) sites, provide valuable insights into this culture period and also contain comprehensive summaries of Early Archaic period sites and assemblages in this region.

In broad terms, the Early Archaic period marks the beginning of what archeologists have previously considered a diversification and intensification of hunting and gathering

economy or an adaptation to relatively broad spectrum of resources. This period is considered to represent the transformation from some emphasis on highly mobile, big-game hunting of Paleo-Indian times, toward adaptations involving a more diversified subsistence economy that included more reliance on smaller game and diverse plant resources. This period appears to have seen a reduction in the biomass of large herbivores such as bison (Dillehay 1974). Dart points changed from primarily lanceolate forms to notched and/or stemmed forms.

**Table 3-2. Central Texas Chronology
(from Collins 1995)**

Archeological Periods	Years B.P.	Diagnostic Artifacts
Historic		
Late Prehistoric	-1,000-	Perdiz Scallorn, Edwards
	-2,000-	Darl
Late Archaic	-3,000-	Ensor, Frio, Fairland Marcos, Montell, Castroville Lange, Marshall, Williams Pedernales, Kinney
	-4,000-	Bulverde
		Nolon, Travis
Middle Archaic	-5,000-	Taylor
		Bell, Andice, Calf Creek
	-6,000-	
Early Archaic	-7,000-	Martindale, Uvalde
	-8,000-	Early Split Stem
		Angostura
	-9,000-	St. Mary's Hall
Late Paleoindian	-10,000-	Golondrina, Barber
		Wilson
Early Paleoindian	-11,000-	Dalton, San Patrice, Plainview
		Folsom
	-12,000-	Clovis

Tool assemblages became more diverse, incorporating groundstone tools together with hunting and game-processing tool kits. Cooking technology also appears to have changed, as burned rocks became more prominent in the archeological record, indicating more extensive use of stones to cook foodstuffs. Burned rocks appear in a variety of features, including general scatters, small hearths, large ovens, and midden-like accumulations that become much more prevalent (and larger) over time.

Another significant aspect of this period is the apparent increase in the number and variety of projectile point types. The “diagnostic” points of the Early Archaic period include Angostura, Baker, Bandy, Gower, Hoxie, Jetta, Martindale, Uvalde, and possibly Early Triangular and Bell/Andice. Johnson and Goode (1994) and Collins (1995) presently believe the Early Triangular and Bell/Andice points pertain to the Middle Archaic. However, several factors render the art and science of typology of Early Archaic period points a dubious enterprise, including the limited frequency of any one point type from any one site, the often poor context and mixing of components that yield these point types, the questionable accuracy of some projectile type identifications, and the general lack of supporting radiocarbon dates. Together, these various problems have contributed to our poor understanding of the precise age and chronological sequencing of the point types within this period.

Nevertheless, general trends in certain projectile point types have been recognized. With the complexity of styles and various abilities of individuals to categorize the several projectile types, broad encompassing point categories, such as Early Barbed (Johnson 1964), Early Corner-Notched (Hester 1971), Early Split-stem (Johnson 1991), Contracting Stem (Dial et al. 1998), Expanding Stem (Dial et al. 1998), and Bifurcate Stemmed (Dial et al. 1998), are terms

often used in the literature. Johnson (1964) originally used his Early Barbed construct as a catch-all group, but presently this and other broad categories have become a means of grouping points. Although these terms are useful for observing broad trends in point forms, the use of broad categories may mask cultural patterns that may be discernable in this cultural period based on stylistic variation within and between individual point types. With various statistical tests it may be possible to establish the stylistic variations within and between the broader groupings.

Specific projectile point types are generally considered diagnostic of specific time periods. However, many individually named Early Archaic point types are currently not well dated, and excavations have yielded many different forms from the same stratum or zone. The grouping of named types into broader categories has hindered the determination of specific ages and distribution of the individual forms/types that may contribute to the advancement our understanding of the variations. The process of lumping different types of projectiles into broad categories will not contribute to our understanding of prehistoric population movements, interactions, or behaviors, although it may be easier for some in the presentation of data.

Angostura points are the earliest of the Early Archaic types and have been dated between 7,900 and 8,900 B.P. based on specimens recovered from Woodrow-Heard (Decker et al. 2000), Richard Beene (Thoms 1992), and Armstrong (Schroeder and Oksanen 2002). Previously, some researchers have considered the Angostura point to be part of the Late Paleoindian sequence based on its lanceolate form (e.g., Johnson 1991, 1994). Angostura points occur stratigraphically below most of the other named points in Early Archaic sites. At the well-stratified Richard Beene Site, charcoal

associated with Angostura points was dated to $8,805 \pm 75$ B.P. in the Perez paleosol that dated between about 9,600 and 9,800 B.P. (Thoms 1992). At the Armstrong Site (41CW54), an Angostura point was found in Occupation Zone 4 with a Hoxie point, a Golondrina point, and three charcoal dates averaging about 8,100 B.P. (Schroeder and Oksanen 2002). The fact that three different point types, one of which is a stemmed type, were recovered in a single, thin stratum may indicate that time period around 8,000 B.P. was transitional between the lanceolate and stemmed projectile points. Although many of the Early Archaic points from the latter portions of the Early Archaic sequence are not well dated, some site contexts and stratigraphic positions provide an indication as to which types occurred earlier than other types and provide general chronological context.

Above the well-dated and sealed Angostura component in the Upper Perez Paleosol at the Richard Beene Site lie several Early Archaic occupations beginning with a $6,930 \pm 665$ B.P. (Beta-47525) date associated with stemmed, indented-base points (Gower-like [Thoms et al. 1996]). An estimated age of 5,500 B.P. for a hearth buried in the Median Paleosol, which yielded a soil humate date of $6,450 \pm 135$ B.P., was believed to be the youngest of the Early Archaic materials at the Richard Beene Site (Thoms 1992).

Gower and Martindale points, as well as other split-stem types, occur primarily below Bell points at the Cibolo Crossing and Landslide sites (Figure 3-2). Two complete Martindale and one broken Bandy point occurred in a sealed component at Cibolo Crossing that lacked acceptable radiocarbon dates, but which was separate and below the Bell/Andice component that was dated to 4,400 B.P. (Kibler and Scott 2000). The Martindale component at Cibolo Crossing yielded three end-/side- scrapers, one biface, seven edge-modified flakes, 385 pieces

Figure 3-2. Selected Early Archaic Sites Near Varga Site

of unmodified debitage, one ground/battered stone tool (possible mano), one bone fragment, one freshwater mussel shell fragment, and five burned rock features. Intact Feature 26 was a slab-lined, basin-shaped hearth. Kibler and Scott (2000) interpret this component, as a short-term camp where production of tools—primarily bifaces—was a major activity.

Bifaces were reduced from fully corticated Edwards chert cobbles using a hard hammer percussion tool along with limited soft hammer or billet work.

At Eckols (41TV528), a mixed Martindale and Bell zone was above an Early Split-Stem component (Karbula 2000). The Bering Sinkhole yielded two Martindale points and one Uvalde point that were generally associated with three charcoal dates of $5,840 \pm 190$ (Tx-6282),

$6,660 \pm 110$ (Tx-6831), and $6,860 \pm 170$ B.P. (Tx-6526, Bement 1994). The two points labeled as Martindale were stratigraphically below the single Uvalde point. However, these two tentatively identified Martindale points have attributes that more closely resemble Early Corner-Notched forms that have not yet been named.

An Uvalde point was associated with a charcoal date of $7,260 \pm 90$ B.P. (Tx-7050) at Turkey Bend Ranch (Treece et al. 1993a). If the Early Split-Stem points from the Sleeper Site are primarily Uvalde/Gower forms, they appear before the Bell/Andice/Calf Creek series, but absolute dates are lacking from the Sleeper Site. The Gower point was first recognized at the Youngsport Site in Bell County (Shafer 1963). A total of 14 specimens from the lowest stratum (Stratum 8) revealed some morphological

variations. The points were described as crudely made, with indented bases; short, parallel-edged stems; and markedly concave bases apparently made by the removal of a single flake (Shafer 1963). These points were stratigraphically below point forms such as Bulverde, Nolan, Wells, and Uvalde, and are morphologically similar to Uvalde and Hoxie forms. Radiocarbon dates associated with the Gower form are lacking. Fourteen Gower points were recovered from the Wilson-Leonard Site and potentially were associated with the latter part of the Early Archaic period (Dial et al. 1998). However, over the years since the formulation of the Gower type, the identification of Gower points appears to have maintained little consistency, making it difficult to place these in a specific timeframe. Ricklis and Collins (1994) observed a technological difference between the earlier Uvalde/Martindale points and the later Bell/Andice/Calf Creek forms, indicating a definite break in the styles.

At Wilson-Leonard, the Hoxie points appear earlier than the Bandy and Martindale points. Apparently, the wide, relatively thick, straight-stemmed, bifurcate points are earlier than the expanding-stemmed bifurcates (Kerr and Dial 1998). This is also supported at the Armstrong Site, where Hoxie points were recovered above Barber and St. Mary's Hall points that were radiocarbon dated to 8,560 to 8,720 B.P. (Schroeder and Oksanen 2002). However, the Hoxie points were associated with Golondrina and Angostura points in Occupation Zones 2, 3, and 4, which were dated between 8,490 and 6,780 B.P.

The Merrell point, which was defined by Prewitt (1985), is rare in the literature as it is not referenced in Prewitt's 1981 chronology; however, it appears in Prewitt's (1995) article. Five similar dart points occur in a stratum referred to as Merrell 3 (Upper Gravel) together in mixed alluvial contexts with a variety of

Archaic point styles at the Merrell Site in Williamson County (Campbell 1948). This gravel deposit apparently was a high-energy alluvial deposit and may contain redeposited and/or mixed cultural materials. Although not specifically defined in the Merrell Site report, this projectile point form exhibits U-shaped side notches and an expanding stem that has large, rounded ears and a deep, U-shaped notch along the basal edge. Prewitt (1995) reveals a high concentration of Merrell points in Val Verde County in the Lower Pecos region and a few points scattered over six other Central Texas counties. The Merrell point also appears in a list of Middle Archaic point styles in Johnson and Goode (1994:27). However, Johnson and Goode (1994) acknowledge that this type may date to either the Early or Middle Archaic periods (Johnson 1995:88). The Merrell point is not well known, is poorly described, and has not been securely dated. Much remains to be learned about this type.

Confusion in the Early Archaic point identification system stems from a variety of contributing factors, including, but not limited to, limited frequencies of projectiles from many investigated sites, poor or limited understanding of their contexts, limited radiocarbon dates associated with individual types, difficulties in identifying types because of reworking of many specimens, poor or limited type definitions in the literature, and subjectivity by individuals classifying projectile points. In trying to deal with these problems at Wilson-Leonard, Kerr and Dial (1998) employed more rigorous analytical methods to investigate the complexity and to help sort out the confusion over these many Early Archaic point types. A total of 102 projectiles was subjected to cluster and discriminate function analyses, which resulted in the identification of 11 major morphological clusters or groups. These statistical analyses of Early Bifurcated Stem projectiles at Wilson-Leonard exhibited several distinct clusters

exhibiting varying degrees of similarity. Although many of the identified clusters contained several different point types, some clusters yielded tight groupings. The Bandy type formed a highly discrete cluster (Cluster 1) based on thinness and short, slightly too moderately expanding and thin stems. The Martindale points also formed a relatively distinct group (Cluster 2) that exhibited relatively thin, expanding stems with a low arcuate to V-shaped base. Cluster 4 contained the traditional Hoxie and Gower forms that exhibited slightly expanding stems of medium length and general thinness. However, Cluster 5 also contained some Gower-type points along with Uvalde points. Members of Cluster 6 revealed similar outlines and dimensions but included diverse types such as Baker, Uvalde, and Gower points. Cluster 11, distinguished by its large size appears to correlate with the Jetta type. Other clusters generally contained points that belonged to more than one morphological type. In the end, the analyses indicated that there is considerable variation in the Early Archaic stemmed points, which grade morphologically from one type to another (Kerr and Dial 1998). The Bandy and Jetta types were the most morphologically distinctive, followed by the Martindale and Hoxie types.

In addition to the projectile points, other items commonly found in Early Archaic period tool assemblages include various bifaces, end- and side-scrappers, Guadalupe tools, gouges, grinding implements such as manos and metates, drills, flake tools, burins and burins spalls, and edge-modified flakes. Clear Fork tools/gouges were once thought to be indicative of specialized use, that of wood working (Hester et al. 1973; Howard 1973), but recent high-powered micro-wear studies indicate that Clear Fork tools had different functions, including woodworking, defleshing, and scraping (Hudler 1997; Church 2000; Hardy 2002). Some sites have gouges (e.g., Wilson-Leonard), whereas other sites lack

this tool (e.g., Sleeper). This differential occurrence pattern may indicate that different tasks were performed at different sites using the same tool form. Guadalupe tools are also thought to reflect primarily woodworking and “percussive cutting tools” (Brown 1985). Grinding implements are also quite frequent at a few sites (i.e., 47 metate fragments and 70 manos at the Sleeper Site), but are not present at other sites (i.e., Camp Pearl Wheat), which may again indicate task-restricted sites/components and/or different exploitative strategies. An engraved pebble was recovered in Early Archaic context at the Turkey Bend Ranch Site (Lintz et al. 1995) and probably was a non-utilitarian object. If so, this object implies the users had time for some kind(s) of non-technoeconomic activities.

Chipped stone debitage is frequent at many of the Early Archaic sites, but is often not discussed beyond the mention of its presence. Sometimes this class of material is sorted into billet and hammerstone flakes and divided into size categories (Johnson 1991). Burned debitage has also been recognized at several sites (i.e., the Sleeper Site). Unprepared cores, the near absence of blades and broad bifaces, reflect the general tool reduction strategy. Small blades were recovered at the Sleeper Site.

Human remains are scarce with the exception of what has been recovered from sinkholes such as the Bering sinkhole (Bement 1991, 1994) in Kerr County, which provides the best-documented evidence of human disposal patterns. Apparently 20 bodies, one bundle, two cremations and 17 others, were dropped or lowered into these sinkholes as their final resting place during a period from 5,100 to 7,100 B.P. The caries rate per person is a relatively low (0.69) for this San Geronimo phase (Bement 1994:93). The low ratio is indicative of a diet relatively low in carbohydrates. The stable carbon isotope analyses of the individuals from

Bering Sinkhole indicate that diet consisted of 54 percent C₃ and 46 percent CAM/C₄ foodstuffs. Although a sizeable cemetery dating to between 7,300 and 6,300 B.P. (calibrated) has recently been reported at the Buckeye Knoll Site (41VT98) on the central coastal plain of Texas (Ricklis 2007), Early Archaic cemeteries are as yet unreported in the Central Texas region.

Direct subsistence data is sparse because preservation of organic materials is poor in most Early Archaic components. In 1981 Prewitt suggested that hunting and gathering occurred with an emphasis on gathering for the period between about 6,000 and 5,000 B.P. The recovered data provides a very skewed picture of past resource-utilization patterns. When bone has been preserved and recovered from an early occupation zone, some researchers have failed to address the potential for incorporation of natural species into archeological deposits. Deer, various small animals, and fish are all indicated as probable resources (Collins 1995). Mussel and snail shells are common in many components such as the Landslide Site (Sorrow et al. 1967), and Sleeper Site (Johnson 1991). Deer and turtle bones were present in stratigraphic association with the Martindale and Uvalde points at the Bering Sinkhole (Bement 1994:82) and deer elements dominated in the lowest levels associated with 11 Uvalde/Martindale points at Panther Springs (Black and McGraw 1985). Burned taxa at the Wilson-Leonard Site include turtle, rabbit, carnivore, and deer/antelope (Collins et al. 1998). Analyses of organic residues in burned rocks from Camp Pearl Wheat indicate that plant, as well as animal products, were processed during this period (Collins et al. 1990). At least 10 charred wild hyacinth bulbs from a burned rock oven (Feature 181) in the Early Archaic strata at the Wilson-Leonard Site were dated to 7,870 to 8,420 B.P. (Collins et al. 1998). The Angostura component at Richard Beene Site, just south of the southern edge of the

Edwards Plateau, yielded a charred sotol or yucca leaf bases that dated to 8,000 B.P. (Thoms et al. 1996). Although not radiocarbon dated, the Early Archaic Sleeper Site did yield two mano caches that would imply that plant processing was an activity pursued at that site. Apparently, the subsistence base was very broad, and peoples exploited diverse river and land resources. In northwest Texas at the Lubbock Lake Site, during at least one Early Archaic event radiocarbon dated between 8,400 and 6,500 B.P. a minimum of three bison were processed (E. Johnson 1987). That discovery indicates that bison were in at least parts of Texas at that time and potentially in Central Texas as well.

The discovery of large cooking features, burned rock hearths or ovens at many sites (i.e., Sleeper, Richard Beene, Wilson-Leonard, Woodrow Heard; and Cibolo Crossing) indicate that large quantities of plant foods were cooked. Small basin hearths such as those at Sleeper Site, Barton Creek, and 41TG307 may reflect different cooking processes for different types of foods. The “baking heaps” at the Sleeper Site are said to have been mostly one stone thick, generally elongated, lacking organic stains, with flat bottoms (Johnson 1991:49), and attributes seemingly not indicating use as ovens. The three cooking hearths at the Sleeper Site are smaller than the “baking heaps”, lined with flat slabs, and slightly basin shaped (Johnson 1991:51). Large burned rock mounds or middens have not been recognized during this time in Central Texas.

At the Turkey Bend Site along the Colorado River, a 5.8-by-5.4 m circular rock structure was charcoal dated to 7,500 B.P. and contained a large, 3.1-by-2.7 m, and 33 cm thick, rock hearth like feature that encompassed most of the structure’s interior space (Treece et al. 1993a; Lintz et al. 1995). The function of this internal feature is unknown, but the central rock mass

was probably a plant cooking feature. Feature 22 at Cibolo Crossing, a large 200 x 380 cm flat concentration of burned rocks contained 24 pieces of lithic debitage, and 700 *Rabdotus* shells, but that lacked charcoal staining, was interpreted to have been used in cooking *Rabdotus* snails (Kibler and Scott 2000). Collins (1995) sees this as a period of specialized cooking appliances, which he suggests were antecedents of the larger burned rock middens.

Some researchers have postulated broad regional distributions of Early Archaic sites and materials. Many artifact forms from this period appear widely distributed across much of Texas. For example, Gower and Gower-like points and Guadalupe tools have been recovered from central and southwestern parts of Texas (McKinney 1981), as well as from the central Coastal Plain. Weir (1976) postulated that population density was low in Central Texas and reflects small nomadic bands. In comparison to the previous Late Paleoindian period, group mobility appears to have lessened. Subsistence patterns appear to have become more diversified to include deer and a range of unspecified plants. Using optimal foraging theory, Kibler and Scott (2000) suggest that Early Archaic site distribution at Camp Bullis revolved around subsistence activities, with the locations of Early Archaic sites with Martindale points concentrated in and along the fringes of the Balcones Canyonlands reflecting a generalized foraging pattern. This is similar to the distributional pattern observed by McKinney (1981) for Gower points.

McKinney's (1981) findings revealed that many known Early Archaic sites appear concentrated along the southern edge of the Edwards Plateau. It was thought that this concentration might be linked to the greater abundance of resources, including water, at a time when the climate was somewhat dryer. In 1991, Johnson reviewed and

discussed 11 important excavated Early Archaic sites that were distributed from the eastern edge of the Edwards Plateau around the Austin area, westward across the Edwards Plateau to include the Lower Pecos region. The distribution of sites form a crescent-shaped pattern along an east-west section through Central Texas. This distribution may be more a reflection of where sites have been investigated, more than it represents an actual distribution of Early Archaic population and land-use patterns. The two extreme ends of this Johnson's crescent are currently in two different archeological regions, the Central Texas and Lower Pecos regions. The Varga Site falls within the crescent-shaped area toward the western side of the Central Texas archeological region.

3.3.2 Lower Pecos

The Lower Pecos is a more restricted geographical region at the extreme southwestern end of the Edwards Plateau that encompasses primarily the southern part of Val Verde County. Three large rivers dissect this area and have created very large caves and rock shelters and deep terraces along streams. Archeological excavations have focused largely on the rock shelters (i.e., Arenosa Shelter, Baker Cave, Bonfire Shelter, Hinds Cave, and Skyline Shelter) and one of the deeply stratified sites (i.e., Devil's Mouth). The shelters have yielded excellent preservation of perishable goods and extraordinary rock art, but often lacked well-defined sealed strata containing a single type of diagnostic projectile with clearly associated cultural assemblages. Various natural and human disturbances have often mixed cultural materials in these settings. Also some investigated sites have not been fully analyzed and detailed reports still remain to be published. Time-period terminology has changed over the years, complicating communication efforts. Projectile point identification has also contributed difficulties as different researchers

have typed some point styles differently than have others, when referring to the same morphological type. This region has been discussed and summarized as a separate and distinct archeological region (Turpin 1984a, 1991, 1995; Shafer 1986; Bement 1989). Although the cultural historical sequence has been developed, it is still in need of good supporting radiocarbon dates from good contexts, fully analyzed cultural assemblages, and well-described diagnostic artifacts.

Based on the results of 268 radiocarbon dates from archeological sites in or adjacent to the Lower Pecos region, it appears humans continually occupied this region throughout prehistory without hiatus (Table 3-3). The following overview focuses on what is known about the Early Archaic material remains and relies heavily on the more recent summaries for the region (Turpin 1991, 1995).

The Early Archaic has been most recently labeled the Viejo Period, which encompasses a long span of 3,400 years between 8,900 and 5,500 B.P., based on 29 radiocarbon dates from seven sites (Turpin 1991, 1995). This time frame is roughly similar to that identified for Central Texas. Although these 29 dates appear to provide a good foundation to build upon, “only six of the core dates for this period are from levels or features that are clearly and solely associated with Early Archaic index fossil” (time-diagnostic points) (Turpin 1991:27). Projectile point styles identified for this period include Early Barbed, Early Stemmed, and Early Corner-Notched. The Early Barbed category often includes Baker and Bandy types, which are sometimes confused with each other, Uvalde types, and Martindale types. A wide variety of other types also occurs. Most point forms are not well-defined, were recovered from poor stratigraphic context, and have a limited number associated radiocarbon dates. The named projectile points are often not dated to a specific

**Table 3-3. Lower Pecos Chronology
(from Turpin 1991)**

Time Units	Years B.P.	Named Periods	Diagnostic Artifacts
Protohistoric		Infierno	Stemmed Arrow Points Plain Brown Ceramics
Late Prehistoric	-1,000-	Flecha	Arrow Points
Late Archaic	-2,000-	Blue Hill Flanders	Ensor, Frio Shumla
	-3,000-	Cibola	Marshall, Montell, Castroville, Marcos
	-4,000-	San Felipe	Lantry, Val Verde, Almagre
Middle Archaic	-5,000-	Eagle Nest	Pandale
	-6,000-		
Early Archaic	-7,000-	Viejo	Early Corner-Notched Early Stemmed (Barker, Uvalde + Others) Early Barbed (Bandy + Others)
	-8,000-		
	-9,000-	Oriente	Golondrina
	-10,000-	Bonfire	Folsom, Plainview
	-11,000-	??	??
Paleoindian	-12,000-		
	-13,000-	Aurora	Clovis
	-14,000-		

time period, but are bracketed by broader time frames. Hinds Cave is the exception with 24 radiocarbon dates, but the associated artifact assemblages that include Bandy and Early Barbed points have not been fully described or published.

Early on, Collins (1976) reviewed the Bandy point type in the Lower Pecos and found this type fell consistently between 5,000 and

5,500 B.P. At Skyline Shelter, an Early Archaic component yielded 14 triangular dart points from levels 23 through 27. These unnotched forms have been named Devils Triangular and dated by charcoal from an adjacent hearth to at least $5,210 \pm 70$ B.P. (Tx-6878) (Turpin and Bement 1992). However, levels 23 through 28 also yielded six Bandy/Martindale, four Baker/Uvalde, three Gower, one Early Barbed, two Golondrina, and five untyped projectile points. A charcoal date from a 30 cm-deep pit originating in level 28 yielded a date of $5,920 \pm 120$ B.P. (Tx-6947). Level 28 lacks Devils Triangular points, but yielded three Bandy/Martindale, one Barker/Uvalde, and one Gower point. The dated charcoal appears to be from good context, but it is unclear of the relationship of the different point types throughout the 50 cm thick deposit. Often the Bandy/Martindale reference is used without specific reference to one or the other point types, because there has been some disagreement over how these similar types were identified and how researchers apply the various definitions. As recently as 1993, archeologists were still disagreeing on classification of these two point types when McReynolds (1993) made an effort to clarify what he thought were Bandy point variations by illustrating 24 specimens.

At Bonfire Shelter an apparent living surface yielded a corner-notched point (not depicted) directly associated with a charcoal date of $7,240 \pm 220$ B.P. (Tx-152) from Hearth 2 in the Intermediate Horizon (Dibble and Lorrain 1968). The date was stratigraphically situated above older charcoal dates and below younger charcoal dates in well-stratified context. This so-called corner-notched point has a relatively long, and slightly expanding stem with a shallow concave base and a reworked blade. It is considerably different from the Bandy, Martindale, and Baker points, being most similar to the Uvalde type.

In Seminole Sink, a single Early Corner-Notched point (unlike the Bandy and Martindale points) was recovered from the very base of the cultural matrix directly associated with human burials (Turpin 1988). Three human bone dates were believed associated with this corner-notched point, and they are $4,671 \pm 64$ B.P. (AA-1314), $5,590 \pm 180$ B.P. (AA-1313), to $5,750 \pm 140$ B.P. (AA-1315) (Turpin 1988). Two corner-notched points referred to as Martindale points by Bement (1994) were recovered from the lower levels of Bering Sinkhole (Levels 36 and 39 in Unit III) with a charcoal date of $5,840 \pm 190$ B.P. (Tx-6282) from Level 37 and two charcoal dates of $6,660 \pm 110$ B.P. (Tx-6831) and $6,860 \pm 170$ B.P. (Tx-6526) from Level 40.

At Wroe Ranch Rockshelter, three Martindale points (one illustrated specimen appears to be a Bandy point) were from the lower levels. At least one Martindale point was recovered from Feature 21, which yielded two radiocarbon dates, one of $5,730 \pm 70$ B.P. (TX-9180) and $6,400 \pm 180$ B.P. (Tx-9104) on prickly pear pads (Turpin 1998). Early Barbed and Bandy points are said to have come from Analytical Unit 7 at Hinds Cave, dated by 11 radiocarbon dates to between $8,490 \pm 130$ B.P. (Tx-2734) and $6,750 \pm 100$ B.P. (Tx-2316). The earlier date potentially came from mixed context. However, a date of $7,470 \pm 120$ B.P. (Tx-2738) was definitely associated with Bandy points (Valastro et al. 1979:267). Analytical Unit 6 also yielded Bandy points, which were radiocarbon dated on charcoal by three samples to between $6,540 \pm 70$ B.P. (Tx-2744) and $6,160 \pm 80$ B.P. (Tx-2735) (Lord 1984; Turpin 1991).

The Eagle Cave deposits yielded a variety of projectiles including Early Barbed, bifurcated base, in Stratum IV and V associated with six radiocarbon dates ranging from $6,060 \pm 120$ B.P. (Tx-139) in Stratum IV to $8,760 \pm 150$ B.P. in

Stratum V (Tx-107; Turpin 1991). These examples reveal the broad structure of the chronology for Early Archaic point styles in the Lower Pecos region. However, the limited data and questionable context do not provide specific linkages between individual point types and radiocarbon dates.

Prewitt (1995:91) reveals that the distribution of Bandy points is restricted to seven counties. Bandy points are most frequent from Val Verde County, but specimens also come from counties within the Edwards Plateau and in the northern part of South Texas. Martindale points have been recovered from the same counties as the Bandy points, but show a much broader distribution (41 counties) and are much more numerous (Prewitt 1995:117). The Devils Triangular points are similar to the Taylor and Baird/Early Triangular points in Central Texas and appear at about the same time period. These unnotched forms occur over a very broad region of central and south Texas, the Lower Pecos, and beyond (Prewitt 1995:91). Baker points are very restricted in distribution to just two counties, one is Central Texas, and the other is Val Verde County, where there is a high concentration (Prewitt 1995:91). Uvalde points are widely distributed across central and part of South Texas with some in the Lower Pecos and Trans-Pecos regions. The highest concentrations appear in Val Verde and Williamson counties (Prewitt 1995:91). Confusions with the identifications of the Baker and Uvalde points make it unclear if Prewitt's distributions reflect reality.

Other than the projectile points, a diverse stone tool assemblage is also represented. Tools including biface preforms, finished knives, Guadalupe bifaces, large flake scrapers, various end- and side- scrapers, edge-modified flakes, spokeshaves, drills, gravers, hammerstones, burin spalls, cores, scratched cobbles, and a grooved stone ball are attributed to the Early

Archaic period. One Guadalupe biface from Skyline Shelter appeared to be associated with the Devils Triangular points, and possibly Bandy/Martindale and Baker/Uvalde points and was dated to about 5,200 B.P. (Turpin and Bement 1992). Under 160X magnification, this tool exhibited polish that resembles polish produced by working wood or other plant substances (Turpin and Bement 1992). Guadalupe bifaces seem to be more frequent in the Central Texas region and date to about the same time.

Collins (1974) has determined that at Arenosa Shelter, chert river cobbles were the primary source of tool stone. These were reduced by direct percussion, as used in much of the tool making process. He also determined that heat-treating of the raw material was uncommon. Projectile points were thinned by soft hammer percussion technique, which produced bifaces with bi-convex cross sections. Some bifaces exhibit further modification of edges through beveling (Collins 1974).

Early Archaic human remains are very sparse and generally found in vertical shaft sinkholes or dry rock shelters (Turpin 1991). A population of 21 individuals from Seminole Sink provides the best information on mortuary practices and biological conditions (Turpin 1988). Non-perishable remains were extremely rare with these bodies, but it is possible that perishable items were included, although this cannot be demonstrated. The three most acceptable radiocarbon dates for this population were obtained on human petrous bones recovered in the lower stratum and are $4,671 \pm 64$ B.P. (AA-1314), $5,590 \pm 180$ B.P. (AA-1313), and $5,750 \pm 140$ B.P. (AA-1315). The individuals were apparently quite healthy, as they lacked evidence of any serious debilities (Marks et al. 1988). The caries rate is a high 1.8 per person for the 10 Early Archaic bodies (Marks et al. 1988). The high rate is attributed to the

consumption of carbohydrate-rich desert succulents. Based on stable carbon isotope analyses, this population exhibits a heavy dietary reliance on C_4 /CAM vegetation; largely desert succulents such as prickly pear cactus, agave, and sotol (Turpin 1988:120). The dental pathologies from the Early Archaic through Late Archaic times in the Lower Pecos have demonstrated stability in the diet that reflects adaptation to xeric biota (Turpin 1988:120). Turpin (1988) suggests that the population, an egalitarian society, using Seminole Sink lived in the region year round as supported by the individuals that were interred having died at different times of the year.

This long Early Archaic time period exhibits a broad resource base. Coprolites from Zone 17, Level 6 in Baker Cave that dated to $8,080 \pm 80$ B.P. (Tx-2931) and associated with Early Triangular points (Turpin 1991) revealed various consumed resources. The more significant foods include: onion, persimmon, walnuts, fish, rodents, and a dominance of prickly pear (Stock 1983 cited in Sobolik 1991a). The 100 coprolites analyzed from Lens 13 at Hinds Cave, dating to between $5,590 \pm 80$ B.P. (Tx-2458) and $5,710 \pm 80$ B.P. (Tx-2459), reveal consumption of desert plants and animals such as rodents, rabbits, birds, reptiles, fish, prickly pear, walnuts, onion bulbs, lechuguilla, sotol, persimmon, and other species (Williams-Dean 1978). General plant identification for a period around 8,500 B.P. also documents the use of many of these same resources (Dering 1977). Large herbivores such as deer were present, but in Analytical Unit 7 at Hinds Cave, large herbivore remains only account for about 1.6 percent of the faunal remains, whereas the rodent material accounts for 58.2 percent of the faunal assemblage (Lord 1984). Baker Cave also yielded a variety of edible foods including mescal beans, pecans, walnuts, and acorns together with netting, matting, cordage, wooden dart shafts and

foreshafts (Word and Douglas 1970). The excellent preservation of perishable remains has allowed for a chronology of the changing forms of basketry and matting through time. At Wroe Ranch, a grass nest (Feature 11) and a fiber nest (Feature 21) were radiocarbon dated to $5,410 \pm 50$ B.P. (Tx-9181) and $5,730 \pm 70$ B.P. (Tx-9180), respectively. These nests contained grass, prickly pear pads, sotol leaves, walnut, mesquite, matting, and a sandal (Turpin 1998). The data indicates a very broad, diverse resource base that included both plants and animals for the Early Archaic period with an intense focus on prickly pear.

A burned rock midden, a prickly pear floor, and latrines that contained many coprolites recognized at Hinds Cave (Lord 1984; Williams-Dean 1978) indicate specific activity areas were in use. The Hinds Cave burned rock midden was about one meter thick with no obvious central pit, yielded massive charcoal deposits together with charred bases of lechuguilla remains, quids of lechuguilla and sotol, and cut leaf bases on the western edge, and was in Analytical Unit 6. The midden was radiocarbon dated to between $6,540 \pm 70$ B.P. (Tx-2744) and $6,160 \pm 80$ B.P. (Tx-2735) and apparently associated with Bandy points (Shafer and Bryant 1977; Lord 1984; Turpin 1991). This may be one of the earliest dated burned rock middens. Lechuguilla and sotol probably were the main plants cooked with the burned rocks in the midden. Also Hinds Cave yielded a pit lined with a large checkered-woven tray of unsplit sotol leaves (Shafer and Bryant 1977). Small burned rock concentrations and hearths have also been identified at sites dating to this period. Further west in Terrell County, the Wroe Ranch Site yielded a grass and prickly pear pad basin about 70 cm in diameter and a nearly 50 cm diameter basin lined with grass (Feature 21) accompanied by a sandal, matting, sotol stake, and leaves, with a Martindale point nearby. Feature 21 was radiocarbon dated by two

samples that yielded dates of $5,730 \pm 70$ B.P. (Tx-9180) on sotol stalks and $6,400 \pm 180$ B.P. (Tx-9104) on prickly pear pads (Turpin 1998).

Mobile art in the form of painted pebbles and unbaked or poorly fired clay figurines (Dibble 1967; Shafer and Speck 1974; Shafer 1975; Shafer and Bryant 1977) are attributed to the Archaic in general and were potentially initiated at this time (Turpin 1995). Painted pebbles were recovered from early contexts at Arenosa Shelter, Hinds Cave, and Eagle Cave. A proposed chronology on painted pebbles has been also presented (Parsons 1986; Mock 1987). The clay figurines are quite rare, and limited information is available concerning them. How these non-utilitarian items were intergraded into the societies is unknown, but their presence indicates human activities extended beyond the constant pursuit of subsistence.

The Viejo period comes to an end with the appearance of Pandale points, the index marker for the Eagle Nest period of the Middle Archaic. This distinct beveled point has regionally restricted distribution, and is prominent in Val Verde and adjacent counties. The Middle Archaic period begins possibly around 6,100 B.P. or more likely around 5,500 B.P. (Turpin 1991:28, 1995). Pandale points were recovered from Stratum 32 in Arenosa Shelter, which yielded a radiocarbon date of $5,360 \pm 170$ B.P. (Tx-313, Johnson 1991). However, Dibble (1967) reports Pandale points at Arenosa Shelter from Strata 21 through 30 during a period from ca. 4,000 to 5,300 B.P. This is about the time period that the Bell/Andice points appear in Central Texas and other parts of the state.

3.4 THE MIDDLE ARCHAIC PERIOD (CA. 6,000 TO 4,000 B.P.)

3.4.1 Central Texas

Johnson and Goode (1994) present a tentative revision of the cultural Archaic for the eastern parts of the Edwards Plateau from that diverges from chronologies previously presented by Weir (1967) and Prewitt (1981a, 1985). A significant change comes with the reassignment of certain of Prewitt's Early Archaic point types, including Bell/Andice, Baird, and Taylor triangular points to the Middle Archaic and Middle Archaic types, such as Bulverde, Pedernales, Marshall, and Williams, to the Late Archaic period. This may confuse many readers as much of the current literature refers to these points according to Prewitt's chronology. Although still using the terms Early, Middle, and Late for divisions within the Archaic, Johnson and Goode (1994) attempt to link the revised periods together based on broad patterns of human behavior. Johnson and Goode (1994) propose a period of about 1,300 years from about 5,600 to 4,300 B.P. for the Middle Archaic.

Johnson and Goode (1994) see the Bell/Calf Creek dart points as dominant at the beginning of the Middle Archaic period at ca. 5,600 B.P. and correlate these points with bison hunting. The bison occurrence at this time is best demonstrated at the Landslide Site (41BL85), where a bison bone was found in apparent association with one Calf Creek/Bell point (Sorrow et al. 1967). A second possible association was at Cervenka Site (41WM267) that also yielded several bison bones scattered around a small, shallow basin hearth, Feature 26, estimated to fall into a time period between 6,000 and 5,000 B.P. (Peter et al. 1982b).

At Cibolo Crossing (41BX377), the 16.8 m³ Bell component contained nine Bell points, one Andice point, and two Baird triangular bifaces, and was radiocarbon dated to 4,400 B.P., based

on the average of three charcoal dates from Feature 19 (Kibler and Scott 2000). The Bell-Andice component yielded 13 dart points, 13 bifacial tools, three end-/side- scrapers, one side-scraper, one end-scraper, one cobble chopper, two multidirectional cores, 19 edge-modified flakes, 897 pieces of unmodified debitage, 41 bone fragments of which 17 percent are burned, one freshwater mussel shell, a piece of hematite, 12 burned rock features, and 715 kg of burned rocks. One point labeled as Bell (Kibler and Scott 2000; Figure 28, g) resembles Early Corner-Notched points. The variety of burned rock features indicates plant and possible meat cooking activities, activities associated with a variety of stone tools. Kibler and Scott (2000) suggest this area was used as base camp. At the Granberg II Site (41BX271), a Bell point was dated to $4,770 \pm 110$ B.P. (uncorrected, Tx-3606 [Black and McGraw 1985]). A Bell component at the Richard Beene Site has been dated to ca. 4,500 B.P. (Thoms et al. 1996:15-16). Beyond the Central Texas archeological region, a Bell point was dated between 5,900 and 5,300 B.P. (calibrated) based on radiocarbon assays on associated *Rangia flexuosa* shells at the McKinzie Site (Zone 3) in Nueces County along the coast (Ricklis 1988, 1993:49). At the Royal Coachman Site (41CM111), three Bell/Andice points were recovered from excavation levels that also contained nine Early Triangular, five Pandale, and five Nolan points with five charcoal dates ranging in age from about 5,000 to 4,700 B.P. (Mahoney et al. 2002).

Later in this period Johnson and Goode (1994) see the occurrence of Early Triangular, La Jita, Travis, and Nolan points, and possibly the appearance of Merrill points. The Nolan and Travis points become the dominant type in the latter part of the Middle Archaic (Johnson and Goode 1994). Although not well documented, Johnson and Goode believe that the Nolan and Travis points date to no earlier than about 5,000 B.P. Goode believes the La Jita and the

Travis points are of the same age, as they share specific manufacturing features (Johnson and Goode 1994:27).

Variations in the terms used to refer to unnotched triangular point forms recovered across broad regions of Texas have caused typological problems. Much remains to be learned about the relationships of these various unnotched forms, their function, and their ages. Use and impact wear on Early Triangular specimens from the Royal Coachman Site show these tools functioned as both projectile points and knives (Shafer and Tomka 2003). In South Texas, the triangular Tortugas points have also revealed multifunctional wear patterns (Church 2000; Hardy 2002). In at least two instances, narrow triangular Tortugas points revealed use-wear on the straight proximal end, whereas the pointed distal end revealed abraded ridges and striations that indicate the half location (Hardy 2002). It has also been suggested that Tortugas points have important adaptive advantages with their wider blades allowing for more numerous resharpenings, and the triangular form may be more resistant to impact failure (Mahoney et al. 2002).

In earlier research, Prewitt (1981a, 1985) placed the Baird (a beveled triangular form) and Taylor (non-beveled triangular form) types between about 5,100 and 4,600 B.P. Turner and Hester (1993) place the Early Triangular within the Early Archaic period, dating roughly between 8,000 and 4,500 B.P. In Central Texas, the triangular Taylor and Baird points are presently considered Middle Archaic, dating from roughly 5,500 to 4,000 B.P. (Johnson and Goode 1994; Collins 1995; Mahoney et al. 2002). Mahoney et al. (2002) believe that the Royal Coachman Site yielded one of the more securely dated Early Triangular components in Texas with five of six radiocarbon assays from wood charcoal returning one-sigma dates ranging from 5,600 to 5,460 B.P. These ages appear earlier than most

known ages, but it may be that these styles have a long use period that is contributing to the difficulty in trying to narrow down the time frame in which these they were used. Goode (2002) interprets Triangular bifaces, specifically specimens referred to Kinney bifaces—Groups 1 through 4, as a series of bifaces that were used and repeatedly resharpened, and reused. He indicates that there is no wear on the bases to indicate hafting, although he also indicates that there is minor smoothing of the flake scar ridges on some specimens. Some Kinney bifaces resemble the points Quigg et al. (2002a) labeled Anton/Tortugas from the Boiler Site in South Texas. As discussed under the Bell/Andice/Calf Creek point series, some Early Triangular points appear in the same stratigraphic zones as some Bell/Andice/Calf Creek forms, indicating they are probably of comparable age.

Johnson and Goode (1994) see the Middle Archaic as a time of considerable borrowing of alien artifact styles or new artifact styles physically brought into the area. They project mixed economics with burned rock middens reflecting intensive periods of collection and processing and link the burned rock middens with Nolan and Travis points.

Evidence for burial practices in the eastern Edwards Plateau are nearly non-existent. The Mason Burial Cave (41UV4), a sinkhole just west of the dividing line in Uvalde, revealed some 25 to 50 bodies with a few Travis, Nolan, and Early Triangular points (Bender and Bender 1962 cited in Johnson and Goode 1994).

Johnson and Goode (1994) see this period as moderately moist but drying. This contrasts with the data from Fort Hood, which Nordt (1992, 1993) interprets as a xeric period that had increases in C₄ grasses at the expense of C₃ trees and shrubs.

In the most recent overview of this period, Collins (1995) divides the Middle Archaic into

three subdivisions based on projectile point types similar to a position taken by Johnson and Goode. The earliest is the Bell/Andice/Calf Creek style that reflects a period of bison hunting that occurred as bison moved into the region. Bison hunting may have carried over into the subsequent period when Taylor points were used. All these points are generally triangular forms with thin blades. The Taylor points are unnotched, whereas the Bell/Andice/Calf Creek forms are distinctive, deeply basally notched forms. Taylor points were the dominant projectile ($n=27$ or 51 percent of the total) at the burned rock midden excavated at Wounded Eye Site (41KR107) in Kerr County (Luke 1980). However, this midden yielded no radiocarbon dates with which to make a precise chronological placement.

It is not clear when bison moved from the region, but toward the latter part the Taylor period and into the Nolan and Travis point type period this animal disappeared from Central Texas. This author interprets the current data as indicating that the Nolan and Travis points are the prominent indigenous types in the Central Texas region at this time, whereas Bell/Andice/Calf Creek points originated to the north and Early Triangular points came from the south. The events reflected by the different point types may all be very close in time and poor stratigraphic context has not allowed individual events to be identified. The lack of significant time between events, coupled with the erosional and depositional sequences, have often mixed these points types together. Therefore, until single-event sites are located and excavated, our understanding of the issue will be constrained.

3.4.2 The Lower Pecos

Most recently Turpin (1991, 1995) indicates this period extends from about 5,500 to 3,200 B.P.

using uncalibrated ages and from 6,500 to 4,000 B.P. with calibrated assays. She labels the first half of this period from 5,500 to 4,100 B.P. (uncalibrated) as the Eagle Nest subperiod, which is characterized by Pandale points. This is a distinctive beveled, stemmed point with a restricted, regional distribution. Pandale points have been recovered from radiocarbon-dated strata at Arenosa Shelter, Eagle Cave, Conejo Shelter, Hinds Cave, Skyline Shelter, and Fate Bell Shelter (Turpin 1991). At Eagle and Hinds caves, Pandale points appear in mixed strata attributed to time of about 6,100 to 5,500 B.P.

Turpin (1991, 1995) believes this period coincides with the culmination of Bryant's Stockton Stage in an extremely hot, dry interlude he called Ozona Erosional, as evidenced at Arenosa Shelter and Devils Mouth Site. This may also coincide with what Brown (1991) observed at Baker Cave with an apparent shift to labor-intensive processing of lechuguilla, sotol, and yucca at around 5,000 B.P.

The second half of this period, from 4,100 to 3,200 B.P. (uncalibrated) or 4,850 to 3,350 B.P. (calibrated) Turpin (1991, 1995) labels the San Falipe subperiod, which is characterized by point types such as the Langtry, Val Verde, and Almagre. These three types were recovered from dated contexts at Arenosa Shelter—Stratum 21, 22C, 22X, 23, 23D; Eagle Cave—Stratum IIA; Conejo Shelter—Lens 50; Hinds Cave—Analytical Unit 3; and Fate Bell Shelter—Zone 3, Level 1.

Turpin (1990) suggests this is the period in which the regional Pecos River style of rock art originated, examples of which include polychrome pictographs thought to be religious (shamanistic) art forms (Kirkland and Newcomb 1967; Turpin 1994a, 1994b). These glyphs are quite diverse, with mountain lions, deer, birds, fish, insects, and anthropomorphs thought to represent shamans. The shaman figures exhibit

animal characteristics such as feathers, wings, claws, fur, and horns and are equipped with atlatls, darts, fending sticks, and pouches (Turpin 1995).

This period sees intensive flooding of the Pecos River as revealed at Arenosa Shelter (Bryant and Shafer 1977), perhaps catalyzed by increased runoff on a landscape that was partially devegetated during a hot, dry interval that Bryant (1966) termed the Sanderson Stage.

Turpin (1991, 1995) suggests that there was an increase in population density, which created societal stresses that were mitigated by the creation of the rock art and its ideational corollaries. Boyd (2003) believes that through documentation and analyzing rock art we can begin to recognize the myriad ways in which it was integrated into the lifeways of the Lower Pecos socio-cultural systems.

3.5 THE LATE ARCHAIC PERIOD (4,000 TO 1,300 B.P.)

3.5.1 Central Texas

In Central Texas, the Late Archaic, roughly 4,000 to 1,300 B.P., is divided into six intervals based on projectile point types (Collins 1995). Prewitt's (1981a) original chronological sequence consisted of three phases: Uvalde (Castroville, Marcos, and Montell points), Twin Sisters (Ensor points), and Driftwood (Mahomet [Darl] points). Many archeological sites of this time have been excavated, although few well-stratified components are represented or reported (Collins 1995; Figure 3-3).

Johnson and Goode (1994) provide a slightly different view by subdividing this period into early ("Late Archaic I") and late ("Late Archaic II") subperiods. The division is based on perceived changes in the archeological record. Common dart points include Bulverde, Pedernales, Marshall, Montell, and Castroville

Figure 3-3. Selected Late Archaic Sites Near Varga Site

in the Late Archaic I, with Marcos, Ensor, Frio, Darl, and Figueroa in Late Archaic II. Johnson and Goode (1994) indicate a time of about 2,500 B.P. for the division of the two subperiods. Although the projectile point sequence has not changed drastically from Prewitt's original work (1981a, 1985), Johnson and Goode (1994) placed the Bulverde, Pedernales, and Marshall points of Prewitt's Middle Archaic into their Late Archaic period. The Johnson and Goode (1994) division, with the Marcos type occurring later than the Montell and Castroville, is potentially problematic as many researchers consider these points to be about the same age. Two of the better contexts with radiocarbon dates and Uvalde phase projectiles are found at 41GT91 and Culebra Creek Site. At 41TG91 (East Levee), Marcos points are associated with three radiocarbon dates of $2,910 \pm 270$ B.P. (Tx-4764B),

$2,540 \pm 80$ B.P. (Tx-4764A), and $2,480 \pm 60$ B.P. (Tx-4761) (Creel 1990). At Culebra Creek Site, three Montell and one Marshall point came from a thin burned rock midden associated with two charcoal dates of $2,700 \pm 50$ B.P. (NSRL-3520) and $2,780 \pm 50$ B.P. (NSRL-3519) (Nickels et al. 2001). These later two sites and associated radiocarbon dates indicate these point types can occur as separate entities.

Burned rock middens, thought to have appeared in the Middle Archaic (Weir 1976; Prewitt 1981a), continue through this period, some with well-defined central pit features or rock ovens (i.e., Ricklis and Collins 1994; Black et al. 1997; Mauldin et al. 2003). The Culebra Creek Site contains one 35-cm-thick by 5-m-long burned rock concentration with what the researcher refers to as the remains of a central heating

element, but no direct evidence of food resources, that is associated with Montell points (Nickels et al. 2001). Many researchers believe that the rock ovens and large middens represent the cooking of bulk plant resources such as sotol or lechuguilla that require long periods of heating to make consumption a possibility. An alternate hypothesis based on the broad distribution of oak trees and burned rock middens is that these features were used to process acorns (Creel 1986, 1991). More recently it has been directly demonstrated by the identification of burned plant parts that geophytes (tubers, bulbs and roots) were also cooked in burned rock middens (Dering 1997, 1998b, 2003a; Mauldin et al. 2003). Chemical residue analysis on burned rocks from a central cooking features at Mustang Branch midden near the Balcones Escarpment revealed animal residues were present (Loy 1994). Other smaller burned rock dumps, scatters, basin, and flat hearths have been recognized at various sites during the Late Archaic.

Other than various plant resources that were bulk processed in earth ovens associated with middens, buffalo were also part of the subsistence base for periods within the Late Archaic, principally associated with Montell points. Bison bones from Barton Site yielded bone collagen radiocarbon dates between about 1,800 and 2,150 B.P. (Ricklis and Collins 1994). This is the same period that bison were also present in the Lower Pecos region, as evidenced by the bison-jump kill at Bonfire Shelter. Therefore, bison were widely distributed across much of Texas during the Late Archaic. Deer continued to be a part of the consumed resources, as were riverine resources such as mussels.

Cemeteries were in use in Central Texas during the Late Archaic, as indicated at sites like Olmos Dam (41BX1) (Lukowski 1988) where some, if not all 13 burials, date to this period. At least

two infant burials, one flexed and associated with grave inclusions, including white-tail deer antlers, traces of ochre, and chert cobbles, were associated with charcoal radiocarbon dates of $2,200 \pm 70$ B.P. (Tx-3989) and $1,920 \pm 160$ B.P. (Tx-3993). Isolated burials are also present as indicated by a semiflexed male skeleton buried 2.2 m deep in an alluvial terrace in Llano County (Bement 1993). This body was associated with a complete Ensor dart point near the dorsal side of the spine opposite the lower thoracic vertebrae, which might have been the cause of death.

The Late Archaic is generally viewed as a continuation of a generalized collection adaptation strategy with population densities increasing from the proceeding period. The regional data show use of diverse plant and animal resources, and demonstrate that burned rock features continued to be used for cooking.

3.5.2 The Lower Pecos

In the Lower Pecos archeological region, the Late Archaic is again a relatively long period dating from about 3,150 to 1,300 B.P. (Turpin 1991). However, no one artifact or technological change marks the essentially arbitrary divide between Middle and Late Archaic periods. Based on projectile point styles, Turpin (1991) has subdivided the Late Archaic into the Cibola period (3,150 to 2,300 B.P.) characterized by Marshall, Montell, Marcos, and Castroville points; the Flanders period (2,300 B.P. to unknown) characterized by Shumla points; followed by the Blue Hills period (2,300 to 1,300 B.P.) with Ensor and Frio points. A Frio point was recovered from next to a fiber nest at Wroe Ranch, and the fiber was radiocarbon dated to $1,710 \pm 40$ B.P. (Tx-9120) (Turpin 1998). Also at Wroe Ranch at least five features (2, 12, 19A, 22, and 24) were attributed to the Blue Hills period with five radiocarbon dates that fell into the stated temporal interval.

At Arenosa Shelter, the Marcos points were stratigraphically higher than the Montell points (Dibble 1967). Some 51 Montell came from Stratum 11, radiocarbon dated to $2,440 \pm 140$ B.P. (Tx-311) and $2,410 \pm 140$ B.P. (Tx-286) (Dibble 1967). At Bonfire Shelter, 25 points of the Montell and Castroville types were found in Bone Bed 3, which produced two charcoal and two burned bone samples dating to $2,310 \pm 210$ B.P. (Tx-46), $2,510 \pm 100$ B.P. (Tx-131), $2,780 \pm 110$ B.P. (Tx-106), and $2,810 \pm 110$ B.P. (Tx-47), respectively (Dibble and Lorrain 1968:51). Possible mixing of deposits in the excavated sites has caused some confusion over which points might be associated with other point types, and the exact beginning and ending dates for these subperiods. The Shumla point type is poorly dated in the Lower Pecos primarily because of poor excavated contexts, though radiocarbon dates from Mexico place this type between 3,100 and 1,850 B.P. (Turpin 1991, 1995). The terminal dating of the Late Archaic is not well-defined, since many of the deposits of this period are disturbed.

Most rockshelter sites that contain Earlier Archaic occupations have also yielded Late Archaic materials (i.e., Hinds Cave, Conejo Shelter, Wroe Ranch) indicating continuity in land use throughout this area. Preservation is good in most rockshelters and the fiber industry is well represented. At Wroe Ranch there were fiber “nests” (Features 2 and 24) with grass and prickly pear pads, shredded agave, matting, and a sandal (Turpin 1998). The fiber layer at Bonfire Shelter was a discrete layer of occupational debris with lechuguilla leaves, prickly pear seeds, yucca fiber, black walnut shells, mescal beans, mesquite hackberry, and buffalo gourd materials (Dibble and Lorrain 1968). This layer yielded radiocarbon dates on charcoal of $1,400 \pm 130$ B.P. (Tx-151) and $1,690 \pm 80$ B.P. (Tx-194).

Human coprolites from Conejo Shelter (41VV162) provide a glimpse at the foods that were consumed in the Late Archaic, specifically during what Turpin (1991) refers to as the Blue Hill period. Bryant (1974) discovered that pollen from coprolites dating from 2,400 to 1,150 B.P. indicates that flowers from plants such as yucca, agave, sotol, cactus, persimmons, leadtree, and mesquite, were consumed. Also part of the diet were wild onion bulbs, millet seeds, small reptiles, grasshoppers, cactus fruits, goosefoot seeds, minnow-size fish, and mammals. The 1,820 B.P. crescent shaped burned rock midden at Hinds Cave with associated Ensor and Frio points yielded about 1,600 seeds and fruit fragments from 9.5 liters of matrix (Dering 1996).

During the Cibolo period, bison returned to this region as evident by bones of this species in the archeological records at Eagle Cave (Ross 1965), Castle Canyon (Greer 1966), Bonfire Shelter (Dibble and Lorrain 1968), and Arenosa and Skyline shelters (Turpin 1991). At Bonfire Shelter a massive, nearly 30-cm-thick bone bed estimated to contain remains of about 800 bison represents a major bison jump kill (Dibble and Lorrain 1968). The bison bones were in direct association with 25 Montell and Castroville points. Bison was clearly added to the existing repertoire of plant and animal resources from previous periods. Turpin (1995) sees an abrupt change in the economic, technological, and site distributional patterns at this time. Dibble (Dibble and Lorrain 1968) postulated that wetter and cooler conditions permitted the emergence of a grassland environment suited to the needs of bison, giving rise to the influx of human populations following migrating herds. The presence of burned rock middens across much of the region also indicate that plant processing in mass quantities also occurred at this time. Besides bison, the use of deer, rabbit, squirrel, fish, and mussels as food resources is indicated

by bones and shells from the fiber layer at Bonfire Shelter (Dibble and Lorrain 1968).

Little is known about the range of cooking facilities used during this period. This might stem from the lack of excavations at well-stratified components pertaining to this period, as well as a lack of dates for individual cooking features. The fiber layer at Bonfire Shelter contained at least two hearths, Hearths 6 and 7. Hearth 6 consisted of three superimposed stone lined constructions, circular in outline and about 115 cm in diameter and 15 cm deep. Hearth 7 was an unlined concentration of compacted ash, lump charcoal, and a few burned limestone rocks about 65 cm in diameter (Dibble and Lorrain 1968). Burned rock middens are often attributed to this period based on projectile point types, but many have not been directly radiocarbon dated (i.e., Hinds Cave). Often these middens contain multiple types of projectile points, leaving some uncertainty as to the period represented by a given midden. Excavations at Piedra del Diablo Site (41VV263) encountered a 30 to 45 cm thick burned rock midden about 10 m in diameter (Prewitt 1970). This yielded charcoal as well as Marshall and Castroville points. Excavations of ring middens in Crockett County revealed central cooking features and yielded a few Late Archaic materials (Moore 1983). Recent eligibility-testing excavations at many burned rock middens in Brown County, at the northern edge of the Central Texas region, have been radiocarbon dated to this period (Mauldin et al. 2003). Further west in Terrell County, the Wroe Ranch site yielded six radiocarbon-dated features of this period, including a layer of dense burned rocks, a cluster of 10 burned rocks on a large fiber mat, a 44 cm diameter by 12 cm deep ash pit, a circular fiber “nest”, and a circular grass-lined basin (Turpin 1998). Dering (1996) interprets the crescent midden at Hinds Cave as having functioned as an oven, and concludes that lechuguilla, sotol, onions, and possibly

Yucca Torreyi are the most likely candidates for baking in the oven.

In addition to the characteristic Ensor and Frio points in the Blue Hill period, the stone tool assemblage also includes a variety of forms including: bifaces, various scrapers, choppers, drills, edge-modified flakes, gravers, burin spalls, painted pebbles, and abraded stones (Collins 1974, Period H). At Arenosa Shelter, this period focused on tool stones recovered from river gravels. Cobbles were shaped into bifacial preforms with limited secondary trimming and no heat treatment (Collins 1974). Tool maintenance and modification are present. Projectile points appear to exhibit poorly controlled percussion and pressure flaking and relatively thick biconvex cross sections. Many edge-modified tools exhibit a highly glossy sheen apparently imparted by cutting, interpreted by Collins (1974) to be the result of harvesting plants.

Clay figurines apparently are part of some Late Archaic assemblages, although most occur with Middle Archaic dart points (Shafer 1975). Shafer tentatively estimated an age range from about 4,000 to 2,000 B.P. based primarily on associated diagnostic projectile points. Specific functions or use of these objects are conjectural (Shafer 1975).

Bundle burials occur in the Blue Hills subperiod with individuals wrapped in painted mats (Turpin 1991, 1995). Stable carbon and nitrogen isotope analyses on two Late Archaic individuals indicate a diet based on CAM plants and C₃ animals (Huebner 1991a).

The Red Linear pictographs have been initially radiocarbon dated to the Blue Hills subperiod (Ilger et al. 1994), although Turpin postulates they may have been initiated earlier in the Cibola subperiod. Painted mats were also recovered with bundle burials.

3.6 THE LATE PREHISTORIC PERIOD (1,300 TO 300 B.P.)

3.6.1 Central Texas

In the Central Texas archeological region, the Late Prehistoric, dating between ca. 1,300 and 300 B.P., is recognized by the introduction of the bow and arrow. This period is divided into two subperiods, early and late, which correspond to the Austin and Toyah “phases” or “intervals,” respectively. The Austin period, characterized by the Scallorn and Granbury arrow points, lacks evidence of pottery, though pottery is common in the later Toyah period sites. When there is good stratigraphy and context at sites that contain both intervals, the Austin material is below the Toyah. However, some radiocarbon dates overlap in time in some parts of Texas and indicate that these two cultural patterns had a degree of temporal overlap (Prewitt 1982b). Toyah materials are primarily dated to between 650 to 300 B.P. (A.D. 1300 and 1650) (Prewitt 1981a, 1985; Creel 1990; Treece et al. 1993b; Johnson 1994; Ricklis 1994b; Quigg and Peck 1995).

Although four projectile point types—Scallorn and Edwards in the Austin phase and Perdiz and Cliffton in the Toyah—are linked to these two time intervals, there appears to be some uncertainty as to the temporal position of the Edwards type. Prewitt (1981a) does not mention Edwards in his Central Texas chronology. However, the Edwards type was defined by Sollberger in 1967 (1971), stemming from excavations in rockshelters and burned rock mounds in Kerr County of the southern margin of Central Texas. Hester (1978) sees the Edwards type as the earliest arrow point form in southwestern Edwards Plateau based on radiocarbon dates from the La Jita Site in Uvalde County that are around 1,000 B.P. and their stratigraphic occurrence primarily below other arrow point types. Prewitt (1995) indicates the

Edwards points are primarily distributed across most of South Texas and into the Central Texas region, with some as far west as the Trans-Pecos region.

The Rainey Site (41BN33) in Bandera County (Figure 3-4) is one of the few well-stratified Late Prehistoric sites in Texas, with multiple discrete events containing Edwards points below the Perdiz points and sometimes associated with Scallorn and Sabinal points (Henderson 2001). Many radiocarbon dates on charcoal from the Rainey Site provide ages for the Edwards points around 900 to 1,000 B.P. Two dates associated with Perdiz occupations (Zone IVe) revealed ages between 670 and 790 B.P. These ages are some of the earliest dates for Toyah occupations in the region. Above this dated zone were other, presumably younger, Perdiz occupations (Zones III, IVa, IVb, IVc, and IVd).

The Toyah archeological manifestation is represented by many sites scattered across a broad area of Texas, except for the panhandle region. Most excavated Toyah sites probably were short-term camps that focused on limited activities such as meat processing (Mustang Branch Site-Terrace; Ricklis 1994b), tool production (Barton Site-North; Ricklis 1994b) and bone grease/pemmican processing (Rush Site, Quigg and Peck 1995; Quigg 1997b).

The material assemblage consists of a constellation of items including large thin bifaces, two and four beveled Harahey knives, Perdiz arrow points, arrow point preforms (the so-called Cliffton point type), end-scrapers, flake drills, prismatic blades, utilized and edge-modified flakes, spokeshaves, choppers/mullers, and hammerstones (Johnson 1994; Collins 1995). Large slabs have also been recovered from campsites, and their context and visual attributes support their use as anvils and/or butcher blocks used for processing meat products (Quigg and Peck 1995).

Figure 3-4. Selected Late Prehistoric Sites Near Varga Site

Grinding implements, metates, manos, and abrading stones are present at many sites (i.e., Johnson 1994). A soapstone pipe was recovered from 41TG91 (Creel 1990), and a ceramic bone-tempered pipe was recovered from Mustang Branch (Ricklis 1994b). Other types of items include bone beads and awls, various bone tools, antler sections, and mussel shell pendants and beads as integral parts of the artifact assemblage (Prewitt 1981a; Creel 1990; Treece et al. 1993b; Johnson 1994).

Also present are Clifton points (Suhm et al. 1954) that are often referred to as unfinished points or preforms for the Perdiz point (Turner and Hester 1993; Johnson 1994), but apparent impact breaks on some specimens hint that this was a finished tool. In several sites, a small

number of different arrow point types occur in direct association with the more frequent Perdiz points and include Harrell, Lott, and Garza points (Creel 1990; Quigg and Peck 1995). Johnson (1994:91-93) illustrates several small triangular specimens that he refers to as preforms for notched type arrow points. The presence of multiple point types may indicate the interaction of different groups.

The tool industry appears to represent a core-blade technology (Bond 1978; Ricklis and Collins 1994). Apparently, byproducts of biface manufacture in the form of thin flakes, were selected for arrow point production (Ricklis 1994b:236), and probably other tools as well. This is an interesting adaptive pattern and reflects an optimally efficient use of the raw

material. Cores are most often largely unidirectional with more or less flat platforms.

Bone tools have also been recovered from many Toyah sites, although not in large quantities. These include items such as awls, flakers, needles, beads, and various shaped and worked bone pieces (i.e., Jelks 1962; Creel 1990; Treece et al. 1993b; Johnson 1994; Ricklis and Collins 1994; Quigg and Peck 1995).

Pottery has long been recognized as a key component of the Toyah assemblage (e.g., Suhm 1955, 1957). In Prewitt's (1981a) synthesis, he identified the pottery as Leon Plain and Doss Redware. Recently, Johnson (1994) refers to these typological categories as outdated and collectively refers to Toyah ceramics not by name, but rather its attributes, including thin-walled vessels, surficial smoothing with a flat wide stick or cane instrument, and fine crushed-bone temper. Colors vary from a light reddish-tan, to orange or brown, and vessel surfaces were generally undecorated. Wide-mouthed bowls and relatively deep jars are recognized vessel forms. Bowls often exhibit distinctive matte-finish wash on the interiors, and vessel surfaces were occasionally slipped. Rims are usually thin and beveled on their inside edges. Forming clay ropes/coils and attaching these on top of one another and then smoothing out the joints was the primary method of construction. The aplastic additives to the clay are dominated burned and calcined bone, but various quantities of quartz sand and other particles have been detected as well (Reese-Taylor 1993, 1995; Robinson 1999).

Despite only a few petrographic and other source studies that have been conducted on Toyah ceramics, Johnson (1994) stated pottery did not often move across drainage systems. Petrographic analysis on seven sherds from San Felipe Springs (41VV444) and previous petrographic analysis on nine sherds from

Infierno sites (Turpin and Robinson 1998), all in Val Verde County, were compared (Robinson 1999). At the petrographic level, Robinson (1999) sees fundamental technological similarities with only minor, regional variations in the matrix, but sees no distinctive or even subtle differences between the Infierno and Toyah phase pottery from San Felipe Springs. The regional variations probably represent different areas of localized production.

A large INAA has recently been completed on a variety of Late Prehistoric pottery sherds collected from many sites across the southwestern and central part of Texas. The results of the INAA on the sample of nearly 400 sherds reveal at least six compositional groups, and provide some interesting geographical distributions (Creel and Johnson 2002). The distribution provides insights into pottery production localities and movement of vessels across the landscape.

The frequency of ceramic sherds varies considerably at Toyah sites, as does the number of vessels represented. As examples, 480 sherds were recovered from Mustang Branch, and they represent five distinct vessels (Ricklis 1994b). At the Rush Site, only 184 sherds were recovered from Occupation 4, and they represent at least seven vessels (Quigg and Peck 1995). Interactions with other groups are indicated in the ceramic assemblage as brushed exterior vessels similar to Caddo types have been recovered in low numbers at several Toyah sites (Quigg and Peck 1995; Ricklis 1994b). However, painted trade vessels from the southwestern part of the U.S. have not been detected in any Toyah components.

Chemical analyses (fatty acids) on sherds have been infrequent, but have yielded animal lipids indicating that vessels were used to cook meat products (Loy 1994). Stable carbon and nitrogen isotope analyses on residues extracted

from sherds have also indicated vessels were used in cooking meat products and in the rendering of bone grease (Quigg and Peck 1995).

Burned rock features including large and small hearths, rock lined and filled hearths, burned rock dumps, and although not many, at least one large burned rock midden (Honey Creek Midden at 41MS32) have been attributed to the Toyah period (Black and Creel 1997). Most archeologists do not see the larger burned rock middens as part of the Toyah Interval, although often a Toyah component lies directly on top of a midden deposit (Ricklis and Collins 1994; see Black et al. 1997 for different view). Limited burned rocks have been subjected to chemical residue analyses. The few chemical results support their use in cooking meat products (Loy 1994). Various other features identified include ash, charcoal and bone concentrations, bison rib alignments, clay-lined pits, knapping stations, organic stains, oxidized areas, and unlined pits (Treece et al. 1993b).

Sizeable quantities of animal bones such as bison, deer, and antelope are often associated with the Toyah sites and reflect a population focused on large game animals (i.e., Creel 1990; Shaffer 1994; Ricklis and Collins 1994; Quigg and Peck 1995). This represents a dramatic shift in subsistence from the earlier Austin phase with its broad-based hunting and gathering economy. At Mustang Branch Site, extensively butchered bone in great quantities was detected and represented a minimum of 19 adult deer, six fetal deer, eight antelope, and two bison. The presence of this many animals processed at one event are testament to group cooperation in the procurement and processing of bulk resources (Masson and Holderby 1994). The frequent fragmentation of bones at sites like Barton and Rush indicate that bone grease production was also undertaken (Masson and Holderby 1994; Quigg and Peck 1995; Quigg 1997b). The tool

assemblage documents the intense procurement, butchering, and processing of the meat products.

Although there has been a tendency to view Toyah groups as hunters of large game, it is clear that they also collected mussels from streams for use as food (Creel 1990). Presumably, plants were gathered as sources of key nutrients and fiber. Fish, turkeys, rabbits, and turtles were also food resources, as indicated by their presence at several Toyah sites (Creel 1990; Shaffer 1994; Quigg and Peck 1995). Charred mesquite seeds and pods were recovered from the Rush Site (Quigg and Peck 1995). Although very late in time, and with agricultural practices underway in the northeast part of Texas, minimal evidence is available for agricultural crops through a few corn cobs (Jelks 1962; Harris 1985) were found in Toyah contexts at the Kyle Rockshelter (Jelks 1962) and at Timmeron Rockshelter (Harris 1985). These may represent agricultural produce that was obtained via exchange between Toyah groups and Caddo farmers to the east. The Kyle Site yielded perishable materials including twisted cordage, pieces of mats, coiled basketry fragments, arrow fragments, a notched stick, pointed sticks, pointed wooden splinters, wood shavings, and pieces of tanned deer skins (Jelks 1962).

Human burials have been found as isolated interments (i.e., Kyle, Jelks 1962) and in cemeteries (i.e., Loeve-Fox, Prewitt 1974, 1982b) with interred bodies in various positions and 10 cremations. The burial at Kyle was a cremation that had been wrapped in an unwoven fiber mat and lacked mortuary offerings. Several bodies reflect conflict and/or hostilities between groups as different arrow point types such as Perdiz points in bodies at Asa Warner #2 (Watt 1956), as well as Scallorn points embedded in human remains (Prewitt 1974; Huebner and Comuzzie 1992). Some interaction probably occurred with Caddoan groups to the

northeast as indicated by some Caddoan vessel types. Some contact probably was with coastal groups as the bodies in Loeve-Fox were associated with conch shell pendants (Prewitt 1982a, 1982b). Radiocarbon dates from Loeve-Fox indicate a period between 1,300 and 700 B.P. (Prewitt 1982b), thus placing this cemetery within the time range of the Austin phase.

It has been suggested that Toyah represents bison hunters who migrated into the area bringing their own technology and changes in adaptive strategies (Prewitt 1981a, 1985; Johnson 1994), or, conversely, that the Toyah assemblage represents the adoption of a particular tool kit, well-suited to large-game hunting and processing, by a wide range of hunter-gatherer groups who were indigenous to the region (Ricklis 1992, 1994b; Collins 1995). The adaptive system involved relatively high subsistence mobility as a correlate of extensive use of large game such as bison, deer, and antelope. The wide distribution of Perdiz interval assemblages across the Texas landscape opens the debate as to whether or not the Toyah interval represents the spread of ideas or people. Black (1986) and Ricklis (1992, 1994b) see it more as a widely adopted techno-complex, whereas Johnson (1994) sees it as a single ethnic group.

3.6.2 The Lower Pecos

In the Lower Pecos archeological region, this time interval is divided into two periods, the Flecha period (1,320 to 450 B.P.) and the Infierno phase (450 to 250 B.P.) (Turpin 1988, 1991). The change from Late Archaic times is characterized by the introduction of the bow and arrow and in the case of the Infierno phase the addition of pottery. Various small arrow points such as, Scallorn, Perdiz, Livermore, and Toyah styles, characterize the Flecha period (Turpin 1988:8), but individual components with only

one type of projectile have not been identified. Circular stone rings and the distinctive Red Monochrome pictographs have been attributed, but not demonstrated, for this period (Turpin 1988). A child burial from Wroe Ranch in nearby Terrell County has yielded two radiocarbon dates of about 660 B.P. (Tx-5430 and Tx-6431) on plant fibers from a grave pit and falling within this period (Turpin 1998). The grave also contained sotol stakes, grass, prickly pear pads, and an antelope robe. Thirty-eight coprolites from Baker Cave, dating to about 1,050 B.P., indicate that the diet included prickly pear cactus, onion bulbs, fish, bird, rodents, and fiber from sotol, prickly pear, and yucca (Sobolick 1991a, 1991b). Diet in the Lower Pecos does not appear to have substantially changed through time as many of these same resources were documented for the Early Archaic period back to about 9,000 B.P. Pollen from grasses, sagebrush, and Brassicaceae were also in the coprolites. No cultivated species were identified. Overall, very little is known about this period in Western Texas. Turpin (1995) attributes the limited information for this period to highly disturbed deposits in the upper levels of the investigated rockshelters. The rock art changes to a Red Monochrome style and Bold Line Geometrics (Turpin 1991, 1995).

The Infierno period is said to be distinguished by small triangular stemmed arrow points (not typed) together with plain brownware pottery, steeply beveled end-scrapers, prismatic blades, and circles of stones forming house foundations (Turpin 1988, 1991). The Infierno phase has not been securely dated by radiocarbon dates and much remains to be learned about the artifact assemblage. The estimated age is post 450 B.P. (Turpin 1991:36-37).

The plain pottery, although not clearly defined, has been thought of as the key index marker. Only 12 ceramic-bearing sites, yielding less than

100 sherds nearly all of which are bone tempered, have been located in the Lower Pecos region. This ware is described as coil made, low fired in open oxidizing atmosphere, with surface colors ranging from orange-red through yellowish-brown to pinkish and light tan, the cores have black and gray carbon streaks, the exterior surfaces show smoothing and polishing, vessel walls range in thickness from 2 to 9 mm, and vessel form is unknown (Turpin and Robinson 1998). Petrographic analysis on 11 prehistoric sherds indicates a combination of bone and calcium carbonate aplastic additives (Turpin and Robinson 1998). The pottery consists of plainware sherds with surface smoothing and polishing, occasional red-slipped surfaces, poor firings, bone and calcite-tempered brownwares with dark cores (Turpin 1995; Turpin and Robinson 1998).

Petrographic analyses on Infierno phase and Mission pottery sherds indicate the presence of similar tempering agents and potentially some continuity in the ceramic assemblage over time or between groups of Natives (Turpin and Robinson 1998). Recent petrographic analysis on seven plainware sherds thought to represent the Toyah phase ceramic industry from San Felipe Springs (41VV444) were compared with petrographic analysis of nine Infierno phase sherds from five sites in the Lower Pecos region. The results indicate no distinctive or even subtle differences in the Toyah and Infierno sherds sampled (Robinson 1999). Robinson (1999:188) interpreted this to indicate that there are no discernable technological or compositional differences between the bone-tempered pottery of classic Toyah phase and the bone tempered pottery of the western Toyah and Infierno phases of the Lower Pecos proper. At 41VV444, one charcoal sample from the base of same stratigraphic position in the A horizon that yielded 97 percent of the Toyah sherds yielded a radiocarbon date of 600 ± 80 B.P. (Beta-116161-E; Mehalchick et al. 1998). It appears that the

plainware ceramic technology was shared knowledge across a vast region, and production occurred at many different places as evident in slightly different percentages of additives.

Tool technology is seldom discussed with a few exceptions such as the work by Collins (1974) on materials from Arenosa Shelter. Though not directly attributed to the Flecha period, the technology observed for the Late Prehistoric was that of cobble reduction by direct percussion. The cores and flakes served as blanks for further unifacial and bifacial reduction. Most arrow points were produced on flakes. Unifaces, bifaces, burins, and graters are represented.

Burned rock was still a very important aspect of this period with small clusters, hearths, large crescent shaped concentrations, and circular ring middens. Information concerning these and other features is constrained by the limited number of components excavated and dated to this period. North of the Lower Pecos region in Crockett County, slab lined hearths 1 to 1.5 m in diameter, with basin-shaped cross sections have been radiocarbon dated to this period (Word 1971). The charcoal dates from hearth 1 (A) were 940 ± 120 B.P. (Tx-310), 630 ± 90 B.P. (Tx-357), and 540 ± 80 B.P. (Tx-358). A second series of slab lined basin hearths were observed in profiles and charcoal from between the two was dated to 670 ± 80 B.P. (TX-351), 570 ± 100 B.P. (Tx-359). Diagnostic projectile points include Perdiz arrow points and Ensor dart points, although the dates place these features in the Late Prehistoric period.

The burial patterns are diverse and include cremations (Turpin 1988), cairn burials (i.e., Las Haciendas, Mallouf 1987), flexed, and seated bodies, which may reflect movement of different peoples into the region. A single cremation from Zone 1 at Seminole Sink yielded two radiocarbon dates on charcoal from the cremation of 390 ± 80 B.P. (Beta-10472) and

470 ± 150 B.P. (AA-946) (Turpin 1988:32). No artifacts were found in association, though the two dates correspond to the Flecha and Infierno periods. An infant burial from Wroe Ranch had been wrapped in an antelope skin robe, lined with hair. At the same site, a flexed child burial was placed in a grass-lined pit outlined with bent sotol stalks, and covered by an antelope robe, two mats, a large rock, and a scattering of prickly pear pads. This burial yielded two radiocarbon dates of 700 ± 135 B.P. (Tx-5430) and 760 ± 160 B.P. (Tx-5431) (Turpin 1998). Although some distance to the southwest in Mexico, the Las Haciendas cairn burial implies some degree of care extended to the dead. Besides a prominent location and the energy and time invested in construction of the burial placement, the interred individual was provided with an extraordinary large assemblage of Perdiz arrow points ($n=180$) directly associated with 14 points representing four other types. These attributes from this cairn burial and those elsewhere point to a belief in the after life.

In general, the inhabitants of the Lower Pecos region are thought of as foragers. These folk collected and hunted a wide range of plants and animals, and lacked any cultivated crops. They were also extremely mobile, relocating to where resources were plentiful. Turpin (1991 and personnel communication 2007) believes the Infierno phase of the Lower Pecos is distinctive from the Classic Toyah of Central Texas, based on the presence of circular stone tipi rings, calcite temper in pottery, and a dearth of Perdiz-type arrow points.

3.6.3 Protohistoric and Historic Periods (400 to 200 B.P.)

The end of prehistory is marked by the arrival of the written record to the region and contact between Native Americans and Europeans. The Spanish were the first Europeans to encounter and describe Apaches during Coronado's

expedition in A.D. 1541. A Spanish expedition under the direction of Gaspar Castano de Sosa passed through the Lower Pecos region on their way to Pecos Pueblo in A.D. 1590 (Hammon and Rey 1966; Wade 2003). However, Native Americans remained in control of the region until the Europeans began to establish settlements and the arrival of the railroad in the region in the middle of the nineteenth century. The initial period of only very limited European-Native interaction is referred to as the Protohistoric period. One would expect to see trade goods of metal and glass, such as metal arrow points or knives, and glass trade beads, appearing in native campsites if sites of this period. Few sites of this age have been recognized or documented, however.

Mission San Lorenzo de la Santa Cruz was founded by Franciscan missionaries of the College of Queretaro in the winter of A.D. 1762 near Camp Wood about 21 km (35 mi) south of the Varga Site. The mission was established to convert Lipan Apache Indians. Investigations, both archeological and ethnohistorical, were pursued in A.D. 1962, culminating in a report by Tunnell and Newcomb (1969). The Native cultural assemblage includes sandy paste potsherds, Perdiz and triangular arrow points, chert blade scrapers, a tubular stone pipe, and chert flake tools.

Some 27 federally recognized tribes and several Native American organizations have been linked to the Lower Pecos archeological region (Kenmotsu and Wade 2002), having ranged through the area in historic times. In their extensive studies of the early literature for that region, researchers have not been able to link one specific group to the archeological remains in the region (Kenmotsu 1994, 2001; Kenmotsu and Wade 2002, 2003).

Collins (1995:373) acknowledges the difficulty in tying the prehistoric record to the

ethnographic records and stated that Central Texas archeological materials cannot be linked with ethnohistorically recorded indigenous groups. Attempts to link the archeological Toyah assemblage to the Tonkawan populations has been unsupported, since ethnohistorical information indicates that the Tonkawas moved into Central Texas from the north during the Seventeenth Century (Campbell 1988; Newcomb 1993).

The Bosque-Larios Expedition, undertaken between April 30 and June 12, 1675, traveled within the general vicinity of the Varga Site (Wade 2003:24-52). The fundamental aspects of Native lifeways in this area, revealed by the records of this expedition are 1) bison hunting was an important subsistence activity that permitted, or at least helped to facilitate, relatively large aggregations of people, 2) Native settlement/subsistence patterns involved a fission-fusion (aggregation-dispersal) residence pattern, 3) aggregate-group populations may have numbered from several hundred to over one-thousand people, 4) constituent groups tended to form “coalitions” for the purpose of mutual defense against common enemies; 5) intergroup conflicts were fairly common, and involved killing of enemies, cannibalism, and the taking of captives, and, 6) very interestingly, the Mexican language (i.e., *Nahuatl*) was spoken as a *lingua franca*, if not on the southern Edwards Plateau, at least as far north as the Rio Grande Plain immediately to the south of the Plateau. This, along with the pattern of group coalitions, warns against a simplistic assumption that the hunter-gatherers of the region lived in geographic or cultural isolation from a larger, more inclusive world. It is not clear, however, whether or not the natives observed by Bosque-Larrios made use of horses for travel and/or transport; were this the case, it would have dramatically affected residential mobility patterns and long-distance interactions between groups. Further, the speaking of Nahuatl in this

area might actually reflect little-understood post-conquest shifts in cultural geography as, for example, Nahuatl-speaking Tlaxcalan people were relocated northward under the auspices of the Spanish Colonial authorities.

While the historic documentation provided by Wade (2003) widens our anthropological perspective, it does not provide us with specific empirical tools for interpreting most of our inherently limited archeological data, as the patterns she reveals are not the sort that will be directly represented in the material record within an archeological site context. Indeed, Wade’s material is yet another cautionary signal that the limits of archeological data should not be assumed to represent directly corresponding limits on the cultural experience of the past people we are trying to study and understand. For example, there is no clear indication at Varga that the Toyah group(s) that occupied the site could have been members of a larger population (or “coalition”). As far as we know, the Toyah component is spatially restricted, and there is very little in the way of exogenous cultural material that might alert us to interaction with people beyond the local group, or perhaps a number of groups that comprised a relatively local population.

Wade’s presentation of the documentary record does, however, alert us to the possibility that the extremely scarce archeological evidence for widespread interactions at Varga (i.e., the very scant marine-shell items and a single sherd of El Paso Polychrome pottery), may represent extensive, inter-group exchange and concomitant information flow that archeologists might not otherwise fully appreciate, given the quantitatively rare occurrences of such materials at the site. And, of course, the extensive distribution of the Toyah artifact assemblage in itself probably represents wide-ranging information flow across smaller-scale social boundaries, as has already been implied or

explicitly discussed at some length in the Texas archeological literature (e.g., Black 1986; Ricklis 1992, 1994; Arnn 2007). Additionally, Wade notes several instances of documented inter-group gift-giving, in which regional hunter-gatherers offered presents/gifts to

Spaniards. It is not too far-fetched to assume the Indians did this among themselves, as well, and this might account, as a specific mechanism, for the just-mentioned rare exotic artifacts from the Varga Toyah component.

4.0 RESEARCH DESIGN

Jeffrey D. Owens

This research design is organized in two major sections. Following this introduction, Section 4.1 discusses the general theoretical research orientation that informed this project, including the cultural- ecological and culture-historical perspectives that underlie the proposed program of research. Section 4.2 presents detailed discussions of specific research questions, underlying assumptions, data needs, and investigative strategies. These research questions are organized according to several general research domains, including Paleoenvironmental Reconstruction, Subsistence, Technology, Culture History, and Mobility and Land Use. The specific research questions posed within each of these topical sections are relevant to overall theoretical concerns, and many of them are more pertinent to some archeological components or to some subsets of data than to others.

The proposed research design was submitted to TxDOT following the second interim report from the second phase of data recovery. That research design was accepted by TxDOT and presented in the initial draft of this report. Subsequently, this research design was slightly reworded to read as to what eventually occurred in the final analysis.

4.1 THEORETICAL ORIENTATION

The proposed research program for the Varga Site takes advantage of the unique opportunity afforded by a site that contains multiple cultural

components that can be relatively clearly defined both stratigraphically and chronologically. In addition, data recovery excavations at the Varga Site yielded substantially larger samples of material for some cultural periods than any that are known in southwestern Texas (especially the Early Archaic). The Varga Site stands, therefore, to make a substantial contribution to our understanding of prehistoric hunter-gatherer systems in southwestern Texas, a region that has remained less well-studied than adjoining, better-researched culture areas (i.e., Central Texas, Lower Pecos).

The general theoretical orientation adopted in this study combines cultural-ecology, a contextual framework that seeks to identify and explain the adaptive relationships of human populations to their environments, and the culture historical approach, which views culture history as a succession of cultures as normative patterns. These two paradigms provide complementary perspectives, insofar as the sequential ordering of cultures emphasized by culture history overlaps with a historical human ecology that sees cultural changes as adaptive processes that, over the long-term, result in alterations in the complex adaptive system that is culture (see Butzer 1982). While these two fields of inquiry can be misunderstood to be mutually exclusive, they in fact simply represent different modes of interpretation that entail different assumptions about the meaning and causes of variability in the archeological record. The ways in which these two interpretive strategies will be operationalized in the present study will be highlighted throughout the following discussion and throughout the consideration of specific research questions presented in Section 4.2.

4.1.1 Systems Theory and The Archeological Record

As with any formal undertaking, this archeological research program was guided by several assumptions of a basic theoretical nature. First and foremost, as alluded to above, culture is envisioned as a complex adaptive system by which human populations interact, via adaptive decisions and behavior, to the opportunities and constraints afforded by the resource mosaics within their environments. Specifically, a cultural system can be characterized as a system by reference to its *structure* and *organization*. The structure of a system derives from the number, nature, and arrangement of its dynamically interdependent components at a given point in time. The patterned interactions among these constituent parts comprise the organization of the system (cf. Clarke 1968; Ellen 1982; Firth 1975; Geertz 1973; Tainter 1977; Butzer 1982).

In this context, the abstract, composite dimensions that permit the characterization of the structure and organization of a system are denoted in terms of the *integration* and *differentiation* of the system as a whole (Lawrence and Lorsch 1980). Differentiation is defined as the state of segmentation of the entire system into subsystems, and integration refers to the unity of effort among various subsystems in the accomplishment of adaptive tasks (cf. Flannery 1968). A task refers to a complete input-transformation-output cycle. Thus, an organization is a system composed of the interrelated behaviors of people who are performing a task that has been differentiated into several distinct subsystems, each subsystem performing a portion of the task, with the efforts of each being integrated to achieve effective performance of the system. The totality of the differentiated subsystems and the relationships among them comprise the *organizational system* (Lawrence and Lorsch 1980).

The meanings of these terms, as operationalized in this discussion, are most closely approximated by definitions derived from the fields of systems theory and cybernetics. The fundamental theme underlying the analysis of culture systems in these fields concerns the assumption that cultural systems are basically analogous to biological systems (Cadwallader 1980). As “living” systems, both organisms and societies are essentially open systems (Miller 1978). An open system, as defined by Bertalanffy, is “a system in exchange of matter with its environment, presenting import and export, building-up and breaking down of its material components” (1978:141). The basis of the open system model is the dynamic interaction of its components. In an open system, increase of order and decrease of entropy is thermodynamically possible, and an open system may “actively” tend toward a higher state of organization.

Open systems maintain homeostasis or stability through “dynamic equilibrium,” the establishment and maintenance of an approximation of parity between inflow and outflow, with the external environment (Bertalanffy 1968; Miller 1978). In this way, certain components will continuously break down, thereby releasing energy, and new energy will be imported, making it impossible for the system to establish the true equilibrium (i.e., “heat death”) of the closed system model. In an organism, failure to maintain a relatively even balance between the inflow and outflow of energy results in death; in a species, extinction. Thus, processes of regulation and control represent the unifying mechanisms in systems theory and cybernetics that account for the disparate internal movements of an open system.

By definition, all systems are more or less dynamic phenomena as they are maintained by movement of matter, energy, and information into and out of the system and between internal

subsystems. In complex adaptive systems, dynamism is expressed in terms of multiple, definable system states, any one of which probably never achieves sufficient stability to represent true homeostasis (Clarke 1968). The steady state, in which negative feedback prevents rapid change in the structure of the system, is probably the most stable equilibrium that living systems ever achieve (Ricklis and Collins 1994). When negative feedback mechanisms give way to positive feedback loops that promote ongoing, directional change, the system is in a state of dynamic equilibrium. When drastic or abrupt change occurs in the environment, or when the flow of free energy through the system dramatically increases or decreases, the basic organizational structure of the system may become destabilized. Apparently small perturbations in the environment or within the system itself can produce minor modifications to system structure or lead to catastrophic collapse depending on the initial conditions of the system and the variability of circumstances surrounding the perturbations; conversely, the system may rapidly reorganize itself to a higher level of organization that is capable of operating within the new energetic conditions. Such changes may be attended by greater internal organizational complexity, the emergence of higher scales of order involving higher-level integrative mechanisms, and/or increased specialization or simplification of certain subsystems.

Theoretically, cultures as complex adaptive systems may remain relatively stable or change at varying rates depending upon the overall equilibrium states of the human ecosystem, the initial conditions of the system, and the energetic circumstances of episodic change. Simple mechanical models of complexity have been developed that have implications for the analysis of cultural systems. Laszlo's (1987) formulation, for instance, is predicated on a

definition of system complexity in which higher levels of complexity are produced by the development of mechanisms that integrate numerous complex subsystems into a systemic whole. In this sense, integrative mechanisms can be used as measures of the scale of complexity within a human organizational system. Examining the timing among the emergences of these mechanisms provides one avenue for building arguments about the tempo and mode of cultural evolution. Culture, then, is conceptualized as an organizational system composed of various regulatory mechanisms responsible for managing the transference of energy from the environment to the social sphere and for directing the flow of energy between segments of the social universe. This emphasis on the relationship between culture and the natural environment is considered to be of fundamental importance in understanding the structure and organization of hunter-gatherer, as well as more complex types of, societies. In the case of hunting and gathering adaptations, the distribution of natural resources, which represent sources of available energy, act as primary determinants in the distribution of population across a landscape. Although the range of potential energy sources varies regionally and through time, such resources as vegetation and animal communities and the source locations of lithic materials used in the production of technomic artifacts were probably of fundamental importance throughout prehistory.

In emphasizing the primacy of environmental considerations, it is not deterministically assumed that human populations are at the mercy of their environment. Quite to the contrary, the redundant and diversified components of cultural systems tend to buffer the effects of environmental fluctuations, providing human populations with a range of possible solutions through which equilibrium of the culture may be maintained. Still, the ethnographic literature has largely borne out the

notion that the “logistical strategies” of hunter-gather systems, in particular, tend to be organized around the distribution of natural resources (Binford 1983; Kelly 1983, 1995; Hayden 1986, 1987). More complex social organizations, such as those that correlate with, pastoral, or industrial modes of adaptation, must be viewed in the same terms at some level, but the degree of differentiation and integration and the scale at which such systems are organized necessarily tends to be more complex along both horizontal and vertical dimensions. In other words, complex societies are, by definition, generally characterized by greater rank differentiation and economic specialization and are therefore increasingly capable of regulating greater variability in task delegation and in performance and management of energy flow (Tainter 1977). Although exceptions to the rule have been documented (cf. Lee 1979; Lee and DeVore 1976), hunter-gatherer societies are generally characterized by less complex organizational systems and tend to exhibit less status differentiation, lower population levels, and smaller population aggregates. Consequently, the logistical strategies of hunter-gatherer systems are more directly articulated with the distribution of natural resources. As such, the adaptive responses of hunter-gatherer systems are more likely to manifest either in the form of increased mobility and/or transformations in other social mechanisms, such as increased vertical or horizontal sociopolitical development or enhancement of intergroup trade and interaction networks, to maximize the capture of natural resources. As Cadwallader (1980:342) has pointed out, “an open system, whether social or biological, in a changing environment either changes or perishes. In such a case the only avenue to survival is change.”

Ultimately, the spectrum of activities involved in the procurement and processing of natural resources, the organization of these activities at

certain locations that correspond to natural resource availabilities, and the distribution of activity loci across the landscape comprise the subsistence-settlement system of a hunter-gatherer society at a particular point in time. Delineating the organization of subsistence-settlement systems consequently represents the first step in understanding hunter-gather adaptations. Arguably, understanding how and why cultures change is one of the primary goals of archeological research; however, the examination of culture change *over time* properly comes only after the elucidation of organizational systems at particular points *in time*. This means that the variable system states, or “postures” (Binford 1980), that characterize a particular cultural system at more or less one point in time must be fully delimited before significant temporal variation, such as would be of interest in the investigation of cultural evolution, may even be discerned.

The second major premise underlying this study concerns the relationship between human behavior and the archeological record. Specifically, the structure of the archeological record is assumed to reflect the behaviors and behavioral processes that characterize a cultural system in its pursuit of equilibrium. Sackett has outlined the epistemological consequences of this perspective as follows:

Activities are culturally patterned segments of human behavior that have received ordered expressions in the archaeological record. They are isolated in terms of clusters of associated elements—more specifically, the presence and non-random variation in the complementary distributions of attributes and/or classes of...the “dimensions” of archaeology: space, time, and form. Time and space define the loci of activities, while the activities themselves are formally expressed by artifacts—concrete manifestations of human behavior (1968:69).

In other words, the spatial and chronological structure of material remains, properly identified, serve as indicators of the activities responsible for the production of observed patterning in the archeological record. Stated another way, archeological materials are the physical residues of the dynamics involved in regulating the flow of energy into, within, and out of organizational systems (Binford 1965, 1980).

Extrapolating from the assumption that many of the activities in which hunter-gatherer populations are engaged across time and space function integrally in articulating effective interrelations with both the natural environment and with other social systems, it follows that archeological remains can properly be considered in terms of an analytical regime designed to detect functional relationships among components of an archeological assemblage (e.g., artifacts, features, ecofacts). Each functional unit within an assemblage reflects a task, or some phase of a task, undertaken by a particular segment, or subsystem, of a society. Relationships among functional units represent activities that may range in specificity, depending upon the scale of analysis, from an individual event, such as the butchering of an animal, to an entire range of behavioral processes that serve as antecedents to observable events, such as lithic procurement practices, organization of stone tool production, and seasonal resource scheduling involved in the capture of the animal.

All other things, including time, being equal, the spatial relationships among functional units of an assemblage, each representing a particular activity, define the structure of activity loci, either within a single site or across a landscape. The spatial relationships among activity loci within a single site define the structure of the site (or components of the site) in two-dimensional space. The analysis of site

structure, taken together with the relative emphasis on particular activities in relation to others and the spatial organization of activity loci, serve as the basis for interpreting site function. Site function ultimately refers to the relationships among the range of activities performed at one site and those that characterize the occupation of other sites occupied more or less contemporaneously by a single group or by comparable human populations (Winters 1969). Although site function is not, by definition, necessarily a comparative concept, it is most fruitfully understood within a comparative framework. Taken in this context, the study of site function lends itself to the delineation of settlement systems and, in the case of hunter gatherers, the patterns of mobility that mark the movement of people between temporary settlements, which are nodal points upon the landscape. Ultimately, transformation of any component variable internal or external to an organizational system (which introduces time into the equation), taken together with the reaction of the system to the change, comprises the basis for evaluating variation in system states and/or cultural change. Through the development and testing of hypotheses designed to explain the variability observed, the process of building theory about the processes that catalyze changes in human societies throughout space and time becomes possible.

A note of caution must be advanced within any study oriented toward the delineation of site function. Binford (1978, 1979, 1980), for instance, has demonstrated that site function cannot necessarily be determined in all cases, such as at small, temporarily occupied sites, based exclusively on the material culture inventory observed at the site. On the same note, it may not be possible to detect the full range of functional behaviors undertaken at a locality, particularly if certain behaviors do not have non-perishable material correlates or if the material correlates of an activity exit the

systemic context (Schiffer 1976) at another location. Furthermore, some natural processes, most notably erosion, may tend to collapse multiple, discrete occupational components of a site, resulting in a situation in which long spans of time and/or multiple system states are collapsed into a single stratigraphic horizon. Thus, one of the central tasks of archeology is the development of methods and techniques designed to detect patterning within the archeological record that is relevant to the elucidation of organizational systems. The relevance of such patterns is necessarily a function of the middle-range arguments that link the observed patterning to behavioral or systemic inferences.

Based on this consideration of first principles, our discussion now shifts to a more explicit examination of the way in which these general theoretical perspectives are operationalized in this research undertaking.

4.1.2 The Cultural Ecology Approach

The first theoretical paradigm upon which the current study is based is that of cultural ecology, also known as human ecology. Historically, this perspective derives in large part from the work of Julian Steward (1955), who formulated the theoretical framework of cultural ecology to elucidate the interrelations among subsistence practices, other economic behaviors, and other fundamental cultural patterns, such as social organization. Modern cultural ecology is a diversified field of inquiry that draws upon numerous fields of social science, economics, ecology, and geography. The conceptual threads of the paradigm are too diverse and complex to review in the present context; consequently, only those threads that lead to the basic principles of direct relevance to the present investigation are discussed.

As formulated by Ricklis and Collins (1994:5):

The cultural ecology approach focuses on the adaptive relationships of a culture or group to its environment (Anderson 1973; Helm 1962; Vayda and Rappaport 1968). While derived ultimately from the biological sciences, the ecosystem concept as applied in the archeological and social sciences necessarily incorporates some cultural and cognitive dimensions (Butzer 1990; Moran 1990). Based on the principles of systems theory discussed above, the human ecosystem, as defined here, involves three interrelated components (following Ricklis and Collins 1994:5): (1) human population as a biological phenomenon; (2) the population's environment and the opportunities offered by and the constraints imposed by the geographic and temporal heterogeneity of resources; and (3) culture as the complex adaptive system through which human populations articulate with the opportunities and manage the constraints of the environment to ensure collective survival.

Each of these three dimensions is composed of subcomponents and variables that must be taken into consideration. In general, population reflects adaptive viability by its relative size. Other things being equal, expanding populations result from favorable levels of essential matter and energy flow within the ecosystem, whereas declining populations signal serious systemic problems related either to environmental carrying capacity, disease, or cybernetic difficulties in one or more cultural components. In addition, the patterns of distribution of a population within its environment are key indicators of patterns of socioeconomic organization. In other

words, patterns of settlement are closely linked, though they may not directly reflect, the geographic and seasonal distribution and availability of resource extraction and processing opportunities.

As previously discussed, culture is the extrasomatic adaptive system involved in connecting a human population with its natural and cultural environment. Among the interrelated subsystems that may come into play in the extraction, processing, and distribution of energy in hunter-gatherer systems are technology, mobility and settlement strategies, social interaction patterns (e.g., intra- and intergroup relationships, marriage and kinship patterns, family and task group structure), political systems and decision-making structures, cosmological and mythological systems, and codes of morality. In archeology, especially prehistoric hunter-gatherer archeology, the more abstract social and cognitive dimensions of cultural systems tend to be very difficult to discern, but it is not theoretically impossible to do so.

Environment is both spatially heterogeneous and temporally dynamic. The spatial availability of resources provides a given population with adaptive opportunities as well as constraints, depending on the variability of availability and/or accessibility. Particularly for hunter-gatherers operating with more or less limited extraction, processing, and transportation technologies, the predictability and concentration (or patchiness) of resources strongly influences the timing, size, and location of socioeconomic groupings. Patterns of settlement and socioeconomic organization are thus closely interlinked

with spatial and seasonal patterns of resource availability.

The warranting assumption underlying organizational approaches to explaining cultural variability is that humans seek to maximize certain currencies in their responses to environmental conditions. As Jochim has observed:

Evolutionary ecology is the most coherent of current theoretical frameworks for explaining hunter-gatherer organization and change. Its underlying assumption is that if behavior has been shaped by natural selection to maximize fitness, certain optimal behavioral strategies may be expected and predicted. Most applications assume further that net energetic efficiency in foraging is a valid proximate measure of fitness, and consequently is maximized by natural selection. This is a simple, reductionist approach that suggests that the allocation of time or energy is determined by the spatio-temporal structure of the system (1989:106).

This perspective has been operationalized in archeology in numerous ways. Two of the lines of investigation that have proved most fruitful, and which also appear to have the most potential to make significant contributions to archeological theory building, are Binford's (1980) collector-forager dichotomy and optimal foraging models. A brief consideration of these research strategies will set the stage for the current study.

4.1.2.1 The Collector-Forager Dichotomy

The scheduling and nature of resource acquisition depends on (1) the regional extent and spatial structure of the targeted resource(s),

and (2) the seasonality and temporal extent of resource availability. In regions in which resources are abundant and available on a year-round basis, hunting-and-gathering groups can theoretically operate without a complex system of resource-acquisition scheduling. As population increases and/or resources become available on a seasonal basis, other strategies are required for the group to remain economically viable (Testart 1982). In areas with low resource productivity and/or irregular availability, complex scheduling of group foraging activities may be necessary to successfully extract and obtain critical resources over the entire year (Rafferty 1985). Research by Binford (1980), Kelly (1983, 1995), and Hayden (1986, 1987) illustrates how resource acquisition strategies among ethnographically documented hunter-gatherer groups can be characterized along a continuum ranging from forager- to collector-oriented.

The foraging strategy consists of a system of moving people to resources for consumption, wherever they occur in space and through time. This strategy involves relatively unrestricted scheduling; rather, the timing of group movement is dictated by resource depletion and the direction of movement is dictated by the location of the next resource or resource patch to be exploited (Binford 1980). This resource acquisition pattern tends to arise when resources are ubiquitously distributed across the landscape or are available over considerable periods of time. In cases in which critical resources discretely occur within an otherwise homogeneous region, settlements may be reused over long periods of time. When critical resources occur discretely within an otherwise homogeneous region (i.e., in “patches”), settlements near critical resource patches may display redundancy in use over long periods of time (Taylor 1964). Under such “tethered” conditions, foragers may develop a settlement pattern composed of two site types, with

residential camps located near critical resources and “low-bulk” procurement locations located near a wide range of short-term resources. Group size among foragers tends to be very fluid, and considerable coalescence and fission mark the foraging strategy. Storage plays a minor role in foraging economies because few resources are available in sufficiently large quantities to permit bulk acquisition and processing for lean-period consumption.

Tight resource procurement scheduling, as manifested by “seasonal rounds” of exploitation, is likely to occur when incongruently distributed resources are predictably available from limited zones within a broad, ecologically diverse region. Binford (1980) has designated this logistical strategy as a collector’s model, which is characterized by the planned exploitation of predictable, periodically available resources. Collectors use logistical strategies to resolve spatial or temporal conflicts in availability among critical resources, moving resources to the consumers through the employment of task groups to exploit resources that are discontinuously distributed but that occur in bulk. In regions inhabited by collectors, the scarcity of lean-season resources is often sufficiently pronounced that storage is necessary; ideally, the quantities of resources obtained through logistical foraging are sufficient to permit storage for delayed consumption. Storage extends the availability of a resource into resource-scarce seasons. The extreme lack of resources during the winter in temperate and colder environments, for instance, may be resolved through increased seasonal sedentism and increased storage dependence (Goland 1983).

Most of the extensively studied ethnographic groups fall toward the foraging end of the spectrum, while a few practice strategies that strongly emphasize collection. More importantly, some groups are foragers during a

part of their annual cycle and collectors during the remainder. Thus, the forager-collector dichotomy characterizes resource acquisition at the two extremes of a continuum (Bousman et al. 1990). A wide range of variation can occur between the dichotomous forager-collector adaptive strategies; indeed, some options may involve a seasonal shift from one strategy to another depending on resource scheduling and availability. In addition, whole regions or portions of regions may be “simultaneously” exploited by multiple societies with different foraging economies (Syms 1977:1-13). The relationships that develop among such archeologically contemporaneous groups depend on the nature, abundance, and importance of the target resources.

Various researchers have addressed the factors that generate logistically organized systems in temperate climates (Conaty 1987; Hayden 1986). In general, foraging strategies appear to correlate with the exploitation of evenly distributed and relatively stable resources, whereas collecting strategies appear to be more commonly employed in the exploitation of clumped and transient resources. In other words, logistical collection strategies become necessary as the patchiness of key resources increases and/or the duration of availability decreases. Foraging tends to generate a highly nomadic land-use pattern, whereas collecting lends itself toward more sedentary or semisedentary settlement strategies. Beyond these generalizations, researchers vary in their assessment of the critical characteristics of resources that cause hunter-gatherer populations to exploit them according to these two models. Hayden suggests that the reliability, richness, and seasonal nature of the resources are the critical aspects conditioning the mode of resource acquisition. Other researchers (Conaty 1987; Horn 1968) view availability and distribution (evenly distributed and stable versus

highly clumped and transient) rather than density as the critical variables.

Heffley (1981) suggests that three resource availability/distribution modes are the primary determinants of settlement patterns: (1) evenly spaced and stable; (2) mobile, clumped, and unpredictable; and (3) clumped and predictable. Evenly spaced and stable resources appear to be exploited by small groups under a dispersed, relatively mobile settlement pattern (i.e., foragers). Mobile, clumped, and unpredictable resources are often exploited in bulk by larger mobile groups, but the larger return for the energy invested generates storable surplus that permits some degree of seasonal sedentism (i.e., collectors). The highest degree of sedentism is found in the context of clumped and predictable resources (e.g., salmon runs by Northwest Coast groups). Seasonal variations in the mobility and patchiness of the resource base can stimulate a shift in mobility strategies by hunter-gatherers within a single annual cycle. Thus, groups such as the Tanana (Heffley 1981) exploit mobile, clumped, and unpredictable resources for short periods in the spring, summer, and fall and evenly spaced, stable resources throughout the remainder of the year; thus, a seasonally varying mix of logistical collecting and residential foraging strategies is possible.

One of the components of this discussion that is important in the current research undertaking concerns the strategies involved in gathering chert for stone tools and clay for pottery. Procurement of geological materials (in contrast to biotic and animal resources) is often attributed to incidental, or “embedded,” activities that are conducted while individuals are engaged in other economic pursuits (Binford 1980). Embedded collection behavior is especially evident where geological resources occur in areas with easily accessible subsistence resources and where materials are of sufficient size for manual transport. Other modes of

acquisition of non-biotic resources include group interaction and trade networks.

The forager-collector continuum is particularly useful for developing expectations about the relationships among resource acquisition and mobility strategies, site function, assemblage composition, occupation length, group size, and regional settlement and subsistence patterns (Ellis et al. 1993; Lintz et al. 1993). The archeological signatures of foraging strategies should differ from collecting strategies and should be marked by such things as low-intensity occupations except at tethered sites, low rates of curation and maintenance activities, a lack of stored or cached goods and other site furniture, evidence of highly generalized and portable assemblages, and possibly less assemblage variability at any given location because of the generalized approach toward resource procurement. In contrast, the collector strategy includes a hierarchy of sites in which base camps are situated near the most stable and abundant resource in the area, with field camps, observation points, and specialized work stations located near various other resources. Base camps can be archeologically distinguished by their greater intensity and duration of occupation, a wider range of site functions, evidence of curation and maintenance activities, storage facilities, communal processing areas, and other kinds of site furniture. Base camps should also tend to have a greater density and diversity of implements and residues than the satellite procurement loci and work stations.

4.1.2.2 Optimal Foraging Models

One aspect of resource procurement that is not explained directly by these broad models is the actual mix of resources utilized by prehistoric groups given the regional resource structures and procurement strategies outlined above. Furthermore, the specific constraints that influence hunter-gatherer decisions about

mobility and resource scheduling are only dealt with in a general descriptive fashion. Developments in optimal foraging theory help to fill in some of these gaps.

Optimal foraging theory is concerned with building and testing models of optimal strategies of energy acquisition. The concept of optimality, originally borrowed from microeconomics, is central to contemporary evolutionary theory, where it is recognized that natural selection operates on complex organisms in complex and variable environments, so that questions of adaptive response to any one problem or opportunity involve many other sets of adaptive responses and environmental factors. Since the complexity of most environmental situations leads to a multitude of constraints, the theoretically optimal solution favored by natural selection will balance various conflicting and/or interdependent demands (e.g., for growth, reproduction, avoiding hazards, capturing energy, competing, cooperating) to maximize fitness (cf. Smith 1979).

Optimal foraging models were originally developed by ecologists interested in understanding the factors affecting non-human foraging behavior (Kelly 1995). The utility of these models to the study of human foragers rapidly became apparent, especially since diversity in human diets cannot be attributed to differences in physical perceptual abilities, prey-capturing appendages, or predator size, all of which are sources of diversity in the non-human world (Hames and Vickers 1982, 1983; Hawkes et al. 1982; Kelly 1995; O'Connell and Hawkes 1984; Smith 1983, 1991; Smith and Winterhalder 1992; Winterhalder 1986a, 1986b, 1987; Winterhalder and Smith 1981).

Optimal foraging models include a *goal*, a *currency*, a set of *constraints*, and a set of *options* (Kelly 1995). In studies of hunter-gatherer foraging behavior, the goal is normally

maximization of foraging efficiency (i.e., food gathered per unit of time), though foraging efficiency need not be the goal. The currency most commonly used is caloric value, though again goals other than caloric intake are possible. Constraints include such things as the maximum amount of time that can be spent foraging or the forager's capacity to digest certain foods. Options include the range of potential food resources and other choices about how to spend time (e.g., childcare). Given a set of resources with specified characteristics (e.g., nutritional content, harvest and processing times), optimal foraging models propose how those resources were acquired and used.

While optimal foraging research has made substantial progress in measuring some of the trade-offs that modern human foragers make in managing the opportunities and constraints of their environments, optimal foraging models generally require a high degree of resolution that currently is not available in the archeological record. Specifically, the detailed botanical and faunal information needed to develop rigorous and quantified expectations regarding the resources utilized by prehistoric populations simply does not exist. Furthermore, the finely tuned time scale implicit in optimal foraging models is far beyond the reach of most archeological investigations.

However, this discussion of optimal foraging theory draws attention to the basic assumption that the limiting factors in energy capture are the *availability* of energy at the right time and at the right place (i.e., given where people are located and the mode of exploitation) rather than the abundance of energy itself (Smith 1979; Torrence 1983, 1989). Given the basic assumption that time-budgeting is crucial to hunter-gatherer behavior; organizational (i.e., cultural) responses to variability can be expected to vary according to both the character and the

severity of stresses in the environment. As summarized by Torrence:

[T]he degree of stress will mainly condition the quantity of the response, whereas the type of stress will determine the quality of adaptive...behavior....[I]f the total amount of time available is limited, tools which increase the speed at which the activity is carried out will be employed....In other cases, the overall quantity of time may be sufficient, but it may be necessary to schedule certain types of behavior in order to avoid competition among various activities for particular periods of time (1983:12).

4.1.2.3 A Note on the Explanatory Potential of Models

It is important to note when discussing models that models are not intended to be used as classificatory devices that describe and account for all possible dimensions of variability in the phenomena they are used to explain. Rather, models are intellectual constructs that are used to assess variability against a set of expectations, holding some variables constant while allowing others to vary. The implicit assumption in working with models is that the expectations of the model should hold only when *other things remain equal*. Thus, a model is a closed system used to measure variability in an open system. Because other things usually are not, in fact, equal, naturally occurring phenomena often will not conform to modeled expectations. Thus, models provide a baseline for identifying and investigating variability. The processes and assumptions that underlie the variability allowed by the model are known; variability not accounted for by the model represents a point of departure, pointing to phenomena that reasoned arguments, hypothesis building, and hypothesis testing must seek to explain. In other words, models are intellectual constructs and are not

designed to account for the full possible range of variability that occurs in nature.

However, archeologists often use models as descriptive and classificatory devices rather than as tools that help to measure the variability of organizational systems. Variability that cannot be accounted for by modeled expectations tends to be discarded, and the known variability becomes the focus for subsequent discussion. The use of modeled expectations about specified dimensions of behavior often results in the discovery that some organizational patterns at various points in space and time fail to conform to expectations. While these discoveries should properly represent the springboard for investigations into the causes of the observed similarities and differences, they are commonly used, erroneously, to argue for dismissing the models used.

This type of argument, in which a model is rejected because empirical evidence has been encountered that does not support it, is extremely common in archeology. It is unrealistic to expect all of reality to conform to the expectations generated from a limited set of observations and assumptions. Empirical evidence can *always* be found that contradicts generalizations based on other empirical evidence; this, in fact, is the point of the scientific method. It is the variability that we encounter that has the most potential to inform us about the differential organization of cultural systems through time and across space. If all cultural systems conformed to our expectations, there would be nothing left to learn.

4.1.3 The Culture History Approach

The underlying assumptions of culture historical research are (1) that identifying/defining sociocultural manifestations as normative phenomena and describing what happened to them are appropriate goals of archeology, (2) that stylistic variability within and among

artifact types denotes different sociocultural groups, and (3) that investigation of stylistic variation in material culture is the proper method for investigating the histories and interactions of specific sociocultural groups across space and through time. Thus, the culture historical approach is based on the idea that cultures encompass measurable dimensions that can be “mapped” across space and time based on “types” and “varieties” of classes of material culture (cf. Gifford 1960). These units represent the building blocks for constructing cultural taxonomies—the “periods,” “phases,” and “foci” of the Midwest Taxonomic System (McKern 1939). In turn, the arrangement of these cultural taxonomies in space forms the basis for building cultural chronologies through time.

Wiley and Phillips (1958) developed the procedural guide for chronology building that was subsequently used throughout North American archeology. The Wiley and Phillips approach assumes identities between archeological assemblages and specific groups of people that are presumed to be equivalent to the ethnic groups or emically defined cultures documented by ethnographers (cf. Binford and Sabloff 1982). The approach establishes such identities under the assumption that stylistic expressions are generally specific to sociocultural groups. Thus, according to the Wiley and Phillips procedures, an accurately defined phase represents a socioculturally integrated group of people who share a stylistic tradition by virtue of their sociocultural integration. A “phase,” therefore, is a representation of a single group of people who occupied a given geographic area for a given length of time. By extension, the process of building chronologies using Wiley’s and Phillips’ procedures is the process of building “social taxonomies” (Johnson 1987:20) that place a chronological sequence of particular societies within known spatial and temporal boundaries. Patterned changes within classes of

material culture are therefore presumed to represent changes through time within a single group and/or the movement and influence (i.e., diffusion) of different groups of people across the landscape (cf. Gifford 1960).

The degree to which studies of cultural chronology can be considered successful must be measured in terms of their ability to isolate and define particular sociocultural groups in the archeological record. This is not a functional or evolutionary mode of explanation. As chronological investigations are usually built on studies of one or more classes of material culture, criticism of the approach focuses on the issue of whether or not a chronology of projectile points, for instance, is anything more than a chronology of projectile points (cf. Peter et al. 1982a). In other words, the warranting argument that links variability in projectile point morphology to definable sociocultural units is that stylistic variability correlates directly with sociocultural or ethnic variability. To illustrate the epistemological basis of this argument, a review of the operative assumptions that are implicit in stylistic approaches to archeology is warranted. Ellis (1993) presents a thorough survey of the development of chronology building in Central Texas archeology, and the interested reader is directed to his work for details on the historical trajectory of culture historical research in Central Texas. The present discussion focuses on the epistemological framework within which culture historical research operates.

As a prelude to the following discussion, it is worth noting that studies of material culture were quite fashionable in the nineteenth and early twentieth centuries, often to the exclusion of other components of cultural systems. Ethnographic work conducted during this period included extensive, albeit rather sterile, descriptive inventories of material culture. As the field of anthropology matured, attempts to

understand how classes of material culture, such as fishing, hunting, or cooking technology, fitted into larger social, economic, and symbolic systems were rare, and interest eventually shifted away from material culture to new domains, such as kinship, sociopolitical organization, and ideology (Lemonnier 1992). As the field of culture historical research developed, the most common approaches to the study of material culture have tended to use “cognitive” and “stylistic” frames of reference in which stone tools, pots, and other aspects of material culture are used as more or less direct indicators of cognitive or social processes. While “cognitive” approaches to the study of material culture are more characteristic of Old World archeology, a brief review of their underlying assumptions are useful as elements of this paradigm tend to creep into the reasoning that supports many studies of “style” and sociocultural organization.

4.1.3.1 The *Chaîne Opératoire* and the Ancient Mind

The central assumption of cognitive approaches to the study of material culture is that a necessary relationship exists between the material expressions of human behavior and the mental processes of the actors. In the study of techno-economic artifacts---the most ubiquitous class of material available throughout most of the prehistoric archeological record---where this paradigm has achieved the greatest currency, ancient cognition is accessed through the *chaîne opératoire*, or *behavioral chain* (Lemonnier 1976; Leroi-Gourhan 1943, 1945; Schlanger 1994). The *chaîne opératoire* consists of a series of steps in the production of tools, beginning with raw material procurement and continuing through core preparation, blank production, retouch, use, resharpening and recycling, and discard. The act of fabrication is seen as a dialogue between the artisan and the worked material, with each step in the sequence

both facilitating and constraining the next. The trajectory between each link in the chain, such as between raw material acquisition and tool manufacture, is not linear, and the choices of the artisan, as conditioned by the physical properties of the raw material and the norms of the cultural tradition, are enacted at certain strategic moments. Based on the material evidence of past human actions, then, an “archeology of the mind” is possible.

Methodologically, analyses of the *chaîne opératoire* use the same classificatory and contextual devices as do most studies of material culture, but they invoke a radically different set of explanatory principles than those that are brought to bear in organizational approaches to past cultural systems. Variability in lithic technology, for instance, is explained in terms of the decision-making capabilities, as conditioned by the physical properties of raw material, and the motivations, as conditioned by cultural morés, of prehistoric flintknappers. By way of a brief critique, it is not clear what is to be learned from the *chaîne opératoire* aside from the idea that cognitive activity and decision-making represent part of the technological process. The operating assumption seems to be simply that knowledge is brought to bear and operationalized in technique. However, variability is attributed to the idiosyncratic behavior of individual flintknappers operating within a virtually infinite series of unique events rather than to any social dimension that necessarily involves broader cultural processes. Assuming, for the sake of argument, that knowledge of the idiosyncratic behavior of individual actors is germane to the explanation of organizational systems or cultural change, a necessary causal link between mental templates and technological behavior has not been demonstrated. In addition, this logical framework is purely accommodative, and analytical results do not appear to possess any objective or replicable properties, rendering

them largely useless in the process of hypothesis formation and testing.

4.1.3.2 Style and the Prehistoric Emic

In contrast to the *chaîne opératoire*, which is believed to represent a material map of the “mental templates” of prehistoric craftsmen, stylistic approaches deal primarily with informational aspects of material culture. Stylistic analysis of archeological assemblages are predicated on a dichotomous distinction that is presumed to exist between function, which is associated with evolutionary processes, and style, which results from stochastic processes with no “detectable selective value” (Dunnell 1978). Stylistic aspects of technological behavior are considered to involve arbitrary choices, physical actions, and materials that are not dictated by function, but which are instead an integral feature of larger symbolic systems.

Although rarely explicitly stated, the underlying assumption of stylistic analyses is often that the etic can be recreated through analysis of the emic, rather than the other way around, as expressed in the choices and symbology of technological productions. The influence of post-processual archeology can be clearly discerned here (cf. Hodder 1986). Style is defined as the manifest expression on the behavioral level of cultural patterning that is neither cognitively apprehended, nor even necessarily knowable, by the members of a cultural community (Close 1978). Thus, penetrating through to the emic so that the etic can be reconstructed is the duty of the archeological community. Implicit within this approach is the assumption that the emic component of past systems, the perceptions of the actors, can be accessed by “interviewing” prehistoric flintknappers or potters through the medium of the refitted core or the arrangement of punctuations on a ceramic vessel. As causal links between cognition or received knowledge

and technological consequences have proved to be difficult to demonstrate, the reconstruction of past systems or sociocultural groups tends to be true by definition and is not available to public scrutiny, testing, reproduction, or falsification. As such, stylistic studies of sociocultural systems tend toward “paleoethnology” rather than science.

To illustrate the pitfalls of this approach, this discussion turns to an examination of an often-cited study of variability in North African lithic assemblages. Close (1978) argues that a single end, or function, can frequently be achieved by any one of several, equally valid means (cf. Sackett 1977). The specific method chosen, then, is independent of functional considerations, and is determined by what has been learned in the broader sociocultural context. To test this assumption, Close considers several alternate explanations for lithic variability, including the “handedness” of the toolmakers. After discounting as many alternate hypotheses as possible, Close accepts the only remaining hypothesis on the list, which posits stylistic preference as the explanation for variability. Beside the fact that this form of argument is largely specious, a necessary link between style and variability is not demonstrated and the causal “social factors” are never identified. The argument, true by stipulation, is not constructed in such a way as to be falsifiable, yet it is nevertheless used to support the assertion that stylistic variability provides the most reliable means of identifying social groups in the archeological record.

A rare exception to the rule is presented in Johnson’s (1994) study of Late Prehistoric Toyah phase projectile points in southwestern Texas. Through rigorous application of pattern-detecting techniques and statistical validation, Johnson demonstrates that patterned variability exists within a certain class of artifacts—Late Prehistoric Perdiz points—that has both a

morphological component (i.e., patterned variability within the artifact class) and a related spatial component (i.e., geographic segregation of detected pattern clusters). To explain this variability, Johnson hypothesizes that the morphological and spatial patterning observed in Perdiz points represents sociocultural variability, perhaps even distinctiveness among emically defined cultural groups living in a landscape at the same point in time. As a hypothesis, this argument is valid, though it is possible that the observed variability may be equally well explained in reference to a functional argument. This is the point from which hypothesis building and testing must necessarily be launched.

In defense of stylistic approaches to reconstructing culture history, there can be no doubt that symbolic systems represent important components of any human culture, and that these symbolic systems are encoded, among other things, in stylistic material expressions. The problems that arise in identifying and interpreting style in archeology are that (1) only the non-perishable components of material culture tend to survive in the archeological record, (2) identifying non-functional variability that is truly stylistic in its origin and frame of reference is problematic, and (3) demonstrating a necessary link between stylistic variation and some meaningful dimension of sociocultural distinctiveness has not yet been conclusively demonstrated (in most cases, it is not even hinted at). While ethnographic studies of potters have demonstrated a possible link between the process of transmitting pottery-making skills (i.e., ceramic variability) and specific sociocultural groups (defined by matriline in many cases [cf. Rice 1984]), the problem is significantly more complicated with projectile points, the artifact class that is used most often as an indicator of stylistic variability in Central Texas and upon which most of the cultural chronologies are built (cf. Hudler 2003a).

Despite these difficulties, the historical perspective is a valid mode of interpretation in archeological research (cf. Sahlins 1985). In addition to elucidating the organization of economic systems in prehistory, the movement of specific sociocultural groups across the landscape and their interactions with other groups are important modes of analysis for understanding the human past. It is conceivable that some kinds of patterning in the archeological record might, in the end, be better explained by reference to a sociological or historical mode of reasoning than an adaptive or scientific one. For prehistoric cultures that existed before any ethnohistoric records were recorded, style may be the only source of information with the potential to offer insights into the origins, development, behavior, and fate of specific groups of people. Thus, historical exegesis is a mode of explanation that deserves to be more fully elucidated and supported with middle-range theory than it has so far enjoyed in archeology.

4.2 RESEARCH DOMAINS

The scope of research within which cultural resource management- (CRM-) based archeology usually operates tends to be somewhat narrowly defined. This is as much, if not more, the result of the site-focused nature of CRM archeology than it is due to the biases or interests of specific researchers. While large-scale survey, testing, and data recovery projects, such as reservoir studies, provide rare opportunities to investigate entire settlement systems, most CRM studies are based on limited investigations of single sites or a small number of sites, and the resulting range of research parameters tends to be largely site-specific. Even on multiple-component sites, the “system states” or “postures” represented by definable components represent only a part of the cultural system of which they form a part. Thus, examining components within single-sites, even

under ideal circumstances in which they can be clearly defined stratigraphically and chronologically, does not necessarily provide a substantive basis for evaluating larger-scale organizational systems or cultural change. For example, a definable bison-processing “episode” in one component may be clearly stratigraphically separated from an underlying component containing a diversified base-camp. Other things being equal, such diverse “system states” might represent two events within the seasonal round of a single cultural group, different site types representative of distinct contemporaneous groups, or an economic shift over time from generalized foraging to specialized bison hunting. Evaluations of systemic organization and cultural change must be based on the investigation of entire organizational systems at definable moments in time. While larger-scale organizational systems and historical processes can be addressed from the perspective of site-based archeology to some degree, opening up the scope of research provides a broader comparative framework within which to build better-informed hypotheses about systemic phenomena.

With this in mind, the research program for the Varga Site incorporates site-specific lines of investigation as well as reference to a more regional base of information. While there are avenues that can be profitably explored from the perspective of site-based archeology, studies of settlement and mobility patterns are best approached from a comparative, multi-site program of research. Thus, while most of the database in this research design derives from data recovery excavations at the Varga Site, several lines of investigation involve studies of archeological and geomorphological materials from other sites and locations in southwestern Texas. The proposed supplemental database provides a cost-effective way to develop a more comprehensive suite of data relevant to this

research program, and it will provide a broader comparative base for other researchers.

The following discussion is organized into five general research domains—Paleoenvironmental Reconstruction, Subsistence, Technology, Culture History, and Mobility and Land Use. These research domains encompass general problem areas within which focused research questions are explored to provide the foundational data upon which archeological inferences are based. These domains do not represent exclusive avenues of research in their own right; rather, they serve as means to organize research questions that share certain operative assumptions, modes of analysis, and data requirements.

The first three research domains—Paleoenvironmental Reconstruction, Subsistence, and Technology—ask basic questions about paleoenvironmental conditions, site formation processes, tool and feature functions and production processes, lithic procurement and manufacturing strategies, and subsistence resources. The answers to specific questions posed within each of these domains comprise the data set upon which hypotheses about adaptation and culture historical relationships are built. The final two research domains—Culture History and Mobility and Land Use—represent secondary domains within which the primary data sets are manipulated to answer questions that pertain specifically to the historical/sociological and organizational/adaptive spheres of research.

Within each broad research domain, specific research questions are posed. Some of these questions have relevance to more than one domain of research; this is to be expected, as cultural systems incorporate integrated systems of behavior and archeological data sets are often pertinent to more than one research category. For the sake of clarity and brevity, formal “null”

hypotheses are not presented, although these may be fairly easily deduced. The research questions are merely testable propositions to which alternate answers or modes of interpretation are appropriate. This research has not set out to “prove” any single idea; rather, the approach is to propose various alternative explanations of observed patterning and to gather evidence needed to confirm or disprove them. As the following discussion will show, some research questions are explicitly sociological or ecological in reference, whereas other questions lend themselves equally well to culture historical and ecological lines of investigation. Unless otherwise noted, all research questions pertain to all identifiable components at the Varga Site, including the Late Prehistoric (Toyah phase), Late Archaic, Middle Archaic, and Early Archaic components. Clearly, the available data sets are more robust for some components than for others as the result of differential preservation conditions, and the range and depth of results are correspondingly richer for some time periods than for others. As the following discussion will illustrate, proxy indicators of important data sets are proposed for components that may lack one or more direct lines of evidence (i.e., using lipid residue analysis as a proxy measure in components with poor organic preservation). This is considered to be a critical mode of investigation as it contributes to the development of middle-range arguments that can be operationalized on other sites that lack one or more classes of primary data.

Following the listing of specific research questions within each research domain is a brief consideration of the relevance of the research domain to the broader theoretical issues of concern. Next, the data requirements for answering the research questions are outlined. Finally, the investigative strategies that were used to generate and to detect patterning within the necessary data are discussed. This section

includes a discussion of the specific data (i.e., range of observations) that are needed, the analytical methods, and the middle-range warranting arguments, as appropriate, that provide the justifications for using the data to address the questions asked. The investigative strategies section also presents available information about data recovered from the Varga Site that are relevant to the research domain. This information derives from the previously submitted interim reports that describe the results of data recovery excavations at the Varga Site (Lintz et al. 2002; Owens et al. 2002) as well as from preliminary assessments that have been conducted of specialized data sets to determine whether or not data would be available (i.e., lipid residues in burned rock, pollen, phytoliths). Actual counts and the presence and absence of certain data sets are known and specific counts of samples are presented for specialized analyses.

4.2.1 Paleoenvironmental Reconstruction

The theoretical foundations of this research program regard environmental conditions as a primary context of opportunities and constraints to which hunter-gatherer subsistence and mobility strategies represent responses. The climatic conditions, spatial (i.e., geographic) and temporal (i.e., seasonal) structure of biotic resources across the landscape, and hydrologic conditions at any given point in time represent strong causal factors in the organizational behavior of hunter-gatherers. Similarly, changes in one or more dimensions of the natural setting may represent important sources of change in human adaptive systems over time. Consequently, paleoenvironmental reconstruction is an essential component of this research design. Reconstruction of past environments and climates provides the backdrop for understanding the relationships between human activities and the environment.

The seasonal availability and geographic distribution of resources in the natural environment directly and significantly affect the foraging, settlement, and technological strategies employed by hunting and gathering populations. Thus, one objective of this research program is to recreate the mosaic structure of natural resources with the highest possible degree of resolution so that it is possible to document changes in the floral, faunal, and physical environment over time, which in turn will serve as the basis for evaluating the effects of spatial and temporal resource variability upon prehistoric organizational systems. The other chief concern of this project is the reconstruction of the depositional and erosional regimes that characterized and influenced the formation of the terrace deposits that contain the archeological materials at the Varga Site and the degree to which these were local versus regional processes. The task of paleoenvironmental reconstruction is therefore, a function of local landscape factors as well as regional, and possibly even global, environmental characteristics, as well as, the preservation of primary data sets.

Paleoenvironmental reconstruction is concerned with establishing the nature of the non-human environment to identify the natural conditions upon which human populations depended. In this way, the study of paleoenvironmental conditions provides an independent frame of reference for making inferences about cultural systems. This is not to say that humans did not form an integral component of the natural environment or that the behavior of human populations had no impact on the environment (cf. Butzer 1982). Rather, it is to make a heuristic distinction that somewhat simplifies the description and explanation of human ecology by first isolating its non-human components and then placing the human components in context (Ellis et al. 1993). Thus, the object of this domain of research is to develop as detailed an

understanding as possible of the environmental conditions and processes with which humans interacted.

Thus having established the importance of paleoenvironmental conditions as an independent frame of reference, it is important to note the limitations imposed upon this task by site-based archeology. Ideally, paleoenvironmental reconstruction would be undertaken from a regional perspective using data from non-cultural contexts (i.e., data gathered from natural as opposed to archeological contexts). However, it is not always possible to undertake comprehensive regional paleoenvironmental investigations within the context of site-based archeology; consequently, this task is necessarily dependent on previous regional research and on data recovered from on-site archeological deposits. While the paleoclimatic indicators recovered from archeological deposits may directly reflect past environmental conditions, they can be skewed as the result of cultural and taphonomic factors. Though some organic data sets (e.g., pollen) are somewhat more resistant to cultural factors than others (e.g., macrobotanical remains), the cultural and natural taphonomic factors that influence the formation of archeological assemblages must be carefully evaluated. In this context, the differential rates of preservation of such things as bone, shell, and floral remains must be taken into consideration, and questions of context must be resolved. When one or more primary data sets (e.g., faunal bone, macrobotanical remains) are poorly preserved, proxy indicators of plant and animal resources may be necessary (e.g., lipid residues, stable carbon and nitrogen isotopes). Following this, reconstructing the actual potential of the general region to supply various food and material resources is an analytically distinct task, though it is necessarily based on much of the same data. Clearly, any assemblage of subsistence remains on an archeological site

reflects the selection processes of the occupants of the site and preservation processes more strongly than it reflects the natural structure of the surrounding environment. Thus, it is necessary to use as many alternate lines of investigation as possible in reconstructing paleoenvironmental conditions.

4.2.1.1 Research Questions

- Did local and/or regional climatic change occur over time in the vicinity of the Varga Site? If so, what were the characteristics and trajectories of change?
- What floral and faunal communities characterized the local and regional natural settings of the Varga Site through time?
- What animal populations existed (locally and regionally) in the vicinity of the Varga Site through time? What migratory animal species may have been available? What relative degree of emphasis on *r*-selected versus *k*-selected species is evident?
- What geographical and temporal patterns of resource availability characterized the biotic communities surrounding the Varga Site through time at local and regional scales? Which resources were available on a seasonal basis? Which resources were available year-round? Which resources were available locally? Which resources were not available locally? Which resources were available continuously (geographically)? Which resources were available in discontinuous patches?
- Do the floral and/or faunal assemblages show changes in climatically sensitive species over time?
- What topographic and geomorphological features characterized the Hackberry Creek floodplain and nearby upland settings

through time? What topographic features did fluvial processes produce in the Hackberry Creek floodplain?

- At any given time, did colluvial processes at the interface between upland and fluvial surfaces create surfaces that would affect biotic diversity and/or patchiness?
- Were the depositional and attritional geomorphological processes that influenced the development of the Hackberry Creek floodplain and nearby uplands local processes (i.e., specific to Hackberry Creek) or regional processes? How do the sediments on and near the Varga Site relate to other alluvial chronologies in the region?
- What was the distribution of water sources in the vicinity of the Varga Site?
- Can human influences on the landscape be identified in the archeological record?
- Did the composition, spatial patterning, and/or seasonal structure of ecological communities change over time?

4.2.1.2 Relevance

Paleoenvironmental reconstruction is necessary because the natural environment provides the array of biotic and geological materials used by hunter-gatherers, and the spatial (i.e., geographic) and temporal (i.e., seasonal) arrangements of these resources across the landscape and through time represent the opportunities and constraints that conditioned the organizational responses of cultural groups with hunting and gathering economies. Thus, understanding the difference between what was available and what was chosen for subsistence is a major factor in developing hypotheses about hunter-gatherer adaptations and the potential environmental causes for change in subsistence strategies. In addition, understanding

environmental conditions that affected the nature, timing, and rate of sediment deposition and incision through time is important in developing hypotheses about hunter-gatherer land-use strategies and site formation processes.

4.2.1.3 Data Requirements

Stratigraphic Profiles and Sediment Samples

Detailed stratigraphic profiles of relevant contexts in the T0, T1, and T2 terraces of the Hackberry Creek valley were recorded during data recovery excavations and geoarcheological trenching. These profiles will serve as the basis for defining sedimentary units and archeological components, establishing the chronology of sediment deposition and site occupation (together with chronometric dating techniques), and selecting samples of data sets for specialized analyses that are pertinent to the task of paleoenvironmental reconstruction. Samples of sediment from on-site control columns as well as from a variety of feature and non-feature contexts were collected to support these studies.

Chronometric Assays

Radiocarbon assays of organic remains, such as faunal bone, charred wood, shell and organic inclusions in sherds and burned rocks from cultural and non-cultural contexts, as well as sediment humate assays from more generalized contexts, as necessary, serve as the primary basis for evaluating a broad range of questions about site chronology. Optically stimulated luminescence (OSL) dating of quartz grains in sediments collected from definable strata also were used as a proxy dating method. In reference to the paleoenvironmental research domain, a comprehensive chronometric dating framework is needed throughout the stratigraphic sequence at the site to firmly establish the spans of time over which discrete

sediment units formed. In addition, three ceramic sherds from the Buckhollow Site, two sherds from the San Lorenzo Mission Site (41RE1) in Camp Wood, Texas, and two sherds from the San Juan Mission (41BX5) in San Antonio were processed (see below).

Faunal and Floral Subsistence Data

While analyses of the floral and faunal remains from the Varga Site are primarily relevant to studies of prehistoric diet and, secondarily, to resource procurement strategies, faunal and floral subsistence data comprise a proxy data set for reconstructing paleoenvironmental conditions. Thus, most of the analyses conducted in reference to the subsistence research domain (discussed in Section 4.2.2) are also relevant to paleoenvironmental reconstruction.

Macrobotanical evidence collected from various on-site contexts, including feature and non-feature contexts, were identified and quantified. Clearly, data from discrete stratigraphic contexts (e.g., features, securely dated sediment zones) provide the best basis for reconstructing paleoecological communities, but samples from less discrete contexts (e.g., general sediment zones) also provided significant supporting evidence.

Evidence of faunal subsistence resources were identified and quantified from on-site features as well as from less discrete on-site contexts. Macroscopic data such as faunal bone, mammal teeth, and shell represent the best data for evaluating the range of animal resources exploited by the inhabitants of the site and provide a method for investigating paleoenvironmental conditions.

Evidence of faunal and floral resources were analyzed based on extraction of lipids (fatty acids) from burned rock and ceramic sherds.

Previous research has demonstrated that organic residue samples can be extracted from burned rocks (including limestone, the predominant form of cooking stone at the Varga Site) used by prehistoric peoples to process foodstuffs (cf. Malainey and Malisza 2003; Quigg et al. 2001). This proxy line of investigation may be helpful when conditions are not conducive to the preservation of primary organic data, such as macrobotanical remains and faunal bone, and in older deposits in which organic preservation generally is not good.

Pollen and Phytolith Analyses

Analyses of phytolith and pollen data collected from T0 terrace sediments, the fine-grained sediments in which the cultural components are situated, were analyzed. While pollen and phytolith profiles from non-cultural settings are preferred in reconstructing plant communities, site-based data can also be profitably used for this purpose. Changes in pollen profiles can often be interpreted reliably as corresponding to changes in the general character of an area's vegetation (Bryant and Holloway 1985). Similarly, phytolith analysis can provide information about the basic structure of plant communities at least to a level of resolution that distinguishes between forested and grassy environments (Rovner 1988). Phytolith analysis, therefore, may be useful in identifying basic shifts in the composition of vegetation communities at large scales. Twenty paired sediment samples collected from a column in excavation Block A and five paired sediment samples from dated context were analyzed for pollen and phytoliths (as well as for stable carbon and nitrogen isotopes).

Granulometric Data

Granulometric studies (six samples) were conducted on the same column sediment samples from excavation Block A on and four

other dated sediment samples which pollen, phytolith, and stable isotope studies were performed. Grain-size analyses are pertinent to reconstructing the fluvial conditions under which sediments were deposited.

Isotope Studies

Stable carbon and nitrogen isotope data collected from a variety of contexts was analyzed. Twenty sediment samples collected from a column in excavation Block A and five sediment samples from other dated context within the site were analyzed for stable isotopes (as well as for pollen and phytoliths). In addition to the sediment column samples, isotope studies were conducted on one sample of faunal bone from archeological contexts. Specifically, bison bone from the Late Prehistoric component and deer and/or antelope bone were analyzed for stable isotopes from any component in which they occur. Finally, the organic residues recovered from 13 ceramic sherds and 87 burned rock matrices were analyzed for stable isotopes. Evidence of carbon and nitrogen isotopes extracted from burned rock were used in conjunction with the lipid residue evidence from the exact same samples of burned rock to help interpret the results of the fatty acid analyses. This varied suite of carbon and nitrogen isotope studies provides multiple lines of investigation that serve as proxy indicators of local and regional vegetation communities and also helps to interpret the results of other analyses.

4.2.1.4 Investigation Strategies

Strategies for the extraction of paleoenvironmental information included stratigraphic analysis of sediments in the T0, T1, and T2 of Hackberry Creek, analyses of macro- and microfloral and faunal remains from excavations (that included screened and floated samples); phytolith, pollen, and grain-size

analyses of sediments from a column sample in the first terrace at Block A (as well as supplementary pollen and phytolith data from feature sediments); and stable carbon and nitrogen isotope analyses from sediment column samples, faunal bones, and organic residues recovered from ceramic sherds and burned rock matrices. This suite of analytical techniques is tightly integrated, and several of the techniques contribute information relevant to subsistence studies as well as to paleoenvironmental reconstruction.

Stratigraphy and Chronology

Stratigraphic and chronometric analyses are the backbone of this research program. Consequently, they are discussed in detail in this section, though they apply equally to all research domains. Stratigraphic interpretations are necessary to reconstruct the dominant sedimentation environments through time. Preliminary stratigraphic interpretations were presented in the two interim reports submitted following the two episodes of data recovery fieldwork (Lintz et al. 2002; Owens et al. 2002). Additional studies focused on refining existing interpretations of stratigraphic units, and possible erosional episodes, delineating floodplain and terrace formation processes at the site, assessing the ages and development of the terrace sediments, and evaluating whether alluvial processes are unique to the Hackberry Creek Valley or operated at a regional scale.

Absolute dating techniques established bracketing dates for depositional events associated with the archeological components and with episodes of terrace formation and incision. The framework established by the absolute dates was used to anchor relative dating strategies based on typological seriation. The radiocarbon dating program consisted of a multi-stage process. Sixty-six radiocarbon dates were obtained for the Varga Site.

The dating program advocated relied heavily on AMS radiocarbon dating. AMS methods are capable of providing accurate assays on small samples, but the accuracy of the resulting age estimates depends on the degree to which the samples can be securely linked to geological events. In other words, large, immobile, and stratigraphically secure objects provide more reliable age estimates than materials that have been significantly altered chemically by weathering or pedogenic processes (cf. Stafford et al. 1987). In addition, the viability of radiocarbon studies is entirely dependent on the preservation of organic materials in the archeological record.

Based on the stratigraphic interpretation of the Varga Site deposits, organic preservation is excellent for the Toyah phase component but somewhat patchier for more deeply buried strata. Faunal bone, wood charcoal, and carbonized seeds and nutshells are present in the most of the four assemblages, but to different degrees. Flotation of sediment samples collected from individual features provided macrobotanical samples suitable for radiocarbon dating. Occasional chunks of wood charcoal were recorded from feature contexts in the Late Archaic and Early Archaic components, but most of the organic materials that were recovered from the lower (i.e., sub-Toyah) sediment zones occurred in non-feature contexts. Whether these materials were in situ or translocated from overlying events was of abiding concern.

Thus, the strategy that was employed for radiocarbon sample selection focused on directly resolving chronological issues and also on providing a set of “tie-ins” for radiocarbon assays determined on non-charcoal samples (e.g., faunal bone, sediment dates, snail shell, pottery and burned rock residues), which are thought to have larger degrees of error and a broader range of potential interpretive problems.

Large pieces of in situ charcoal were the preferred materials, and burned rock features were the preferred contexts. Other materials selected for radiocarbon dating included faunal bone, snail shell, sediment humates, and organic residue from burned rocks and pottery sherds, as applicable, ideally from secure stratigraphic contexts. To provide the most secure context for interpreting radiocarbon dates on such materials, an attempt was made to run dates on carbonized wood, nuts, and/or seeds as well as on bone, shell, sediment humates, and/or pottery and burned rock residues from comparable contexts in order to determine the range of potential chronometric variance in different sample types. Thus, a broad range of material types were radiocarbon dated from the Toyah phase component, which contains the entire suite of dateable materials recovered. The suite of dates thereby served as a frame of reference for radiocarbon dates derived from the lower components, which contained more limited range of potentially dateable materials (i.e., aside from scattered charcoal, bone, and nut shells recovered from non-feature contexts in the Early Archaic component. Understanding the relationships among radiocarbon dates on a range of materials from a secure context like the Toyah component helped in the interpretation of dates obtained from a more limited range of sample types from earlier components in which organic preservation is poorer.

The radiocarbon dating strategy was a multi-staged process between the radiocarbon specialists and the archeological analysts. An initial run of radiocarbon samples was submitted and processed while the second phase of excavations was still underway. The initial run consisted of one sample from each of the Late Prehistoric, Late Archaic, and Early Archaic components selected from materials recovered during the first data recovery phase. Following submission of the second interim report (Owens et al. 2002), 24 additional samples were run,

yielding seven Late Prehistoric dates, six Late Archaic dates, four Early Archaic dates, and five sediment humate dates. The radiocarbon dates were derived from the three primary cultural components (i.e., Late Prehistoric, Late Archaic, and Early Archaic), but several dates were obtained from the Middle Archaic component.

In addition to the robust radiocarbon dating program undertaken, this research program developed an independent frame of reference for chronology building based on OSL dating. OSL is still a somewhat experimental technique, but it has provided potentially promising results and offers an alternative to radiocarbon dating at sites or in specific stratigraphic contexts that do not offer well preserved organic carbon (cf. Bruseth and Martin 2001). Basically, OSL measures the amount of light emitted by crystal grains in sandy sediments and determines the amount of time that has elapsed since the grains were last exposed to daylight. The technique can be used to provide dates on sediments that are composed of or contain quartz or feldspar within a range of 100 to 200,000 years. To demonstrate the utility of this technique for dating the more deeply buried sediment units at the Varga Site (i.e., the units that do not have good organic preservation), it was necessary to run a control set of OSL dates for the components that yielded a reliable radiocarbon chronology (i.e., Toyah, and Late Archaic) to establish an interpretive framework. Seven sediment samples were collected for OSL dating during the second phase of data recovery excavations, which included two from the Late Prehistoric Toyah component, two from the Late Archaic component, and three from the Early Archaic component.

Thus, the chronological framework for the Late Prehistoric component was built using multiple radiocarbon dates on various kinds of organic materials that included burned rock and ceramic residues, wood charcoal, carbonized seeds/nuts,

sediment humates, and OSL. This established both an alternate framework of dates for the Toyah phase component itself, as well as a set of links between charcoal dates and dates run on a variety of other materials. The Late, Middle, and Early Archaic period components yielded some wood charcoal, nut shells, and faunal bone, which were dated, thus allowing us to rely more heavily on the reliable organic materials and not on humate dates as is often the case at so many older sites. The robust radiocarbon dating program allowed us to determine that some charcoal and bone pieces were translocated downward.

Geomorphology

A major geomorphic research question for the Varga Site concerns how the sediments within and adjacent to the site relate to other alluvial chronologies in the region. Nine backhoe trenches were excavated in the T0, T1, and T2 terraces to obtain relevant geomorphological data. Radiocarbon-dateable sediments were recovered from trenches in the T0 and T1 terraces in the interest of developing an alluvial chronology for this part of the Hackberry Creek valley. The question then arises as to whether this chronology correlates with others in the region or if it is relatively unique.

While it is not within the scope of this research design to conduct a systematic study of alluvial chronologies for southwestern Texas, two avenues of investigation provided at least a preliminary basis for establishing a regional geomorphic context for the Varga Site. First, previous research conducted on floodplain and terrace formation processes in the region was evaluated and discussed in the context of the results from investigations at the Varga Site. As discussed in the first interim report (Lintz et al. 2002), relatively little is known about the geomorphological conditions of the rivers within the southern Balcones Escarpment region (Blum

et al. 1993; Mear 1953, 1998). In general, previous research has concluded that the relative height of terraces does not permit the correlation of ages due to the differential stream gradients. Thus, it is conceded that the results from one stream valley can not be used as a measure of alluvial chronologies in adjacent systems.

The second means used to establish a regional geomorphic context was to determine if chronologies can be correlated across stream valleys in the deeply dissected Balcones Canyonlands. Specifically, Johnson (1994:17) describes a buried soil horizon in the Copperas Creek terrace at the Buckhollow Site (41KM16) in Kimble County, Texas. The Buckhollow Site is located on an alluvial terrace that overlooks the confluence of Copperas Creek and the North Llano River approximately 96 km (60 miles) north of the Varga Site. Based on the preliminary results of geomorphological analysis of the Varga Site sediments, the Varga and Buckhollow sites appear to have experienced similar depositional sequences. Specifically, the sediment zones designated as Units II and III in Block A of the Varga Site appear to be similar, if not identical, to the Buckhollow Site's Components 4 and 3, respectively (Johnson 1994:17, Fig. 5). At the Varga Site, Unit II is currently being interpreted as a buried A horizon underlain by a thin lens of pea-sized gravels (Unit III), which in turn constitutes the capping layer of a thick Bk horizon that shows considerable evidence of pedogenic development (Owens et al. 2002). At the Buckhollow Site, Johnson (1994:17) describes the stratigraphy as follows:

The next episode of flooding saw the slow build-up of a very compact clayey silt with some sand, about 10 ft. (3 m) thick (Component 2). The growth of this alluvium is thought to have been fairly constant, occurring at a slow but steady rate.... Above this clayey silt is a very thin lens of pea-sized gravel and small river

cobbles (Component 3), bespeaking a large-scale flood on Copperas Creek itself. In contrast, the underlying fine-grained sediments [Component 2] were derived largely from the North Llano River and its headwaters....Above the pea gravel, milder flooding again created a stratum of clayey silt with sand which is about 4 ft. (1.2 m) thick (Component 4). The lack of internal bedding argues for a very slow rate of deposition and growth—so slow that small lenses of graded sediments have had plenty of time to become homogenized by bioturbation and the formation of an A soil horizon that moved ever upward as the terrace surface increased very slowly in elevation.

The similarities between the Varga and Buckhollow stratigraphic sequences are intriguing. Other correlations besides the buried A horizons and underlying pea-gravel lenses may also exist between the two sequences. While the deposits at the Buckhollow Site are considerably thicker than those in the investigated portion of the Varga Site, the relative proximity of these two sites raises the distinct possibility that investigations of sediments at both sites are directly relevant to the evaluation of regional paleoclimatic patterns. The buried A horizon (Component 4) at the Buckhollow Site was not systematically investigated by Johnson as he was primarily concerned with the overlying Toyah phase component; consequently, radiocarbon dates were not run on Component 4 sediments or associated cultural materials. Nevertheless, Johnson identifies Component 4 as being associated with the Late Archaic period; at the Varga Site, Unit II is the buried A horizon that contains Feature 1, the Late Archaic feature that is being tentatively identified as an incipient burned rock midden. We intended to investigate and compare the two sediment zones from these two sites, but we could not locate a well-provenienced sediment sample from the curated

Buckhollow materials in which to pursue this line of investigation.

Flora and Fauna

Analyses of archeofaunal and archeobotanical remains form an important component of paleoenvironmental as well as subsistence studies. As discussed above, the plant and animal remains recovered from archeological deposits generally do not directly reflect the structure or distribution of plant and animal communities in the local and/or regional environment, but they can serve indicators of the kinds of natural resources in the past environment. The assemblages of archeofaunal and macrobotanical remains from the Varga Site were recovered from coarse (6.4 mm) and fine (3.2 mm) screening and from flotation of matrix samples. The range of analyses that were conducted on the floral and faunal assemblages from archeological deposits at the Varga Site is discussed in Section 4.2.2, “Subsistence”, and will not be repeated here. In addition, the lipid residue and carbon isotope studies for ceramic sherd and burned rock matrices, as well as use-wear analyses, are discussed in reference to the subsistence and technology research domains.

Pollen and Phytoliths

Two columns of matrix sediment samples were collected from Block A for detailed analyses of such data sets as soil texture, sediment grain size, stable carbon and nitrogen isotopes, humate dating, and phytoliths. These sediment column samples were collected from two separate locations in Block A. One sample column is intended for use in sediment studies (i.e., grain-size analysis), whereas the second column was collected primarily for use in phytolith, pollen, and stable carbon and nitrogen isotope analyses.

Phytoliths are opal silicate bodies that form as inclusions in plant cells. The taxonomic distinctiveness of various types of phytoliths

varies, but the grasses are among the most distinctive, diverse, and easily recognized. Specifically, three diagnostic grass phytoliths occur: panicoid, festucoid, and chloridoid. Recent studies in the eastern portion of Central Texas have shown that panicoid forms occur in greater frequencies in open, grassy communities, whereas both festucoid and chloridoid forms are common in forested environments (Scott-Cummings 1991). Phytolith studies are important in reconstructing the general vegetation structure in local environments through time (in contrast to pollen studies, which are more attuned to regional reconstructions).

Because pollen preservation is often poor in southwestern Texas, five pollen and five phytolith samples from the sample columns were submitted for preliminary processing to assess whether or not pollen and phytolith data would be available for study. Fossil pollen was observed in all five initial samples that ranged in depth from 23 to 96 cmbs (Jones 2003). The presence of pecan (*Carya* sp.) pollen in the samples is significant as these grains are fairly fragile and would not be expected to occur in poorly preserved assemblages. It was noted, however, that pollen preservation appears to decrease with depth. Phytoliths were also noted in all samples, and preservation was quite good throughout the column. Thus, pollen and phytolith analyses make a substantial contribution to this poorly studied region. A total of 25 paired pollen and phytolith samples, 20 from a single column from Block A, two dated sediment samples from Trench 1, and three dated samples from Trench 7 were analyzed and provide indications of past biota.

Granulometry

Grain size analysis is used to help differentiate the basic soil properties of each horizon, to indicate patterns of pedogenic development, and

to define major depositional breaks in sediment accumulation. Specifically, soil textures are determined empirically based on percentages of gravel, sand, silt, and clay as obtained by sieve and hydrometer methods, and percentages of organic matter and calcium carbonate equivalent are calculated. Grain-size data were useful in estimating the depositional environments within which sediments were deposited (e.g., colluvial, alluvial, lacustrine, eolian), and are consequently an important, empirical supplement to conventional stratigraphic interpretation and macroscopic observations of soils/sediments. Here, 10 sediment samples from a column in Block A were analyzed and these were the same sediments that were used for the pollen, phytolith, and stable isotope analyses.

Stable Isotopes

Differences in stable carbon isotope values reflect variations in the integration of atmospheric carbon by plants through three photosynthetic pathways, which are designated as C₃, C₄, and CAM. Although much less is known about nitrogen isotopes, they have been shown to be important in distinguishing between C₃ legumes (bean-producing plants such as mesquite [*Prosopis glandulosa*], Texas ebony trees [*Pithecellobium ebano*], huisache [*Acacia farnesiana*], Texas Kidneywood [*Eysenhardtia texana* Scheele], and many others) and C₄ non-leguminous plants (DeNiro and Epstein 1981). Taken together, isotopic analyses provide data on the plant and animal resources that were potentially used for food by prehistoric peoples and complement other types of analysis. For instance, if studies of the lipid residues contained within burned rocks from a single feature return a general interpretation such as “large herbivore,” isotopic analyses can help refine that interpretation (e.g., if isotopic analyses return a result of “C₄ pathway,” then it is likely that the “large herbivore” indicated by lipid studies was a bison). Stable carbon and

nitrogen isotope analyses were conducted on 158 samples to assess the relative proportion of C₃ or C₄/CAM photosynthetic pathways of the plant residues, or animals that ate these plants, and were cooked by these artifacts. The selected samples included the interiors of 87 burned limestone rocks, six Toyah ceramic sherds from Varga, five ceramic sherds from Mission San Lorenzo, two ceramic sherds from Mission San Juan, 20 sediment samples from the sediment column in Block A, five other dated sediment samples from trenches, and 33 modern plant samples to facilitate the interpretations. The stable isotope samples were extracted from the same sediment samples that were used for pollen and phytolith studies, and the same samples of burned rock and ceramic sherds that were analyzed for lipid residues (see Section 4.2.2, Subsistence).

4.2.2 Subsistence

Determining the range of natural resources exploited by prehistoric populations, including plant, animal, and mineral resources, is a necessary component of any archeological investigation of hunter-gatherer adaptive systems. The exploitation patterns employed by hunter-gatherer groups are differentially conditioned and constrained by numerous environmental and cultural factors, including the distribution, density, and patchiness of natural resources on the landscape; the seasonality of economically important species of plants and animals; the location of important sources of tool and cooking stone; the size (i.e., range) of exploited territory; and group size. The presence and variability of faunal and floral remains in an archeological assemblage (1) reflect the resources that were hunted, collected, or grown by the prehistoric inhabitants of the site, (2) provide the basis for estimating how intensively those resources were exploited, and (3) supply inferential tools for developing hypotheses about the organizational strategies

involved in trapping energy from the environment and distributing it within the cultural system. As discussed in Section 4.2.1, Paleoenvironmental Reconstruction, these data also serve as proxy indicators of paleoenvironmental conditions.

Research conducted over the past 30 years has demonstrated that taphonomic issues must be carefully evaluated before advancing any interpretations about prehistoric behaviors. Reconstructing patterns of subsistence is a matter of establishing a human rather than natural origin for the biotic items in an

archeological context. A broad range of possible natural and post-depositional processes can introduce naturally occurring plant and animal specimens into a cultural assemblage. For instance, burrowing activity is known to be relatively extensive in some parts of the investigated area of the Varga Site, so the presence of rodent bones in the faunal assemblage would not necessarily indicate that the prehistoric occupants consumed any or all of the rodents (Table 4-1).

Table 4-1. Summary of Artifact Assemblages Recovered from Two Phases of Data Recovery Excavations at the Varga Site (41ED28)

Artifact Category	Block A (West of Road)	Block B (East of Road)	Total ¹
Lithics			
Projectile Points	215	68	283
Bifaces	166	50	216
Unifaces/Edge-Modified Flakes	95	34	129
Cores	50	14	64
Debitage	69,444	19,197	88,641
Other Tools			
Groundstone Tools	6	3	9
Bone Tools	2	3	5
Burned Rocks	1,214.19 kg	834.40 kg	2,048.59
Faunal Remains			
Bone	8,451	11,496	19,947
Mussel Shell	30	11	41
Snail Shell	5,378	439	5,817
Floral Remains			
Wood Charcoal, Carbonized Seeds and Nutshells	386.2 g	134.2 g	520.4
Ceramics			
Sherds	16	76	92
Historic/Modern Objects	44	18	62
Soil/Sediment Samples	446.80 kg	192.85 kg	639.65 kg

¹ Unless otherwise noted, all quantities are reported in raw frequencies (i.e., number of items). Numbers do not include tiny materials recovered from the floated sediments.

In addition, the effects of carnivore activity have been repeatedly demonstrated to be an important post-depositional factor in the formation of some archeofaunal assemblages (cf. Binford 1981; Klein and Cruz-Urbe 1984). Any analysis of faunal and botanical remains must identify the various agents responsible for introducing the specimens into the site as well as the events and processes that may have chemically altered the materials following their deposition.

As Ellis et al. (1993:151-152) succinctly illustrates, investigations of subsistence in archeological research designs tend to collapse two distinct research topics—the identification of subsistence resources and the description/explanation of subsistence strategies—into a single analysis. Identification of the subsistence resources that actually were used must logically occur prior to beginning the discussion of subsistence strategies. Indeed, describing a subsistence base can be a sufficiently complex task to warrant individual treatment. Furthermore, it is necessary to have a description of the actual resource base before it is possible to hypothesize about the procurement strategies that might account for the assemblage of subsistence resources. Describing a subsistence strategy involves a high level of analysis that necessarily relies on inferences from an array of data of which faunal and floral resources form only a subset (Winterhalder and Smith 1981; Jochim 1976). Thus, identifying the subsistence resource base is here treated as a research domain in its own right to establish a set of reliable empirical claims about the nature and range of exploited resources. The task of investigating the decision-making structures and other elements that went into procuring and processing the resources is discussed in Section 4.2.5, Mobility and Land Use.

While analyses of macro- and microfloral and faunal materials are primarily useful for reconstructing prehistoric subsistence

economies, these data sets can provide proxy indicators of the resource communities exploited by hunter-gatherers, thereby contributing to the task of paleoenvironmental reconstruction. Furthermore, specialized analyses of biotic remains can provide information about resource processing strategies, butchery patterns, and the nutritional value of the exploited resources.

It should be noted that the subsistence research domain addresses only biological resources used for food. Such items as lithic resources and technological patterns may also be directly related to the subsistence process. A parallel treatment of lithic resources and procurement strategies is discussed in Section 4.2.3, Technology.

4.2.2.1 Research Questions

- What economically important plant and animal species are represented? What naturally occurring flora and fauna are present in the assemblage?
- What season(s) of occupation do faunal and floral remains recovered from cultural contexts represent?
- What regional resources are present that would not have been available locally?
- What potentially available subsistence resources were not exploited?
- What evidence supports the idea that various biotic resources were consumed immediately versus processed for storage?
- How were specific kinds of animal resources butchered? For larger game animals, are entire animals represented at the site or were selected parts transported to the site for processing from kill or procurement sites?
- What types of wood were used for fuel?

- What relative degree of emphasis on animal versus plant subsistence resources can be detected?
- Are organic remains in lower components contemporaneous with those components or have they been translocated from overlying components in which organic preservation is demonstrably better?

4.2.2.2 Relevance

Identification of the nature and range of resources that compose the subsistence base is a critical dimension of hunter-gatherer research because the nature and location of subsistence resources is a major determinant of hunter-gatherer behavior. The subsistence resource base also serves as a direct, if partial, record of the exploitative decisions made by human populations. Therefore, the subsistence data collected from various sources provides direct information that will inform hypotheses about the spatial and temporal dimensions of resource procurement strategies. Consequently, the data obtained in this domain is roughly equivalent to a catalog of subsistence goals toward which people directed their activities and organized their strategic decisions about resource capture. Thus, by the time that research in the paleoenvironmental and subsistence domains is well advanced, the researcher has in hand evidence for the nature of the environmental context of human activity and a basis for beginning to investigate the patterns of subsistence strategies operationalized by human populations. The hypothesized organizational systems through time then serve as the basis either for further investigations into diachronic variability in the organization of resource procurement systems (i.e., spatial/cultural variability across space) and/or synchronic variability (i.e., spatial/cultural variability through time).

4.2.2.3 Data Requirements

Floral Subsistence Base

Macrobotanical, pollen, and phytolith evidence collected from various on-site contexts, including feature and non-feature contexts, were analyzed. Clearly, data from discrete stratigraphic contexts (e.g., features, securely dated sediment zones) provide the best basis for reconstructing the subsistence base, but samples from less discrete contexts (e.g., general sediment zones) provide supporting evidence.

While wood is not necessarily a component of the subsistence base, species identifications of wood samples from cultural contexts provided evidence both of the kinds of wood located in the vicinity of this archeological site as well as the range of preferred fuel wood types. Samples of wood charcoal from 44 float samples extracted from 18 cultural features and 75 individual pieces of charcoal from across the excavations were analyzed.

Faunal Subsistence Base

Faunal bone fragments (19,947 pieces or 17,879 g) were analyzed from on-site features as well as from less discrete on-site contexts. Macroscopic data such as faunal bone, teeth, and mussel shell represent the best data for evaluating the range of potential animal resources in the prehistoric diet. Analyses of faunal elements also contribute to the formulation of hypotheses about procurement and processing strategies, discard patterns, and secondary uses of faunal materials for technological (e.g., awls) and ornamental (e.g., beads, pendants) items.

Chemical-Residue Evidence

Faunal and floral resources were further studied through extraction of 94 lipid residues (fatty acids) from burned rock and eight ceramic sherd matrices. Previous research has demonstrated

that organic residue (fatty acids) samples can be extracted from burned rocks and pottery used by prehistoric peoples to process foodstuffs (cf. Quigg et al. 2001). This proxy line of investigation is critical when chemical and environmental conditions are not conducive to the preservation of organic data, such as faunal and floral remains, and in older deposits in which organic preservation generally is relatively poor.

Isotope Studies

Carbon and nitrogen isotope evidence extracted from 87 burned rocks, six Varga Site Toyah sherds, and seven Mission sherds were used in conjunction with the lipid residue evidence from the exact same samples of burned rocks and ceramic sherds to help interpret the results of the lipid residue chemical analyses.

Stone Tool Analyses

Analyses of stone tool variability and use-wear analyses of stone tools contributes information on subsistence extraction and processing activities, which in turn can aid in reconstructing subsistence bases. The presence or absence and relative proportions of certain tool forms indirectly indicates subsistence practices. While tool assemblage variability is more directly articulated with procurement and processing strategies, some results may lend themselves to reconstructing the subsistence base. Also, use-wear analyses contributed results that are relevant to identifying the resources processed, given that use-wear studies resulted in the recovery of identifiable plant fibers or animal hairs. Analyses of stone tools are discussed in detail in Section 4.2.3, Technology.

4.2.2.4 Investigative Strategies

Data recovery excavations yielded a rich faunal assemblage associated with the Late Prehistoric period Toyah phase component. While the Late

Prehistoric faunal assemblage is quite robust (in terms of raw counts), many of the bone elements represented are highly fragmented. Organic preservation in the soil/sediment units associated with the earlier components is much poorer. Scattered pieces of faunal bone were recovered from the lower components, but many were determined not to be directly associated with these earlier occupations, having been translocated downward from the overlying later components.

Macrobotanical remains, primarily wood charcoal, were recovered during the field investigations and subsequent flotation of collected sediment samples. Wood charcoal was relatively common in the upper components (i.e., Late Prehistoric and Late Archaic period components), though it became increasingly infrequent outside of feature contexts in the lower occupation zones (i.e., Middle Archaic and Early Archaic period components), presumably due to time-dependant attrition. Rare specimens of carbonized seeds and nuts were also identified.

The composition of the faunal and floral assemblages recovered from data recovery excavations, the subsistence base of the Toyah phase inhabitants was evaluated through the analyses of faunal bone and macrobotanical remains. However, because of the relatively poor organic preservation conditions in the lower components, understanding of subsistence is largely dependent on proxy indicators of plant and animal exploitation, such as lipid residues from burned rocks, microwear analyses of stone tools, and studies of stable carbon and nitrogen isotopes. To establish an epistemological link between the primary and proxy data sets, it was also necessary to perform the proxy studies (i.e., lipid residue, use-wear, and isotope analyses) for the upper components, in which organic preservation is good. This helped to interpret the resource processing techniques for the later

components; more importantly, it provided the confirmatory links among the primary and proxy data sets upon which sound inferences were made for the lower components, which relied more heavily on the proxy data.

The faunal bone assemblage was analyzed for species identifications, bone element size classes, cultural modifications (e.g., cut marks, impact fractures), burning patterns, and minimum number of individuals (MNI) estimates. Floral analyses focused on species identifications.

Aside from the studies of faunal bone and macrobotanical remains (for those components that produced them), analyses of lipid residues (fatty acids) in burned rock were completed. Previous research has demonstrated that organic residue samples can be extracted from burned rocks and groundstone tools used by prehistoric peoples to process foodstuffs (cf. Quigg et al. 2001). Basically, this technique involves extracting and identifying the fatty acids that are preserved within the matrices of porous rocks used in cooking and other food preparation activities. Fatty acids are the major constituent of fats and oils (lipids). Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. When the fatty acid residues recovered from burned rock matrices are compared to decomposed fatty acid compositions of modern potential food plants using gas chromatography, general categories of lipid residues can be determined. Although the degree of resolution of lipid analysis is still quite general (e.g., “large herbivore,” “fish/corn,” “large herbivore/plant”), the potential of this research for subsistence studies is significant for archeological assemblages that do not have adequate preservation of organic materials. While most burned rock lipid studies conducted to date have focused on sandstone, recent research has

demonstrated that limestone, the primary cooking stone material at the Varga Site, also yields lipid residues amenable to this type of research (Malainey and Malisza 2003). Other analytical techniques, such as stable carbon and nitrogen isotope analysis, help to refine the general determinations provided by analyses of lipid residues. While neither approach is sufficiently precise to directly identify specific species, together they permit the development of inferences concerning broad subsistence patterns when used in combination (Quigg et al. 2002:365).

The sampling strategy for burned rock lipid studies was to process three to four rocks from each of the smaller cultural features to provide a representative sample of each selected feature. Feature 1, the Late Archaic incipient burned rock midden, was more extensively sampled. A total of ninety-four lipid residue samples were extracted from burned rocks from the four identified site components. In addition, six sherds from the Late Prehistoric component were submitted for lipid residue analysis. Samples from all of the burned rocks and sherds submitted for lipid residue analysis were also run for stable carbon and nitrogen isotopes to develop a corroborative data set.

Pattern-recognition studies of the artifact assemblage provide a basis for defining “kits” of tools involved in specific resource procurement and processing activities. Studies of feature function also contributed to studies of subsistence. In addition, use-wear analyses of selected stone tools from each component provided data on the range of materials on which the stone tools in the assemblage were used. When tools were recognized during data recovery excavations, they were often bagged with minimal handling to protect the edges from incidental damage that might skew the results of use-wear analyses. These same tools were not washed or handled prior to being examined for

use-wear patterns. High-powered microscopy was the primary method used in use-wear studies. See Section 4.2.3, Technology, for a full discussion of technological research questions and investigative strategies.

Seasonality studies are more strongly dependent upon good organic preservation as they focus on seasonally sensitive faunal elements and floral specimens. Seasonality information is often difficult to obtain in warm regions like southwestern Texas, where only slight changes in temperature and moisture occur throughout the year; seasonal information is more easily defined in regions with more marked seasonal differentiation. Seasonally sensitive indicators include growth patterns in fish otoliths and mussel shells; dentine layers in deer, antelope, and bison teeth; the presence/absence of deer antlers; the presence/absence of extra calcium build-up in bird bones; macrobotanical remains; and chemical signatures of isotopes and lipid residues in burned rocks and pottery. As noted above, the Late Prehistoric period Toyah phase component yielded a rich archeofaunal assemblage that contained minimal indicators of seasonal availability of specific resources. The recovery of macrobotanical remains, especially seasonally restricted plant parts such as charred berries and fruits from such plants as juniper trees, walnuts, and geophytes, would also contribute to seasonality studies. A few charred walnuts and cactus seeds were identified within the assemblage.

4.2.3 Technology

Arguably, one of the most critical dimensions of hunter-gatherer archeology is the study of how past humans obtained, produced, maintained, and discarded their technological devices. Technology is an topic especially amenable to investigation because the products of technological behavior tend to be the most easily recognizable and best-preserved units in the

archeological record. “Technology” refers to almost any aspect of material culture, ranging from irrigation systems, roads, and houses to textiles, tools, and hearths. In prehistoric archeology, technology tends to be understood to refer more or less exclusively to those components of material culture that are directly involved in procuring and processing resources (e.g., hunting gear, agricultural equipment, cooking utensils) and fabricating and maintaining other implements (woodworking tools, weaving devices). These materials tend to be made of various types of tool stone, which are well preserved in the archeological record. Whereas other technological components, such as basketry, textiles, clothing, organic tools, and domiciles are no less important to understanding prehistoric economies, they tend not to be preserved in most archeological contexts. Operationally, this research design understands “technology” to refer to the entire range of objects and strategies manipulated by humans to achieve specific goals. In addition to stone tools (and a small number of bone tools), this research program was concerned with exploring pottery and burned rock features as intrinsic components of the technological system. Thus, both artifacts and cultural features are included in the scope of research.

For the investigation of technological systems under this research design, technomic artifacts are presumed to reflect the strategies used by prehistoric humans to exploit and process resources and to perform fabrication and maintenance activities. The composition of artifact assemblages and other characteristics of toolkit design are investigated in reference to the constraints imposed upon the technological system by external factors, such as environmental and ecological conditions; resource distributions and availability; mobility requirements; raw material locations, quality, and availability; and tool design, production, maintenance, and replacement strategies

(Ammerman and Feldman 1974; Bleed 1986; Kuhn 1989; Nelson 1991; Shott 1989; Torrence 1989). Theoretical models of hunter-gatherer adaptations have highlighted the articulation of technological systems with other components of hunter-gatherer adaptive strategies, such as food procurement and processing, mobility patterns, and territorial organization (Binford 1977, 1979; Collins 1975; Gould 1980; Kelly 1988, 1995; Shott 1986, 1989; Torrence 1983, 1989; Ricklis and Cox 1993). Many archeological studies have concentrated on extractive tools (Blead 1986), or tools used to extract resources from the environment (such as weapons), but other efforts have focused on maintenance tools (Bousman 1993), or tools used to manufacture and repair other tools or devices. Furthermore, while cooking features have not traditionally been extensively mined as a primary source of data for technological studies, recognition of the importance and ubiquity of burned rock features across the Greater Edwards Plateau of Central Texas has catapulted cooking and heating technology to the forefront of Central Texas archeology.

Still, while investigations into the systemic organization of technological systems may represent the forefront of current ecological research in archeology, questions about artifact typology and cultural systematics cannot, nor should they necessarily, be avoided. Many investigators have posited that technological devices may reflect non-functional dimensions of variability, such as style, ethnic distinctiveness, symbolic systems, and “cognitive templates.” The delineation of cultural taxonomies and debate over their meaning has interested Central Texas archeologists since the inception of the discipline. Numerous researchers have developed regional syntheses and overviews of Central Texas cultural sequences over the years (cf. Suhm et al. 1954; Suhm 1960; Johnson 1967; Weir 1976; Jelks 1978; Prewitt 1981a,

1985). While this research may suffer from some problematic assumptions about the relationship of tool morphology to emic distinctiveness among prehistoric cultural groups, the study of cultural-taxonomic sequences has historically garnered the larger part of most archeologists’ attention in Central Texas. In addition, it is perhaps the mode of investigation with the most potential to contribute to diachronic perspectives on prehistory.

This research design employed both an “organizational” approach and a “stylistic” approach to the study of technology. The “organizational” approach characterized the research questions and methods discussed in this research domain, while the “stylistic” approach came into play in the investigation of culture historical concerns presented in Section 4.2.4, Culture History. Both analytical frameworks rely on many of the same data sets, so the investigative strategies outlined here pertain equally to the organizational and culture historical investigations.

In general terms, the theoretical approach adopted in this study treats technology as an integrated system of knowledge and techniques through which humans solve problems and/or respond to changes in their natural and social environments. Thus, investigations were organized according to components, or subsystems, of the overall technological system and included raw material procurement strategies, tool/feature design and manufacturing strategies, tool/feature use and maintenance strategies, and resource preparation and processing strategies. In this context, the descriptive categories typically used in CRM reporting, such as “Lithic Technology” or “Ceramic Artifacts,” were used only secondarily. The “organizational” structure implemented here is preferred to the “artifact class” structure often employed in archeological

reporting. Investigating archeological assemblages according to artifact classes may be well suited to studies of manufacturing techniques on specific raw materials, but technological systems are not organized or operationalized according to artifact classes. Rather, raw material procurement, tool design and production, toolkit design and use, and tool maintenance occupy different sequential positions within a technological system, and each stage is differentially influenced by, constrained by, and responsive to external factors.

In other words, there is a difference between the physical components of technology and the operational knowledge implemented by hunter-gatherers in the actualization of specific goals. For instance, the numerous stages in the process of procuring and processing the meat from a large animal, such as a bison, cross-cut so many specific artifact class categories as to render them virtually useless in delimiting the strategic decisions implemented by prehistoric hunter-gatherers in obtaining and consuming food resources. Prehistorically, tool stone, wood, and other hunting tool components (i.e., bow, atlatl) were obtained to manufacture spears, darts, or arrows. The community must position itself in a particular place on the landscape where (and when) buffalo would be available. A projectile point must either be freshly manufactured from a raw material nodule or bifacial preform or reworked from a preexisting tool. Wood must be shaped into a hafting device and the dart or arrow must be constructed from composite elements. The individual hunter or hunting party must locate, track, and kill the bison. The animal must be butchered and reduced into portable, consumable, and/or storable size elements. A processing/cooking technology must be implemented to transform the edible parts of the animal into a consumable form. If leftover meat is to be stored for a period of time, a form of storage technology

must be implemented (e.g., pemmican production). Other raw materials from the animal, such as sinew, hide, and bone grease, may need to be extracted and processed. Thus, at its most simplistic level, this process involves numerous components of what would generally be called tool production/use, raw material procurement, butchering, cooking, ceramic, and storage technologies. The procurement and consumption of an animal involves a series of distinct technological subsystems, each of which is interdependently articulated with other subsystems that are operationalized to achieve specific goals related to the capture of energy from the environment and its distribution among the human population.

4.2.3.1 Research Questions

- What lithic quarry sources were exploited by the inhabitants of the Varga Site through time? Were local bedrock and gravel chert sources emphasized at particular times, for particular grades of raw material, or for the manufacture of particular types of tool? Were non-local sources emphasized for any of these purposes?
- How large is the lithic raw material procurement area?
- Are locally peculiar tool production techniques evident that may imply local cultural or environmental influence on tool manufacture?
- What components of the artifact and feature assemblages indicate procurement, preparation, and processing activities related to subsistence practices? What means of procurement, preparation, and processing are indicated? Is there a basis for distinguishing between primary activity areas and discard areas based on the spatial distributions of tools?

- What types of artifacts (e.g., tool rejuvenation flakes) and/or components of artifacts (e.g., reworked tool edges) represent tool maintenance activities? What kinds of maintenance activities are indicated?
- To what degree are tool assemblages at various time periods based on formal versus informal or expedient tool production strategies? Do different segments of the tool assemblage within any given component vary in relation to formal versus informal techniques? What tool production strategies are evident?
- What were Late Prehistoric period Clifton points used for? Clifton points have often been interpreted as preforms for Perdiz points; however, the authors suspect that Clifton “points” are actually a distinctive tool type.
- How did Feature 1, the Late Archaic period burned rock feature that has been preliminarily identified as an incipient burned rock midden, form? What range of functions does Feature 1 serve? Are discrete dumping or use episodes distinguishable within the feature? Are there detectable differences in the size of burned rock clasts in the core versus the periphery of the feature? Does the center, or core, of the feature have evidence for in situ burning, such as oxidized sediments, ash, or basin features? Are there activity-free zones denoted by a relative lack of artifacts surrounding this feature? Are there associated activity areas farther away?
- Can individual activity areas be identified within each occupation zone? Are functionally specific activity areas represented? Do activity areas that exhibit evidence of multiple functions appear to have formed as the result of activity area overprinting, successive occupations, or erosional processes?
- What temporally diagnostic tool forms are present in the assemblage? Are any tool types or forms that are considered to be diagnostic of pertinent time periods missing from the assemblage?
- Does the diversity of points within various components represent contemporaneous point styles or sequential point forms? Do morphologically similar “types” (e.g., Martindale/Bandy, Gower/Merrell, Perdiz/Clifton) represent typologically distinct tool styles or a continuum of variability with a single type?
- Is ceramic technology at the Varga Site similar to Infierno phase (Lower Pecos Late Prehistoric), Classic Toyah (Central Texas Late Prehistoric), and/or Protohistoric/Historic (Mission) period ceramics? Is there continuity between regions and/or between the Late Prehistoric and Protohistoric periods? Is the same technology being used across these different culture areas and/or through time?
- What arguments best account for variability in the lithic and ceramic assemblages? Is variability stylistic or functional?
- What tool production strategies can be discerned within each component? What specific flintknapping techniques, tool manufacturing strategies, and/or patterns of tool maintenance and/or discard are associated with each component?
- What raw material procurement strategies are evident in the various components? Do patterns and/or source areas of raw material procurement change through time? Can instrumental neutron activation analysis

(INAA) help determine source areas for lithic raw materials and/or ceramic pastes?

- Why are so many complete projectile points (i.e., points that could have remained in use) present at the Varga Site?

4.2.3.2 Relevance

Technological studies at the Varga Site are organized according to components, or subsystems, of the overall technological system rather than to specific artifact categories. These subsystems include raw material procurement strategies, tool/feature design and manufacturing strategies, tool/feature use and maintenance strategies, and resource preparation and processing strategies. The first of these subsystems, raw material procurement, represents an area of study that is not only important in technological studies, but also forms the basis for estimating the geographic extent of the area across which the prehistoric inhabitants of the Varga Site ranged and/or accessed through interaction with other groups. Raw materials were often chosen according to specific criteria that may have included expediency and/or immediate availability as well as functional suitability for an intended production process or tool category. In addition, in site-based archeology, the geographic range of raw material resources is often the only available set of data that directly demonstrates the spatial extent of the procurement area. Thus, it is necessary to identify which sources of chert for tool stone and clay for pottery were selected and which were not selected for use by prehistoric peoples. Limestone, the primary constituent of burned rock features at the Varga Site, is extensively available in the immediate vicinity of the site in bedrock and stream gravel exposures. Consequently, it is assumed that this resource was procured locally. Similarly, wood probably was procured from a relatively limited catchment area around the site; while the exact

locations of fuel wood sources are not specifically of interest, the overall range of wood species that were selected for use provides information about the arboreal composition of the surrounding area.

Techniques of tool design and manufacture are important in developing an understanding of tool function, as the techniques of tool production are the steps through which the producer establishes the basic characteristics of tool morphology and suitability for intended uses. Hence, an understanding of artifact production techniques serves as the basis for determining whether morphology and/or suitability for an intended use were related to functional decisions. Furthermore, it is necessary to discover whether formal tool classes such as projectile points and ceramics are characterized by locally peculiar production techniques that may imply distinctive local cultural or environmental influences on tool-making. Tool and toolkit design may also serve as the basis for inferences about the mobility strategies employed by prehistoric groups in procuring important resources, and tool manufacture and its derivatives (e.g., debitage, broken preforms) often provide important sources of information for delimiting activity areas on a site and in assessing site function.

The attributes of tool use and maintenance are distinct from the attributes of artifact morphology associated with production because the latter are acquired during manufacture, while the former are acquired after manufacture. While attributes of manufacture may represent the intended use of a tool, the attributes of use reflect the actual range of uses to which the tool was applied. Note that artifacts that may not have been manufactured prior to use (e.g., hammerstones, manos, metates) are subject to analysis within this framework. In this case, the artifact enters the technological system directly from nature without passing through a tool

production process. Strictly speaking, such tools are identifiable only on the basis of their use-related attributes. Tool maintenance and recycling represent two potentially distinct processes. Tool maintenance generally refers to refreshing the working edges of a tool to prolong its use life for its designated function(s), whereas recycling refers to reworking a used tool to serve a different range of functions. Thus, in the case of recycled artifacts, the use-related attributes resulting from use before recycling are distinct from the use attributes after recycling. For example, the use-related attributes of a projectile point are distinct from the drilling function of a point that was reworked into a drill.

Resource preparation and processing include those aspects of the technological system involved in transforming resources into energy that can be consumed by the population. Thus, it is important to understand the resource preparation, processing, and storage technologies of a society. Resource preparation and processing may include the butchery patterns used to obtain economically important animal elements; methods of grinding plant resources; techniques for extracting desired or removing unwanted components of specific resources (e.g., extracting grease from bones, removing tannin from acorns); and the cooking techniques used to prepare resources for consumption (e.g., heating features). Some aspects of resource processing are represented by use-related characteristics of artifacts, while other aspects are properly considered through analyses of feature function and formation processes.

4.2.3.3 Data Sets

4.2.3.4 Chert Sourcing Data

A comprehensive suite of source location assessments for cherts present in the various

components of the Varga Site was completed. Sourcing data served as the basis for identifying the general quarry regions or areas from which the site's inhabitants obtained raw material for stone tools and provided a means for estimating the size of the resource acquisition territory. An extensive set of sourcing analyses was conducted to obtain a representative sample of the different raw materials and types of tools represented in each of the site's components. In addition, the chemical signatures of cherts available in the immediate vicinity of the site (upland outcrops of cherts and chert from the Hackberry Creek) were determined. These signatures served as the baseline for identifying locally available cherts in the cultural assemblages. Furthermore, the chemical signatures for additional chert sources located in the region surrounding the Varga Site were obtained.

Clay Sourcing Data

The source locations of the clay paste used in the manufacture of pottery during the Toyah phase occupation of the Varga Site was minimally pursued. A regional database of Toyah phase pottery paste sources is not readily available and is difficult to provide from individual site investigations. Here a single sample of sediment from the Varga Site was investigated through INAA and petrography. It is still necessary to perform broad regional wide sourcing analyses on a control set of clays from natural settings to further address the movements of the vessels and or peoples across the landscape.

Petrographic Thin-Sections

Thin sections of 11 ceramic sherds from the Toyah phase component and one local matrix sample from the Varga Site were part of the analysis of pottery technology and production techniques. A comparative set of thin-sections for petrographic thin-section analysis was also

conducted for Protohistoric sites (i.e., San Lorenzo Missions and San Juan Mission) in the surrounding region. Previously conducted and published petrographic analysis was from various Toyah sites and site in the region were also consulted and compared with the Varga Site sample.

Tool Identifications and Use-Wear Data

A broad range of data is needed on the tools in the recovered assemblage, including typological designations for diagnostic tools from each component, functional determinations of tools based on morphological, macroscopically and microscopically observable use-wear characteristics, and metric and non-metric characterizations of attributes of various temporally and functionally diagnostic tools. In addition, various derivative measures of relationship among classes of artifacts (e.g., ratios of specific tool types to other tool types, ratios of tools to features, ratios of cores to debitage, ratios of scrapers to bone, statistical measures of correlation and covariation) provide the basis for analyses of inter- and intra-assemblage variability. In addition to studies of tools, analysis of a small percentage of the debitage assemblage was performed for studies to address lithic reduction sequences and techniques.

Feature Form, Function, and Formation

For each of the burned rock features excavated here, a range of data was acquired for definitions of function and formation processes. Definitions of feature form were based on mapped distributions of burned rocks (vertically and horizontally). Clast-size data and the results of specialized analyses of organic residues (i.e., lipids) and stable carbon and nitrogen isotopes in

burned rock were collected for interpretation of feature function and formation processes.

Comparative Data

As a possible avenue of investigating relationships between the Varga Site's Toyah phase inhabitants and those of other Toyah phase sites to Protohistoric populations in the surrounding region, a limited collection of data (petrographic and INAA) was generated from three non-bone tempered sherds from the San Lorenzo Mission (41RE1) in Camp Wood, Texas; and five bone tempered sherds from the San Juan Mission (41BX5) in San Antonio.

4.2.3.5 Investigation Strategies

Raw Material Sourcing Analyses

Chert Resources

One major element in the study of technological organization relates to the amount of time and energy expended in the manufacture of stone tools. Arguments have been offered that demonstrate a link between prehistoric mobility and the level of effort expended in procurement of raw materials for, and the production of, stone tools (Andrefsky 1991; Bamforth 1986; Kelly 1988; Morrow and Jefferies 1989; Parry and Kelly 1987; Torrence 1983, 1989; Ricklis and Cox 1993). Other research indicates that the availability of lithic raw materials, defined by both abundance and quality, may be an even more important variable with regard to tool morphology, production effort, and time budgeting (cf. Andrefsky 1994). As the organization of systems of raw material procurement is clearly and strongly dependent on spatial patterns of raw material availability, it is beyond the scope of investigations of a single archeological site to fully define the raw material exploitation strategies embedded in broader patterns of mobility, presuming that it is

embedded. However, determining the locations for technologically important raw materials can establish important inroads into this critical dimension of hunter-gatherer technological organization. While it may not be possible to determine all quarry locations utilized by a group, it is sufficient to determine a representative sample in order to broadly outline the extent of the procurement territory. Excavations at the Varga Site yielded two data sets that are amenable to raw material sourcing studies, deriving from INAA analyses on chert and pottery.

The general environmental setting of the Varga Site within the Greater Edwards Plateau region is marked by one of the most extensive outcrops of chert resources in mid-continental North America—the Edwards Group cherts (Frederick and Ringstaff 1994), which occur within the Cretaceous-age limestone that crops out along the Balcones Escarpment. Previous INAA research has resulted in the development of a database of chemical signatures of cherts deriving from various locations within the Edwards Group chert resource area, primarily from the vicinity of Fort Hood in Bell and Coryell counties, Texas (Frederick et al. 1994). This research indicates that Edwards Group chert samples are heterogeneous and that differences occur among samples of various types or from different geographic areas within the Edwards Formation. INAA studies consist of irradiating chert samples and calculating the concentrations of various trace elemental constituents. Differential proportions of these trace elements among samples form the basis for defining groups within the sample set.

Because the existing INAA database for Edwards Group chert was compiled based on samples from the eastern portion of Central Texas, research on the Varga Site cherts involved INAA studies on chert from the site as well as surrounding localities. Here, we

submitted 261 chert samples for INAA studies, including 154 chert tools from the four cultural components from the Varga Site, and control samples of chert materials from non-cultural contexts at the Varga Site, control samples of chert from the surrounding region, with a total of 107 off-site samples.

While the size of this sample population may appear to be large, this sample size allowed for submission of samples representing a broad variety of artifact types, including projectile points, bifacial tools and preforms, unifacial tools, edge-modified flake tools, and unmodified lithic debitage, from each of the four components at the site. Specimens from securely dated contexts, such as features and definable site components were selected. All totaled, 48 Toyah phase tools, 23 Late Archaic, 17 Middle Archaic and 66 Early Archaic specimens were analyzed, for a total of 154 specimens from cultural contexts. Sample selection was directed towards a representative sampling of tools, as well as of debitage categories as identified on the basis of macroscopically observable characteristics of chert color and structure. It was important to submit samples from a variety of tools as well as tool manufacturing debris (i.e., debitage) to investigate the relationships among local and non-local source areas and the types of tools that were manufactured from each. Because INAA is a destructive analytical technique, chert samples were often from non-diagnostic portions of tools whenever possible (i.e., portions that do not contain use-wear or diagnostic attributes). As INAA requires only about one gram of sample material, the impact on individual artifacts from sample removal was minimal.

In addition, it was necessary to run numerous samples from naturally occurring chert sources in the immediate vicinity of the site to provide a comparative database of locally available chert. During the second phase of excavations a

collection of chert samples from a variety of non-cultural contexts in the site environs was undertaken. Samples of water-worn cobbles, including chert-bearing and non-chert-bearing specimens, were collected from on-site and off-site contexts. Natural chert samples were collected from the basal gravel lens of the first terrace of Hackberry Creek within Block A (mainly, but not exclusively, from the seven “sample units”); from exposed gravel deposits along the T0 and floodplain of Hackberry Creek near the site; and from chert-bearing lenses exposed in the uplands south of the Hackberry Creek terrace. Chert gravel samples were also collected from gravel bars along the Nueces River in Camp Wood, Texas, located approximately 29 km (18 miles) south of the Varga Site. In addition, chert samples were obtained from a bedrock exposure located near Devil’s Sinkhole approximately 5.5 km (3.4 miles) northwest of the Varga Site. Also, numerous chert samples from the surrounding region had been previously collected by TRC in conjunction with an earlier study of Edwards Chert chemical characteristics (Frederick et al. 1994). These samples were not processed for this earlier study, but selected samples were submitted in the present study. Specifically, these include samples from Val Verde, Kerr, Real, and Pecos counties. Some 107 samples from source locations at and near the Varga Site and from the surrounding region were submitted for INAA studies. Finally, the INAA results published by Frederick et al. (1994) provide an existing body of research which was amenable to incorporation into the Varga Site analyses. The INAA studies conducted here not only bear directly on the research issues of interest in the Varga Site investigations, but enhance an existing database that other researchers may use, thus broadening the scope of future inquiries of this nature.

Ceramic Resources

A modest number of pottery sherds ($n=119$) was recovered from the Varga Site Toyah phase component. A total of 18 sherds plus one sediment sample were submitted for INAA studies. The ten sherds from the Varga Site were associated with the Toyah component. For ceramic INAA studies, it was not necessary to submit a set of ceramic control samples. Chemical compositional analyses based on INAA studies have recently been completed for more than 400 samples of Late Prehistoric period pottery from across Central Texas (Creel and Johnson 2002). Most samples consisted of plain, bone-tempered vessels generally identified as Leon Plain, the primary Toyah phase pottery type. Six major compositional groups have been defined to date, and the geographic distribution of the members of these groups provides insights on how the production and movement of pottery vessels reflects the movement of or interactions among prehistoric populations over hundreds of kilometers.

Finally, three non-bone tempered sherds from the San Lorenzo Mission site in Camp Wood, Texas, and five bone tempered sherds from the San Juan Mission in San Antonio were submitted for INAA studies. The purpose in selecting these samples was to provide comparative samples from Toyah phase components from investigated sites near the Varga Site to address certain culture historical questions. The selected 19 analyzed samples have contributed to the growing Central Texas ceramics database and to an understanding of the mobility strategies of the Varga Site’s Toyah period inhabitants.

Wood Resources

As discussed in Section 4.2.1, Paleoenvironmental Reconstruction, and Section 4.2.2, Subsistence, samples of wood charcoal were quantified and identified for the

species of wood exploited by the inhabitants of the Varga Site. Identifying the types of fuel wood used by the site's inhabitants provides a general indicator of the kinds of microenvironments that were exploited for wood through time in the vicinity of the site. The analyses, discussed in detail earlier in this research design (see Sections 4.1 and 4.2) and are not repeated here.

Tool Design and Manufacture

The degree to which archeologists have succeeded in reconstructing past human organizational systems and isolating and explaining systemic change in these systems is, in some sense, a measure of the interpretive devices that have been brought to bear in the construction of arguments. The instruments of measurement that are most commonly used to define units of analysis in archeology, particularly in the study of technology, are typologies and ordinal scales of classification. These classification schemes often build self-fulfilling interpretive conventions into the process of measurement and classification that present serious obstacles to the expansion of knowledge about human technological activities. This problem has seriously hampered the progression of archeological science in Central Texas (cf. Ellis et al. 1993), which has perhaps dwelled on the classification and seriation of projectile point styles at the expense of more expansive avenues of research. While it is beyond the scope of this research design to provide a thorough survey of the epistemological tangles of the study of technology in archeology, several points of relevance are discussed below.

Research on the organization of technology often posits a linkage between lithic technology and patterns of mobility and sedentism in the form of artifact curation (i.e., maintenance and reuse), the functions of bifacially retouched

tools, and core technology (cf. Henry 1989; Parry and Kelly 1987). Many such studies have focused on the relationship between the amount of effort expended in tool production and the settlement strategies of the toolmakers. A primary and important distinction has been drawn between tools with little effort expended in their production ("informal" or "expedient" tools) and tools with more effort and planning expended in their production ("formal" tools [Andrefsky 1994]).

In technological studies, the term "formal" is generally used to encompass a wide variety of tools that have undergone relatively intensive planning and production effort, whether the manufacturing occurred over the course of multiple resharpening or rehafting episodes or in a single episode of production from raw material to finished product. Formal tools occupy one end of a production continuum, while "expedient" or "informal" tools—tools that are manufactured with relatively little effort—occupy the opposite end. Some researchers characterize formal tools as "flexible" or "reliable" tools, or tools that are designed to be rejuvenated and have the potential to be redesigned for use in unanticipated contexts (Bleed 1986; Torrence 1983). These tools have been hypothetically linked to populations that practice more mobile settlement strategies with short-term site occupations based on a relationship that is presumed to exist between restricted raw material availability and unforeseen tool needs or uses (Andrefsky 1994). As mobile groups tend to occupy relatively larger areas, they may periodically find themselves in regions where lithic raw materials are not available or are unsuitable for specific tool needs; thus, they must have ready-made and/or adaptable tools at hand. According to this line of thought, portable tools, tools that can be modified or redesigned as needed, or tools that have variable functions would be best suited for such situations.

Tools that meet these specifications include such items as bifaces, formally prepared cores, and retouched flakes. Bifaces can be used repeatedly, even after they become dull, by resharpening some or all of their working edges (Andrefsky 1986; Sollberger 1971). Bifaces can be used for many different tasks (Ahler 1971) and have the added benefit of serving as highly efficient cores (i.e., less overall mass per amount of cutting edge). Some researchers suggest that such cores represent the most efficient form of usable cutting-edge storage (Clark 1987), a desirable characteristic for mobile populations that must restrict excess weight. Retouched flake tools have also been proposed as a practical tool type for mobile groups. Retouched flake tools can be used for a wide variety of functions; archeologically, the presence of retouch on flake tools is, in many cases, an indication of how the tool was adapted for specific uses (Odell 1981; Siegel 1984; Keeley 1982).

By contrast, “informal” tools are non-standardized or casual with regard to form and/or production strategy, and they are manufactured, used, and discarded over a relatively short period of time. Expediently produced tools are included in this category. Binford (1979) characterizes such tools as “situational gear,” or tools that are put to use in *response* to conditions rather than in *anticipation* of events or situations. This kind of technology tends to be wasteful of raw material and tends to produce tools that have less formal patterning of shape or design. Informal or expedient technologies are thought to be associated with more sedentary populations characterized by longer-term occupations (based on the presumed availability of raw material and lack of the need to expend much effort in tool design), but these tool technologies are in fact also common components of hunter-gatherer toolkits.

It must be pointed out that these categories are, in some fashion, relative to specific contexts. For instance, whereas few would dispute that a large dart or spear point is a formal tool that results from a well-planned and standardized sequence of lithic reduction, other artifact classes might be properly viewed as either formalized or expedient depending on circumstances. Prismatic blade cores are a good example of the latter case. Prismatic blade cores are highly formalized cores that are designed to yield large numbers of expediently produced flakes that may be adapted to specific situations. Thus, prismatic blade technology incorporates elements of formalized planning as well as expedient production. As with any heuristic classification device, the dichotomy of formal versus informal or expedient is best viewed as a model against which the empirical realities of archeological assemblages should be permitted to vary.

Ultimately, while technological research varies in emphasis, the study of technology has led archeologists to the realization that the organization of technology is differentially constrained by different factors in different contexts. Raw material availability may represent the primary constraint on toolkit design in one area, time period, or phase of an overall seasonal settlement cycle, whereas it may not impose any constraints at all in other contexts. This conclusion may appear trite, but it illustrates a fairly important point. Based on the research that has been conducted, several environmental and technological properties have been suggested as determinants in tool design and manufacture, but the constraints that condition specific patterns of technological variability appear to be quite complex and have so far eluded systemization. Much pattern-recognition work remains to be done upon which arguments of referral can be built between the domains of variability and causality.

Researchers vary somewhat in their use of the terms “formal,” “informal,” and “expedient.” In the current study, these terms are understood to represent extremes along a continuum of *morphological* variability. Specifically, “formal” and “informal” tools reflect opposing categories that describe the relative intensity of design planning and manufacturing input. Formal tools include implements that tend to exhibit a complex and/or standardized lithic reduction strategy, to exhibit regular patterning along working edges, and to have a high degree of formalized patterning in the finished object (e.g., most projectile points, formalized unifaces, bifaces, bifacial drills). Specialized or prepared cores (e.g., prismatic blade cores) would also fit this definition. Informal tools are those that tend to exhibit less overall planning prior to lithic reduction, to exhibit unpatterned working edges and/or irregular use-related damage patterns along working edges, and to lack formalized patterning in the finished object (e.g., edge-modified flakes, most retouched flakes, multidirectional cores). In this context, “expedient” is used interchangeably with “informal.” In some senses, “expediency” refers to a more strategic level of technological organization than to morphological characteristics; however, separating out “strategy” from “morphology” in this context would seem to imply that it is possible to distinguish a flintknapper’s intentions from the physical results of the process of tool production itself. Whereas tool design and manufacturing can be processually distinguished to some degree in ethnoarcheological research, they tend to form a single dimension of variability in archeological assemblages.

Studies of tool design and manufacturing strategies at the Varga Site will attempt to outline some of the dimensions of variability represented in the tool assemblages contained within the various cultural components on the site. Each of the three primary cultural

components (i.e., Toyah, Late Archaic, and Early Archaic) are represented by substantial assemblages of projectile points, finished and unfinished bifacial tools and preforms, scrapers and edge-modified flakes of all shapes and sizes, and scattered fragments of groundstone tools. The Toyah phase component even contains a few bone tools, and one bone tool may be present in the Early Archaic period component (though its context is currently in question). The Middle Archaic component contains a few formal tools, including Early Triangular projectile points, but the densities are relatively low compared to the other components and their stratigraphic associations are less unclear.

Projectile Points and Bifaces

As Turner and Hester (1993:3) have noted, projectile points are among the most “distinctive and popular artifacts sought by amateur and professional alike.” Traditionally, archeologists have used projectile points as the basis for building chronologies and reconstructing culture history; however, the relationships between projectile point types, or identifiable varieties within broader types, and sociocultural groups remains elusive, and it is demonstrable that the geographic distribution of specific point types often crosscuts known contemporaneous sociocultural boundaries. In an attempt to define a new tradition of projectile point research, Hudler (2003a) outlines a system for investigating variability in Central Texas projectile point assemblages that does not depend on traditional typological systems to define variability among projectile points. Rather than defining the unit of analysis in the classification system, which is usually the “type,” Hudler’s (2003a) proposal is to collect various metric and non-metric data from a collection of projectile points, subject the corpus of measurements to multivariate pattern-detecting techniques, and to allow the statistical methods to detect groups or clusters within and

between the variable set. A similar technique was applied in the analysis of chipped stone artifacts from the Wilson-Leonard Site (Collins 1998). While this tradition of research is still somewhat in its infancy in Texas, it provides a tantalizing alternative to type-based approaches in which the interpretive conventions are built into the taxonomic system.

This research program used both methodologies in the study of projectile points from the Varga Site. First, the point assemblages from each component were typed according to accepted taxonomic systems in use in Central Texas archeology (cf. Davis 1995; Suhm et al. 1954; Suhm and Jelks 1962; Suhm 1960; Johnson 1967; Weir 1976; Jelks 1978; Prewitt 1981a, 1985; Turner and Hester 1999). The traditional method for discerning patterning in projectile point collections was to visually inspect the artifacts and divide them into groups of morphologically similar objects. To ensure that the points were relegated to the proper subjective type categories, the Varga Site research program incorporated examination of points by Elton Prewitt to confirm our use of typological designations. Mr. Prewitt is a leading expert in projectile point typology in the region.

Following the typological identifications, a detailed analysis was performed on the points. First, a comprehensive suite of metric and non-metric attributes was recorded for the entire assemblage of projectile points from each component at the Varga Site. The data sets recorded generally followed those discussed in the Hudler (2003a) and Collins (1998) research programs, though some categories that did not prove to be productive in previous research were eliminated and a few new categories were added. Decisions about additions or deletions of categories from the variable sets defined in earlier research were based on initial inspections of the Varga Site collections to ensure that

variables are defined for representative dimensions of point variability. In addition to metric (i.e., quantitative) and non-metric (i.e., qualitative) variables, several derivative variables, such as ratios, were included as variables.

Next, the recorded variables were subjected to various pattern-detecting techniques to define dimensions of variability in the data. First, multivariate statistics such as principal components analysis (i.e., factor analysis) and cluster analysis were used to identify major axes of variability. Once these were defined, the next proper step was to utilize a variety of bivariate and multivariate investigations of small sets of variables to detect the nature and direction of patterning indicated by the large-scale multivariate statistical methods (in this latter procedure, this research program varies from the Hudler (n.d.) program, which uses the multivariate analytical results as the springboard for further discussion).

The projectile point assemblages from the Late Prehistoric and Early Archaic components at the Varga Site are extremely robust. In fact, to our knowledge, the Early Archaic point assemblage is the largest that has yet been excavated in southwestern Texas. Most other sites have relatively limited ranges of types and/or numbers of specimens. Consequently, the taxonomic investigations of the Varga Site collections shed light upon projectile point variability in the region. However, only the Late Prehistoric and Early Archaic point populations are sufficiently large to run valid statistical studies on them. While several different point styles are present in the Late Archaic and Middle Archaic components, these collections are significantly smaller. Thus, the Late Archaic points were added into the overall collections to determine if they have any associations with the early types/styles.

Quantities of bifaces were recovered during the excavations and these were subjected to documentation of metric and non-metric observations similar to the projectile points, though the range of variables that were recorded on the bifaces was much narrower. To the extent that bifaces are projectile point preforms, preforms for other tools, or tools in their own right, these characteristics did not provide meaningful dimensions of variability that could be compared to the results of the point study as a baseline for investigating the earlier stages in the biface reduction process.

The “groups” of items that are defined based on the results of the typological and statistical analyses were used as units of analyses against which other variables from the Varga Site research program was compared and contrasted. Rather than defining the significance of any detected “groups” or “clusters” of objects before undertaking the analysis, a program of pattern-recognition work provided the correlation and covariation among the defined “types” and “groups” and between various “types” or “groups” and other data sets served as the basis for inference.

Unifaces and Edge-Modified Flakes

Formal unifaces, such as gouges, side-scrapers, end-scrapers, and discoidal scrapers, were subjected to a detailed documentation comparable to the projectile point and biface study. In other words, an array of metric and non-metric variables were recorded, certain derivative measures (e.g., ratios) were calculated and added to the data set.

All informal and expedient tools, such as edge-modified flakes, were not subjected to these more rigorous documentations.

Other Formal Tools

Other formal tools (i.e., tools exhibiting a high degree of morphological patterning such as gouges and drills) were investigated and classified in reference to metric and non-metric variability. As the sample sizes of other formal tool categories are small, statistical analyses were not performed.

Debitage

Samples of lithicdebitage were examined to determine which stages of the raw material reduction and tool production processes are represented at the site. Excavations yielded extensive collections ofdebitage. As the focus of the technological studies proposed in this research design were primarily focused on formal tools, it was not desirable to analyze all 85,483 pieces ofdebitage recovered. Consequently, approximately 15 percent of thedebitage was subjected to detailed analysis. The samples were selected according to provenience (i.e., excavation unit and level), such that each sampled unit would consist of one 10-cm excavation level in a 1-by-1 m excavation unit that had been assigned to one of the four identified components. Sample selection was non-random and biased towards sampling a variety of features and non-feature contexts, high- and low-density areas, from the best context possible in the four cultural components.

However, all of thedebitage from the site was examined to separate out the informal tools and specific kinds of flakes that are relevant to studies of tool resharpening. Specifically, the entire collection ofdebitage was scanned for two kinds of specialized flakes—bifacial and unifacial tool rejuvenation flakes. When identified, these flakes were removed from their source bags and treated as individual specimens as they are directly relevant to issues of tool resharpening and maintenance. The rest of thedebitage—that which is not part of the 15

percent detailed analysis nor identified as a specialized flake type—were quantified and weighed, but no further analyses were conducted.

The focus of the 15 percent debitage analysis was on reduction strategies involved in tool production. Biface production flakes were identified and sorted into production-related stages, such as early- versus late-stage. All flakes were categorized according to percentages and type of observable cortex. In addition, information about heat alteration was documented. While it was difficult to recognize heat treatment in raw materials for which a heat-treated comparative collection is not available, the clear presence or absence of heat-treatment was recorded, and indeterminate specimens were noted as such.

Cores

Cores were examined and classified according to the reduction trajectories apparent on them. Various metric and non-metric variables were recorded, including variables relating to size and the number and direction of flake scars.

Ceramics

Analyses of the pottery sherds from the Toyah phase component provided information on ceramic technology at the Varga Site. By incorporating samples of ceramic sherds from other Toyah and Protohistoric sites in the region, this research design proposes to build a broader comparative sample for the investigation of ceramic technology.

Analyses of the ceramic sherds from the Varga Site included the determination of the Minimum Number of Vessel (MNV). The MNV assessment was based on color, thickness, temper, paste, firing characteristics, and, when possible, refitting. Metric and non-metric characterizations were recorded for the ceramic

assemblage. In addition, petrographic, organic residue (e.g., fatty acid), and stable carbon and nitrogen isotope analyses were employed to help identify the techniques used in pottery manufacture and the functional contexts of the pots represented.

In addition to the INAA studies discussed above, a sample of 18 ceramic sherds and one local sediment sample were thin-sectioned for petrographic analysis. This sample included 10 sherds from the Toyah component at the Varga Site; three non-bone tempered sherds from the San Lorenzo Mission Site in Camp Wood, Texas, and five bone tempered sherds from the San Juan Mission in San Antonio. Included in the ceramic sample for INAA and petrographic analyses was one fragment of what appears to be a non-vessel, possible ceramic figurine recovered from the Varga Site. The selection of ceramic sherds from the site for petrographic and INAA analyses was an attempt to sample the different vessel groups identified.

Tool Use and Maintenance

Conceptually, the attributes of tool use are distinct from the attributes of tool morphology; the latter are presumed to be associated with manufacture (or maintenance), while the former are presumed to be acquired after manufacture (or maintenance). In reality, manufacture may, to some degree, be an ongoing process, as generalized tool forms may be carried “into the field,” as it were, and modified for use in specific contexts depending upon situational needs. However, the processes of tool manufacture and use can be conceptually distinguished based on the presence of use-related wear patterns overlying manufacture- or maintenance-related attributes.

Two avenues of investigation were used to identify the range of functions or uses to which the tools in the Varga Site assemblages were applied—analysis of assemblage variability and

use-wear analysis. First, analyses of variability within the assemblages excavated from each component were based on identifying functionally related “clusters” of objects within each component. Clearly, this task is intrinsically connected with the analysis of site structure as it involves an explicitly spatial component, but functional “clusters” of objects may or may not occur in spatially discrete areas (see Section 4.2.5, Mobility and Land Use, for more details about spatial analysis studies at the Varga Site). First, the relative proportions of different classes of artifacts were examined in an attempt to identify “toolkits,” which in this context refers to functionally related segments of the assemblage rather than to the suite of tools that a hunter may take on an expedition. These “toolkits” may or may not have a discrete spatial dimension; spatially discrete clusters of functionally related artifacts were defined as activity areas, which serve as distinct units for further spatial analyses, whereas “toolkits” that were generally spread across the occupation were simply treated as general functional segments of the assemblage. This line of investigation was conducted primarily on the basis of subjective evaluations of artifact distributions across each component, although statistical pattern-detecting techniques were used to examine correlation and covariation among specific artifact classes.

In addition to general observations of tool morphology and macroscopically observable indicators of use, interpretations of the range of organic and inorganic materials processed with lithic tools were derived through an integrated study of macroscopic and microscopic use-related scars, scratches, abrasions, and polish on the surfaces of stone tools. In use-wear studies, distinctions are drawn between tool action and the material(s) processed based on careful examination of wear patterns on tools. Microscopic use-wear and polishing provide indications of the tool surfaces that were

selected and used as working surfaces and the direction of tool movement. Tool edges used to process plant versus animal tissues were distinguished through microwear analyses, as were non-technological modifications produced through natural processes. Under ideal conditions, the type of animal (e.g., muscle, hide, antler, bone) or plant (e.g., wood, soft plant) material that was processed with a tool can be identified, although this level of specificity could not be attained with the Varga Site material. It was possible to characterize tools used for single and multiple functions based on the extent and location of edge-wear, reduction techniques, composite tool construction (e.g., hafting wear), and the presence and extent of reworking or resharpening. Finally, the functional, behavioral, and technical diagnoses made through use-wear analysis may be verified, refined, or questioned through additional studies, such as evaluations of archeological contexts and spatial relationships with other artifact categories.

A total of 156 individual tools was submitted for use-wear analysis. A representative range of tools including points, bifaces, end scrapers, drills, gouges, and edge modified flakes was analyzed. Microscopically observable, use-related wear patterns on the archeological specimens were compared to experimentally replicated specimens to determine the range of functions and contexts of use of the tools. These studies provide qualitative measures of tool use that may be usable as a basis for quantitative studies of the entire assemblage. Sample selection emphasized the two components with the most robust assemblages (i.e., Late Prehistoric and Early Archaic), though the Late Archaic and Middle Archaic components were also sampled. Samples were selected from a representative range of feature- and non-feature contexts and areas of high and low debris density.

Tool maintenance or resharpening was investigated to the maximum possible degree in this study. While recognizing whether or not an individual tool has been resharpened is problematic, certain types of secondary or derivative artifacts serve as direct indicators of the resharpening process. Resharpening flakes are often difficult to distinguish from manufacturing debitage; however, some resharpening flakes retain remnants of former use-worn edges on their dorsal surfaces and/or on their platforms. Bifacial and unifacial rejuvenation flakes are two of these specialized flake types that directly represent resharpening activities. The debitage assemblage was examined for these types of flakes to aid in assessing the relative presence and degree of emphasis on tool maintenance activities in the various components. Resharpening trajectories can sometimes be identified within single artifact categories or tool types if a sufficiently large assemblage of unbroken specimens is recovered (i.e., within a single projectile point type).

Resource Preparation and Processing

Burned Rock Features

Whereas most studies of technological organization focus on chipped stone (and groundstone) technologies, there has been a growing realization in Central Texas archeology that burned rock features are an important part of the archeological record of prehistoric hunter-gatherer behavior (Black and Ellis 1997; Quigg et al. 2002a). In all likelihood, burned rock technology can profitably be studied in was analogous to those proposed for analyses of chipped stone tools. For instance, although the annular and domed varieties of limestone burned rock middens are more common in areas where limestone is readily available, ostensibly similar cooking features in adjacent regions of Texas

that use burned clay nodules, sandstone, or other thermal storage devices have been documented. To some degree, the varying morphologies of burned rock middens and the thermal storage devices used in them may be related to raw material availability, the resources being processed, and/or cooking techniques. Clearly, this is a provocative field of research that can be undertaken using many of the same theoretical frameworks as have been implemented in the study of chipped stone toolkits.

As the majority of the cultural features in much of Texas, and specifically in the Varga Site (among all four documented cultural components) are clusters, scatters, and/or incipient middens of burned limestone rocks, the study of burned rocks was a major focus of our research. The only extensive burned rock feature was Feature 1, a burned rock lens, five to six meters in diameter, associated with the Late Archaic component. This feature appeared to represent a relatively discrete episode of cooking activity (i.e., it cannot be described as a structureless, domed midden of burned rocks). Several discrete clusters of burned rocks were apparent within the overall matrix of this feature, which is classified as an incipient burned rock midden, and there appears to have been a central pit oven or core in the center of the feature (unfortunately, most of the central pit was excavated in a backhoe trench during the first phase of fieldwork). The remaining burned rock features on the site consist of more isolated clusters and scatters of burned rock. Furthermore, scattered burned rocks were encountered across each component in non-feature contexts. As burned rocks represent one of the most common artifact and raw material types on hunter-gatherer sites in Central Texas specifically and on the Great Plains in general, a promising focus of research has developed around the recognition that burned rock features may be among the most informative elements of the archeological record in these areas.

Analyses of the burned rock features at the Varga Site were focused on delimiting the form, function, and formation processes represented by each feature.

Analyses of burned rock features focused on three primary characteristics—form, function, and formation processes. Feature form was addressed based on various empirical characteristics, such as the horizontal shape and size, depth, and structure of the feature. Feature function was investigated using a range of analyses that included analyses of lipid residues and stable carbon and nitrogen isotopes recovered from burned rock matrices. As discussed previously in this research design, three to four rocks were submitted for these analyses from each of the smaller features, though a greater number of samples was necessary to sample the anticipated range of variability in Feature 1. Within Feature 1, a wide range of different contexts was sampled, including definable clusters of rocks (i.e., possible dumping episodes), the central pit feature, and undifferentiated scatters of rocks. Seventy-three burned rock samples were analyzed to obtain the necessary representation from all documented features. In addition to the specialized analyses, a range of contextual considerations, including relationships to other features, artifacts, and/or artifact clusters, informed studies of feature functions. Analyses of feature formation processes focused on identifying whether burned rock clusters represent in situ features (e.g., hearths) or secondary deposits (e.g., dumps/discard piles) and evaluating the processes involved in formation. For most smaller burned rock features, the question focused primarily on whether or not the features have been redeposited. For Feature 1, detailed analyses of different parts of the feature were important to develop an overall understanding of the range of use episodes represented in the rock cluster. An attempt was made to differentiate among

episodes of cleaning out the central pit feature, although one was never clearly identified, versus identifying discrete clusters of rocks that may represent unique dumping or cooking episodes. Clast-size analysis and detailed vertical and horizontal mapping of rock distributions were the primary data used in analyzing feature formation processes. All burned rocks excavated were sorted into standard size categories (i.e., 0 to 4 cm, 4 to 9 cm, 9 to 15 cm, and >15 cm) in the field, quantified, and weighed. Samples of burned rock from each feature and from non-feature contexts were retained for specialized analyses.

4.2.4 Culture History

The underlying assumptions and epistemological framework of studies of culture history have been discussed in some detail in Section 4.1, Theoretical Orientation. As this research domain does not have any unique data requirements that have not been discussed in previous sections, this section is driven largely by the specific research questions. Some questions posed below pertain to specific time periods, whereas others are equally applicable to all of the cultural components at the Varga site.

4.2.4.1 Research Questions

General

- Do the uses of specific classes or forms of artifacts change in time-sensitive ways?
- Do subsistence activities and/or utilization of one or more specific biotic resources change in time-sensitive ways? Are one or more specific biotic resources utilized during one or more periods but not during other periods?
- Does the overall geographic range (i.e., catchment area) of lithic raw material procurement change over time in time-

sensitive ways? Are one or more lithic source areas utilized during one or more periods but not during other periods?

- Do segments of the tool assemblage change in nature or proportion over time in time-sensitive fashions?
- Do mobility patterns change over time in time-sensitive ways?
- Does burned rock technology change over time in time-sensitive ways?

Late Prehistoric Period (Toyah Phase)

- Does the diversity of points in the Late Prehistoric component represent contemporaneous point styles or sequential use of different point forms?
- Does the Toyah phase component at the Varga Site significantly predate the Protohistoric period or does it fall within the period of late prehistory? In the latter case, were the Toyah phase occupants of the Varga Site the same people, or part of the same large sociocultural group, that occupied one or more of the Protohistoric period mission sites in the area.
- Does the ceramic evidence at the Varga Site conform to “Classic Toyah” ceramic technology (cf. Johnson 1994)? Are the Classic Toyah assemblages in Central Texas the same age and composition as the Varga Site assemblage? Does Toyah ceramic technology at the Varga Site fall within one of the ceramic groups defined by Johnson (1994)? If so, are the Varga Site inhabitants part of the same large sociocultural group, as those represented by the similar ceramic group in Johnson’s (1994) study? If not, did the Varga Site inhabitants possess a distinctive ceramic tradition?
- Are there time-sensitive (i.e., diagnostic) formal tools in the assemblage that have not been previously documented for this time period? Are any classes or types of artifacts that are normally considered diagnostic of the Late Prehistoric period absent from the assemblage?
- Are one or more point styles present on-site that are intrusive to the region?
- Is the Toyah phase ceramic technology local in origin? Does the Toyah phase component at the Varga Site represent a spread of ideas (i.e., a technocomplex) into southwestern Texas (cf. Ricklis 1994) or a distinct group of people (cf. Johnson 1994)?
- Do the Perdiz points conform to the Classic Toyah points (Johnson 1994) or are they regionally or locally distinctive?
- Are Toyah phase tool manufacturing strategies based on blade-based technologies such as those observed at Classic Toyah sites?
- Are Clifton points preforms for Perdiz points or do they represent a distinctive type of tool?
- Does the Varga Site conform to either Classic Toyah or Lower Pecos models? Does it reflect a cultural boundary zone between Central Texas and the Lower Pecos regions? Does it represent a distinctive tradition?
- Is the Toyah phase ceramic technology at the Varga Site carried over into the Protohistoric period?

Late Archaic Period

- Does the diversity of points in the Late Archaic component represent

contemporaneous point styles or sequential point forms?

- Are there time-sensitive (i.e., diagnostic) formal tools in the assemblage that have not been previously documented for this time period? Are any classes or types of artifacts that are normally considered diagnostic of the Late Archaic period absent from the assemblage?
- Are one or more point styles present on-site intrusive to the area?
- Why were relatively large numbers of projectile points discarded in Feature 1, the incipient burned rock midden?

Middle Archaic Period

- Are there time-sensitive (i.e., diagnostic) formal tools in the assemblage that have not been previously documented for this time period? Are any classes or types of artifacts that are normally considered diagnostic of the Middle Archaic absent from the assemblage?
- Are one or more point styles present on-site intrusive to the area?
- Are the Early Triangular points in the assemblage later than Early Archaic materials?

Early Archaic Period

- Does the diversity of points in the Early Archaic component represent contemporaneous point styles or sequential point forms?
- Are there time-sensitive (i.e., diagnostic) formal tools in the assemblage that have not been previously documented for this time

period? Are any classes or types of artifacts that are normally considered diagnostic of the Early Archaic absent from the assemblage?

- Are Martindale and Bandy points distinctive point types or do they represent variability within a single point type?
- Are Gower and Merrell points distinctive point types or do they represent dimensions of variability within a single point type?
- Did the idea of heating and cooking with hot rocks begin in the Early Archaic period?
- Are one or more point styles present on-site intrusive to the area?

4.2.4.2 Relevance

Typological investigations are based on the assumption that distinct types can be defined within a given artifact class, such as projectile points, that can be shown to belong to limited spans of time on the basis of reliable stratigraphic and chronometric evidence. Thus, it is necessary to show a correlation between stylistic variability on the one hand and definable chronological periods on the other. Theoretically, any aspect of material culture, such as features, tool production strategies, house patterns, or artifact classes, may exhibit time-sensitive characteristics and therefore be considered diagnostic of a particular cultural period or span of time within a cultural period. Other aspects of material culture do not show significant changes over broad spans of time. Alternatively, one basic class of material culture may not change in form over time, but it may be applied within exclusive functional contexts during different time periods. Thus, the concept of identifying chronologically sensitive markers in material culture need not be limited to the traditional concern over “types” and “varieties” within specific classes of tools; the important

connection that needs to be made is a clear association between some dimension of culturally meaningful variability and definable periods of time.

4.2.4.3 Data Requirements

This research domain does not have any unique data requirements that have not been discussed in previous sections. See Section 4.2.1, Paleoenvironmental Reconstruction; Section 4.2.2, Subsistence; and Section 4.2.3, Technology, for complete presentations of data requirements under this research program. The specific data needs for this research domain are as follows:

- Data relevant to paleoenvironmental conditions, subsistence, and technology
- Designations of feature form, function, and formation for all features within each component
- Pattern-recognition studies of cultural materials associated with various cultural periods, phases, and soil/sediment units based on a variety of pattern-detecting measures, such as stratigraphic interpretation, vertical distributions of plotted artifact elevations, and statistical indicators
- Secure chronological assessments of definable sediment units and cultural features
- Measures of correlation and covariation among artifact types, features, and raw material types within each component
- Analyses of clast sizes, organic residues, and spatial patterning in burned rock features and a sample of burned rock recovered from non-feature contexts

- Functional and typological designations for tools from each component
- Distributional data (vertical and horizontal) for the artifact assemblages from each component
- Spatial analyses of distributions of tools, lithic debitage, cores, bone, pottery, and other artifact classes within each component (qualitative and quantitative)
- Analysis of a sample of the lithic debitage assemblage (e.g., raw counts, size-class designations, flake types) and classifications of flake characteristics (e.g., core preparation techniques, percussion techniques, reduction stage, technological strategies)
- Measures of relationship among various classes of artifacts (e.g., ratios of specific tool types to other tool types, ratios of tools to features, ratios of cores to debitage, ratios of scrapers to bone, measures of correlation and covariation)
- Distributional data (vertical and horizontal) for the artifact assemblages from each component

4.2.4.4 Investigation Strategies

Studies of artifact typology, and culture historical studies in general, are ultimately built on the assumption that morphological variation in particular tool categories, especially projectile points, represent (1) an ordered sequence of changing styles of tool production through time and (2) a hypothetical model of the succession of sociocultural. Chronological investigations based on typological studies do not generally purport to model the succession of adaptive or organizational systems through time, though they may indirectly make the assumption that such is the case.

Typological studies at the Varga Site progressed according to generally accepted classifications of diagnostic tool categories developed for the Central Texas and surrounding regions (e.g., Davis 1995; Prewitt 1995; Turner and Hester 1983). Most chronological research in Central Texas applies primarily to projectile point typology, but other time-sensitive artifacts have been recognized and defined (e.g., Clear Fork gouges for the Early Archaic, Harahey knives for the Toyah phase). The chronometric and stratigraphic investigation strategies described in Section 4.2.1, Paleoenvironmental Reconstruction, serve as the backbone of chronological investigations here and serve to anchor the relative framework based on diagnostic tools in time.

Culture historical investigations was used to integrate suites of data that have been generated based on the requirements discussed in the paleoenvironmental, subsistence, and technological research domains (Sections 4.2.1 through 4.2.3, respectively), with emphasis on the technological domain. Units of analysis that were assumed to represent socioculturally or historically relevant groups of people or time periods were defined based on traditional typologies in use in Central Texas, though other categories of artifacts and statistical groups or clusters of artifacts were investigated in this context. Research proceeded by comparing and contrasting relevant variables within the Varga Site assemblage.

4.2.5 Factors Influencing Archeological Site Interpretation

Ultimately, the primary objective of this research design is to identify those dimensions of variability within the assemblage of excavated data from four cultural components at the Varga Site that could contribute meaningfully to the process of building hypotheses about the organizational systems of

prehistoric hunter-gatherers in southwestern Texas. As discussed in Section 4.1, “Theoretical Orientation”, the dimensions of those past organizational systems that are most directly of interest in the present context concern resource procurement strategies, mobility strategies, and patterns of land use. The process of building hypotheses about organizational systems is a knowledge-building activity that must necessarily be based on dimensionalized data that can be inferentially substantiated as circumstantial evidence of past human activities. The paleoenvironmental reconstruction, subsistence, and technology research domains discussed previously represent the source main areas of the dimensionalized data. However, before issues of hunter-gatherer mobility strategies and landscape use can be approached, it was first necessary to complete the task of establishing the necessary linkages between the static data of the archeological record to the dynamic conditions of past cultural systems. Thus, this discussion now turns to a consideration of site formation processes and intrasite structure.

Site Formation Processes

Schiffer (1987) divides archeological site formation processes, the suite of factors that act upon soils/sediments and cultural materials to produce the archeological record, into natural and cultural processes. Natural formation processes include the environmental dynamics that affect the structure of a site or an artifact assemblage. Cultural formation processes include the effects of past human activities on the distribution and character of an archeological assemblage. This research objective is an outgrowth of paleoenvironmental reconstruction as it uses many of the same data sets and analytical techniques. However, the emphasis of study is substantially different in determining the processes that contributed to the formation of site deposits than that involved in the

reconstruction of past environmental settings. In the current context, the study of site formation processes included (1) the study of landscape evolution and alluvial geomorphology as it relates to the depositional clarity of human occupational residues within the fine-grained sediments that comprise the first terrace of Hackberry Creek and (2) natural post-depositional factors human activities that affected the structure and integrity of sediment deposits and the archeological materials contained within them.

Patterns of landscape stability and change have an enormous effect on the formation of the archeological record by influencing the depositional context of archeological materials. Differential patterns of sediment deposition, soil development, and erosion are primary determinants in the preservation of intact archeological deposits, and presumably also constrained prehistoric hunter-gatherers' selection of landforms suitable for habitation. Consequently, natural landscape formation factors can strongly influence archeologists' interpretations of the archeological record. For example, some researchers have argued that deposition rates are the primary factor resulting in the formation of different "types" of burned rock middens in Central Texas (cf. Black and Ellis 1997:7; Suhm 1959:247). The domed form of midden, for instance, often appears amorphous when sectioned, lacking obvious internal structure, whereas the annular, or ring-shaped, midden form retains a high degree of structural integrity. Some researchers have argued that these are two fundamentally different forms of burned rock middens (Collins 1991), whereas others believe that the domed middens occur in stable or slowly aggrading sedimentary contexts in which discrete and brief depositional or behavioral events are not likely to be separated (Black and Ellis 1997). Although both midden forms are assumed to relate to the processing of foodstuffs, factors

such as the overt structural differences mentioned above (among other things) have led archeologists to radically diverging conclusions about the function and temporal and geographic distributions of these enigmatic features.

The activities of prehistoric humans also have significant effects on the distribution and preservation of archeological materials. Humans engage in an enormous range of activities that obscure the patterning of cultural materials. Even on single-occupation campsites, humans tend to remove trash from living areas ("sweeping up"); rework and reuse "diagnostic" tools dating from earlier time periods that they encountered and picked up in their travels; recycle "site furniture," such as rocks for cooking stone and construction elements, from nearby sites; and engage in multiple activities whose material results tend to overlap spatially. The problem of isolating clear patterns is compounded on sites that were reoccupied over several seasons or over hundreds or thousands of years, which is commonly the case in the rich alluvial environments that characterize much of the greater Edwards Plateau in Central Texas.

Sites of prehistoric human activity that were reoccupied over time tend to be subjected to numerous post-depositional sources of disturbance, such as trampling (the downward displacement of artifacts exposed on the surface due to normal foot traffic). Even normal pedogenic soil development on stabilized land surfaces tends to result in some downward translocation of smaller artifacts. Rodents, other burrowing animals, and insects can have massive impacts on the integrity of archeological deposits by displacing features of all shapes and sizes to move below the surface.

Clearly, in order to place any confidence in arguments about the cultural significance of observed patterning, archeologists must be careful to isolate and explain the cultural and

non-cultural post-depositional factors that may have altered the record of past human activities. Some post-depositional processes have been documented rather extensively and have clear, recognizable signatures; others have less well-understood effects on the archeological record.

Site Structure and Function

The goal of the analysis of intrasite structure is to identify distributions of artifacts and features on ancient “living surfaces” so as to obtain insights into the activities, behaviors, and processes for which material remains are the surviving evidence. As decades of research have demonstrated, problems of taphonomy and site formation processes must be taken into account before any cultural or behavioral explanations may be advanced. In the early days of spatial analytical studies, archeologists and paleoanthropologists developed complicated scenarios about the behaviors of early hominids based on the patterns of debris exposed on “living floors” without considering that other, non-hominid forces may have been responsible for producing the patterning. While spatial analyses have become more scientifically rigorous, much yet remains to be done in developing reliable linkages between observed patterning and the human activities that produced the available record.

Models of modern hunter-gatherer organization have provided useful starting places for explaining variability encountered in the archeological record (cf. Bartram et al. 1991; Binford 1977, 1980; Cahen et al. 1979; Keeley 1991; O’Connell et al. 1991; Stevenson 1991; Whitelaw 1991, 1994; Yellen 1977). Observations of the spatial organization of activities at ethnographically documented hunter-gatherer sites have permitted identification of material correlates of specific activities, such as the arrangement of site facilities, trash-discard behavior; dispersion of

artifacts via human, animal, insect, and natural processes; and variability in site functions on landscapes. Various researchers have proposed a wide range of potentially informative determinants of site structure and size, including residential mobility patterns, length of camp occupation, number of site occupants, seasonal weather variability, degree of food-sharing among households, kinship structure, reliance on food storage, social ranking, and risk from large predators. A central aspect of the ethnographic site structure work that has been conducted is that much of it has occurred on sites that are the products of single occupations. While it is important to build warranting arguments at this level, archeological deposits, even within relatively distinct stratigraphic contexts, often contain material remains from multiple occupations that may have accumulated through a combination of site reuse and erosional processes (which produce palimpsests of artifacts that contain heavily overprinted activity areas). Clearly, much work remains to be done at the pattern-recognition level.

Settlement and Land Use Patterns

In ethnoarcheology, hunter-gatherer mobility and land-use patterns can be recorded for a single group of people as they move across the landscape during their seasonal cycle. In archeology, mobility, settlement, and land-use strategies represent an organizational domain that may only be reconstructed through the process of building well reasoned arguments about human behavior derived from the static archeological record. Building hypotheses about prehistoric settlement systems and land-use strategies is strongly conditioned by the breadth of available information from investigations conducted at various types of sites dating to specific time periods. Thus, in some areas, such as parts of the American Southwest in which virtually every site that has been preserved in the

archeological record has been recorded and subjected to at least survey-level archeological investigations, the task of hypothesis building is strengthened by the sheer wealth of available settlement data. Other regions have not been as fortunate. In the American Midwest, for example, large-scale investigations historically focused on the mortuary centers and earthen mounds of the Middle Woodland and Mississippian periods to the exclusion of generalized base camps and limited-use, resource extraction sites. In Central Texas, burned rock middens have been the favored type of site for excavations. In southwestern Texas, only a few sites have received systematic archeological investigation; consequently, the array of information available for building hypotheses about past organizational systems is extremely limited.

Nevertheless, hypothesis building must always begin somewhere regardless of the quantity of available data upon which inferences may be based. The reconstruction of settlement systems is necessarily approached from a multi-site or regional level of investigation. Since so few sites in southwestern Texas have been subjected to systematic excavation and analysis by professional archeologists, the current study is by necessity based on an incomplete database. Nevertheless, previous cultural resource surveys of the region surrounding the Varga Site have resulted in the documentation of numerous types of sites in both riverine and upland settings (cf, Devils Sinkhole by Howard et al. 1996). In addition, very few archeological sites in the surrounding region have been excavated and the results of analysis have been published. Based on these sources of information and the data derived from excavations at the Varga Site, the process of building hypotheses about prehistoric hunter-gatherer mobility, resource procurement, and land-use strategies can be reasonably undertaken.

4.2.5.1 Research Questions

- How much confidence can be placed on identifying the integrity and association of artifacts from various occupation zones?
- To what degree do the densities of cultural materials within various occupation zones relate to differential habitation intensity versus differential rates of sedimentation and/or erosion?
- What degree of post-depositional mixing of materials has occurred on the site? Is it possible to isolate individual occupations within broad occupation zones? Can laminae, microstrata, and/or individual occupation surfaces be discerned within overall occupation zones (i.e., components) based on stratigraphy, vertical distributions of plotted artifact elevations, and/or statistical indicators?
- Do the four cultural components on the site represent palimpsests of occupations or do they contain discrete, definable occupation episodes?
- Can distinct activity areas be defined within various cultural components based on feature distributions and/or the horizontal patterning of different artifact and/or material types?
- To what degree does overprinting of features and/or activity areas affect interpretations of the spatial structure of various occupation zones? Can individual activity areas or specific activities be detected within occupation zones that may be palimpsests of multiple occupations?
- To what degree do the densities of cultural materials within various occupation zones relate to differential habitation intensity

versus differential rates of sedimentation and/or erosion?

- Can horizontal and/or vertical patterning be detected based on the distribution of and correlation and covariation among features, tools, residues, and other classes of artifacts across various occupation zones?
- What kinds of features typify each component? What range of functions do features within each component indicate? Do feature functions and/or forms vary in regular ways across time (i.e., among components)?
- Which segments of the assemblages from each component represent collector-based strategies? Forager-based strategies?
- Which segments of the tool assemblages from each component represent formal or standardized technologies? Which segments represent informal or expedient technologies?
- What relative emphases are evident on curated versus expendable tool technologies?
- Are subsistence economies through time focused on local versus regionally distributed resources?
- Are the subsistence economies through time focused on specific resources or limited ranges of resources (i.e., specialized) or are they more diversified (i.e., broad-based) economies?
- What was the surface distribution of geological materials (e.g., chert for stone tools, clay for pots) on the prehistoric landscape through time? Which resource localities were used? Which were not used?

Was lithic raw material procurement embedded in other economic activities?

- Were specific types of material, such as lithic raw materials, pottery, or sociotechnic objects, obtained and/or manufactured by the inhabitants of the Varga Site or obtained through trade? Were they manufacture at the Varga site or elsewhere?
- What types of sites characterize various time periods in the middle to upper Hackberry Creek Valley and the surrounding uplands?
- At various points in time, was the Varga Site part of a locally-based settlement system (i.e., the Hackberry Creek Valley and environs) or a regionally-based system (i.e., trans-valley)?
- What was the seasonal structure of group mobility?
- Were the cultural components at the Varga Site formed during intensive, long-term occupations or did they result from multiple short-term occupations.
- Are the inhabitants of the Varga Site a large family, multi-family, or other large social unit or a specialized task group?

4.2.5.2 Relevance

The primary data generated in pursuit of answers to the questions outlined in the paleoenvironmental, subsistence, and technology domains are of direct relevance to the task of tracing the formation of archeologically significant sediments and delimiting the organization of activities at the Varga Site. The spatial distributions of various tool classes, debitage, features, faunal bone, and other artifacts across each site component provide the foundation upon which assessments of site function may be made. The differential

function, or range of functions, that characterize the site at a given point in time, in turn, provide for a range of inferences about the role of the site in the overall settlement system of which it formed a part through time. Explorations of such hypotheses may eventually lead to qualified characterizations of hunter-gatherer organizational systems in southwestern Texas.

4.2.5.3 Data Requirements

Although this research domain has a few unique data requirements that have not been discussed in previous sections, most data needed to answer questions pertaining to hunter-gatherer mobility and land-use systems have been discussed previously. See Section 4.2.1, Paleoenvironmental Reconstruction; Section 4.2.2, Subsistence; and Section 4.2.3, Technology, for complete presentations of data requirements under this research program. The specific data needs for this research domain are as follows:

- Data pertaining to paleoenvironmental conditions, subsistence, and technology
- Studies of floodplain formation processes and alluvial geomorphology of the Hackberry Creek terrace system
- Designations of feature form, function, and formation for all features within each component
- Pattern-recognition studies of cultural materials associated with various cultural periods, phases, and soil/sediment units based on a variety of pattern-detecting measures, such as stratigraphic interpretation, vertical distributions of plotted artifact elevations, and statistical indicators
- Secure chronological assessments of definable sediment units and cultural features
- Measures of correlation and covariation among artifact types, features, and raw material types within each component
- Presence/absence and extent of signs of burning, weathering, and patination on cultural materials
- Analyses of clast sizes, organic residues, and spatial patterning in burned rock features and a sample of burned rock recovered from non-feature contexts
- Functional and typological designations for tools from each component
- Distributional data (vertical and horizontal) for the artifact assemblages from each component
- Spatial analyses of distributions of tools, lithic debitage, cores, bone, pottery, and other artifact classes within each component (qualitative and quantitative)
- Analysis of a sample of the lithic debitage assemblage (e.g., raw counts, size-class designations, flake types) and classifications of flake characteristics (e.g., core preparation techniques, percussion techniques, reduction stage, technological strategies)
- Measures of relationship among various classes of artifacts (e.g., ratios of specific tool types to other tool types, ratios of tools to features, ratios of cores to debitage, ratios of scrapers to bone, statistical measures of correlation and covariation)
- Distributional data (vertical and horizontal) for the artifact assemblages from each component

- Spatial analyses of distributions of tools, lithic debitage, cores, bone, pottery, and other artifact classes within each component (qualitative and quantitative)

4.2.5.4 Investigation Strategies

Site Formation Processes

The data requirements and analytical needs for studies of site formation processes mirror those involved in paleoenvironmental reconstruction; the study of site formation processes is distinct from the latter research domain in emphasis rather than in kind. Studies of site formation processes at the Varga Site consisted of three separate investigative activities: (1) alluvial geomorphology and its effect on the resolution of archeological deposits and the sequencing of prehistoric occupations; (2) the effects of post-depositional natural factors, such as pedogenesis and bioturbation; and (3) the effects of prehistoric cultural behavior on the integrity of deposits.

Some data needed for these investigations are similar to those involved in the paleoenvironmental investigations described in Section 4.2.1, including rates of deposition of the fine-grained sediments that comprise the first terrace of Hackberry Creek and the presence/absence and periodicity of erosional episodes. Other natural phenomena that need to be assessed include the impact of krotovina and historic and modern farming, ranching, and construction activities on the integrity of deposits. Other data needed for evaluating site formation processes are derived from pattern-recognition studies, as discussed below in conjunction with analyses of intrasite structure. Among the cultural formation processes considered were curation of tools and “site furniture” by the prehistoric occupants (e.g., reuse of items from earlier components),

overprinting of features and activity areas, and the periodicity of occupations.

In large part, evaluating site formation processes was an outgrowth of pattern-recognition studies. The existence of certain post-depositional factors is known based on fieldwork, such as the presence of extensive rodent and insect activity in some parts of the investigated site area, but the process of building arguments about observed patterning in the archeological record must begin with the elucidation of the patterning itself. The spatial analysis techniques that were brought to bear in the current study are discussed in more detail below.

Site Structure and Function

Spatial analysis studies at the Varga Site focused on elucidating the spatial organization of activities within each of the cultural components defined. It was not possible to discriminate among separate occupation episodes within broad cultural components; therefore the scale of spatial studies was directed towards the identified components. Thus, the suite of investigative strategies described below was applied to each of the four analytical units in the study, including the Toyah phase, Late Archaic period, Middle Archaic period, and Early Archaic period components in general.

The study of intrasite structure at the Varga Site was the use of functional and typological variables that represent the range of tools types, features, and other artifact and ecofact classes. In this sense, these spatial analysis studies were necessarily predicated upon the classification systems applied to the assemblage of artifact, ecofact, and feature data. In the current context, investigations of site structure were therefore heavily dependent upon the results of technological research (see Section 4.2.3, Technology). The technology research domain generated most variables that were used in spatial studies, such as determinations of feature

form and function, tool types, debitage categories, projectile point types or morphological clusters, burned rock size categories, scraper varieties, and so forth. Other dimensions of variability for use in spatial analyses arose from studies of faunal butchering patterns, plant and animal processing techniques, and/or flintknapping activities.

The primary mode of spatial analysis consisted of examinations of the horizontal and vertical distributions of features and various artifact classes, such as burned rock (non-feature); tools (chipped stone, groundstone, and bone), ceramic sherds, cores, lithic debitage, and faunal remains. Vertical provenience was based on broad soil/sediment units (which are largely correlated with the occupation zones) as well as the point-elevation data recorded on larger artifacts during excavation. Field personnel were instructed to record the bottom elevations of all larger cultural specimens that were encountered in situ during excavation. The assumption underlying this practice is that larger items (i.e., larger than a golf ball) probably experienced relatively less post-depositional movement than smaller items; therefore, the elevations of these items may serve as a basis for identifying occupation surfaces that do not have any other stratigraphic indicators.

Within each component, horizontal distributions were plotted and examined based on densities of various material categories. Densities were measured in terms of numbers of items per cultural component per 1-by-1 m² excavation unit across the excavations. These density were measured in terms of raw counts per m² (for area measurements) or item counts per m³ (for volume estimates) interchangeably based on the degree of vertical resolution that was determined within each component and on the goals and requirements of specific analyses (i.e., raw item counts work better with some pattern-detecting techniques, whereas others require density-

corrected data). The block excavation strategy that was implemented during data recovery excavations, emphasized exposing large, continuous occupational areas, resulted in a data set that is strongly suited for a robust suite of spatial analysis techniques.

Spatial studies employed various qualitative and quantitative measures of correlation and covariation among artifact and material type classes. Plan maps of artifact distributions were examined for subjective impressions of association among variables, and quantitative techniques designed to detect patterning within data sets organized according to grid cells were implemented. Ratios among various classes of artifacts, features, raw material, and/or ecofacts were examined from a spatial perspective to aid in the process of defining functional and spatial patterning within the assemblage.

Settlement and Land Use Patterns

As discussed at the beginning of this section, the process of building hypotheses about hunter-gatherer mobility, settlement, and land use patterns based on the limited perspective of a single archeological site (complemented by a small body of relevant data from other sites in the region) is based entirely on inferences. The empirical data requirements for this task derive from the paleoenvironmental, subsistence, and technology domains discussed in Sections 4.2.1 to 4.2.3 of this research design. This discussion will therefore turn to the frames of reference and the epistemological framework of knowledge building advocated in this research design.

Hunter-Gatherer Mobility and Foraging Strategies

Having completed the empirical analyses of data from the various cultural components at the Varga Site and armed with independent

ecological and ethnographic frames of reference, the process of building hypotheses about hunter-gatherer mobility, foraging strategies, and land use patterns may begin. In this context, it is perhaps more germane to understand how archeological inferences are constructed and used rather than to discuss the specific hypotheses that may result from this research. After all, archeological inference necessarily arises from dimensionalized data, and it would not do to impose interpretive frameworks upon the data before it has been analyzed.

In his most recent book, Binford (2001) likens the scientific investigation of the human past and ethnographic present to a theatrical presentation whose theme is the growth of knowledge. Unlike the conventional stage, however, where action is organized in terms of a plot with a beginning, a middle, and an end, this drama is open-ended and improvisational. It depends for its direction and pace on the goals and strategies of the *dramatis personae*—a group of scientific researchers with a common interest in hunter-gatherers—who work to reduce their ignorance about the past. In the prologue of this performance, the players describe the steps they have taken to define a class of observations. These *operational definitions* are intended to prevent confusion and misunderstanding as the play of ideas develops. Not all of the descriptive criteria that will later play a part in argument and analysis can be identified initially, however, since the direction that research will sometimes take is dependent on what the players learn about the validity of their ideas as the action of the play unfolds. If some or all of a player's corpus of knowledge is discovered to be irrelevant to the investigation of a particular problem, he or she must develop another set of propositions that are more germane to the trajectory of research. Mid-stream regrouping of this nature does not necessarily represent failure; in fact, the process of recognizing one's ignorance, or the limits of one's knowledge, or

the inadequacies of one's operational definitions, is a profound form of knowledge that allows the player to search for new, more relevant information and then to reformulate the argument.

Once a researcher has recorded observations on material phenomena and has selected the initial dimensions in terms of which these observations are going to be organized, the scientific dialogue can begin. This is the juncture at which, if one resists the temptation to make accommodative arguments that stipulate what the data represent, the data have the opportunity to “talk back.” The generic term for all subsequent investigation is *analysis*, which embraces all of the tactics and strategies that a researcher may implement in the search for relationships in the data set. Analysis is the study of how vectors of dimensionalized data interact with other, independently dimensionalized data either in the same or another data set. Once relationships are identified, the “conversation” between the researcher and the data begins as the researcher attempts to link the identified patterns to other sources of knowledge.

In archeology, investigations all too often fail to make it past this point. Good science consists of the strategic use of prior knowledge to make projections from better-known domains to less well-known domains. When observations on the lesser well-known phenomena are inconsistent with our projections, this is an important clue to the way in which the world may have been different from our conception of it. When ideas that we have considered germane are shown to be irrelevant, or at least poorly conceived relative to the way the world is organized, an opportunity for learning has been identified. Tactically, the tools that may be used to develop a dialogue with the data include independent frames of reference and pattern-recognition techniques. Interpretive conventions must not be imposed on detected patterning a priori;

rather, the role of the scientist is to identify correlation and covariation among patterns and to build arguments about causality.

4.3 SUMMARY

The Varga Site (41ED28) is a multicomponent prehistoric archeological site on the northern T1 of Hackberry Creek in Edwards County, Texas. A two phase data recovery excavation conducted in a limited portion of this site by TRC archeologists under contract to TxDOT in 2002 resulted in the documentation of four prehistoric archeological components. The three most robust and clearly defined components date to the Late Prehistoric period Toyah phase (ca. 300 to 600 B.P.), the Late Archaic period (ca. 1,700 to 2,300 B.P.), and the Early Archaic period (ca. 5,200 to 6,300 B.P.). A specific Middle Archaic period (ca. 3,900 to 4,800 B.P.) component was also recognized, but was not as clearly defined as the other three components.

Whereas the undocumented boundaries of the Varga Site extend hundreds of meters along the northern terrace of Hackberry Creek, TRC's investigations were limited to a narrow part of the site that lies within the area of potential effect in the TxDOT right-of-way of a small county road. Block area excavations conducted on both sides of the pavement resulted in the excavation of a total of 207.75 m², including an 83.00 m² block excavation area on the west side of the road (Block A) and a 124.75 m² block excavation area on the east side of the road (Block B). A total of 104.46 m³ of sediment was manually excavated, including 66.20 m³ in Block A and 38.26 m³ in Block B. Nine backhoe trenches were mechanically excavated to aid in the task of interpreting the site's

stratigraphy, including seven trenches in the investigated site area on the first terrace, one in the T0/T1 terrace interface just south of Block A, and one in the T1/T2 terrace interface about 100 m north of Block A.

The fine-grained, overbank alluvial sediments that contain the archeological components appeared relatively intact. However, krotovina disturbance was relatively extensive in parts of the investigated area, and the modern ground surface had been impacted by road construction and maintenance activities as well as some degree of erosion. Nevertheless, the archeological deposits exhibited a high degree of contextual integrity. Based on the site's stratigraphy, the Varga Site provides a rare opportunity to study definable cultural components in a region that is largely unknown archeologically. Furthermore, the site yielded a robust but mixed Early Archaic period assemblage. Unmixed Early Archaic assemblages have been documented in only a few investigated sites in Central Texas.

This research design was developed and served as a focus for profitably studying the recovered assemblages of artifact, ecofact, feature, and geomorphological data. Specific research avenues have made meaningful contributions to current studies of hunter-gatherer paleoecology and to culture historical studies near the interface of two archeological regions, Central Texas and the Lower Pecos regions, of southwest Texas. Research contributions were made towards understanding the paleoenvironment, subsistence, technology, culture history, and people's mobility and land use during specific use periods over the last 6,300 years.

5.0 INVESTIGATIVE METHODS

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5.1 INTRODUCTION

Data recovery excavations at the Varga Site were undertaken in two separate phases. The first phase of fieldwork included mechanical stripping and trenching as well as manual excavation of a small part of the site. Upon completion of the first phase of fieldwork, TRC submitted an interim report to TxDOT that summarized the archeological and geomorphological investigations undertaken to date (i.e., February 2002) and presented a preliminary tabulation and limited assessment of artifacts and feature data recovered (Lintz et al. 2002). This report documented the significant research potential of this site, recommended a second phase of data recovery excavations to mitigate the proposed construction impacts, and presented a data recovery plan that guided the second phase of excavations.

The field tactics employed during the second phase of fieldwork emphasized opening up large block excavations on both sides of the road. The excavation blocks enabled TRC archeologists to expose large portions of each occupation zone at once, providing a window on the spatial patterning of features and artifacts, rather than sinking a series of adjacent “telephone booth”—type pits in discontinuous areas. Excavations on the west side of the Ranch to Market Road (Block A) targeted the entire sequence of occupations at the Varga Site, including the

Early Archaic through Toyah period components, while excavations on the east side of the road (Block B) focused exclusively on the Toyah period component.

5.2 PREVIOUS INVESTIGATIONS

The Varga Site was originally documented during a cultural resource reconnaissance of the upper Nueces River Natural Area near the Devil’s Sinkhole (Kennard 1975; Marmaduke and Whitsett 1975). Although the original site forms are missing from TARL files (or were never submitted), the survey report briefly describes site 41ED28 as a 250-meter-long site of undetermined width that extends along a terrace on the north side of Hackberry Creek (Marmaduke and Whitsett 1975:92). The recorders identified two “burned rock middens” on the highest portion of the terrace as well as several additional “fire hearths” on the lower parts of the terrace. Burned rock and lithic artifacts were observed scattered across the entire surface (see Marmaduke and Whitsett 1975:107, Fig. 5).

Following its initial discovery and documentation, no further cultural resource investigations occurred at the Varga Site until the current TxDOT undertaking. These archeological investigations were initiated in response to the planned reconstruction of the Ranch to Market Road crossing over Hackberry Creek immediately south of the site. The existing low-water crossing had washed out twice during severe flooding in the winters of 2000/2001 and 2001/2002. At the time that archeological investigations began, final decisions had not yet been made regarding the long-term solution for repairing the creek crossing, but either a bridge or a reinforced low-water crossing were considered to be options. Either way, the portion of the Varga Site lying within the existing road right-of-way on the northern terrace of the creek would be impacted

by construction activities, so TxDOT initiated cultural resource investigations of the potentially affected part of the site.

5.3 PHASE I OF DATA RECOVERY INVESTIGATIONS

5.3.1 Archeological Field Procedures

In 2001, TxDOT's Environmental Affairs Division contracted TRC to investigate the part of the site that lies within TxDOT's right-of-way. TRC's scope of work was originally quite limited; it was designed to exhaust the information potential of a purported burned rock oven feature located on the rim of the first terrace of Hackberry Creek on the west side of the Ranch to Market Road (Lintz et al. 2002). During a field inspection of the damage to the low-water crossing following the most recent flood event in the winter of 2001/2002, TxDOT archeologists noticed a low topographic mound within the right-of-way on the west side of the existing road. This topographic anomaly was reported to be covered with lithic debris, burned and unburned rocks, and animal bones and was suspected to be a prehistoric burned rock oven "midden." Local informants apparently reported that this "midden" had been subjected to repeated collecting and digging activities over the years, though no obvious potholes or other evidence of vandalism were evident (the authors now believe that these reports of pothunter excavations apply to other burned rock midden features located elsewhere on the site, beyond TxDOT's right-of-way). As this "midden" was located within the area of potential effect regardless of the manner of highway repair construction of the low-water crossing, investigations of the area were warranted as required under Section 106 of the NHPA.

In an effort to streamline the regulatory procedures of NHPA Section 106, TxDOT archeologists entered into consultation with the THC. Based on these consultations and

available information about the site, it was determined that any archeological testing within TxDOT's right-of-way would most likely result in the determination of the "midden" feature as eligible for inclusion in the National Register of Historic Places (NRHP). Consequently, the parties agreed that data recovery investigations should be initiated in the "midden" feature without implementing a formal testing phase.

In consultation with TxDOT, TRC developed a scope of work that employed mechanical ground surface stripping and backhoe trenching as well as manual excavation of up to 10 m³ to efficiently extract data from the intact parts of the purported "midden" feature. A delivery order for these investigations was issued to TRC under an existing scientific services contract for cultural resource services. TRC archeologists and a subcontracted geoarcheologist performed data recovery fieldwork at the Varga Site between January 14 and February 10, 2002, under Texas Antiquities Committee Permit 2779. During these investigations, changes in site conditions necessitated contract modifications to reallocate the 10 m³ excavation area to examine the archeological potential on both sides of the Ranch to Market Road near the lip of the second terrace.

The initial plan for investigating the site was developed by TxDOT archeologists specifically to document the burned rock "midden," to identify any intact cultural deposits, and to extract information from any intact portions of the feature (Lintz et al. 2002:6). Consequently, the initial work authorization called for TRC archeologists to restrict excavations to the "midden" feature. First, the presumed, disturbed surface sediments overlying the "midden" feature on the west side of the Ranch to Market Road, which was described as being "armored" with lithic debris, burned and unburned rocks, and animal bones, were mechanically stripped using a Gradall®. The initial stripping showed

that very sparse burned rocks, and deer and bison bones were present under the armor of surface rocks. Thus, these sediments appeared to lack the stratigraphic integrity necessary to contribute information about the site. In addition, the light brown sediments showed little evidence of the reported vandalism in the topographic mound.

Although the true nature of the site was not known at this time, it appears in retrospect that the surface stripping may have removed portions of the Toyah component at the site, especially on the west side of the Ranch to Market Road (i.e., Block A). The initial interim report states that the upper 10 to 20 cm of sediment was removed from the site surface on the west side of the road. These sediments were determined to consist largely of roadway gravel and/or sediments that had been moved during road construction and subsequent maintenance activities. The ground surface in the Ranch to Market Road right-of-way is highest along the bordering fence lines and slopes down toward the existing pavement in the center, resulting in elevation differences of about 40 cm on the west side and about 20 cm on the east side of the road. While the original surface contour prior to stripping was not known, the uppermost alluvial sediments containing the Toyah component are 40+ cm thick along the fence lines at the edges of the right-of-way, but the depth of these sediments decreases rapidly moving inwards toward the road. In some areas on the west side of the road (Block A), the Toyah component was entirely absent. In addition, most of the faunal bones recovered from the Toyah component are highly fragmented, possibly as the result of heavy equipment movement. Surface stripping on the east side of the road was not conducted during the first phase of data recovery excavations.

After surface stripping on the west side of the road was completed, a north-to-south-oriented

trench (BT 1) was excavated west of the small concentration of burned rocks revealed during the stripping (i.e., through the west half of the topographic anomaly interpreted as a burned rock “midden”). For mechanical excavations, TxDOT provided a Gradall® with a 1.2 m wide, straight-edged bucket and an operator. BT 1 exposed a 5-to-6 m long rock lens (designated as Feature 1) in a shallow basin buried under 30 cm of fine sediments and overlying about 60 cm of fine sediments and coarse gravel deposits. In accordance with the work authorization, a second, east-to-west-oriented trench (BT 2) was excavated perpendicular to the first trench through the northern half of the shallow burned rock lens. This trench reaffirmed the scarcity of burned rock in most of the deposits. The evidence clearly indicated that the topographic mound feature did not represent a classic burned rock midden. The trench walls were profiled and photodocumented. The project geoarcheologist, Mr. Grant Smith of TRC’s El Paso office, described and drew profiles of both trenches. He also collected a series of sediment samples from the west end of BT 2 to assist in characterizing the texture and chemistry of the sediments near Feature 1.

In addition to the excavation of BTs 1 and 2, the initial work authorization called for manual excavation of up to 10 m³ of site sediments. Thus, upon completing the excavation of BTs 1 and 2, a grid system composed of 1 m square units was laid out over the “mound area” on the west side of the road. The southwest corner of the “mound” near the edge of the TxDOT right-of-way boundary was arbitrarily assigned the designation of N100/E50, and the grid was extended north and east to cover the entire area. All 1-by-1 m units were designated according to the coordinate of their southwest corner in relation to the reference point, while the 0.5-by-0.5 m units were designated using the quadrant’s position within the larger 1-by-1 m unit (e.g., NW 1/4 of N103/E52). Vertical depth was

maintained in reference to a site datum installed along the fence line and extrapolated to a subdatum placed near the west side of the intersection of BTs 1 and 2.

Initially, TRC's scope of work called for excavating 0.5-by-0.5 m columns at two-meter intervals along the edges of BTs 1 and 2. These excavation columns were designed to obtain information on the internal structure of the midden feature as well as any associated features or occupation zones. Four 0.5-by-0.5 m units were initially excavated—two on the eastern side of BT 1 and two along the southern edge of BT 2. Sediments excavated from these four columns were screened through 3.2 mm (1/8 in) hardware cloth. The manual excavations of these two columns documented the occurrence of elevated quantities of chert debitage above the burned rocks and again just above the basal gravels. The recovery of diagnostic Early Archaic dart points and Late Prehistoric Perdiz arrow points, high densities of prehistoric artifacts above and below the thin rock lens, and the lack of vandalism all suggested that the second terrace area contained stratified occupations with considerable integrity. Furthermore, the cultural deposits appeared to extend laterally beyond the topographic mound.

TRC entered into field consultation with TxDOT archeologists, and the original scope of work was altered to include the investigation of deposits on both sides of the Ranch to Market Road to ascertain the geometry of the terrace deposits and the extent of archeological remains. TRC archeologists were asked to excavate additional Gradall® trenches north of the original target area on the west side of the road and to extend investigations to the east side. In addition, the original requirement to screen all excavated sediments through 3.2 mm mesh was waived, and TRC personnel were granted latitude of judgment in the placement and distribution of 0.5-by-0.5 m and 1-by-1 m

manual excavation units. However, the level of effort expended to excavate on both sides of the road was restricted to the original volume limit of 10 m³.

Two additional Gradall® trenches were excavated on the west side of the Ranch to Market Road (BTs 3 and 4) and three trenches were excavated on the east side (BTs 5 to 7). A total of seven 0.5-by-0.5 m units was excavated along the edges of the deeper backhoe trenches (four on the west side of the Ranch to Market Road and three on the east side of the road), and an eighth 0.5-by-0.5 m unit was excavated just south of BT 3 on the west side of the road. A scatter of five 1-by-1 m units was excavated on the east side of the road, and two 1-by-2 m units were excavated on the west side of the road near the initial backhoe trenches (BTs 1 and 2). Manual excavations were conducted using hand tools (i.e., picks, shovels, and trowels). The fill from 23 10 cm levels from four 0.5-by-0.5 m units was screened through 3.2 mm mesh; and two of these columns were systematically fine-screened from top to bottom to obtain a consistent sample. All other fill was screened through 6.4 mm (1/4 in) hardware cloth.

Clusters of artifacts, such as faunal bone or burned rocks, and ashy stains were designated as cultural features. Seven such features were originally documented in the field, though three were attributed during later analyses to natural causes (i.e., two were burned root casts and one was a cluster of mineral deposits originally believed to possibly be decomposed human long bones). The four remaining cultural features included the burned rock lens (Feature 1), two sparse scatters of burned rock, and one bison and deer bone dump associated with burned rocks. Samples of sediments comprising the features were often collected, but not in all instances. All hand-excavated units were terminated upon encountering culturally sterile gravel deposits. The first phase of fieldwork was halted upon

fulfilling the contractual excavation limit of 10 m³.

Information about all levels was recorded on standard excavation level forms. Observed rocks and other materials found *in situ* were plotted on the level forms, and elevations were collected from the bottom of the plotted artifacts. Burned rocks were sorted according to size, shape, and material class in the field, and these attributes were recorded on the level forms. After being counted and weighed, most burned rocks were discarded on-site.

All flakes, bones, ceramic sherds, pieces of burned clay, charcoal, and tools were placed in clear line seal top bags with completed provenience tags. Excavators compiled preliminary field counts of collected materials in the field to facilitate the compilation of information about material distributions for the first interim report (Lintz et al. 2002). Laboratory work associated with the first phase of fieldwork, however, was limited to assessing the completeness and accuracy of field records and collected materials; no cleaning or cataloging of artifacts occurred at this stage. All material classes were examined, counts and weights were compiled for the unwashed artifacts, and an effort was made to identify the types of projectile points and pottery recovered from the excavations. In addition, soil samples were collected from various strata observed in the backhoe trenches to aid in preliminary geomorphological interpretations of site stratigraphy and terrace formation processes.

The results of this initial phase of fieldwork have been summarized in an interim report (Lintz et al. 2002) and served as the basis for designing a second, more robust phase of data recovery excavations at the site. The first interim report documented that the archeological setting and context of the Varga Site were quite different than originally expected, and a second

phase of fieldwork was recommended to fully investigate the cultural deposits within the area of potential effect. In anticipation of a second phase of data recovery excavations, all Gradall® trenches and hand-excavated test units were lined with plastic and backfilled with excavated sediments and sterile sand upon completion of excavations under the supervision of an archeological monitor.

The first phase of fieldwork established that thick (70+ cm) deposits of stratified fine sediments containing predominantly Toyah, Late Archaic, and Early Archaic archeological materials existed on both sides of the Ranch to Market Road within TxDOT's right-of-way (the sparse Middle Archaic component was identified only during the second phase of fieldwork). Despite some variability in depositional packages across the site, two major and one minor occupation zones were documented. The uppermost major occupation zone, attributed to the Toyah phase, was present in the uppermost 10 to 40 cm of deposits on both sides of the road. Large quantities of artifacts were recovered from this component, and the preservation of bone and organic remains was excellent in these upper sediments. Several associated cultural features (i.e., debris clusters) were documented.

The minor occupation was associated with the large, shallow lens of burned rock (Feature 1) at depths of 30 to 60 cm below surface (cmbs). This occupation was tentatively dated to the Middle Archaic period based on the presence of a possible Pedernales/Martindale point (subsequent investigations established that this feature and the surrounding cultural component actually date to the Late Archaic period; consequently, this cultural component is referred to as Late Archaic throughout this report). Even though associated artifacts were not abundant, this occupation zone was marked by superb stratigraphic clarity on both sides of the road

(although high burned rock densities were limited to the immediate vicinity of Feature 1).

Finally, a substantial Early Archaic occupation zone was identified at depths ranging from 60 to 80 cmbs east of the Ranch to Market Road and from 60 to 110 cmbs west of the road, near the base of the excavations above the basal gravel deposits. Preservation of organic materials was not perceived to be especially good in these lower zones, and no associated features were found during the first phase of fieldwork, but artifact densities were observed to be extremely high.

Based on variability in artifact densities, the most productive areas to be examined in the second phase of fieldwork appeared to include all occupation zones on the west side of the Ranch to Market Road, including Toyah, Late Archaic, and Early Archaic occupations (as well as any general Middle Archaic components that may occur between the Early and Late Archaic period occupation zones), but only the Toyah component was targeted on the east side of the road. Older occupations were documented on the east side of the road, but the preservation appeared to be poor and temporal and cultural diagnostics and features were rare. Thus, the first interim report recommended that the second phase of fieldwork target all three components on the west side of the Ranch to Market Road and only the Toyah component on the east side of the road. The report presented a data recovery plan that guided the proposed second phase of excavations at the Varga Site and outlined eight primary research domains to be addressed with the data recovered. Upon consultation with THC, TxDOT concurred with TRC's recommendations and issued a work order to proceed with the proposed second phase of data-recovery excavations.

Before the second phase of excavations could begin, however, TxDOT entered into

consultation with any interested parties (per Section 106 of the NHPA) regarding the possible human remains recovered during the first phase of fieldwork. At TxDOT's request, a sample of the possible human remains was examined by three physical anthropologists. The physical anthropologists concluded that the materials could not be assigned to a species, though one concluded that the size and position of the materials were consistent with human leg bones (Appendix J). Given the inconclusive results, TxDOT submitted a sample of the material to a bone histologist for examination of the cellular structure of the material. The histologist and his academic advisor both concluded that the material was not bone. The histology information was also submitted to osteologists in California who reaffirmed the conclusion that the material was not bone. Once all opinions were gathered, TxDOT's archeological staff, TRC archeologists, and the THC concluded that the material was not human in origin (these materials are now believed to be sediment cavities, probably root casts that were subsequently filled with carbonates [see Appendix J for a full report]). Based on this conclusion, it was determined that the second phase of data recovery excavations could proceed.

5.3.2 Geoarcheological Field Procedures

Geoarcheological investigations were conducted during the first phase of fieldwork at the Varga Site to evaluate site integrity, to identify the soil/depositional units relevant to the archeological investigations, and to characterize the natural setting (Lintz et al. 2002). These investigations were accomplished primarily through examination of Gradall® trench exposures, inspection of hand-excavated unit profiles, and pedestrian observation of the surrounding terrain. Seven backhoe trenches, including four on the west side of the Ranch to

Market Road and three on the east side of the road, and 10 m³ of hand-excavated units were excavated at the Varga Site during the first phase of fieldwork. Although the initial backhoe trenches were excavated in areas directly related to known cultural materials, additional trenches on the east side of the roadway helped delineate the extent of soil/depositional units with the potential to yield prehistoric cultural materials. Based on these investigations, several distinct, relatively intact sediment packages were identified on the first terrace on both sides of the roadway. Although some variability in the depth of the various depositional units was observed, the stratigraphic sequence was similar across the investigated site area.

Field descriptions followed standard sedimentologic and pedogenic procedures established by the Soil Survey Staff (1962, 1975), Krumbein and Sloss (1963), Gile et al. (1966), Reineck and Singh (1980), Birkeland (1984), Birkeland et al. (1991), and Waters (1992). Field investigations were recorded on standardized profile-exposure forms.

At the time of the first-phase geomorphological investigations, the sediments were moist due to precipitation. This tended to obscure the stratigraphic boundaries in the upper portions of the profiles. Some profiles dried out later during the excavations, and additional observations from the archeologists were included as part of the geomorphological investigations.

Four backhoe trenches (BTs 1 through 4) were placed on the west side of the road, and three more (BTs 5 through 7) were excavated on the east side of the road. All trenches were examined by the project geoarcheologist, Mr. Grant Smith of TRC's El Paso office, and were profiled and photographed. In general, 0.5-by-0.5 m units were placed adjacent to the deeper backhoe trenches (BTs 1, 2, 6, and 7).

Two 1-by-2 m units within the grid system looked at cultural features on the west side of the road, and one 1-by-1 m unit was excavated east of the road to investigate an ash stain exposed in BT 7. A few other 1-by-1 m units were opened on the east side of the road in areas between backhoe trenches to obtain a larger sample of deposits. Most of these units were not placed with regard to the vertical datum established on the west side of the road, and only after excavations were underway was the horizontal grid system expanded to encompass the units on the east side of the road (this resulted in some problems in correlating all excavation units to a single grid system during the second phase of fieldwork).

5.4 PHASE II DATA RECOVERY INVESTIGATIONS

5.4.1 Archeological Field Procedures

The tactics employed during the second phase of fieldwork emphasized large block excavations on both sides of the road. The excavation blocks enabled TRC archeologists to expose large parts of each occupation zone at once, providing a window on the spatial patterning of features and artifacts. Excavations on the west side of the road (Block A) targeted the entire sequence of occupations at the Varga Site, including the Early Archaic through Toyah period components, while excavations on the east side of the roadway (Block B) focused exclusively on the Toyah period component (Figure 5-1).

5.4.1.1 Block A Excavations

Block A was excavated west of the road to capture data from all three previously identified cultural components (i.e., Toyah, Late Archaic, and Early Archaic) as well any additional, less well-defined components might exist in that part of the site. Block A was designed to cover a horizontal area of approximately 80 m², though the actual volume of matrix to be excavated was

Figure 5-1. Varga Site (41ED28) Phase II Investigation Areas

not specified in the scope of work as the depth of the basal gravel layer was known to vary considerably across the project area (ranging from ca. 35 to 130 cmbs within Block A). Block A was excavated into gravels at whatever depth they occurred.

The natural and artificial features of the road right-of-way largely determined the boundaries of Block A (Figure 5-1). The southern boundary was defined by the northern edge of a gravel driveway that runs along the rim of the terrace, providing access to the ranchlands lying to the west. The western boundary was demarcated by the fence line that marks the edge of TxDOT's right-of-way; and the eastern boundary fell 1 meter shy of the road shoulder. The northern boundary was the only open boundary of the excavation block. Artifact densities along the northern boundary remained high, and the archeological deposits appear to extend an undetermined distance to the north; however, the depth of deposits thinned considerably along the northern edge.

The final outline of Block A formed an irregular rectangle, measuring approximately 11 m north-to-south by 10 m east-to-west (Figure 5-2). The northern boundary exhibited a somewhat denticulated silhouette produced by three non-contiguous 1-by-1 m units that were excavated to provide larger exposures of features that extended into the northern wall of the excavation block. In addition, a portion of the southwestern corner remained unexcavated due to the convergence of the ranch gate, the gravel driveway, and the distal end of BT 1 that left no room for the block to be squared out in this area. Internally, the continuity of the excavation block was interrupted by backfilled BTs 1 and 2 as well as by blocks of sterile sand used to backfill the manually excavated 0.5-by-0.5 m and 1-by-2 m units from the first phase of fieldwork.

Prior to initiating the second phase of excavations, TRC archeologists relocated the previous backhoe trenches and manual excavation units. BTs 1 and 2, which formed a "T" that transected Feature 1 (the burned rock lens) along two axes, and the hand-excavated units, had been lined with clear plastic prior to being backfilled during the first phase of fieldwork. The backhoe trenches were then backfilled with the matrix that had been excavated from them, whereas the manually excavated units had been backfilled with sterile sand. In addition, some of the pin flags and nails used to mark the corners and edges of the excavation units and backhoe trenches were still in the ground. Consequently, the previous excavations were easily relocated and remarked with pin flags during the second phase of fieldwork. In sum, TRC's prior investigations on the west side of the road included four mechanically excavated backhoe trenches (two of which transected the buried burned rock lens [Feature 1]) and five 0.5-by-0.5 m and two 1-by-2 m hand-excavated units.

Next, a grid composed of one-meter-square units was laid out within the designated Block A area based on the site datum that had been installed along the western right-of-way fence line during the first phase of fieldwork. This datum stake consisted of a length of rebar set in a concrete-filled posthole. Although the datum was not marked on the field maps published in the first interim report (Lintz et al. 2002), it is located on the N112 line of the grid where it intersects with the fence line a few centimeters west of the W47 grid line. The final boundaries of Block A encompassed all of the manually excavated units and BTs 1 and 2 from the first phase of fieldwork.

Figure 5-2. Block A Excavation Grid Lines

The same grid system that was used during the first phase of investigations was used for the second phase. Both grids were based on the datum stake installed along the western fence line. The arbitrary coordinates of the datum stake were rounded to N112/E47, with grid coordinates increasing to the north and east (the origin of the grid was the southwest corner of the topographic mound, which was arbitrarily designated as N100/E50 during the first phase of investigations). While setting up the grid for the second phase of excavations, it quickly became apparent that the hand-excavated, 0.5-by-0.5 m units from the first phase did not align correctly with the new grid (i.e., many were offset by as much as 20 cm along one or both grid axes). The 1-by-2 m units from the first phase of fieldwork, however, did align with the grid. The reason for this was that the original contract for the first phase of fieldwork called for placing the 0.5-by-0.5 m units at 2 m intervals along the edges of the backhoe trenches excavated into Feature 1 (the burned rock lens). The backhoe trenches were excavated prior to setting up the site grid, which was consistent with the limited scope of work of the original work authorization (i.e., to investigate only the purported burned rock “midden”). The site grid was established only after the original scope of work was modified to expand the excavations beyond the vicinity of the burned rock feature. Thus, the 1-by-2 m units were excavated on the grid, whereas the 0.5-by-0.5 m units and the backhoe trenches were not.

During the first phase of TRC’s investigations, the upper 10 to 20 cm of sediments on the west side of the road, including the Block A area, were removed using a Gradall® because it had been thought that they consisted largely of roadway gravel and/or sediments that had been moved during road construction (Lintz et al. 2002:8). This procedure enabled TRC archeologists to identify dense bone or burned rock concentrations and ashy areas that could be

designated as features and serve as guides for placing the two 1-by-2 m, hand-excavated units. Thus, data for compiling a detailed topographic map was not collected at the outset of the second phase of investigations because the surface had been substantially altered. Eventually, however, the elevations of the grid coordinates relative to the site datum (i.e., the top of the concrete slab used to encase the rebar stake) were determined using a transit so that excavation depths could be tied into absolute centimeters below datum (cmbd) across the entire project area (i.e., Blocks A and B).

A total area of 83.00 m² was hand-excavated in Block A, including 5.25 m² during the first phase of fieldwork and an additional 77.75 m² during the second phase. This figure does not include the area encompassed by the two backhoe trenches excavated in Feature 1 during the first phase of fieldwork, nor the baulks that were left standing along the edges of these backfilled trenches during the second phase to prevent them from collapsing; however, it does include all of the manually excavated 0.5-by-0.5 m and 1-by-2 m units excavated during the first phase of fieldwork, as well as all of the complete and partial 1-by-1 m units excavated during the second phase. In sum, 66.20 m³ of sediment matrix was excavated in Block A, including 4.69 m³ during the first phase of fieldwork and an additional 61.51 m³ during the second phase.

Due to the shallowness of the upper occupation (i.e., the Toyah component), the spacing of underlying occupation zones, and the previous mechanical stripping of surface sediments, no additional mechanical stripping was performed in Block A during the second phase of fieldwork. All 1-by-1 m units were hand excavated using primarily shovels and picks, with trowels and brushes used to expose and excavate features. Each 1-by-1 m excavation unit was designated by the coordinate of its southwest corner (e.g., N109/E53). Excavations

proceeded in arbitrary 10 cm levels. Vertical elevations were determined using level lines strung from subdatum nails in the vicinity of each excavation unit. Whenever possible, the subdatums were located at the southwestern corner of each excavation unit, but it was not always possible to locate the subdatums in the southwestern corner—sometimes, adjoining units had already been excavated and no ground surface was present in which a subdatum nail might be secured. In these cases, another corner of the excavation unit or the nearest intact subdatum nail served as the subdatum. All elevations were recorded in centimeters below the appropriate subdatum nail. Later, these elevations were tied into the primary site datum and translated into cmbd.

To the extent practicable, subdatum nails were placed on or near the grid coordinate with the highest topographic elevation. The southwestern corner was preferred as a subdatum location, though strong topographic relief strongly influenced subdatum placement. On occasion, this practice resulted in the first excavation level of some units being less than 10 cm thick (i.e., because of strong topographic relief, the first level would have been a partial level). In these cases, the first two excavation levels were sometimes excavated together. Also, individual 10 cm levels were occasionally broken into two separate five-cm levels to more clearly demarcate transitions between major stratigraphic zones or to provide tighter vertical control within features.

The excavation strategy favored the exposure of broad horizontal areas to allow for identification of the spatial juxtapositions of features and artifacts. Thus, multiple, adjacent, 1-by-1 m units in Block A were excavated together a few levels at a time rather than as individual units excavated from top to bottom one at a time. The constraints of individual 10-day field sessions, the logistics of organizing excavations within

the spatially restricted confines of Block A, and the need to manage varying excavation rates in feature and non-feature contexts limited the extent of continuous, horizontal areas that could be opened at one time. Nevertheless, excavations proceeded in at least four square meter blocks whenever possible, exposing comparable excavation level floors in adjacent units before proceeding downward. The amount of area being excavated at any one time ranged from 4 to 12 m² throughout most of Block A. Along portions of the western and eastern edges of the excavation block, however, the excavation area narrowed to as little as 1 m in width due to the extent and orientation of the backhoe trenches. In these areas, linear (i.e., 1 m wide) series of two to four units were excavated together in this manner.

All sediments were screened through 6.4 mm (1/4 in) hardware cloth during the second phase of excavations (i.e., none of the sediments excavated during the second phase of investigations were fine-screened). During the excavation of Block A, screened sediments were periodically moved to a backfill pile located well to the north of the excavation area using front-end loaders provided and operated by TxDOT personnel under the supervision of TRC archeologists.

Information about all excavation levels was recorded on standard excavation level forms in the field. Rocks and other materials found *in situ* were plotted on the level forms and elevations were collected from the bottoms of the items. As a rule, systematic attempts to determine artifact elevations applied only to those artifacts that were larger than a golf ball. It was presumed that the larger size of such items would mean that they had been subjected to less vertical translocation than smaller artifacts; consequently, they may serve as indicators of buried occupation surfaces. Any diagnostic artifact found *in situ* was also plotted

on the level sketch map along with its bottom elevation.

Field tactics during the second phase of excavations included the designation of seven “sample units” in Block A. As a rule, TRC’s excavation strategy included discarding certain classes of material in the field after counting and weighing them. Discarded material types included most non-feature burned rocks, some burned rocks from features, snail shells (both *Rabdotus* and *Helicina* species), and natural gravels. In general, these materials were counted and/or weighed, as appropriate, the information was recorded on excavation level forms, and then the materials were discarded in backfill piles. However, in the seven “sample units,” all of these materials were collected. The “sample units” were designed to provide a control sample of data classes that may be used for specialized analyses.

Burned rocks were analyzed for size, shape, and raw material class (almost always limestone) in the field, and these attributes were recorded on the excavation level forms. After being counted and weighed, most burned rocks recovered from non-feature contexts, as well as some of the rocks from feature contexts, were discarded. However, random samples of non-feature burned rocks, in addition to large samples of burned rocks from features, were collected for analyses.

All lithic debris, faunal bone, ceramic sherds, pieces of burned clay, mussel shells, charcoal, tools, and other artifacts and ecofacts were placed in clear seal-top plastic bags with completed provenience tags. Upon completing each excavation level, field personnel counted and/or weighed the material collected and included these preliminary tabulations on the excavation level forms. These field counts served as the basis for the preliminary

assemblage tabulations presented in the second interim report.

All units in Block A were excavated at least 10 cm into the layer of limestone gravels that defines the lower limit of artifact-bearing sediments at the Varga Site. As will be discussed more thoroughly in Chapter 6.0—*Geomorphology*, the lowest occupation zone (the Early Archaic component) continues 5 to 10 cm into the basal gravel stratum. Excavations were terminated when the density of artifacts in the lowest occupation zone decreased markedly. Excavations in some units (every fourth or fifth unit) pushed deeper into the gravel substrate to verify that the drop in artifact density served as a consistently valid marker of the bottom of the occupation zone. In all instances, artifact recovery below this point resulted in no more than a few small chert flakes per 10 cm excavation level excavated into the sterile gravels. Clearly, some artifacts had been translocated downwards into the gravel deposits, but the bulk of the occupation zone was associated with the soil zone immediately overlying the gravels and interdigitated with the upper 5 to 10 cm of the gravels.

Whenever stone tools were identified in the field, whether they were found *in situ* or recovered from screens, they were minimally handled and bagged immediately so as not to contaminate them. Furthermore, many of these were neither handled nor washed in the laboratory. A sample of these pristine tools was submitted for use-wear analyses.

The criteria for recognizing and designating cultural features during the second phase of field operations differed from those used during the first phase. During the first phase of fieldwork, any dense bone or burned rock concentration or ashy stain was designated as a feature (Lintz et al. 2002:8). During the second phase, it quickly became apparent that the artifact densities

associated with various occupation zones were either extremely high or extremely low. Using these criteria, almost any cluster of materials would constitute a feature when surrounding densities were extremely low (i.e., at the level of Feature 1 [the burned rock lens] and in the thick, culturally sterile deposits separating the lowest, Early Archaic period occupation zone from overlying occupation zones). When artifact densities were high (i.e., in the Toyah and Early Archaic period components), however, this strategy would have resulted in the designation of hundreds, if not thousands, of “features” of dubious validity. Consequently, the high-density, Toyah and Early Archaic components are designated generally as “occupation zones.” Features within these occupation zones were required to demonstrate clear patterning beyond a general clustering of artifacts or burned rocks. In practice, the criteria for designating features varied somewhat among the components, but generally included clear clustering of rocks and/or artifacts, the presence of charcoal, changes in soil color and/or texture, vertical internal feature structure, and/or the relative density of “artifact clusters” compared to the density of artifacts in the surrounding matrix.

After features were identified and designated as such, each feature was carefully exposed horizontally using small hand tools (e.g., trowels and brushes) and a detailed plan map was drawn. Next, the feature was sectioned along one axis and half of it was excavated with hand tools to expose the vertical cross-section of the feature. Profiles of these cross-sections were drawn for those features that exhibited some vertical structure. Observations about the form, construction, content, context, integrity, and associations of burned rocks, bone, charcoal, or other artifact classes were recorded on individual feature forms. In some cases, scatters of burned rock and artifacts lacked clear, recognizable boundaries. The Principal Investigator or Project Archeologist used their

judgment to decide on the boundaries of such ambiguous features. Artifacts associated with features and sediment matrix samples were collected, bagged, and labeled separately for each feature. Feature fill was collected for subsequent flotation, fine-screening and/or wet-screening, and other possible analyses (e.g., phytoliths, stable carbon and nitrogen isotopes) in the laboratory.

Samples of burned rocks from feature and non-feature contexts were collected and returned to the laboratory. Sampling of burned rocks emphasized collecting of rock by size categories (<4 cm, 4.1 to 9 cm, 9.1 to 15 cm, and >15 cm in diameter). A suite of residue and dating analyses was conducted on these burned rocks that provided data on cooking technology, feature function, feature age, and prehistoric subsistence practices.

Two columns of matrix sediment samples were collected from Block A for detailed analyses of soil texture, grain size, stable carbon and nitrogen isotopes, humate dating, and pollen and phytoliths. These sediment column samples were collected from two separate locations in Block A from baulks left standing on either side of the intersection of the two backhoe trenches. One column sample, intended for use in sediment studies (e.g., humate dating, grain-size analysis), was collected from a balk located on the northern side of the intersection of the trenches (the west wall of excavation Unit N105/E51). The second column sample, collected primarily for use in phytolith analysis, was collected from the southern side of the trenches’ intersection (the south quarter of the west wall of excavation Unit N103/E51 [a 1-by-0.25 m unit]). Sediment samples were collected at five-cm levels within each sample column.

Additionally, seven sediment samples were collected for optically stimulated luminescence (OSL) dating, including two from the Toyah

component, two from the Late Archaic component (associated with the burned rock lens), and three from the Early Archaic component. Since these samples were collected near the end of the Block A excavation work, they were taken from locations around the outer walls of the excavation block.

A sample of water-worn cobbles, including chert-bearing and non-chert-bearing specimens, was collected from on-site and off-site contexts for instrumental neutron activation analyses. These samples were collected from (1) the basal gravel lens of the second terrace within Block A (mainly, but not exclusively, from the seven “sample units”); (2) from exposed, non-cultural gravel deposits along the floodplain of Hackberry Creek near the site; (3) from non-cultural, chert-bearing lenses exposed along the upper slopes of ridges in the vicinity; and (4) from gravel beds exposed along the banks of the Nueces River in the vicinity of the town of Camp Wood, Texas, approximately 29 km (18 mi) south of the Varga Site. Natural chert samples were collected from additional locations following the completion of fieldwork to provide a more comprehensive set of Edwards chert source data from the western portion of the Balcones Escarpment (see Appendix F)

Various rare and anomalous objects encountered during excavations were collected for further examination in the laboratory. While the determination of whether these objects were contextually cultural or natural was allowed to remain open until confirmed by later analyses, such items were collected based on their potential to provide additional insights into site stratigraphy, site formation processes, and/or cultural activity as analyses proceed. Items in this category include mineral deposits (e.g., red and yellow ochre), exotic (i.e., non-local) gravels, and natural calcium carbonate concretions (believed to be mineralized root casts).

Finally, one last activity was planned for the second phase of excavations that did not, in the end, bear any fruit. As discussed in detail in Section 6.2—Methods and in Section 6.4—Interpretation and Discussion, an additional backhoe trench was excavated in the slope of the T0 immediately south of the gravel driveway that defines the southern boundary of Block A. This trench was excavated primarily to investigate the juxtaposition of the T0 and T1, but it was hoped that cultural material might be observed in this area (Lintz et al. 2002). If present, cultural features and artifacts below the terrace rim may have provided data relevant to prehistoric trash disposal patterns at the Varga Site. It was hoped that the proximity of the terrace edge to the occupations indicated by the high artifact densities and cultural features present in Block A might offer a chance to determine whether the terrace escarpment was used as a discard area. Such discard patterns may have offered significant insights into the structure of activity areas and occupation zones within Block A. Unfortunately, careful monitoring of the excavation of this backhoe trench by TRC archeologists and geoarcheologist did not reveal any indications of cultural material below the terrace lip (aside from a few chert flakes). The trench profile was scrutinized for any indications of cultural deposits, and sediments deposited in the backfill pile during the trench excavations were randomly sampled for artifacts, but no substantial indications of cultural activity appeared. Consequently, the placement of hand-excavated, 1-by-1 m and 1-by-2 m units along the edge of this trench, as indicated in the first interim report and the scope of work for the second phase of fieldwork, was deemed inadvisable.

5.4.1.2 Block B Excavations

Block B was excavated on the east side of the Ranch to Market Road to obtain data from the

Toyah component at the Varga Site. Block B was scoped to cover an area of approximately 108 m², targeting the Toyah occupation in the upper 20 to 30 cm of sediment. The first phase of investigations determined that the Toyah period component was associated exclusively with a sediment zone composed of relatively unconsolidated overbank deposits (designated as Depositional Unit I) overlying a well developed A horizon composed of black, granular soil (designated as Depositional Unit II). The Late Archaic burned rock lens (Feature 1) sits atop this darker, granular soil unit on the west side of the road (see Section 6.0—*Geomorphology* for detailed descriptions of stratigraphic units). In the first interim report, the boundary between these two depositional units was described as abrupt and very easily recognized once soils dried out to some degree. Thus, the bottom of the Toyah period component was signaled by the appearance of the underlying black soil unit.

The boundaries of Block B were determined by the locations of natural and artificial features of the road right-of-way, characteristics of the archeological deposits, and time constraints (Figure 5-3). The fence line that marks the edge of TxDOT's right-of-way defined the eastern boundary. Along the western boundary, the depositional unit that contains the Toyah component became very thin (less than 10 cm thick) and highly disturbed as it approached the road shoulder (much of the ground surface in this area had probably been stripped during road construction and/or maintenance activities). The western boundary, therefore, fell a minimum of 4 m short of the road shoulder. The southern boundary was determined by a pronounced decrease in artifact densities. Artifact densities along the northern boundary remained high, and the Toyah component appears to extend an undetermined distance north of Block B. Excavations continued in this direction until the end of the second phase of fieldwork. As a result, Block B excavations covered a

substantially larger area than originally proposed.

Before beginning the second phase of excavations, TRC archeologists relocated the previous backhoe trenches and manual excavation units on the east side of the road. The backhoe trenches and the hand-excavated units had been lined with clear plastic prior to being backfilled following the first phase of fieldwork. The backhoe trenches had been backfilled with the matrix that had been excavated from them, whereas the manually excavated units had been backfilled with sterile sand. In addition, some pin flags and nails used to mark the corners and edges of the excavation units and backhoe trenches were still in the ground. Consequently, the previous excavations were easily relocated and remarked with pin flags during the second phase of fieldwork. In sum, TRC's prior investigations east of the road included three mechanically excavated backhoe trenches and three 0.5-by-0.5 m and five 1-by-1 m hand-excavated units.

A grid composed of one-m² units was laid out within the designated Block B area based on the site datum that had been installed along the western right-of-way fence line during the first phase of fieldwork. Due to a mapping error, the Block B grid was not continuous across the entire excavation area. The reason for this pertains to the sequence of activities during the first phase of fieldwork. As discussed in Section 5.4.1.1—Block A Excavations, when TRC archeologists were reestablishing the site grid in Block A for the second phase of investigations, it became apparent that the previously excavated 1-by-2 m excavation units on the west side of the road were on-grid.

Figure 5-3. Block B Excavation Grid Lines

Consequently, it was assumed that the previously excavated 1-by-1 m units on the east side of the road would be on-grid as well. Thus, during the second phase, field personnel began to excavate in Block B while the grid was still being established on the west side. Two of the 1-by-1 m excavation units from the first phase of investigations, one in the north half and one in the south half of Block B, were used as the reference points for beginning the Block B excavations. New excavation units were set up adjacent to these two previously excavated units, and additional units were added on as needed until the site grid could be extended to the east side.

As it turned out, the assumption that the previously excavated 1-by-1 m units on the east side were on-grid was incorrect. The original scope of work for the first phase of fieldwork called for limited investigations of the burned rock “midden” on the west side of the road. The site grid was established later, after modifications to the work authorization expanded the scope of investigations to include archeological deposits on the east side. The backhoe trenches and manually excavated units on the east side were placed before the site grid was extended to this side. As a result, none of the backhoe trenches or hand-excavated units on the east side of the roadway were actually on-grid. This unfortunate fact did not become apparent until the second phase of investigations was already underway, with discontinuous excavation areas open in the north and south halves of Block B. As a result of this mapping discrepancy, the northern and southern excavation areas in Block B did not match up. The two halves of the Block B excavations ran into each other in the vicinity of the N121/N122 lines, leaving a linear, east-to-west-oriented row 0.5 m in width between the N121 and N122 lines (i.e., the N121 row was composed of 0.5-by-1 m units rather than 1-by-1 m units). Rather than excavate partial units, it was decided that

the N121 row of excavation units should remain unexcavated. The final boundaries of Block B included part of one of the three backhoe trenches (i.e., BT 6), one of the three 0.5-by-0.5 m hand-excavated units, and all or parts of three of the five manually excavated 1-by-1 m units from the first phase of fieldwork.

No surface stripping had been conducted on the east side during the first phase of fieldwork. However, the central portion of Block B, which is roughly coterminous with the southern half of the northern half of the excavation block, was covered with a dense layer of pea-sized road gravels. Local informants told TRC archeologists that a dump truck full of road gravel had accidentally dumped its load in this general vicinity at some point in the recent past. This layer of road gravel varied in depth from 1 to 12 cm across an approximately 7 m diameter area. At the outset of Block B excavations, the surficial layer of pea gravels was screened as an ordinary excavation level. The pea gravels did not contain any artifacts (indicating that the gravels had not been mixed with sediments from the site), but they did contain broken pieces of non-cultural chert (presumably from the quarry from which the gravels originated). Thus, after the pea gravel layer was systematically excavated and screened in a few preliminary units, the surficial pea gravels from all subsequent units were removed without screening.

A total of 124.75 m² was hand-excavated in Block B, including 5.75 m² during the first phase of fieldwork and an additional 119.00 m² during the second phase. This figure does not include the area encompassed by a portion of BT 6 that extends into Block B, nor does it include the unexcavated N121 line of partial units; however, it does include one of the three 0.5-by-0.5 m hand-excavated units, the entirety of two of the five manually excavated 1-by-1-m units, and approximately one-half of a third

hand-excavated 1-by-1 m unit from the first phase of fieldwork, as well as all of the 1-by-1 m units excavated during the second phase. In sum, 38.26 m³ of sediment matrix was excavated in Block B, including 5.49 m³ during the first phase of fieldwork and an additional 32.77 m³ during the second phase.

The field methods employed during Block B excavations were identical to those used in Block A with two exceptions. First, because excavations in Block B targeted only the upper occupation zone, excavations were terminated 5 to 10 cm into the black, granular soil zone (Depositional Unit II) that underlies the Toyah component. Depositional Unit II contained only moderate densities of artifacts across the entire site (except for the immediate vicinity of Feature 1), so there was limited danger of contaminating the material collections from the upper sediment zone (Depositional Unit I). Therefore, excavations continued a short distance into Depositional Unit II to capture the Toyah material that had penetrated into this unit and to confirm that the artifact densities associated with the Toyah component had, in fact, dropped off.

Second, field tactics during the second phase of excavations included the designation of 10 “sample units” in Block B. As a rule, TRC’s excavation strategy included discarding certain classes of material in the field after counting and weighing them. Discarded material types included most non-feature burned rocks, some burned rocks from features, snail shells (both *Rabdotus* and *Helicina* species), and natural gravels. In general, these materials were counted and/or weighed, as appropriate, the information was recorded on excavation level forms, and then the materials were discarded in the field. However, in the 10 “sample units,” all burned rocks were collected. The “sample units” were designed to provide a control sample of data classes that could be used for special

analyses. Because the excavations in Block B were much shallower than those in Block A, the deeper depositional units that contained high densities of some of these material classes, such as snail shells and natural gravels, were not encountered in Block B. Consequently, most of the extra material collected from Block B “sample units” consisted of burned rock, with only rare snail shells or natural gravels.

5.4.2 Geomorphologic Field Procedures

Geomorphologic investigations for the second phase of data recovery excavations focused on obtaining information relevant to the investigation of floodplain and terrace formation processes along Hackberry Creek. As discussed in more detail in Chapter 6.0, *Geomorphology*, very little is known about the geomorphologic conditions of the rivers within the southern Balcones Escarpment region. Based on his investigations of the Sabinal River terraces, Mear’s (1953) suggested that the relative height of terraces in the Hill Country of Central Texas does not permit the correlation of ages due to differential stream gradients. Nevertheless, in a later article, he adopted the chronological sequence of the Pedernales River, which was initially defined based on the earlier dating program from the O. H. Ivie Reservoir, and identified three major erosional events at pre-11,500, 5,000, and 1,000 years ago (Mear 1998).

The geoarcheological studies conducted during the first phase of mitigation efforts at the Varga Site concentrated on the fine sediments within the first terrace, but further textural, chemical, and chronometric studies were needed to delineate the ages and development rates and processes associated with these sediments. Consequently, additional geoarcheological fieldwork was recommended to discern the age of the cutting of the first terrace and the initial construction of the T0 terrace. The T0 terrace is

armored by boulders and gravels scoured during frequent flood events, but it was unclear whether or not finer sediments might exist near the base of the T0 terrace that could be used to date the initial terrace-filling episodes. Such dates would be important, as they would pertain directly to the prehistoric landscape setting and the human use of the Varga Site and the Hackberry Creek valley. In addition, geomorphological information from the intersection of the first and older second terraces was considered equally important in developing an understanding of the morphology of the upper Hackberry Creek valley, though these surfaces are probably too old to be directly relevant to the prehistoric occupations along the rim of the first terrace.

With these research considerations in mind, the work authorization for the second phase of fieldwork called for TRC's geoarcheologist to conduct additional investigations to ascertain the age of the terraces along Hackberry Creek. This involved excavating a backhoe trench (M-1) west of the road and south of the gravel drive to private lands in an attempt to understand the juxtaposition of the T0 and T1 interface that may help resolve the antiquity of the terrace cutting and filling sequence (Figure 5-1). One additional backhoe trench (M-2) was excavated at the interface of the T1 and T2 approximately 100 m north of the Block A excavations to investigate the intersection of these two terrace facies.

Both backhoe trenches were excavated using a backhoe operated by TxDOT personnel under the supervision of the TRC geoarcheologist and Project Archeologist. Trench profiles were carefully examined for features, artifacts, or any other indications of prehistoric cultural activity. In addition, sediment that was excavated from the trenches and deposited in nearby backfill piles was randomly inspected for cultural materials. No indications of significant cultural activity were observed in either backhoe trench.

After excavation, each trench profile was thoroughly examined, sketch maps showing major stratigraphic divisions as well as localized sediment anomalies were drawn, profiles were photodocumented, and sediment samples were collected from major soil/depositional units. After each trench profile had been recorded and sampled, the trenches were backfilled using the matrix that had been excavated from them.

Finally, limited additional geomorphological investigations were undertaken within the excavation blocks to refine and assess existing interpretations of the stratigraphic structure of the fine sediments that comprise the first terrace. Detailed profile maps were drawn of extensive areas within each excavation block to provide a data set for refining the stratigraphic profiles recorded during the first phase of excavations and published in the first interim report (Lintz et al. 2002). Also, as discussed in Section 5.3.1.1—Block A Excavations, sediment samples were collected from two columns in Block A for specialized analyses of selected sediment characteristics, such as grain size and stable carbon and nitrogen isotope analyses.

5.5 LABORATORY METHODS

All materials collected during the first and second phases of data recovery excavations at the Varga Site were transported back to TRC's laboratory facilities in Austin, Texas, for processing, cataloging, analysis, and temporary curation.

In general, artifact processing entailed washing and cataloging most of the cultural material recovered including lithic debitage, stone tools, and most bones. Washing involved lightly scrubbing the dirt from artifact surfaces using tap water and soft-bristled toothbrushes, arranging wet artifacts on fine mesh screen-lined drying trays, and allowing them to dry. Fragile material such as burned clay, ochre, mussel shells, and charcoal were not washed. In

addition, some stone tools identified in the field were bagged with minimal handling and were not washed. A subset of these tools was submitted for use-wear analysis and others were set aside for long-term curation with only minimal handling by laboratory and analytical personnel. All personnel wore nitrile gloves when handling these unwashed tools.

Individual artifacts and artifact lots from within single provenience units were assigned unique catalog numbers. TRC's cataloging system assigns strings of numbers to artifacts that encode information on provenience, artifact class, a unique identifier, and samples taken from the artifact or lot for specialized analyses. Unique provenience numbers (PNUMs) were assigned to lithic debitage, stone tools, burned rocks, sediment, burned clay, faunal bones, ceramic sherds, historic artifacts, and mussel shells. PNUMs are sequential integers that designate the overall provenience unit (i.e., excavation unit, backhoe trench, modern ground surface) and level, or depth, within that provenience unit by reference to a master list of PNUMs. All of the cultural material recovered from a single excavation level within an excavation unit was assigned a unique PNUM designation (e.g., #1261). Within each PNUM, the various artifact classes were assigned a secondary designation (i.e., lithic debitage [001], faunal bone [002], burned rock [003], soil [004], feature [005], shell [006], macrobotanical remains [007], ceramic sherds [008], and historic material [009]) referred to as the artifact class number. Individual tools and other unique items were assigned individual artifact numbers starting with the number 10 within the same unit and level designated by the PNUM. Thus, individual tools, and other unique objects were assigned a material class number appended to the provenience number (e.g., #1261-001, #1261-002, and #1261-003).

In many cases, individual samples were removed from larger bags or objects of sample material for specialized analyses (e.g., radiocarbon dating, wood identifications, and instrumental neutron activation analysis). For example, if a single burned rock was extracted from the collection of burned rocks designated as #1261-003 for lipid residue analysis, then that burned rock would be designated as #1261-003-001 to indicate it constituted the first sample from that provenience. In another words, a catalogue number such as #1261-003-001 would identify that specific rock as the first sample (001) taken from the burned rock class of artifacts (003) within a specific provenience unit (#1261). If burned rock #1261-003-001 was subdivided into two pieces for different types of analyses, such as lipid residue and stable carbon and nitrogen isotope analyses, then lower case letter designations (i.e., a and b) would be added following the last number in the sequence (i.e., #1261-003-1a and #1261-003-1b) to signify that two parts (part a and b) were taken from burned rock #1261-003-1. The complete two or three part number sequence assigned to each object or class of objects constitutes the catalog number. This process allows individual pieces of large collections of various materials to be individually handled and tracked.

Cultural materials in the Varga Site collection were labeled according to the curation standards of the Center for Archeological Research (CAR) of The University of Texas at San Antonio (UTSA). Individual catalog numbers were given to each unique tool identified in the overall assemblage, and each such unique object was labeled. Approximately one in 10 artifacts (10 percent) occurring in bulk classes (e.g., chert debitage, faunal bones) within specific provenience units (e.g., a level) were labeled. Size of the object was also a major consideration for labeling purposes. Artifact labeling consisted of inscribing the State of Texas Archeological Site Trinomial for the Varga Site

(41ED28) and the catalog number on designated artifacts using black indelible ink. After the ink was dry, the artifact labels coated with clear acetone to preserve the inscriptions.

Permanent tags were included with each individual artifact or class of artifacts collected from a single provenience. These tags include the Varga Site's trinomial (41ED28), provenience information, the class or type of artifact(s), the date of excavation, the excavator's initials, and the quantity of items in the bag. These permanent tags were printed on acid-free, 30.4 kg (67-lb) card stock and filled out using No. 2 pencils.

All stone tools, samples of lithic debitage, samples of matrix from features, samples of burned rocks, all field records, and photographs from the two phases of investigations are permanently curated at CAR. Two to three burned rocks from each of the burned rock features are also curated. Individual artifacts and artifact lots, including all stone tools, ceramic sherds, sociotechnic items (e.g., bone beads), debitage, burned rocks, faunal bones, and mussel and snail shells, are in clear line seal-top plastic bags according to provenience. Upon completion of laboratory processing, cataloging, and analysis, these bags of artifacts were placed in acid-free cardboard boxes with lids for permanent curation. Small samples of sediment from various proveniences were stored in a similar fashion. Each polyethylene bag contains an archival-quality, acid-free curation tag that lists the site number, provenience data, date of excavation, excavator(s) initials, artifact type, and quantity. Color slides, black and white negatives, black-and-white photographs, and copies of digital photographs printed out on a color printer were placed in CAR-approved, acid-free plastic preservers for curation. All original field records are on acid-free paper and placed in acid-free reinforced file folders for curation.

5.5.1 Flotation

Sixty-eight bags of sediment totaling 573 liters, including matrix samples from 22 feature proveniences and two non-feature proveniences across the four major temporal components at the Varga Site, were floated to maximize the recovery of macrobotanical and small artifactual remains that would not be recoverable in 6.4 mm (1/4 inch) or 3.2 mm (1/8 inch) mesh screens. These matrix samples were processed using a Dousman Flotation System at TRC's laboratory facilities. The recovered light and heavy fractions were dried and then sorted by material class into flakes, mussel and/or snail shell, burned rock, and macrobotanical remains. The floated feature matrices were thoroughly inspected following flotation and drying. Some samples did not yield any visible macrobotanical remains. Forty-seven light fraction samples from 18 cultural features, encompassing 10 Toyah features, two Late Archaic features (including Feature 1 and its subfeatures 1a, 1b, and 1d), two Middle Archaic features, and four Early Archaic features were sent to Dr. Dering for analysis. Besides the light fractions from these features, 75 individual samples of wood charcoal collected from various proveniences, including 35 from Toyah contexts, 11 from Late Archaic contexts, three from Middle Archaic contexts, and 26 from Early Archaic context were submitted to Dr. Dering for identification. Dr. Dering's analytical procedures and results are presented in Appendix I.

5.6 ANALYTICAL METHODS

Artifacts were subjected to different metric, non-metric, typological, and other special analyses, including use-wear and neutron activation analyses. In some instances, artifact quantities within specific classes were so high that only a sample of the class could be subjected to more detailed analyses. A set of predefined attributes for each material class was first encoded on

paper, then entered into TRC's electronic database management system based on Microsoft's (MS) Access 2000 software. This MS Access 2000 database constitutes the master database for this project. A copy of this database is provided on the CD-ROM attached to the back cover of Volume II of this report. The specific data recorded for each class of artifacts are presented below. Analytical methods pertinent to each data class and the various secondary suites of software used for specialized analyses are discussed in detail in the appropriate parts of this report. The materials from Phases I and II were integrated into one database.

5.6.1 Chipped Stone Tool Analyses

The edges and surfaces of each piece of chert were macroscopically examined for signs of use as a tool. If worked areas were identified, the artifact was assigned to a morphological and/or technological category based on general form and inferred function. Sets of observations were recorded for the entire tool classes recovered, though it was necessary to sample some classes of tools that were recovered in exceptionally large quantities. The following subsections provide definitions of major tool classes.

5.6.1.1 Bifaces

Finished bifacial tools are those finely or crudely worked pieces in which the manufacturing process has apparently been brought to completion, as evidenced by secondary retouch, edge straightening, hafting preparation, notching, and similar characteristics. Bifaces are defined based predominantly on morphological characteristics, but they may also have functional associations (e.g., cutting, piercing, chopping, drilling). Bifacial tools exhibit purposeful, usually patterned flake removals on both faces of the object. Most or all of each facet may be covered with flake scars,

and in some cases one face may be completely modified while the opposite face exhibits only partial modification. Bifaces may be fashioned either from large bifacial cores or from flakes; however, if only the margin of a specimen exhibits modification rather than most or all of at least one face, then the tool would be classified as an edge-modified flake tool. Included within this overall morphological category is such diverse functional groups as projectile points and drills (see below).

Data on 22 distinct dimensions of variability were recorded for bifaces. Attributes included non-metric observations concerning the completeness of the specimen, overall morphology, manufacturing characteristics, and manufacturing stage based on morphological classes adapted from Callahan (1979). Metric measurements of length, width, thickness, and weight also were recorded. Measurements of appropriate dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.1.2 Projectile Points

Projectile points are a functional subset of the biface class specifically designed to be hafted to the distal end of a shaft used in stabbing, throwing, or shooting to penetrate animal hides and flesh. Projectile points are bifacial tools formed by fine secondary retouch, usually with basal modification in the form of notching, stemming, or thinning of the proximal end for purposes of hafting. Dart points, arrow points, and indeterminate points are all classes of projectile points. Dart points are those employed to tip hand-held darts or spears; arrow points are used to tip arrows; and indeterminate points are, as the name implies, of uncertain usage. While dart points are usually manufactured from bifacial preforms, arrow points are often manufactured on thin flakes.

Projectile points were assigned to recognized types whenever possible. In traditional archeological literature, projectile points are normally referred to by their typological designation, which usually connotes a set of morphological characteristics (most of which relate to hafting modification) shared in common by groups of similar points. Initial point classifications were accomplished by TRC's laboratory personnel in reference to established point typologies in use in Texas archeology (Davis 1995; Suhm et al. 1954; Prewitt 1985; Turner and Hester 1993). On September 30, 2003, Mr. Elton Prewitt came to TRC's Austin office to examine the entire projectile point assemblage from the Varga Site to finalize and confirm the typological designations. Some recovered projectile points did not exhibit characteristics that allowed their assignment into previously named types. One group of points exhibits a cluster of similar characteristics and therefore is assigned to a single group – Group 1. Group 1 points exhibit generally wide bodies with expanding stems that exhibit rounded basal corners and deep concave bases. A second group of points exhibits a different cluster of characteristics (deep corner-notches) and are assigned to Group 2. Similar point have been referred to as Early Corner-Notched in other literature, but these early corner-notched forms have not been officially named.

A comprehensive suite of 33 metric and non-metric observations was recorded for all projectile points recovered from the Varga Site. Non-metric attributes recorded include descriptors of overall morphology and manufacturing and reworking characteristics. Numerous metric measurements also were recorded. Measurements of appropriate dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated. In addition to the typological classifications of individual

specimens, the projectile points from this site have been subjected to a battery of measurements designed to detect patterning in the assemblage that may or may not be linked to the criteria usually employed in typological studies. The results of this analysis are presented in Appendix A.

5.6.1.3 Drills

Drills are another functionally specific subset of the biface class. Drills generally consist of two sections—the distal bit (or working edge) and the proximal stem or end section. Distal bits are typically long, tapered, and bifacially flaked, resulting in a diamond-shaped cross-section that distinguishes this type of tool. The bit is usually relatively thick and is designed to produce a stable base for rotary motion. Drills are usually presumed to have been used on hard substances, such as wood, shell, or bone, and spun in a rotating fashion to penetrate the material; therefore, drill tips usually exhibit heavy rounding and/or polishing of bit edges.

Drills are often subdivided into specific types, such as T-butt, irregular, or notched, but this typology was not employed in this analysis. Twenty-one metric and non-metric observations were recorded for drills from the Varga Site. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.1.4 Unifaces

Unifaces are those tools that exhibit flake scars on one face only. Like bifaces, unifaces are defined based predominantly on morphological characteristics, but they also tend to have functional associations (e.g., scraping, planing, cutting, engraving). Unifacial tools exhibit purposeful flaking across most or all of one face, while the opposite face most often remains flat and unmodified. Unifaces may be fashioned

from cobbles or flakes. This category includes such functionally diverse groups as scrapers, gouges, edge-modified flakes, graters, and spokeshaves. One or more edges of a unifacial tool may exhibit manufacture- and/or use-related flake removals that may be patterned or unpatterned. To some degree, unifacial tools form a continuum from formal tools exhibiting intentional, patterned, manufacture-related edge flaking to informal, ephemeral tools that show only use-related edge scarring. The former tend to fall within the scraper and gouge categories, whereas the latter are generally classified as edge-modified flakes.

5.6.1.5 Scrapers

Scrapers are a specific type of unifacial tool that have at least one intentionally modified working edge. In some instances, bifacial modification may be present, but in such cases the intentional retouch tends to be located on the dorsal flake surface while the ventral surface tends to exhibit primarily use-related flake scars. Based upon the location of the primary working edge, scrapers are subdivided into end, side, or combination types. End scrapers are pieces with retouch restricted to either the distal or proximal end of the flake blank, generally producing a convex working edge. The opposing end of the piece may bear some minimal retouch, presumably to facilitate hafting the piece. Side scrapers are pieces with retouch present on one or both lateral edges of the flake blank. Working edges may be convex, straight, or concave. On combination scrapers, marginal retouch may appear along the end as well as along one or more lateral edges of the blank. As implied by the name of this tool, the primary function of scrapers is presumed to relate to scraping relatively soft materials such as animal hides or vegetable matter, or slightly harder materials, such as wood or possibly antler or bone.

Twenty-four metric and non-metric attributes were recorded for scrapers. Many of these measurements relate to the number, location, and characteristics of the various working edges on the tool. Among the measurements, the total number of identifiable working edges on the tool was noted, and then multiple observations pertaining to the characteristics of a maximum of three of these edges were recorded. For example, if five working edges were identified on a single implement, detailed measurements of edge characteristics would be recorded for only the three primary edges, but the total number of five working edges would be listed. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.1.6 Gouges

Gouges are chisel-like woodworking tools that may be either bifacially or unifacially flaked, are usually triangular in shape, and are worked along the wider end to produce a steep, beveled, straight working edge or bit. The wide distal edge may be convex, straight, or slightly concave. The edge angles of the bit and lateral edges tend to be relatively steep. The end opposite the bit, at the point of the triangle, represents the end of the tool that would be hafted (generally perpendicularly) into a handle. In cross-section, gouges are usually plano-convex to pyramidal (for which reason they are included among the unifacial tools). These tools are generally associated with woodworking tasks as scrapers or adzes rather than as true gouges. Some gouges, such as Clear Fork bifaces or unifaces, are considered diagnostic of various cultural periods in Texas prehistory.

For purposes of data coding and analysis, gouges were considered to be generally equivalent to scrapers, and the same 24 metric and non-metric attributes encoded for scrapers

were also recorded for gouges. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.1.7 Edge-Modified Flakes

Edge-modified flakes are minimally modified flakes, flake fragments, or pieces of angular debris that are characterized by one or more areas of flake scarring along margins. The edge flaking may be patterned or unpatterned, continuous or discontinuous, and may result from intentional pressure retouching to prepare an edge for use or may result exclusively from use-related activities. Many edge-modified flake tools exhibit combinations of these characteristics, and most have more than one working edge. The edge modifications, however, usually are restricted to the edges of the piece and do not significantly alter the original flake form. Edge modifications may be either unifacial or bifacial. Edge-modified flakes are usually considered to be “expedient” tools, or pieces of raw material that are picked up, utilized for a short-time with or without first being minimally modified, and subsequently discarded at the location of use or soon after use.

Twenty-four metric and non-metric attributes were recorded for edge-modified flakes. Many measurements relate to the number, location, and characteristics of the various working edges on the tool. Among the measurements, the total number of identifiable working edges on the tool was noted, and then multiple observations pertaining to the characteristics of a maximum of three of these edges were recorded. For example, if five working edges were identified on a single implement, detailed measurements of edge characteristics would be recorded for only the three primary edges, but the total number of five working edges would be listed. Measurements of dimensions were taken only

when the dimension in question was completely represented and/or could be reasonably estimated. Due to the large number of edge-modified flake tools recovered from the Varga Site, only a sample of this artifact class was selected for detailed data encoding and analyses.

5.6.1.8 Gravers and Spokeshaves

Many types of specialized working edges are commonly found on tools otherwise identified as scrapers or edge-modified flakes. While it is possible that only one such specialized bit may exist on a tool, these types of tools are considered to primarily fall within the appropriate scraper or edge-modified flake category, while the specialized working edge would be classified as one of the working edges. Types of specialized working edges that are often recognized include perforators or borers, graver spurs, spokeshaves or notches, and burins. For purposes of this analysis, graver spurs and borers are combined into a single category, as are spokeshaves and notches.

Graver spurs, or gravers, are additional carefully flaked, prominent, sharp protrusions formed on scrapers or edge-modified flake tools by the creation of adjacent shallow concavities or notches. Graver spurs may be quite short, only a millimeter or two in length, or rather prominent, in which case they grade into the category of tools often referred to as borers or perforators. Graver spurs may exhibit alternating edge retouch, but this is usually present only on longer specimens. The function of graver spurs is assumed to be engraving relatively hard substances such as wood, bone, and antler.

Spokeshaves, or notches, are working edges on scrapers or edge-modified flakes formed by the removal of numerous small flakes in a limited area along the lateral edge of a piece to form a single, relatively deep, concave area. Such notches may be relatively small or quite large, shallow or deep. The function of spokeshaves is

assumed to relate to scraping or planing relatively hard substances, such as wood, bone, and antler, that are either tubular in shape or for which a convex outer surface is desired (e.g., dart or arrow shafts).

By definition, graver spurs, spokeshaves, and burins are considered to be specialized tools made on objects that may otherwise be classified as scrapers or edge-modified flake tools. As such, the metric and non-metric data encoded regarding that working edge would follow the procedures used for scrapers or edge-modified flakes, as appropriate.

5.6.1.9 Cores

A core is a cobble, pebble, or other mass of lithic raw material (usually chert) that exhibits one or more flake scars resulting from the systematic removal of flakes by flint knappers. Technically, any chipped stone tool may properly be classified as a core as it is the object created through the removal of flakes from the exterior surface of the original mass of lithic material. In common parlance, however, cores are generally considered to be those masses of material from which one or more flakes were removed. In other words, cores do not exhibit any intentional or use-related flake scarring along any of their edges, though scars resulting from platform preparation may be evident, and a core might be expediently used as a tool (e.g., extensive crushing damage along one or more thick edges of a core would probably result in classification of the object as a chopper).

Various types of cores are recognized according to the degree of knapping and the flake removal strategy. Four basic types of cores are unifacial, bifacial, multidirectional, and blade core. The last-named type often has a distinctive conical polyhedral shape, the result of the repeated, parallel removal of long, narrow flakes known as prismatic blades.

Tested cobbles are natural clasts of tool stone that exhibit only a very limited number of flake scars, often just one or two, removed by hard-hammer percussion. Generally, these scars removed the exterior, cortical surface of the cobble, exposing the interior structure of the cobble. The edges of the flake scars do not evince any further alteration, such as edge grinding, dulling, or crushing that may be indicative of additional modification or use. Tested cobbles most likely represent intentional exposure of the interior of the stone for the purpose of evaluating its quality and suitability for manufacturing stone tools.

A unifacial core is one that exhibits flake scars removed from only one face. The flake removals may be in various directions and exhibits no pattern or structure to the removals. There are usually only one or two platforms.

A bifacial core exhibits flake removals from both faces and again these may be in multiple directions. The parent rock is generally a cobble that exhibits two detectable faces. The flakes were driven from the lateral edges, thus the platforms are along the edges.

The multidirectional core is generally a chunk of raw material that does not necessarily exhibit two obvious faces. Generally there are a number of platforms from which flakes were removed.

Blade cores are intentionally prepared chunk of raw material to facilitate the removal of a specifically desired flake. These generally exhibit two or more parallel scars driven from the same platform in the same direction with the same overall shape.

Fifteen metric and non-metric observations were recorded for cores. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.2 Ground Stone Tool Analyses

This broad artifact class includes pieces of natural rock that have been modified by grinding, pecking, or battering either to intentionally form an implement or through use. Ground stone tools are recognized by the presence of non-natural abrasions, grooves, and striations and/or smoothing. Significant rounding, flattening, and/or pitting of used surfaces may also usually be identified. Categories of ground stone tools recognized among the Varga Site assemblage included hammerstones, manos and metates (milling stones), and anvils.

The edges and surfaces of each piece of rock were macroscopically examined for signs of use as a tool. If battered, smoothed, unnaturally flattened, pitted, ground, striated, incised, or pecked areas were identified, then the artifact was assigned to a morphological and/or functional category based on general form and inferred function. Sets of observations were recorded for the tool classes recovered. The following subsections provide definitions of major tool classes.

5.6.2.1 Hammerstones

A hammerstone is a hard nodule of lithic material, usually of hard and dense siliceous rock such as quartzite, used for direct percussive fracturing of tool stone during lithic reduction. These pieces usually exhibit limited or extensive areas of battering, crushing, and/or pitting on one or more surfaces of the natural cobble. In some cases, small flake scars may form as the result of hard-hammer percussion, creating an appearance similar to a tested cobble core.

Metric and non-metric observations were recorded for hammerstones. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.2.2 Manos and Metates

A mano is a round to ovate-shaped nodule of rock, usually of dense siliceous rock such as quartzite or sandstone, with one or more surfaces that have been smoothed and possibly flattened through grinding. A metate is a large, thick slab, also usually of dense siliceous rock such as quartzite or sandstone, that has been ground smooth on one or both surfaces. Manos and metates are used together to grind friable materials into powder, such as vegetable matter or pigments. Manos are hand-held grinding stones, and the utilized facets usually have a smoothed appearance and may be convex to flat. Metates are grinding slabs, and the use facets may have either a flat or basin-shaped appearance.

Metric and non-metric observations were recorded for manos and metates. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.2.3 Anvils

Anvils are cobbles or slabs of rock with one or more small, circular indentations in the center of one or more faces. Anvils were presumably used as a base in the processing of nuts and/or grains. Over time, anvil pits used to repeatedly crack open nuts of specific species take on distinctive shapes. Anvil pits are often found on the flattened, smoothed surfaces of other ground stone tools, such as manos and metates.

Metric and non-metric observations were recorded for anvils. Measurements of appropriate dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.6.3 Lithic Debitage Analyses

Chipped stonedebitage is the unmodified debris that results from lithic reduction activities associated with the manufacture and maintenance of stone tools. Lithicdebitage lacks any macroscopic indications of use or modification. Pieces that exhibit any sign of use-wear or intentional modification would be placed in the appropriate tool category. Alldebitage was counted and weighed. Due to the large quantities ofdebitage recovered from the Varga Site, it was necessary to designate a sample of the overalldebitage collection for detailed analysis. In the detailed analysis,debitage was sorted into each of the following classes.

5.6.3.1 Core Preparation Flakes

This category includes flakes, flake fragments, and pieces of angular debris associated with initial core preparation activities, such as removing test flakes to determine the quality of raw material within a cobble as well as decorticating a cobble for further reduction. Items in this category tend to have cortex covering more than 50 percent of their dorsal surfaces. By definition, most of these items tend to be relatively large (smaller flakes with dorsal cortex often fall within other categories, such as early- and late-stage biface flakes or indeterminate flakes, depending on their diagnostic characteristics). Core preparation flakes may or may not exhibit pronounced platforms, bulbs of percussion, or ventral concussion rings, though most do have one or more of these characteristics.

5.6.3.2 Biface Manufacture Flakes

Biface manufacture flakes were classified based on the presence of multifaceted striking platforms, multidirectional dorsal flake scars, parallel to slightly expanding flake margins, and slight to moderate longitudinal curvatures. This

category was subdivided into early- and late-stage biface manufacture flakes. Early-stage biface flakes tend to be somewhat larger than late-stage biface flakes, have fewer and larger dorsal flake scars, and may retain a considerable amount of cortex on their dorsal surfaces. As employed in this analysis, early-stage biface flakes correlate roughly with Callahan's (cf. 1979) revised Stage 1, 2, and 3 bifaces ("blank," "rough out," and "primary preform" stages) while late-stage biface flakes correlate with Callahan's revised Stage 4 and 5 bifaces ("secondary preform" and "final preform" stages). In practice, Stage 1 ("blank") flakes are more likely to fall within the core preparation flake category due to the lack of clear diagnostic characteristics on many such specimens. Final percussion thinning, pressure thinning, and retouch flakes that do not clearly exhibit biface manufacture characteristics due to their small size would likely be included in the tertiary thinning/retouch flakes category. The early- and late-stage biface flake categories may contain complete flakes, proximal and distal flake fragments, and/or small pieces of angular debris that exhibit clear characteristics of the biface manufacture process (in practice, the latter type ofdebitage—angular debris bearing bifacial traits—is rare in the biface manufacture flake categories).

5.6.3.3 Tertiary Thinning/Retouch Flakes

This category includes flakes and proximal and dorsal flake fragments resulting from the final stages of tool manufacture, including final percussion thinning and any subsequent pressure retouch. By definition, flakes in this category tend to be quite small, and it is difficult to distinguish whether they result from biface manufacture, uniface manufacture, or resharpening.

5.6.3.4 Blades

Blades are long flakes that are at least twice as long as they are wide with single-faceted striking platforms (either corticate or decorticate), parallel unidirectional or opposed bidirectional dorsal flake scarring, dorsally trimmed platform preparation, and straight rather than curving longitudinal cross sections.

5.6.3.5 Tool Rejuvenation Flakes

Tool rejuvenation flakes are resharpening flakes removed through percussion or pressure flaking from the working bits of bifacial or unifacial tools in order to restore the working edge of the tool. They may occur in a variety of shapes and can be either bifacial or unifacial depending upon the type of tool being rejuvenated. Most rejuvenation flakes are narrow and curved. Tool resharpening flakes bear use-related scarring indicative of tool use on the former bit edge. At least one worked tool surface or face is always present, and a major hinge fracture usually occurs along one edge. In addition to bit damage, tool rejuvenation flakes of sufficient size may also bear characteristics that reflect the overall morphology of the tool from which they were struck. Rejuvenation flakes are presumably the result of tool resharpening and refurbishing processes whereby a working edge that has become dull, broken, or otherwise compromised is removed from the parent tool so that a new working edge may be crafted. Thus, while rejuvenation flakes exhibit manufacture and use-wear patterns consistent with the original tool's functions, the rejuvenation flakes themselves presumably were not used as tools.

5.6.3.6 Angular Debris

Angular debris, or “shatter,” includes angular pieces of lithic raw material that break away from the core as flakes are struck. In contrast to flakes, angular debris does not generally retain any diagnostic characteristics of the

flintknapping process (i.e., platforms, bulbs of percussion, concussion rings, and definable dorsal or ventral surfaces). In this analysis, those few pieces of angular debris that exhibit characteristics diagnostic of biface manufacture were included in the appropriate biface-manufacturing category (i.e., early- versus late-stage biface flakes).

5.6.3.7 Indeterminate Flakes

This category includes flakes and flake fragments that lack diagnostic traits that would permit their placement into one of the other categories. Generally, these flakes are small fragments of flakes and/or thin pieces of angular debris that do not display clear evidence of a platform, concussion rings, or flake scar patterning on their dorsal surfaces. This category also includes a small number of potlid flakes and fractured heat spalls resulting from thermal alteration of raw materials.

5.6.4 Use-Wear Analyses

Chipped stone tools from both excavation blocks (Blocks A and B), sampled from within each of the four cultural components represented at the Varga Site, were selected and sent to Dr. Bruce Hardy at Grand Valley State University in Allendale, Michigan, for high-power, microscopic use-wear analysis. Most tools were selected from the group of tools that were minimally handled in the field and not washed in the laboratory. All chipped stone tool classes present in the Varga Site assemblage were sampled and submitted for use-wear analysis. The analytical methods and results of Dr. Hardy's findings are presented in Appendix C. Two unusual chipped stone tools (#726-010 and #837-001) from the Toyah component were sent to Dr. Marvin Kay at the University of Arkansas for detailed use-wear analysis. His results are presented in Appendix M. Use-wear results from specific tools are also summarized in the

descriptions and discussions of various tool categories and cultural components in this report.

The use-wear analyses included 59 chipped stone tools from the Toyah component, 17 tools from the Late Archaic component, 17 tools from the Middle Archaic component, and 63 tools from the Early Archaic component. The number of tools submitted per component is a general reflection of the number of tools representing that particular period. A diverse assemblage of points, scrapers, bifaces, unifaces, drills, and edge-modified flakes were submitted from each of the four components. Projectile points were one of the classes of tools least selected as most have a previously defined and demonstrated use as projectiles. In general, the Perdiz points are assumed to have functioned in a piercing motion and presumably the penetration occurred so few times prior to breakage that use-wear would not be present on a Perdiz specimen, thus, Perdiz points were not intensively sampled. On the other hand, there is some disagreement about the function of Clifton points and thus, they were more intensively sampled to address their function. Edge-modified flakes were intensively sampled as they presumably functioned in a variety of tasks and on a variety of materials. Therefore, it was thought that most functional diversity would be apparent in the edge-modified tool class. The edge-modified tools included a variety of shapes to the various edges and we tried to select flake tools that would be classified as graters, spokeshaves, and rejuvenation pieces. Within the projectile point group for each period, multiple point types were submitted for analyses, but because of the extensive number of projectile points and the limited number of specimens that could undergo use-wear analyses some trade offs were made.

5.6.5 Burned Rock Analyses

Burned rocks are natural rocks that have been heated and often rapidly cooled as the result of involvement in cooking or other heating activities. While it is occasionally difficult to distinguish burned from unburned rocks in the field, many burned rocks exhibit cracking, discoloration, crazing, and angular, fragmented edges. During excavation, burned rocks were treated as cultural artifacts.

Burned rocks were first sorted according to raw material type, usually limestone, in the field. All burned rocks were then sorted into four size categories (i.e., 0 to 4 cm, 4.1 to 9 cm, 9.1 to 15 cm, and greater than 15 cm) based on maximum diameter, and then counted and weighed by size class. Burned rock clasts were further categorized according to the angularity of their fracture planes (i.e., angular, subangular, subrounded). Most burned rocks from feature contexts and a sample of burned rocks from non-feature contexts were collected, bagged, and returned to the laboratory for processing, cataloging, and analysis. Some burned rocks from features and most burned rocks from non-feature contexts were discarded in the field after being counted and weighed. Thus, while the entire volume of burned rock encountered during excavation is known, only a sample of this volume was retained for possible further analyses.

Ninety-four burned rocks were selected and submitted for lipid residue and stable carbon and nitrogen isotope analyses. One piece of a limestone burned rock (#1030-5-3-2c) weighing about 103 g from 30 to 40 cmbs in Feature 38 in the Toyah component was submitted to the Center for Applied Isotope Studies (CAIS) at the University of Georgia in Athens (UGA) for direct radiocarbon dating.

All four major time periods were represented by the 94 burned rocks submitted for lipids residue

analysis. Twenty-nine burned rocks from seven features and three non-feature burned rocks were from the Toyah component. Thirty-four burned rocks from eight features were submitted from the Late Archaic component. Nine burned rocks from two features were submitted from the Middle Archaic. Twenty-two burned rocks from six features were submitted from the Early Archaic. The detailed sample preparation, analysis, and interpretations of the lipid residues are presented in Appendix G.

The exact same rocks that were selected for lipid residue analysis were also used for the stable carbon and nitrogen isotope analysis. Once a burned rock was selected, about 1 to 2 g of matrix was ground off using a Dremel® tool from the spot targeted for lipid residue analysis. The idea being that the matrix for both analyses would come from the same spot and thus the results would complement each other. These tiny matrix samples were first submitted to Paul Price Associates, Inc. in Austin, for decalcification. Once the carbonates had been removed the samples were submitted to University of California at Davis, Stable Isotope Facility, for stable carbon and nitrogen isotope analyses under the supervision of Dr. David Harris.

5.6.6 Faunal Analyses

5.6.6.1 Faunal Bone Analysis

The faunal remains from each component were divided into ten major taxon groups based on the size and type of animal represented. The 10 groups include mammals in size class 1 that are mole and mice (*Soricidae* and *Critetidae*) size, size class 2 includes rabbit (*Leporidae*) size mammals, size class 3 includes raccoon (*Procyon*) size animals, size class 4 includes dog/coyote size (*Canis*), size class 5 includes deer (*Odocoileus* sp.) and antelope (*Antilocapra americana*), and size class 6 includes bison

(*Bison bison*) size animals, with turtles (*Testudines*) in class 7, snakes (*Serpentes*) represented in class 8, birds (*Aves*) in class 9, and fish (*Osteichthyes*) in class 10. The assignment of a bone fragment into a specific size class was based primarily on cortical wall thickness, bone shape and structure, and specific observed attributes. If these attributes were not sufficient to confidently assign a bone into one of the 10 classes, then the fragment was assigned to an unknown category. Bones were identified as to element and symmetry where possible, but many pieces are small long bone fragments (LBF) that could not be identified. The counts and weights of each group or types of bones were recorded.

The bones were also recorded according to size categories that range from 0 to 3 cm, 3.1 to 6.0 cm, 6.1 to 9.0 cm, 9.1 to 12.0 cm, and greater than 12.1 cm. Knowing the size of a bone helps in the descriptive discussion and provides an indication to the type or potential cultural processing that occurred. The bones were inspected for various alterations that include burning and cut marks. The cut marks include various types such as thin and thick lines from small tool marks, broad chop marks from larger tools, and impact location from smashing the bones. Burning results in a variety of colors that are generally related to the temperatures (degrees Celsius [C]) that the bone was subjected too. This includes bones burned to a solid black, a solid brown, a mixture of brown and black, a calcined white, and a mixture of black and white. Generally speaking, the bones of an ungulate turn to a brown color in the range around 200 degrees C, black in the 300 degrees C range, gray in the 300 to 400 degrees C range, and white above about 700 degrees C range (Nicholson 1993).

5.6.6.2 Mussel Shell Analysis

Fresh water mussel shell fragments were rare occurrences in the terrace deposits at the Varga Site, and those that were recovered consist predominantly of small, unidentifiable fragments. Larger and more complete mussel shell fragments, usually those on which the hinge or major portions of the shell are represented, were identified to genus and/or species whenever possible using TRC's comparative collection of mussel shells. Valves were counted, identified as to side, and examined for signs of human modification. The fragments were counted and weighed.

5.6.6.3 Snail Shell Analysis

Rabdotus, *Polygyridae* sp. and *Helcina* sp. snail shells and shell fragments were recovered. The data recovery plan and research design for this project have not specifically targeted snail shells as an analytical medium for deriving information about the prehistoric occupations at the Varga Site. Consequently, snail shells were sorted by species in the field, general notes were recorded about the relative density of snail shells in each excavation level, and the snail shells were discarded. In the 17 designated "sample units," including seven 1-by-1 m units in Block A and 10 1-by-1 m units in Block B, all snail shells were collected, counted, and weighed. However, snail shells were not further analyzed.

5.6.7 Flotation Macrobotanical Analyses

Bulk matrix samples, incorporating 573 liters of matrix, from 44 proveniences including 24 selected cultural features, were collected in the field for flotation and/or fine-screening in the laboratory. Most features did not exhibit any basin-like internal structure that may have helped to trap small materials within the feature. Based on the absence of basins and the

demonstrable tendency for some small objects to translocate through the profile (especially seeds and charcoal flecks), flotation was the sole method used to recover materials from matrix samples. As discussed above in this chapter, fine-screening (i.e., screening through 3.2 mm [1/8 in] hardware cloth) was employed in some manually excavated units during the first phase of fieldwork. The relative abundance of materials smaller than 6.4 mm (1/4 in) recovered in these fine-screened samples was quantified to provide a general estimate of the kinds of material that were not recovered through use of 6.4 mm (1/4 in) hardware cloth during the rest of the data recovery excavations.

Forty-four light fraction samples from the flotation process were selected and sent to Dr. Phil Dering of Shumla Archeobotanical Services in Comstock, for sorting and identification of organic materials. Dr. Dering's detailed technical report is presented in Appendix I.

The heavy fractions were carefully picked for charcoal, burned seeds, bone, lithic debitage, burned rock fragments, and snail shells. These materials were then counted and weighed by material class and the results presented in the appropriate feature discussions within the test of the report.

5.6.8 Charcoal Analyses

A total of 75 macrobotanical or charcoal samples with sufficient mass for potential identification from feature and non-feature context were selected and submitted to Dr. Dering of Shumla Archeobotanical Services in Comstock for identification. Parts of charcoal pieces used in radiocarbon analysis were also identified as to species thereby, the age of specific species was also known and could contribute to our understanding of past vegetation changes and or cultural selection. Dr. Dering presents the detailed methods,

macrobotanical identifications, and interpretations in Appendix I.

5.6.9 Petrographic Analyses

A total of 20 samples, 19 plainware pottery sherds and one local sediment sample were selected for petrographic analyses. These samples were first submitted to National Petrographic Services, Inc. of Houston, for slide preparation. The thin sections were stained for carbonates, and the finished thin sections were not covered. These slides were submitted to Dr. David Robinson, Research Fellow at the Texas Archeological Research Laboratory (TARL) at The University of Texas (UT) at Austin, for analysis. Microscopic thin section analysis has been around for over 50 years and provides a means of quantifying the details concerning the sherds through point counts of materials for interpreting and addressing questions concerning manufacturing, production techniques, and cultural differences.

The 19-plainware sherds include 12 ceramic samples from the Varga Site Toyah component, five samples from the historic Mission San Juan (41BX5) in San Antonio, and three samples from the historic Mission San Lorenzo de la Santa Cruz (41RE1) in Camp Wood. The 12 Varga Site sherds were thought to represent at least five separate vessels or vessel groups identified prior to submission for analysis. The vessel group identifications were not provided to Dr. Robinson, so his efforts were conducted without knowledge to previously determined groupings. One of the 12 ceramic sherds (#840-81) from the Varga Site was known to be of an object that was not from a cooking vessel, but represents an ornament or figurine-like object. Dr. Robinson's detail technical report is presented in Appendix D, and the information contained therein is incorporated into the body of this text.

5.6.10 Granulometry Studies

Ten matrix samples were submitted to Ms. Mary Jo Schabel of Milwaukee Soil Laboratory, LLC in Milwaukee, for grain-size analyses and a variety of chemical analyses. Included are five 1 to 2 cm thick matrix samples from a single column through dated cultural deposits immediately south of BT 2 near the middle of Block A, plus five radiocarbon-dated matrix samples extracted from specific soil horizons identified in backhoe trenches across the site. Parts of these same matrix samples were those used for the pollen and phytolith analyses, and radiocarbon assays.

The various chemical analyses conducted include: percent of organic matter, percent carbonate, percent of available phosphate, and total phosphate. These data contribute to the descriptive aspects necessary to develop interpretations of the various site soils and matrices. Individual sample results are presented in Table K-1 in Appendix K.

5.6.11 Pollen and Phytolith Analyses

Twenty matrix samples of about 100 g each were initially sent to Dr. John Jones at the Palynology Laboratory at Texas A&M University in College Station, to process paired samples for pollen and phytolith extraction. A conservative extraction technique was employed. Dr. Richard Holloway of Quaternary Services in Flagstaff presents the details of the extraction procedures for pollen and phytoliths in Appendix E. Once extracted, the paired pollen and phytolith samples were then sent to Dr. Holloway for counting and interpretation.

Twenty samples were from a vertical column on the southern edge of BT 2 that penetrated through the entire cultural sequence that spans some 6,000 years. Care was taken to collect the original matrix from 1 to 2 cm thick horizons at about 10 cm intervals down through the column.

The column-contained radiocarbon dated and associated materials from the Toyah component, the Late Archaic, Middle Archaic, and Early Archaic components. Two samples (#1207 and #1208) came from radiocarbon-dated matrix extracted from BT 1 located in Block A. Sample #1208 was from a 1,870-year-old 2Ab soil horizon, whereas sample #1207 was from a 6,279-year-old a 2Bw soil horizon. Three samples (#1209, #1210, and #1211) came from radiocarbon matrix extracted from BT 7 at the north end of Block B. Sample #1211 was from a 1,900-year-old buried A soil horizon, sample #1210 was on a 4,820-year-old 2Bk soil horizon, and sample #1209 was a 5,230-year-old Bk2 soil horizon. Dr. Holloway presents the pollen and phytolith methods, results, and interpretations in Appendix E.

5.6.12 Radiocarbon Analysis

A total of 66 radiocarbon assays were conducted in two laboratories—Beta Analytic Inc. of Miami, and the Center for Applied Isotope Studies (CAIS) at the University of Georgia in Athens (UGA). The submitted samples primarily targeted three principal components—Toyah, Late Archaic, and Early Archaic—with limited effort directed to materials from the Middle Archaic component. Charcoal and bone were plentiful in the Toyah component, but relatively sparse in the earlier components. The radiocarbon dating focused on the charcoal with 34 charcoal samples, with other materials including 11 ceramic sherd samples, eight bone samples, five walnut shells, five sediment samples, one *Rabdotus* snail shell, one burned prickly pear seed sample, and one limestone burned rock.

Of the total assays, 20 samples relate to the Toyah component, 13 relate to the Late Archaic, five relate to the Middle Archaic, 17 relate to the Early Archaic, two to the historic mission period, and the others are subject to discussion

elsewhere in the report. The results from charcoal dating help assess the age of selected individual features, provide age ranges for the cultural components, provide concrete data to discussurbation problems, and provide a comprehensive basis for assessing the absolute ages of burned rock residues identified.

In a continuing effort to assess the potential for direct dating of organic materials other than charcoal and bone, two other organic bearing materials—ceramic sherds and a limestone burned rock—were submitted for AMS dating. It was anticipated that individual ceramic sherds and the burned rock would yield absolute ages from cultural residues within the walls of these objects that had been culturally used and may have more secure contexts than tiny pieces of charcoal. Nine sherds were selected for radiocarbon analysis in order to help narrow the range of time represented by the Toyah component, potentially refine the ages of individual Toyah events, and overcome some potential dating problems deriving from the use of old wood by site occupants. The individual charcoal results from the laboratories are presented in Appendix B, with results also presented in various parts of the text.

5.6.13 Stable Isotope Analyses

Matrix from the interiors of 87 burned limestone rocks, six Varga Site Toyah sherds, two Mission San Juan sherds, five Mission San Lorenzo sherds, all believed to contain cultural organic residue were extracted for stable carbon and nitrogen isotope analyses. Isotope samples were extracted from those same burned rocks and ceramic sherd samples employed in lipid residue analysis. Also 25 sediment samples, 20 from the one column in Block A and five from dated sediments were analyzed. These tiny matrix samples (about 1.0 g) were submitted to University of California at Davis, Stable Isotope Facility, for stable carbon and nitrogen isotope

analyses. About 33 modern plant samples were also isotopically analyzed to enlarge the current comparative database and facilitate the interpretations of the cultural materials. The isotope results from the modern specimens supplement and support the recent stable isotope data gathered on modern edible plant parts, animals, and nuts from the Central, South, and West Texas regions (Quigg and Cordova 2000; Quigg et al. 2000; Quigg et al. 2002a, 2002b).

The selected burned rock matrix submitted for isotope study came from 23 recognizable cultural features unevenly representing the 6,000 years of prehistory at the Varga Site. The limestone burned rocks were broken and the outer edge matrices were broken off or ground using a Dremel® tool with a variety of metal bits. The ground rock matrix was placed in a 3.5 dram plastic vial and sent to Paul Price Associates, Inc. of Austin, for calcium carbonate removal. The laboratory processing to remove the calcium carbonates from the extracted residues involved: at least two acid washes with a 20 percent hydrochloric acid (HCl) solution. After each acid wash the sample was allowed to settle overnight (ca. 12 hours). After settling, excess solution was poured off of the sample and a subsequent acid treatment was conducted until a reaction was no longer visible. Upon completion of the acid treatment, each sample was thoroughly washed with distilled water and placed in a drying oven approximately two to three hours and allowed to dry. Sample vials were rinsed thoroughly with distilled water and allowed to dry before repacking each sample within their respective vial. Less than 1 g of decalcified matrix from each sample was sent to University of California at Davis, Stable Isotope Facility for encapsulation and stable isotope analyses.

Carbon isotope results derived from the organic residues inside the burned rocks and ceramic sherds are used to assess the relative proportion

of C₃ or C₄/CAM photosynthetic pathway of the plant residues, or animals that ate these plants, and were cooked by these items. The isotopes provide relative abundance proxies of each photosynthetic community and probably reflect a mixture of food resources. The stable nitrogen isotope results are believed to be informative for the identification of legume versus non-legume plants. The values derived probably reflect a mixture of food resources. The specific stable isotope results derived from the isotope laboratory are presented in Appendix H with results presented in appropriate sections of the text.

5.6.14 Lipid Residue Analyses

A total of 102 samples was submitted to Dr. Mary Malainey in Winnipeg, Manitoba, for lipid residue analysis. These include 94 limestone burned rock samples from 23 identified features and eight ceramic sherds that include two sherds from Mission San Juan in San Antonio. The Late Archaic burned rock midden Feature 1 and its subdivisions Feature 1a, 1b, 1c, and 1d was intensively investigated through 27 individual samples. Seven Toyah features were investigated through multiple samples, whereas two Middle Archaic features and six Early Archaic features were sampled. Chunks of the burned rocks, weighing from 11 to 134 g, were broken from the parent burned rock for submission. The parent rock was retained and is curated for future reference. The selected burned rocks were mostly from burned rock features that are radiocarbon dated. These same burned rocks were also used to extract matrix for stable carbon and nitrogen isotope analyses. The six sherds from the Varga Site were thought to reflect Toyah period events. These eight sherds were thought to represent at least three vessel groups; #1030 and #1055 were assigned to Vessel Group 1, #965 and #1157 were assigned to Vessel Group 2, and #900 and #901 were assigned to Vessel Group 3. The two

sherds from the Mission San Juan reflect the Native American manufacture and use during the historic period around A.D. 1731 to about A.D. 1823 (Habig 1968). The lipid analysis was conducted to identify the cultural lipids within the organic residues that remained inside the burned rock or ceramic sherd, which may indicate the kinds of foods that were cooked. These data potentially reflect changes in subsistence practices or species available over the nearly 6,000 years of prehistory represented. Drs. Malainey and Malisza present the detailed procedures, results, and interpretations of the lipid analyses in Appendix G. Their results have been incorporated into the appropriate sections within the body of the text.

5.6.15 Optically Stimulated Luminescence (OSL) Dating

We anticipated that charcoal or other organic materials would not be preserved from the Early Archaic component; and therefore, we would lack the necessary organic material to radiocarbon date this important early component. In anticipation of not being able to procure radiocarbon dates for early occupations at Varga, we collected six to eight OSL samples from the three primary components during the field investigation and proposed this strategy to TxDOT in our research proposal. The proposal was accepted and six sediment samples for dating were submitted for OSL analyses. We anticipated the combined radiocarbon and OSL results from the Toyah and Late Archaic components would provide the necessary crosscheck for the OSL dates derived from the Early Archaic component. The comparison of the results from the two dating techniques in the upper two components would provide the foundation for determining the validity and interpreting the OSL dates from the Early Archaic.

Six matrix samples incased in light-tight, 5 cm diameter plastic tubing with sealed ends were submitted to Dr. James Feathers at the Luminescence Dating Laboratory at the University of Washington in Seattle, for single-grain OSL dating. Two samples were collected from each of the three major components, two from the Toyah (#1237 and #1238), two from the Late Archaic (#1239 and #1240), and two from the Early Archaic (#1242 and #1243). Separate sediment samples from immediately adjacent to each collected sample for dating were also sent to the laboratory for determination of environmental dose rate and moisture content. The details of the methods and procedures for the OSL dating and the interpretation by Dr. Feathers are presented in Appendix L.

5.6.16 Instrumental Neutron Activation Analysis (INAA)

A total of 280 samples (TRC001 through 280) were submitted to the Archaeometry Laboratory at the University of Missouri Research Reactor in Columbia. A total of 107 natural chert samples (TRC001 through 107) were from known source localities across the southwestern part of the Edwards Plateau and were submitted to establish signatures for natural Edwards chert. Thirty-six natural chert samples came from nine different localities (TRC047 through 082) originally collected by Dr. Charles Frederick as part of his work in defining the Edwards chert area of exposure. The provenience information of these nine localities was first published by Frederick and Ringstaff (1994). The “sample number” used in the original publication was again used here along with the sufficix of CF. The localities from which natural chert samples were submitted at this time include sample number 6 (TRC061 through 065), 7 (TRC047 through 051), 9 (TRC052 through 055), 10 (TRC056 through 060), 11 (TRC066 through 071), 12 (TRC072 through 074), 16 (TRC075

through 078), 17 (TRC079 through 081), and 19 (TRC0082). These samples purposely focused on the southwestern end of the Edwards chert exposure since this is the location of the Varga Site. Another natural chert sample consisting of six pieces (TRC001-006) came from a road cut along State Highway 377 in western Edwards County and was collected by Mr. Quigg. Seven natural chert pieces (TRC007 through 012 and 016) came from 41ED58, one piece was from 41ED54 (TRC013), one from 41ED57 (TRC014), and one from 41ED141 (TRC015), all of which are located in an upland setting at the Devil's Sinkhole State Natural Area (Howard et al. 1996). The Texas Parks and Wildlife Department, cultural resource archeologists in Austin, provided these samples. Another 21 natural chert cobble samples (TRC083 through 103 = #1252) were collected from the gravel deposit exposed in the bottom of Hackberry Creek immediately adjacent to the Varga Site. Ten pieces of upland chert (TRC017 through 026 = #1274-1 through 10) were collected from eroding uplands exposure on a slope south of the Varga Site. Twenty natural chert cobbles (TRC029 through 046 = #1253) were also collected from the Nueces River bottom just south of Camp Wood. Three pieces of Georgetown chert in three different colors (TRC104 through 106) and one piece of Burro Mesa chert (TRC107) were also submitted.

A total of 154 samples of cultural chert from the four components at the Varga Site were submitted to investigate the original sources of the stone tool material used over time. These cultural samples included parts of stone tools that represent a wide variety of tool classes from each component. Parts of 17 chipped stone tools from the Middle Archaic (TRC108 through 124) were submitted. Parts of 66 chipped stone tools from the Early Archaic (TRC125 through 190) were submitted. Twenty-three chipped stone tool pieces from the Late Archaic (TRC191 through 213) were submitted. Fragments of

48 chipped stone tools from the Toyah component (TRC214 through 261) were submitted. The results of the INAA on the lithic materials are presented in Appendix F.

Eighteen plainware ceramic sherd samples (TRC262 through 279) and one matrix sample (TRC280) were also submitted for analysis. These included three non-bone tempered sherds from the historic Mission San Lorenzo (41RE1) in Camp Wood (TRC262 through 264), five bone tempered sherds from the historic Mission San Juan (41BX5) in San Antonio (TRC265 through 269), and ten mostly bone tempered sherds from the Toyah component at the Varga Site (TRC270 through 279). The ten samples from Varga represent at least five vessel groups. The matrix sample (TRC280 = #1259-4b) was a dark gray silty loam Bk soil horizon at 65 to 70 cmbs and part of geomorphic Unit 3 from BT 2. This local alluvial sediment was used for comparison to assess the presence of locally made pottery versus pots of non-local production. The results of the INAA of the pottery are presented in Appendix N.

5.6.17 Possible Human Remains Analyses

During the first phase of investigation, some unidentifiable materials were discovered. Since there was a possibility that this material was highly degraded human bone, three physical anthropologists were consulted to view and comment on the unknown material. Additionally, samples a number of other specialists. The physical anthropologists concluded that the materials could not be assigned to a species, while a bone histologist determined that the unknown material was definitely not bone. Once the analyses were completed and all opinions were gathered, TxDOT's archeological staff, TRC's archeologists, and the THC concluded that the material was not human in origin, but rather was

more likely carbonate-filled root casts. The various technical opinions on this material are presented in Appendix J.

5.6.18 Spatial Analysis

The primary data utilized for analyses of spatial distributions at the Varga Site derive from the distributions of various tool classes, burned rock, debitage, faunal bone, and other artifacts across each site component, or “analytical unit.” The differential function, or range of functions, that characterize the site at a given point in time, in turn, provide for a range of inferences about the role of this site in the overall settlement system of which it formed a part through time. Finally, outlining the structure of the settlement system at a given time provides the general structure within which hypotheses may be developed and tested to explain the patterns of mobility and differential use of the regional landscape. Explorations of such hypotheses may eventually lead to qualified characterizations of hunter-gatherer organizational systems in southwestern Texas.

The cultural material distributions analyzed in this study were recovered from hand-excavated units in two separate block areas—Blocks A and B—on the west and east sides, respectively, of the road. These excavations yielded a rich and complex array of cultural materials. Twenty-seven cultural features were documented during the first and second phases of investigations. Originally, 41 cultural features were documented in the field; however, five of these features are actually part of Feature 1, the large burned rock lens in Block A (i.e., these are burned rock clusters and scatters within a larger, incipient burned rock midden), and were subsequently combined for analytical purposes. In addition, nine of the features that were designated, as cultural features during the first phase of fieldwork were later removed from the list of features. These nine features consist

of clusters of bones, burned rocks, and/or artifacts and natural soil anomalies (e.g., burned root casts, natural mineral concretions) that failed to meet the criteria for feature designation used during the second phase of fieldwork. Finally, features dating to the historic and modern periods (fence post molds) were not included in this count.

An extensive collection of artifacts was recovered during the data recovery excavations, including chipped stone projectile points, bifacial tools and preforms, unifacial tools, and edge-modified flakes; cores; lithic debitage; groundstone tools; bone implements; faunal remains (including bone, mussel shell, and snail shell); floral remains (wood charcoal, carbonized seeds, and nutshells); ceramic sherds; historic objects; and burned rock. It should be noted that these item counts might differ slightly from the final tabulations presented elsewhere in this report. Data were tabulated in preparation for the spatial analyses before all artifact analyses were completed, and artifact frequencies within some categories may have changed slightly as a result of the latter studies. For example, a few edge-modified flake tools were identified during analysis of the lithic debitage, thereby changing the frequencies of each category slightly; however, the altered frequencies of these two artifact categories are not reflected in the data analysis. It is assumed that the resulting small number of changes to final artifact category counts do not substantially alter the findings of spatial analytical studies presented here. Also, the artifact category summaries do not differentiate between materials recovered from feature versus non-feature contexts. For purposes of the spatial analyses, artifact counts from features and non-feature matrix within a single excavation unit have been combined.

For the purposes of spatial studies, five separate data sets representing the four recognized

analytical units across the two excavation blocks were developed. Only those cultural materials recovered from continuous excavation areas were used in the spatial analysis; thus, all four cultural components from Block A are represented, whereas only the Toyah component was included from Block B. Cultural materials from the deeper (i.e., Late Archaic, Middle Archaic, and Early Archaic) components in Block B were recovered only from scattered excavation units during the first phase of excavations—they provide discontinuous representation of artifact densities across Block B and were consequently excluded from spatial analyses. The five data sets therefore consist of all four analytical units in Block A plus the Toyah component in Block B.

In tabulating counts of cultural materials for spatial analyses, all of the individual 10 cm thick excavation levels assigned to a particular analytical unit were collapsed, and their artifact counts were combined within each excavation unit. Thus, if the upper four 10 cm excavation levels from Unit N100/E47 were assigned to the Toyah component, then the counts of lithic debitage from all four levels were combined into a single count. Excavation levels that could not be confidently assigned to either the overlying or underlying analytical unit were excluded from spatial studies. In addition, cultural materials encountered in lower portions of the stratigraphic profile that could be demonstrated to have translocated downward from their original positions farther up the profile were excluded from study. Most often, materials falling into this category were faunal bones encountered in lower levels that could reasonably be assigned to overlying analytical units based on their state of preservation. Demonstrably Early Archaic faunal bone was substantially more eroded than Toyah bone, so an isolated, well-preserved bone found in the Early Archaic component could reasonably be assigned to the Toyah component. To avoid

introducing confusing “noise” into the data, such out-of-context specimens were summarily excluded from analyses. The only exception to this rule was faunal bone recovered from the upper portion of the Late Archaic component. The interface of the sediment zones comprising the Toyah and Late Archaic analytical units (depositional Units I and II, respectively) was relatively abrupt, and the loosely consolidated, fine-grained depositional Unit I sediments were interdigitated with the upper portion of depositional Unit II, especially in the vicinity of Feature 1, where depositional Unit II consists primarily of large clasts of fire broken limestone. As faunal bone is otherwise common throughout the Toyah component and correspondingly rare in the Late Archaic component, faunal bone recovered from such contexts was summarily included in the Toyah component for analytical purposes.

Preliminary examination of raw artifact frequencies and weights (i.e., data that were not corrected for the volume of sediment from which they were recovered) revealed patterns in the spatial distribution of artifacts categories that appear to be primarily density-dependent. Artifact frequencies within any given category tend to increase across space as a function of increases in artifact counts within other categories. In other words, cells that contain high frequencies of one artifact type are likely to contain high frequencies of other artifact types as well. Thus, an increase in the frequency of one artifact category across space provides a fairly accurate prediction of the frequencies of other types. This pattern is consistent among typological categories and among spatial units, indicating that the variability represented in the raw data is primarily a function of artifact density, the volume of recovery units, and sample size. The analytical utility of these data is severely restricted. Put simply, 100 artifacts recovered from a 10 cm-thick analytical unit in a 0.25-by-0.25 m excavation unit means

something very different than 100 artifacts recovered from a 40-cm-thick analytical unit in a 1-by-1 m excavation unit.

To remove the biasing effects of sample size, excavation unit size, and analytical unit thickness across space, the raw data frequencies were transformed into density-corrected volumetric measures. Within each excavation unit, the average depth of the top of each analytical unit was subtracted from the average depth of the bottom of that analytical unit, and the difference was multiplied by the average size of the excavation unit within the levels covered by the analytical unit. Most excavation units were consistently sized from top to bottom (e.g., 0.25-by-0.25 m, 0.5-by-0.5 m, or 1.0-by-1.0 m), although local unconformities, such as the edges of previously excavated backhoe trenches, sometimes cut into one or more levels. The resulting measure of the volume of each analytical unit within each individual excavation unit was then divided into the raw counts of each artifact category, resulting in a measure of the density of each artifact category per m³. As density-corrected data represent a relative measure of the abundance of an artifact category per unit of space without the biasing influence of excavation unit size or depth, the density-corrected data were directly comparable and formed the basis for all further data manipulations.

Next, principal components analyses were conducted using the statistical package for the social sciences (SPSS, version 12.0). Within each of the five data sets, the density-corrected data array was used as the basis for calculating a matrix of correlation coefficients. In each data set, individual excavation unit designations formed the cases (i.e., rows), and the artifact categories defined for the analysis formed the variables (i.e., columns). The first step in principal components analysis is the computation of a matrix of correlation

coefficients that represents the relative correlation or covariation of each variable (in this case, artifact categories) with every other variable, measured on a scale of -1.0 (perfect disassociation) to 1.0 (perfect association). Before generating the matrices of correlation coefficients, however, one final data manipulation was necessary.

A high ratio of zeroes (in this case, excavation units or entire analytical units that failed to yield any of a particular artifact category) in data matrices presents serious problems in calculating a statistically valid matrix of correlation coefficients. As the number of zeroes manifested in the original data matrix increased, the percentage of total variability in the assemblage accounted for by zeroes, or the non-occurrence of a data class, also increased. To minimize the *effect* of zeroes on analytical results, it was necessary to minimize the *number* of zeroes before generating the matrix of correlation coefficients. This was accomplished either (1) by combining variables and cases in ways that increased the probability that at least one occurrence of every variable (or column) was present in every case (or row), or (2) by selectively deleting variables and/or cases to accomplish the same result. In the current study, the most effective means of eliminating zeroes from the original data matrices was the deletion of artifact categories that were completely absent from particular analytical units. The specific artifact categories that were deleted from each data matrix are listed within the discussion of statistical results for each analytical unit.

Principal components analysis is a factor extraction method used to form uncorrelated linear combinations of the observed variables. The first component has maximum variance. Successive components explain progressively smaller portions of the variance and are all uncorrelated with each other. Principal

components analysis was used to obtain the initial factor solution, and it was used when a correlation matrix was singular. The commonly used procedure of varimax orthogonal rotation for factors whose eigenvalues were greater than 1.0 was employed in the analysis (cf. Vierra and Carlson 1981). The varimax method seeks such orientations that as many of the variables as possible have either a very high or a very low loading on each factor, rendering each factor as mutually exclusive as possible and making them easier to interpret as a result (Cowgill 1968). Three- to six-factor solutions were extracted for the various data arrays analyzed, accounting for 60.59 to 66.22 percent of the total variance in

the data sets. Within each factor loading, only those variables exceeding 0.5 (positive or negative) were considered to represent diagnostic variables for each factor.

Contour maps of density-corrected artifactual data were generated for each variable within each component, using Surfer (version 5.01) mapping software. These maps were used as a visual reference to aid in the interpretation of the spatial distribution of each artifact category and to provide additional depth to interpreting the results of the principal components analyses. These maps are included in the summary section of each of the individual components.

6.0 GEOARCHEOLOGY

Grant Smith and Charles Frederick

6.1 INTRODUCTION

Grant Smith

The geoarcheological investigations of the Varga Site (41ED28) were conducted to evaluate the integrity of the site, determine soil/depositional units relevant to the archeological investigations, and to characterize the site setting. These investigations were done primarily through investigation of backhoe trench (BT) exposures, observation of hand-excavated excavation blocks, and pedestrian examination of the site and surrounding terrain. Though initial backhoe trenches were excavated in areas directly related to known cultural materials centered on the surface burned rock, additional trenches on the east side of the roadway helped delineate the extent of soil/depositional units with the potential to yield prehistoric cultural materials. In addition to investigation into the first terrace (T1), in which the archeological site was contained, the gravel strath terrace (T0) immediately below it, and the terrace immediately behind the first terrace (T2) were examined with the hopes of identifying dateable sediments that would help bracket the age of the second terrace.

Site 41ED28 is located in the T1 on the left (north) bank of Hackberry Creek and is approximately 8 m above the current stream channel. The T1 surface is dominated by relatively fine-grained sediments, approximately a meter thick, that overlie rounded stream

gravels and boulders. The T1 is considered a fill terrace and contains sediments with the potential to yield prehistoric archeological materials. Such materials had already been identified during previous archeological investigations of the area.

Coarse gravel and boulder deposits dominate the lower T0 surface, but immediately adjacent to the T1 some finer-grained sediments cap the boulders (Figure 6-1). The reason for the absence of finer-grained sediments closer to the river channel is probably due to erosional scouring by floods in the years of A.D. 2001 and 2000. A backhoe trench at the T1/T0 margin (Trench M-1, Figure 5-1) appears to indicate that the basal boulders and gravels extend underneath the T1 and are, thus, the result of deposition during the construction of the T1 (Figure 6-1). The finer-grained sediments that cap the gravels appear to be a mixture of slopewash and overbank alluvium that post dates the incision that resulted in the development of the T0. Multiple dates on a variety of Early Archaic materials from the overlying fine-grained sediments indicate that the fines are younger than 6,300 B.P. Thus, the T0 gravels are older than 6,300 B.P. whereas, the T1 developed over at least the last 6,300 years. The down cutting and erosional scouring that followed the deposition of the gravels likely removed some deposits from this sequence.

The T2, located approximately 100 m to the north of the study area, is dominated by colluvial deposition from the adjacent valley wall though some alluvial deposition has almost certainly occurred (Figure 6-2).

The sediments appear to be largely derived from the surrounding limestone bedrock. The occurrence of what appears to be limestone residuum at the base of the backhoe trench helps confirm this hypothesis.

Figure 6-1. Soil and Sediment Relationships at the Transition from T0 to T1 in Trench M-1

Figure 6-2. Soil and Sediment Relationships in T2 in Trench M-2

The backhoe trench (Trench M-2) excavated in the right-of-way, however, may not be representative of the T2 for the majority of the nearby area. In the right-of-way, the T2 is particularly narrow (ca. 25 m wide) and immediately abuts limestone bedrock. This would appear to be an ideal position for maximizing colluvial input and may have retarded soil formation in comparison to portions of the T2 that received the majority of their sediment from overbank flooding episodes. The agricultural fields adjacent to the right-of-way often have T2 surfaces that are at least twice as wide as where the backhoe trench was excavated. Thus, while our backhoe trench within the right-of-way did not reveal any

evidence of buried paleosols that would assist in our temporal understanding of the T1, other portions of the T2 might prove to be more helpful.

6.2 METHODS

Grant Smith

The geomorphic/geoarcheologic investigation of the study area consisted of examination of backhoe trenches, hand-excavated test units, and pedestrian examination of the surrounding terrain. Field descriptions follow standard sedimentologic and pedogenic procedures established by the Soil Survey Staff (1962, 1975), Krumbein and Sloss (1963), Gile et al.

(1966), Reineck and Singh (1980), Birkeland (1984), Birkeland et al. (1991), and Waters (1992). Field investigations were recorded on standardized profile exposure forms. In the vicinity of the hand-dug excavation blocks, the upper 10 to 20 cm of sediments were removed by a Gradall® because it was determined that they consisted largely of roadway gravel and/or sediments that had been moved during road construction. Thus, these sediments lacked the stratigraphic integrity to contribute significant information to understanding 41ED28.

During the first phase, geomorphic investigations of the T1 were conducted in moist to wet conditions which tended to obscure the stratigraphic boundaries in the upper portions of our profiles. Examinations during the second field phase occurred only a few weeks into the hand-excavations and, while it did provide some opportunity to study of the soils and sediments, every exposure was not observed. Some observations included here are from the archeologists that helped excavate the site and who had a longer time in which to develop their own observations.

6.3 RESULTS

Grant Smith

The first phase investigations typically identified four depositional units on the T1 and site. The second phase of the investigations typically identified five. Part of this discrepancy is probably due to the wet field conditions during the first phase that obscured some of the unit boundaries. For comparison with the previous investigations, what was formerly called Depositional Unit 3 has now been split into Depositional Units 3 and 4 (Figure 6-3). It also became apparent, after receiving radiocarbon dates from some of the soil horizons, that Depositional Units 3 and 4 were recognized within BT 7 during the initial investigations. The reason for easier visibility in this location

was that the units are thicker in this area; possibly due to infilling of a swale on the terrace surface, and that the boundary in question was below the wetting line caused by recent precipitation. For the purposes of discussion, the soil/sediment profile in excavation Block A (and BT 2) is described first and used as the primary reference for T1 sediments. As our trenches got farther away from the terrace margin (e.g., BT 7) the soil/sediment properties changed somewhat. These deviations away from the “standard” T1 soil/sediment sequence are discussed in a “variations” section that follows the reference profile description.

The uppermost unit (Depositional Unit 1) consists of fine-grained overbank sediments and only sparsely distributed prehistoric cultural materials. The Late Prehistoric Toyah component, with radiocarbon ages ranging between ca. 660 and 290 B.P., are associated with Unit 1. In the vicinity of Block B, small pea-sized gravel from previous road construction and shoulder stabilization practices was compressed into the surface of Depositional Unit 1 but, many areas are still relatively intact. Depositional Unit 2, which underlies Depositional Unit 1, is the most distinct cultural layer observed in our studies, but also appears to be a buried A horizon. This unit contained the Late Archaic component at the site, radiocarbon dated to between 2,290 and 1,390 B.P. While composed of clay loam to silty clay loam textured overbank sediments (Appendix K), Depositional Unit 2 is most notable for its dark, charcoal and humate-rich appearance and abundance of fire-cracked rock (FCR). Depositional Unit 3 is notable for the abundance of small (<1 cm) gravels within a clay loam matrix. While still relatively dark in color, this unit lacks the charcoal staining and/or A horizon characteristics observed in Depositional Unit 2. It appears that Depositional Unit 3 marks an episode of fairly high-energy overbank deposition in order to deposit pea-gravel on the

Figure 6-3. Stratigraphic Profile of Block A (East Wall)

terrace surface. Such high-energy may have also caused some erosion on the surface of the underlying unit. Depositional Unit 3 contained cultural materials assigned to the Middle Archaic, dating to 4,900-3,800 B.P. Depositional Unit 4 is silty clay loam that, in some profiles, has been subdivided into two

units based on changes in soil structure. Cultural materials in Depositional Unit 4 tend to be infrequent to absent. The one exception appears to be a higher concentration of cultural materials on its lower contact with the underlying gravels. Depositional Unit 5 consists of coarse gravel deposits that are associated with

channel deposition. The only cultural materials found in association with Depositional Unit 5 are those that rest on its upper surface or between the larger pieces, and almost certainly represent occupations after the deposition of the gravels. Early Archaic cultural materials, dating to between 6,300 and 5,200 radiocarbon years B.P., were found in the lower part of Unit 4 and were partially interspersed among the gravels in Unit 5. The following section provides a generalized description of each unit followed by a discussion of variations seen within the project study area.

6.3.1 General Descriptions

The uppermost soil observed on the site, Depositional Unit 1, is typically very dark brown (10YR 3/3) clay loam to loam. In more pristine locations, this unit is entirely composed of these finer, but heavily impacted areas often have a substantial amount (up to 75 percent) of roadway gravel compressed and mixed into the loam. This gravel also tends to form an armored surface over most of the site and this upper portion was removed by a Gradall® in the vicinity of Block A excavations at the beginning of Phase 1. Depositional Unit 1 typically exhibits a weak, coarse, subangular unconsolidated structure that grades to platy structure in areas that appear to have been mechanically compacted. The sediments are strongly effervescent to hydrochloric acid, but no visible pedogenic carbonate filaments are present. This calcareous nature is almost certainly due to sediments largely being derived from the surrounding limestone bedrock. The relatively dark color, surface position, and vegetative cover on this unit result in its classification as a soil A horizon. In comparison to the underlying sediments, the A horizon development is relatively weak and it may be suitable to call this an incipient A horizon (A). It does support the current grassland vegetation, however, and without unaltered parent material

with which to compare humic enrichment, it may be just as suitable to call this an A horizon. Due to the fine-grained nature of the sediments, their position on an alluvial terrace and proximity to perennial Hackberry Creek, Depositional Unit 1 is interpreted as being an overbank flood deposit. Accumulation of these sediments is almost certainly due to multiple flood events over time, but bioturbation and other pedogenetic processes have masked or destroyed any primary sedimentary strata resulting from flooding (e.g., laminae). Depositional Unit 1 has an abrupt, smooth boundary with underlying Depositional Unit 2, a property that suggests a hiatus between the depositions of the two units.

Prehistoric cultural materials in Depositional Unit 1 tend to be dense and randomly distributed. The archeologists indicated that this unit contained Toyah phase materials. The radiocarbon results from cultural carbon provide an age range from approximately 290 to 660 B.P. for the cultural materials. A couple of slightly earlier dates, both on charcoal, 920 and 940 B.P. may indicate the maximum age of Depositional Unit 1 deposits is closer to 1000 B.P. In some portions of the right-of-way investigations, the presence of some cultural materials on the surface appears to be the result of bioturbation, road maintenance disturbances, or slopewash onto the site from slightly higher elevation locales near to the roadway. Observation of the adjacent pastures compared to the roadway shoulder areas indicates that ca. 10 to 20 cm of sediments may be missing from areas immediately adjacent to the road, probably due to erosion. Thus, components that originally may have had a few centimeters of stratigraphic separation may now be concentrated on or near the surface of Depositional Unit 1.

Depositional Unit 2 is a distinct change because of its apparent high degree of charcoal staining and abundant FCR in the vicinity of Block A.

This unit is typically a black (10YR 2/1) clay loam to silty clay loam that exhibits a very weak, fine, subangular blocky structure. The average thickness of the unit is 30 cm. In the main activity area of Block A, cobbles of FCR comprise approximately 35 percent of this unit and in some portions the FCR forms a clast-supported package that contains little of the fine-grained matrix. A few chert flakes also appear to be randomly preserved within this unit. The nine accepted charcoal and two bone dates obtained from the Late Archaic cultural materials in Depositional Unit 2 provide an age range from 1,390 to 2,290 B.P. with an average age close to 2,040 B.P. A humate date from this Ab sediment yielded a mean residence time of 1,900 B.P. Depositional Unit 2 appears to have accumulated over a 600-year long period. The overall shape of Depositional Unit 2, including those areas high in FCR, is that of a large (6+ m diameter), lens of organic and charcoal-rich sediments. A key observation is that the charcoal-stained appearance of this unit appears to gradually decrease away from the FCR lens (Features 1, 1b, 1c, and 1d) yet a relatively dark colored unit is still present. It is our interpretation that the FCR lens was associated with a stable A horizon on the terrace surface and that charcoal was dispersed away from this feature, thus blurring the boundaries of where Depositional Unit 2 should be classified as a cultural horizon and where it should be considered an A horizon. The change is so gradual away from the feature that it is difficult to determine where such a boundary should be placed. Only by observing “end member” samples of the same Unit’s sediments can a clear difference be observed. It is understandable that people would occupy a stable surface on which soil formation was occurring. Indeed it would tend to indicate an environment suitable for occupation. The only trouble is in defining where cultural influence no longer exists. It may be more suitable to use FCR and other cultural

materials to define the site boundaries than use the charcoal staining.

In some portions of the exposures the fine-grained matrix exhibits an abundance of small white masses that do not appear to be calcium carbonate or root filaments. The general impression is that these white masses slightly resemble ash flecks, but never occur in a mass that could be considered an ash deposit. It is tentatively suggested that these may be oxalate crystals resulting from the burning of plant material. Anything more specific would be pushing the credibility of such an interpretation, but if other proxy data regarding plant utilization is forthcoming, this hypothesis might allow corroborating evidence. Depositional Unit 2 has an abrupt to clear, smooth boundary with the underlying Depositional Unit 3 deposits.

Underlying the charcoal and humic-rich sediments of Depositional Unit 2 is Depositional Unit 3, which is notable for the presence of fine-grained “pea gravel” (<1 cm diameter) within a clay loam matrix. Broken snail shell fragments are also common within this unit. The most likely explanation for this deposit of gravelly sediments is a relatively high-energy flood event that resulted in relatively coarse sediments to be washed out beyond the confines of the stream channel. Such a high-energy event may have caused some erosion of the underlying sediments (Depositional Unit 4), but it is difficult to assess how much, if any, material was removed. The result, however, caused the surface of the terrace to be gravel armored, for a time, and may have helped protect the underlying sediments after the initial depositional episode. Such a high-energy of deposition and the fact that this was probably a very quick event, indicates that the deposition of cultural materials in this unit is limited. Limited cultural materials are present, mostly in the upper portion of Depositional Unit 3. Two radiocarbon dates on charcoal and one on deer

bone from the upper portion of Depositional Unit 3 are 3,850 to 4,740 B.P. with a humate date on sediments yielding a 4,790 B.P. mean residence age. Depositional Unit 3 has a clear boundary with the underlying sediments. These ages reveal a period of some 1,000 years for the development of this unit with the high energy event near the beginning of the period.

Depositional Unit 4 is present in every backhoe trench, but lacks FCR concentrations and charcoal staining. Cultural materials were much less common in these sediments than in the overlying units. In general, Depositional Unit 4 is a dark yellowish brown (10YR 4/3) clay loam that exhibits a moderate, fine, subangular blocky structure. In some locales, particularly those where Depositional Unit 4 is over 50 cm thick, a change to massive soil structure was noted by the archeologists in the lower portions of the unit. This may indicate relatively unaltered parent material and, thus, may actually be a C horizon. Given the gradual accumulation of floodplain sediments, however, it may be that these massive sediments actually started as a B horizon, but were subsequently buried to the point where they no longer continued to develop B horizon characteristics. It may be more appropriate to designate these horizons as Bk1 and Bk2, based on the changes in soil structure. Regardless of any subdivisions, these sediments strongly effervesce when tested with hydrochloric acid and have common (four percent), fine, irregular, carbonate filaments and masses. This is considered a Stage I carbonate accumulation (after Birkeland 1984; Gile et al. 1966; Machette 1985) and it is because of this accumulation that Depositional Unit 4 is considered a soil Bk horizon. In general, Stage I carbonate accumulations are typically associated with soils that are middle to late Holocene in age (e.g., Karlstrom 1988, Machette 1985, Smith and McFaul 1997). However, the abundance of carbonate from the

local limestone may have resulted in faster development of pedogenic carbonates.

Cultural materials within Depositional Unit 4 tend to be somewhat randomly distributed, though there may be more of a concentration of some of the earliest cultural components near the lower contact of this unit. Otherwise, chert flakes, FCR, rare pieces of limonite ochre, and *Rabdotus* are distributed throughout this unit. The general impression is that either these materials were displaced vertically in the profile by bioturbation or that their occurrence throughout the profile may represent multiple occupations over time. In fact, both possibilities may be true. These fine-grained sediments are interpreted as overbank flood deposits and probably represent gradual floodplain aggradation over time. In such a scenario, it is entirely plausible that multiple occupations could have occurred in between flood events. Due to pedogenesis, including bioturbation, primary stratigraphic boundaries have been destroyed; so individual flood events cannot be distinguished. Likewise, this obscuring of boundaries probably applies to the cultural occupations as well. That is not to say that some vertical chronology cannot be developed from diagnostic artifacts, just that discrete strata with individual identifiable cultural events (e.g., a lens of Early Archaic materials) were not visible in Depositional Unit 4. The 17 radiocarbon assays from a variety of materials extracted from Depositional Unit 4 reveal an age range from about 5,180 to 6,290 B.P. This is perceived as minimum time range for this unit as potentially older organic materials may not have been preserved, and therefore, not dated.

Depositional Unit 5 is present at depth throughout the site, though its depth below surface is highly variable. This variability was demonstrated in the interim report (Lintz et al. 2002) where this deposit was shown to vary from roughly 30 cm deep at the north edge of

BT 3 to about 130 cm deep next to BT 7 less than 20 m away. In contrast to the fine-grained sediments of the overlying units, Depositional Unit 5 is composed of gravel and cobble-sized (up to 15 cm in diameter), subrounded clasts of limestone and chert. The matrix surrounding these coarse sediments is characterized as a pale brown (10YR 6/3) coarse sandy loam. Carbonate filaments are common (8 percent) within this fine-grained matrix and appear to be more abundant than in the overlying units. This is considered to be a Stage I+ carbonate accumulation (after Birkeland 1984). Stage I+ carbonates are often associated with middle Holocene (6,000+ years old) and older sediments (e.g., Karlstrom 1988). Though these gravels may be young enough to be contemporaneous with cultural occupations in the area, the high-energy depositional environment represented by such large clasts indicates an environment unsuitable for human occupation. Thus, Depositional Unit 4 was considered to be the basal unit for archeological excavations. The radiocarbon dates derived from the cultural materials on top and mixed into the top 5 cm of these gravels indicated these gravels are older than 6,300 B.P. and potentially much older.

6.3.2 Variations

The previous descriptions are provided as general characterizations of the sediments observed at 41ED28. Significant variations from these typical descriptions do occur. In particular, variations to Depositional Units 2, 3, and 4 occur within the study area, and, since these are the units primarily associated with cultural materials, these deviations are described here.

With respect to Depositional Unit 2, the generalized description given above is largely for excavation Block A on the west side of the road. Backhoe trenches and test units east of the

road, however, were not as clearly cultural in origin. In BT 6, a charcoal-rich stain at the appropriate stratigraphic level exhibited a few randomly distributed pieces of FCR and was initially thought to be a feature (Feature 5). Further examination of the profile as it dried revealed oxidized woody material that occurred in the serpentine pattern of tree roots throughout the exposure. As a result, this charcoal-rich zone was probably the result of a natural root burn as opposed to a cultural feature. The exposure is somewhat basin-shaped, however, and that raises some questions as to whether it may be cultural in origin. That cannot entirely be ruled out, but test unit 6-1 into the burn failed to recover any cultural materials. Another possibility is that this is a natural swale that filled with charcoal-rich material from a nearby natural burn. Without definitive cultural material, the detected burn in BT 6 remains questionable as to whether it was natural or cultural in origin.

Another variation in Depositional Unit 2 sediments occurs at BT 7. In this exposure, Depositional Unit 2 sediments were encountered at the proper depth and in the proper stratigraphic position, but did not appear to have significant charcoal staining as observed in trenches on west of the road near Block A (Figures 6-4 and 6-5). A few pieces of bone and a rare chert fragment were encountered in Depositional Unit 2, but otherwise it was not very remarkable. Though dark, Depositional Unit 2 in BT 7 is more indicative of a natural soil A horizon than a cultural unit. This is the same A horizon associated with the cultural occupations responsible for the other clearly culturally influence Depositional Unit 2 sediments observed on the west side of the road. In other areas, the cultural staining was strong enough to overprint this unit and result in its classification as a cultural stratum. At BT 7, however, it appears that Depositional Unit 2 was

Figure 6-4. Stratigraphic Profile of Backhoe Trench 7 (T1)

far enough away from cultural influences that it remains largely unaffected by cultural staining. For this reason it is considered to be a natural unit. Also of note was an ash filled zone with and oxidized base towards the base of Depositional Unit 2 and into Depositional Unit 4 towards the northern end of the trench (Feature 6-6). It was initially entertained that this might be a cultural feature (Feature 4), but the shape of the ash-filled area and the presence of some woody charcoal within it indicates that this was the result of a natural tree root burn instead of cultural activity.

Backhoe trench 7 also contained the most significant variation in the Depositional Unit 3. Within the archeological excavation Block A, Depositional Unit 3 is typically a ca. 15 cm thick stratum that is noted as a thin gravel layer. Within BT 7 this unit thickens to approximately 30 cm thick and the gravels are mostly limited to the lower contact. Given the proximity of excavation Block A near the front edge of T1 and the position of the BT 7 some 35 m north of the terrace edge, these properties appear consistent with the alluvial deposition of a single flood unit. The coarser grained pea-gravels in excavation Block A area represent a slightly higher energy of deposition near the terrace margin while the clay-rich and lower gravel content of this unit further to the north indicates a loss of energy for the floodwaters to carry larger materials further away from the stream channel.

Depositional Unit 4 in BT 7 also vary somewhat from the Depositional Unit 4 observed in the excavation Block A. Whereas Depositional Unit 4 near the T1 margin exhibits a clay loam texture, this grades into sandy clay loam sediments in BT 7. The reason for this apparent disparity is that the BT 7 area appears to be either a swale fill or possible a weakly defined ephemeral drainage channel on the surface of the terrace. It does not appear that this area still

Figure 6-5. Profile of Sediments Exposed in BT 7

Figure 6-6. Ash With Oxidized Base

serves this function, but it may be that a shallow, poorly defined channel traversed this portion of the terrace during the middle Holocene (based on radiocarbon dates provided below). Considering the hummocky appearance of the gravels on the recently scoured T0, it is not surprising that similar undulations could occur on the surface of the gravels comprising the T1. Additional support for this hypothesis is provided by Depositional Unit 5 of BT 7. Depositional Unit 5 is a gravelly unit that would appear consistent with gravels expected at the base of a small channel fill. These gravels are not as coarse as those observed underlying excavation Block A and the rest of the terrace.

They are typically 1 to 2 cm in diameter as opposed to the cobble-sized (6 cm and larger) clasts observed elsewhere. This would appear to be consistent with an inset gravel unit that post-dates the coarser gravels and boulders that comprise the core of the T1.

Cultural materials were recovered from both Depositional Units 3 and 4, though worked pieces of chert were slightly more abundant on the stone line surface separating the two units. Whether these chert pieces were due to people occupying this surface or were concentrated onto the surface by erosional processes remains unclear.

The radiocarbon dates obtained from soil humates helps clarify the age and relationships of the sediments observed in BT 7 and elsewhere on the site. A radiocarbon date on humic material from Depositional Unit 5 basal gravels of BT 7 yielded a mean residence age of $5,230 \pm 50$ B.P. (Beta-175391). It should be repeated that these gravels are not considered to be contemporaneous with the gravels that underlie most of the terrace, but are, instead, a younger channel fill gravel on the terrace. These sediments do, however, help provide an approximate baseline age for the oldest sediments overlying the terrace gravels. The humic material within the 2Bk horizon of BT 7 may have been translocated downward in the profile; and thus, these gravels are older than the 5,230 B.P. age would indicate, but this age is considered to be a rough estimate of when finer-grained sediments began to aggrade on the T1. In addition, a $6,270 \pm 50$ B.P. age was acquired from sediment in similar stratigraphic context (i.e., fine gravel unit overlying coarse T0 gravels) at the T1 to T0 step (Figure 6-1). Thus, aggradation on the T1 appears to have started even earlier, but still after or near the end of any Early Archaic occupations.

Depositional Unit 4 also provided a radiocarbon age that appears consistent with continued aggradation on the surface of the T1. An age of $4,820 \pm 70$ B.P. was acquired from humic material from this Bk2 horizon. In comparison with the observations in the cultural excavation blocks, this date appears consistent. It may appear troubling that an Early Archaic component was associated with Depositional Unit 4 in excavation Block A, but this component was only observed near the basal contact. This would appear to indicate that these cultural materials were deposited on the contact with the underlying gravels before Depositional Unit 4 was deposited. Thus, there may be 5,000 to 7,000 B.P. year old cultural materials at the lower contact of Depositional Unit 4, but the overlying sediments are a few thousand years younger. This indicates there is significant time missing from the depositional record for the site, but it also may indicate that the coarse gravels comprising the core of the T1 were exposed on the surface for an extended period of time before finer grained alluvium was deposited. This would also appear consistent with the possibility that Early Archaic inhabitants may have utilized the gravels as a readily available chert supply, possibly over an extended period of time.

A humate sample from Depositional Unit 2 in BT 7 yielded a mean residence age of $1,900 \pm 60$ B.P. (Beta-175390). This is consistent with the proposed 3,150 to 1,300 B.P. age of Depositional Unit 2 in excavation Block A that is indicated by the Late Archaic cultural materials recovered. Since humates represent a mean residence age for soil development within the sediments, it is entirely possible that deposition of this unit may have begun a few thousand years prior, but this is constrained by the 4,820 B.P. age acquired from Depositional Unit 4 sediments. Using these radiocarbon ages and the depositional interpretations given earlier, it appears that Depositional Unit 3 was deposited in a single

flood event sometime after 4,820 B.P., but prior to 2,300 B.P. In addition, Depositional Unit 2 was also deposited, probably from multiple overbank flood events, and experienced pedogenesis prior to 2,300 B.P. Given the inaccuracies of the mean residence ages provided by soil humates, particularly for a soil that developed over an extended period of time, it is quite likely that pedogenesis within Depositional Unit 2 continued for a few hundred years beyond that date. These ages are, however, still consistent with the ca. 300 to 1,000 B.P. time frame proposed for the overlying Depositional Unit 1 sediments based on the Toyah phase radiocarbon dates and materials from those deposits.

6.4 INTERPRETATION AND DISCUSSION

Grant Smith

The geomorphic questions regarding this archeological site can be divided into two general categories. The first category concerns site-specific questions such as the age of the depositional units and the integrity of cultural materials on the site. The second category of questions concerns how these sediments relate to other regional chronologies, and how the Varga Site data may aid in prediction of the position and context of other archeological sites within the area.

6.4.1 Site Specific Interpretations

Overall, the sediments in T1 appear to be relatively intact. One of the major concerns by TxDOT initially was whether the surface and near-surface deposits were intact or had been disturbed by recent pothunter activity. The fact that Depositional Unit 2, with its dark, charcoal-rich appearance and abundance of FCR, did not show intrusive potholes in any of our profiles indicates that at least the Late Archaic component in Depositional Unit 2 is relatively

undisturbed, and those below that should also be undisturbed.

Radiocarbon ages from humic material and charcoal dates associated with cultural components recovered provide a chronology for sediment deposition and cultural occupation at this location. The gravels that comprise the core of T1 yielded no dateable radiocarbon material. However, given the stratigraphic position and the presence of the overlying Early Archaic components, these gravels are probably late Pleistocene to early Holocene in age. If any paleosols existed over these gravels during this early phase, they must have been removed by erosion prior to ca. 6,300 B.P. because Early Archaic cultural materials occur on the upper contact with the gravels. Either after or near the end of the Early Archaic occupation sandy sediments started to be deposited on some portions of the T1. Sediments in this context on the T1 to T0 margin provided an age of 6,270 B.P., while those in a small channel fill immediately north of the site provided an age of 5,230 B.P. There does not appear to be a depositional unit that corresponds to these dated units immediately under the archeological excavation blocks. Instead, the late Pleistocene/early Holocene gravels are directly overlain by a slightly younger depositional unit that, from correlation to BT 7, dates to ca. 4,800 B.P. To state it in a slightly different way, areas flanking the Varga Site to the north and south exhibit depositional units that date to the 6,270 to 5,230 B.P. time frame, but the first fine-grained depositional unit (Depositional Unit 4) that occurs in both the marginal areas and on the site is one that dates to ca. 4,800 B.P. However, Depositional Unit 4 is very sparse in cultural materials with the exception of Early Archaic materials that occur at the basal contact of the unit and pre-date its deposition.

Sometime after 4,800 B.P., but prior to 2,300 B.P., a high energy flood event deposited

pea-gravel across T1, which transitioned into a clay loam with pea gravel at its base slightly further to the north. Also before 2,300 B.P., clay-rich overbank sediments were deposited on the site which experienced pedogenesis and resulted in the formation of an A horizon. Late Archaic materials from the 2,300 to 1,700 B.P. time frame are associated with these clay-rich overbank deposits. Finally, a younger deposit of clay loam to loam textured sediments caps the stratigraphic profile and forms the modern A horizon. Toyah phase materials associated with the 290 to 660 B.P. time frame are associated with this surficial unit that is less than 1,000 B.P.

6.4.2 Regional Interpretations

Charles D. Frederick

Studies of alluvial stratigraphy in Central Texas can generally be lumped into two types of works: 1) site specific studies, and 2) regional scale studies. *Site specific studies*, like the work reported here for the Varga Site, represent fieldwork performed at a single locality, usually an archeological site, in association with either testing or data recovery excavations. These works are often well-dated and provide good impressions of the historical behavior of the studied stream at a specific point in a specific valley. But because they represent work done at a single point, extrapolation of these stratigraphic sequences to larger reaches of the same stream should be done cautiously and the alluvial chronologies may not be representative of the stream as a whole. *Regional studies* typically involve stratigraphic work along one or more reaches of a stream and therefore, generally provide a more accurate image of the long-term nature of alluvial erosion and sedimentation. Regional-scale studies are much less common than site specific studies and most often are either masters thesis or doctoral dissertations, or in support of cultural resource

projects on aerially extensive landscapes such as military bases.

In order to evaluate how the record of alluvial sedimentation at the Varga Site compares with other records in the region, we summarized the chronology of alluvial sedimentation from 10 streams in the Central Texas region. First, we examined the streams nearest the Varga Site which drain the southern Edwards Plateau, and then we examined at the records of several streams in the San Antonio region. Finally, we examined the alluvial chronologies of four streams in Central Texas. The timing of sedimentary events at each locality is depicted in Figure 6-7 and can be visually compared with the timing of sedimentation at the Varga Site on Figure 6-4.

But before considering the alluvial chronology in detail, it is worth noting the structural differences between the Varga site and many of the studies cited below. The alluvial deposits at the Varga Site are considerably thinner and more fragmentary than most of the alluvial studies in this region. Most studies cited below have recognized allostratigraphic deposits which may range from as little as 2 m thick to more than 10 m, depending upon the stream. This is considerably thicker than the Varga Site deposits that are generally less than 1.5 m thick.

In terms of landscape position, the Varga Site probably most closely resembles Nordt's (1994) work on Henson Creek at Fort Hood, which is a low-order tributary of the Leon River. Although Nordt was able to correlate the depositional events of Henson Creek with the much larger Cowhouse Creek, he noted that there are several differences between the deposits of low-order tributaries and larger streams. In particular, Nordt notes that small streams are likely to contain more erosionally bounded units, are more likely to record more variability in discharge and depositional environments, and

Figure 6-7. Correlations of Alluvial Stratigraphic Sequences Across Central Texas

may contain widespread colluvial and alluvial fan deposits. Nordt also recorded considerably thinner alluvial deposits along Henson Creek, a point the two studies clearly share.

6.4.2.1 Regional Alluvial Chronology

Southern Edwards Plateau

There are alluvial stratigraphic records for several streams along the southern Edwards Plateau, among which are the Dry Frio, the Sabinal, as well as several streams in the vicinity of San Antonio. Unfortunately, many of these are either fragmentary, or poorly dated. Below we present a brief summary of the results of these studies.

The Dry Frio River, Uvalde County

Decker et al., (2000) document two discrete alluvial deposits at the Woodrow Heard Site (41UV88) on the Dry Frio River. These two deposits, termed scroll bars, represent alluvial deposition during two distinct periods in the early and middle Holocene. The upper part of Unit I was deposited around 8,000 years B.P. but the early phases of Unit I deposition were not dated. Unit II was separated into four distinct phases named IIa through IId. The majority of Unit II (specifically Units IIa, and IIb) was deposited in the period between approximately 6,500 to 4,500 years B.P., with incremental

sedimentation occurring since 4,500 years B.P. It is clear that the Dry Frio River sedimentary record as documented at the Woodrow Heard Site is incomplete, with sedimentation during the later Holocene not well represented.

Sabinal River, Bandera County

Mear (1995, 1953) documented the late Quaternary alluvial deposits of the Sabinal River from south of Vanderpool to just south of Utopia. Mear identified three Holocene age alluvial deposits which he named Q2, Q1 and Q0. Using radiocarbon dates from excavated archeological sites associated with these deposits, Mear placed deposition of the Q2 unit in the early to middle Holocene between approximately 10,000 and 5,000 years B.P. The Q1 deposit was placed in the period between 4,500 and 1,000 years B.P., and the Q0 surface was considered to be the modern floodplain. Although neither firmly nor directly dated, Mear's work on the Sabinal indicates a clear correlation with other Central Texas streams such as the Colorado River.

San Antonio Vicinity

There have been several studies of stream deposits in the San Antonio metropolitan region that provide information on the historical behavior of local streams. The studies cited below are the most comprehensively dated, but several other less well-dated studies exist, such as Nordt's work on upper Leon Creek (Nordt 1996) or several projects on the San Antonio River (e.g. Meskill and Frederick 1998; Meskill et al 2000; Nordt 1999; Frederick 2007; Caran n.d.). Although eventually these studies may contribute to the larger picture, they are, as of this time, too fragmentary (either spatially, or temporally) to provide a clear image of the behavior of these streams.

Culebra Creek, Bexar County

The alluvial deposits of Culebra Creek were examined in detail at the Culebra Creek Site (41BX126), first by Frederick (2001) and subsequently by Nordt (2001). This work identified three Holocene depositional units which Nordt (2001) termed III, IV, and V. Unit III appears to have been deposited in the early to middle Holocene between approximately 11,000 and 4,000 years B.P. Unit IV yielded bulk sediment radiocarbon ages of 3,190 and 2,700 B.P. near its base, and 2,080 B.P. near its mid-point, and Nordt bracketed this deposit to the period between 4,000 and 2,000 B.P. although the end of Unit IV deposition was not dated. No radiocarbon ages were obtained for Unit V, but it was considered to be less than 500 years old.

Medio Creek, Bexar County

Nordt (1997) examined the deposits of Medio Creek at Lackland Air Force Base, and recognized three Holocene-age alluvial units. The oldest of these, Unit II, yielded bulk humate radiocarbon ages of approximately 4,900 and 3,800 B.P., and Nordt (1997:33; shown on Figure 4-2) inferred a beginning date in the Early Holocene (10,000 to 3,500 B.P.). Unit III yielded a single bulk soil radiocarbon date of 1,830 B.P., and was bracketed by radiocarbon dates on Units II and IV to the period between approximately 3,500 and 1,800 B.P. Two radiocarbon ages were obtained on buried soils within Unit IV, and these dates of 1,780 B.P. and 1,220 B.P. placed deposition of this deposit in the last 1,800 years, which is considerably older than the modern floodplain deposits of most streams in Central Texas region.

Panther Springs and Salado Creeks, Bexar County

Mear and Frederick (1998) described the alluvial deposits associated with Panther Springs and Salado Creeks, near several archeological sites in the path of the Wurzbach Parkway in San Antonio. Three Holocene deposition units were described: Q2a, Q2b, and Q1a. Each depositional event appeared to have been preceded by a period of channel incision. Bulk sediment samples from the oldest deposits, Q2a, was radiocarbon dated to the period between 10,450 B.P. and a series of charcoal samples collected from a prehistoric occupation near the top of this fill that provided radiocarbon ages slightly older than 8,500 B.P. This deposit appears to have accumulated in an episodic fashion through a series of large magnitude floods during this period, and received only very minor amounts of overbank fines after 8,500 B.P. The next youngest unit, Q2b, was radiocarbon dated at a single locality by four charcoal samples, which indicate sedimentation occurred between 3,200 B.P. and slightly later than 1,490 B.P. The youngest fill (Q1a) yielded three charcoal radiocarbon ages dating between 310 and 450 B.P. in the top 50 cm, but the base of this unit is undated, but certainly no older than 1,490 B.P. Deposition of Q1a was considered to be ongoing today.

Medina River, Bexar County

Excavations at the Richard Beene Site (41BX831), which was discovered in the dam axis of proposed Applewhite Reservoir south of San Antonio, yielded a detailed record of alluvial overbank sedimentation for a single point on the Medina River (Mandel et al., 2005). The most detailed results were obtained from the Applewhite Terrace, beneath which were multiple sedimentary units typically capped by paleosols. Radiocarbon dating of bulk sediment and soils as well as charcoal from cultural

features provides a clear image of the age error associated with bulk sediment/soil radiocarbon dates, especially from the early Holocene depositional units.

A total of five depositional units (named A3 through A7) comprise Holocene sedimentation beneath the Applewhite Terrace. The terminal Pleistocene-early Holocene sedimentation is represented by Unit A3, and the soil formed at the top of this unit was named the Perez Paleosol. Radiocarbon ages from Unit A3 ranged from approximately 15,000 and 8,600 B.P. The Perez soil was buried sometime after 8,600 B.P. as Unit A4 began to aggrade. Deposition of A4 ended around 7,645 B.P., when the Elm Creek Soil formed within it was buried. Deposition of the next younger deposit, Unit A5, spanned a 2,600 year period between approximately 7,000 to 4,400 B.P. A complex cumelic soil named the Medina Pedocomplex was formed within this deposit. Around 4,100 B.P. the Medina soil was buried and deposition of Unit A6 began. Deposition of Unit 6 persisted for almost 1,000 years, as the soil formed within it; the Leon Creek paleosol was buried sometime around 3,000 B.P. The most recent depositional unit beneath the Applewhite Terrace, A7, spanned the period between roughly 3,000 and 400 B.P., and comprised a thin veneer across the Applewhite Terrace within which the modern surface soil is formed. It is probable that a more complete record of late Holocene sedimentation exists beneath the Miller Terrace and the Modern Floodplain, both of which are inset below the Applewhite surface, but were not investigated in detail.

Greater Central Texas Region

Away from the southern rim of the Edwards Plateau, there are at least four other stratigraphic sequences worth examining. These four sequences are briefly discussed below.

Pedernales River

Blum (1987, 1989; Blum and Valastro 1989) documented the alluvial stratigraphy of the Pedernales River near Fredericksburg and identified three Holocene alluvial deposits named Units E, F and G. Unit G was radiocarbon dated to the period between 11,000 and 6,500 B.P., where as Unit F was dated to the period between 4,500 and 1,000 B.P. The youngest unit (E) was described as representing sedimentation during the last millennium. As with Blum's work on the Colorado, all of the dates on the Pedernales sequence were obtained on bulk sediments which may overestimate the age of the depositional event.

The Colorado River

The late Quaternary stratigraphy of the Colorado River has been documented by Blum (1992; Blum and Valastro [1994, 1992]; Blum et al., [1994]) who identified three Holocene alluvial deposits, which Blum and Valastro 1994 formally named the Columbus Bend Alloformation Members 1, 2, and 3 (abbreviated hereafter CBA1, CBA2, and CBA3). All of Blum's radiocarbon ages were obtained from bulk sediment samples and therefore, may be older than the true age of the depositional event. The magnitude of this age error is unknown for these ages, but this factor should be considered when discussing this alluvial chronology. Secondly, the dates presented here are from the most recently published work, and it should be noted that the chronology for Colorado River deposits upstream of Austin are slightly different than those below Austin. The oldest radiocarbon age obtained by Blum for the first Holocene units, CBA1, was 12,970 B.P. and the youngest age for this fill was 5,350 B.P. (Blum and Valastro 1992:1010). The next younger alluvial deposit, CBA2, began to aggrade around 5,120 B.P. and deposition of this unit ceased sometime after 820 B.P. The most recent

deposit, CBA3, began to form around 600 B.P. and deposition of this unit continues today.

Brushy Creek, Williamson County

The alluvial deposits of Brushy Creek, a tributary of the San Gabriel River, have been examined in two localities: in the limestone bedrock confined reach north of Cedar Park at the Wilson Leonard Site (Collins and Mear 1998; Goldberg and Holliday 1998), and at Rice's Crossing, 40 km (25 mi) downstream on the Blackland Prairie in the southeastern corner of Williamson County (Abbott 2001).

In the upper reaches of Brushy Creek the alluvial deposits have been documented during archeological excavations at the Wilson-Leonard Site. Collins and Mear (1998) describe the large-scale stratigraphy, recognizing three late Quaternary deposits, they termed them Q-1, Q-2 and Q-3. The highest and oldest of these deposits, Q-3, is thought to be of late Pleistocene age. The Wilson-Leonard archeological site was fully contained within the Q-2 deposit and appears to represent deposition in the period between approximately 11,500 and 4,000 B.P. Excavations at the Wilson-Leonard Site resulted in a detailed stratigraphic dissection of the Q-2 deposits (Goldberg and Holliday 1998) with three major deposits recognized within it (I, II and III). The Q-1 deposit, which lies inset against the Q-2 deposit, is of an unknown but likely late Holocene age, and probably separated from it by a period of channel erosion, which based on the change in sedimentation rate with the Q-2 deposits probably occurred around 4,000 B.P.

Abbott (2001) recorded five distinct alluvial deposits (termed Units I through V) in the Brushy Creek valley at Rice's Crossing in southeastern Williamson County, and four of these deposits appear to be of Holocene age. The oldest Holocene deposit, Unit II, was dated

by Abbott to the period between approximately 12,000 and 4,000 B.P., with a period of relatively rapid period of alluvial aggradation occurring between 11,900 and 5,200 B.P. The next younger deposit, Unit III, was divided into two parts (III-a and III-b) which were separated by a paleosol. Unit III was dated to the period between 3,400 and 1,900 B.P. No useful radiocarbon ages were obtained by Abbott for Unit IV, but together with Unit III, Abbott placed deposition of these two units in the period between 4,000 to 1,500 B.P. Two charcoal radiocarbon ages place deposition on Unit V into the period after 1,420 B.P.

Fort Hood, Bell and Coryell Counties

One of the best-dated regional scale alluvial stratigraphic sequences in Central Texas may be found at Fort Hood, where Nordt (1992, 2004) has documented the historic behavior of Cowhouse Creek, a tributary of the Leon River in the Brazos River basin, as well as some of its smaller tributaries (Nordt 1995). Unlike many alluvial sequences in Central Texas, Nordt's work is largely anchored by radiocarbon ages on charcoal, often from cultural contexts.

On Cowhouse Creek, Nordt identified four Holocene alluvial deposits: the Georgetown, Fort Hood, West Range and Ford alluvia. The Georgetown Alluvium is buried throughout the catchment, and was dated by Nordt to the period between approximately 11,000 and 8,000 B.P. This deposit is capped by a prominent soil named the Royalty paleosol. The Fort Hood Alluvium that follows was dated to the period between 7,000 and 5,000 B.P. and a period of channel incision separates it from deposition of the Georgetown. Following another period of channel entrenchment in the middle Holocene, the West Range alluvium was deposited. Nordt recognizes two phases of West Range deposition (Upper and Lower West Range) separated by a

brief period of channel erosion around 2,400 B.P. The modern depositional regime is represented by the Ford alluvium, which is less than 600 years old.

Nordt (1994) also examined a small tributary of the Leon River named Henson Creek and found that the periodicity of sedimentation was largely similar to Cowhouse Creek, but there were a few differences in the timing, the nature of the facies present, and their archeological potential. For instance, Nordt notes that the deposits associated with the Fort Hood alluvium during the early Holocene were episodic and often gravelly. Conspicuously absent from the lower reaches of Henson Creek were deposits of the West Range alluvium, which given that deposits of this age were preserved in the upper reaches of this stream, Nordt inferred that they had been eroded from the lower reaches. Nordt also found that where present, the upper West Range alluvium had been buried by deposition of the Ford alluvium, with the interface between these two deposits marked by a paleosol named the Tank Trail Paleosol. Nordt also noted the greater relative importance of colluvial and alluvial fan sedimentation within the Henson Creek drainage.

6.4.2.2 Regional Correlations: Alluvial Chronology

In terms of evaluating the regional correlations of the alluvial chronology at the Varga Site, the interpretation of two key features are critical: 1) the age of Depositional Unit 5, and 2) the geomorphic significance of the apparent buried soil that is Depositional Unit 2.

Depositional Unit 5

Smith notes that Depositional Unit 5 is of variable depth and thickness and that the maximum age of archeological material found above this deposit is 6,300 B.P. but notes that these gravels are "potentially much older"

(Smith, this chapter). In Backhoe Trench 7 a bulk sediment radiocarbon age of $5,230 \pm 50$ B.P. (Beta-175391) was obtained from this deposit, but Smith considered this age to be in error (owing to humic material that had been translocated to this depth). In the site specific interpretations, Smith (this Chapter) states that the Depositional Unit 5 gravels are “probably late Pleistocene to early Holocene in age” although there is no geomorphic or pedogenic rationale provided for this interpretation. Smith does not consider that Depositional Unit 5 could be associated with the overlying overbank sediments and does not provide a firm reason for assuming these gravels are not associated with the fill event that subsequently deposited the fines. Nevertheless, for the sake of this discussion it is assumed that Smith’s contention is correct.

The Depositional Unit 2-Unit 1 interface

If Depositional Unit 2 is a buried soil then it is appropriate to consider Depositional Unit 1 a discrete phase of deposition and part of a different phase of alluvial aggradation (an allostratigraphic unit or AU). The radiocarbon ages from Depositional Unit 1 and Depositional Unit 2 indicate an approximate depositional hiatus of 400 years separates these deposits, and this would seem to be enough time for the formation of the buried soil. Hence, Depositional Unit 1 is here considered to be a separate allostratigraphic unit.

Considered together, there appears to be three main periods of alluvial deposition at the Varga

Site: 1) the “late Pleistocene to early Holocene” Depositional Unit 5 gravels, 2) the overbank fines comprising Depositional Units 2, 3 and 4; and 3) Depositional Unit 1. Comparison of this basic sedimentary sequence with other streams in the region, specifically the southern rim of the Edwards Plateau, as well as stratigraphic sequences in Central Texas, indicates that the Varga Site deposits are broadly correlative with other sites in the region. Given the lack of dates for Depositional Unit 5, this deposit will not be discussed in detail other than to say that most streams in the central and southern Edwards Plateau exhibit one or more depositional phases in the late Pleistocene to early Holocene period.

Deposition of the overbank fines (Depositional Units 2, 3 and 4) is broadly correlative with middle to late Holocene sedimentation in this region. Although no single stream shows a period of alluviation that directly corresponds with the overbank fines at the Varga Site, the starting and ending dates are seen elsewhere in the region. In particular, the early phase of deposition of Depositional Unit 4 begins about the same time as Unit II at the Woodrow Heard Site on the Dry Frio River. Slightly earlier sedimentary phases are also seen on the Medina River and at Fort Hood. The end of deposition around 1,400 B.P. is relatively common, as is alluvial aggradation in the last millennium, but especially in the last 600 years, which is observed at most streams in the region. Hence it is possible to say that the alluvial chronology from the Varga Site shares some attributes with other streams in the region.

7.0 ARCHEOLOGICAL RESULTS

J. Michael Quigg

7.1 INTRODUCTION

This section presents an overview of the cultural stratigraphy followed by definitions of the cultural components that have been formulated to provide an overall structure for analyses and reporting in relatively narrow time units. Once the components were finalized in the laboratory, the cultural materials from each excavation level were assigned to one of four cultural components. If cultural materials appeared to represent a mixture of two components, or could not be confidently assigned to one particular component, the materials from that level have been left unassigned and placed in a miscellaneous category. The materials from the four individual components and the miscellaneous category are presented in detail the subsequent chapters.

7.2 ANALYTICAL COMPONENTS

Projectile points recovered during the first phase revealed the presence of Late Prehistoric Toyah, and Late, Middle, and Early Archaic components. These components were represented at different vertical elevations by different densities of cultural debris, and were distributed differently across the investigated parts of the right-of-way. So much cultural material was present in the top 30 to 40 cm of the deposit that it was difficult to always distinguish between major cultural events represented by the Toyah and Late Archaic

components. Late Archaic materials were directly associated with an observable soil horizon, which facilitated its identification. However, the northern half of Block A revealed compressed stratigraphy and lacked visible soil stratification. Combined with the discernibleurbation activities in that area, this necessitated definition of arbitrary vertical boundaries between the cultural components in the northern part of Block A. Various data sets were examined to help determine the assignment of arbitrary excavation levels to the recognized components. Many larger pieces of cultural material, generally burned rock, were piece plotted during the hand-excavations. From the individual pieces plotted on individual level records, we were able to constructed back plots to help determine the depths of the components, possible sloping aspects to the materials, and what materials or concentrations might be traceable horizontally across Block A (Figures 7-1 through 7-4), although the lack of plotted burned rocks near the middle and lower parts of the deposits in some areas hindered this approach. To further investigate the vertical positions of the components, we plotted the frequencies of the lithic debitage, burned rock, and bone counts at various locations across Block A. Examples of these vertical plots are represented in Figures 7-5 through 7-8. Figure 7-5 reveals three units along north line 101 that reveals the lack of a clear, vertical separation in the top 30 cm of the Toyah and Late Archaic components. It does reveal a well-demarcated Early Archaic component in the lowest part of the profile. Figure 7-6 also reveals the pronounced Early Archaic component, a the light concentration of the Middle Archaic component near the middle of the profile, and limited materials representing the Late Archaic and Toyah components in the top of the profile, in the southeastern corner of Block A.

Figure 7-7 reveals the well-defined Toyah, Middle Archaic and Early Archaic components, which are in contrast to the very sparse Late Archaic component along the eastern edge of Block A. Figure 7-8 reveals the very well-defined Middle and Early Archaic components, and the apparent absence of the Late Archaic component at this location in Block A. It is believed that the smaller cultural items such as flakes, tiny bones, and small tools potentially were displaced over time. Therefore, the larger burned rocks were relied on to provide the vertical position of cultural components.

The recovered cultural materials were grouped into four major time components, more or less vertically distinct, to provide useful data by time period. This was necessitated by the lack of patterning representing distinct cultural activities over a substantial horizontal area. In very limited areas, sometimes within one excavation unit, such as along the very western edge of Block A, vertically discrete and separated events in the Toyah component were detected. However, most often in the adjacent unit, these separate events were indistinguishable from one another. The middle part of this alluvial deposit yielded sparse and dispersed cultural materials, although occasionally, horizontally and/or vertically restricted areas yielded relatively dense material. Generally, the relatively shallow depth of the alluvial fines that accumulated over a long time span, combined with some turbation, hindered our ability to separate individual cultural events within a component.

As already noted, four analytical components have been defined at the Varga Site—Late Prehistoric, specifically a Toyah phase component, a Late Archaic component, a Middle Archaic component, and an Early Archaic component. The Toyah component was unevenly represented starting from the exposed (and mechanically altered) surface to depths of 20 to 30 cmbs in loose brown (10YR 4/3)

overbank deposits that extended over most of the southern end of the first terrace and across most of the current right-of-way. This upper cultural component/sediment deposit suffered from disturbances from the Phase I mechanical trenching and stripping west of the road, previous TxDOT road construction and maintenance activities, and phone cable installation east of the pavement. In fact, large quantities of scattered burned rocks and other cultural materials representing the Toyah component were exposed on the disturbed surface and mislead TxDOT personnel to assume that a disturbed burned rock midden was present. No burned rock midden was identified in this near-surface component, just quantities of scattered cultural materials and 11 cultural features that represented a broader Toyah component. Blocks A and B targeted this extensive and dense cultural zone.

A sharp break in matrix color and texture demarcated the top of a buried A horizon at the bottom of the Toyah component. The buried A horizon, a very dark gray (10YR 3/1) to black (10YR 2/1) clay loam to silty clay loam, contained cultural materials pertaining to the Late Archaic (Figure 7-9). No sterile sediment existed between the two visibly distinct horizons, and so some mixing of the materials from the two components was expected and later detected. In Block A, a broad, buried burned rock lens that is interpreted to reflect an incipient burned rock mound dominated the Late Archaic component. However, beyond the ill-defined margins of this feature, the component was impossible to follow as the frequency of cultural material – the burned rocks, dropped off sharply. Only in widely dispersed places was this component recognized outside this one broad burned rock feature. In Block B, the dark buried A horizon was detected between 8 and 30 cmbs.

Figure 7-1. West-East Line—Plotted Materials Across 1-by-1-m Test Units

Figure 7-2. West-East Line—Plotted Materials Across 1-by-1-m Test Units

Figure 7-3. North-South Line—Plotted Materials Across 1-by-1-m Test Units

Figure 7-4. North-South Line—Plotted Materials Across 1-by-1-m Test Units

Figure 7-6. Vertical Concentration of Cultural Materials Along the E56 Line, Block A

Figure 7-7. Vertical Concentration of Cultural Materials in Unit N103/E56, Block A

Figure 7-8. Vertical Concentration of Cultural Materials in Unit N104/E56, Block A

Figure 7-9. View West of N118/E71 Showing Light Gray Toyah Zone Over Dark Buried A Horizon that Contained the Late Archaic Component

Again, Late Archaic materials were detected, but very sporadically and in relatively low frequencies. Therefore, the Late Archaic was not targeted in Block B during Phase II investigations. A few Middle Archaic projectiles from deposits on both sides of the road signaled the presence of a Middle Archaic component. This component is represented by relatively sparse materials in the upper part of Depositional Unit 3, the brown (10YR 5/3) clay loam. This material was horizontally patchy and showed up prominently in only a few square meters, but not a continual basis. Along the southern edge of Block A the Middle Archaic deposits were up to 40 cm thick, between ca. 40 and 80 cmbd, but thinned quickly across the northern part Block A. This zone was so sporadic on the eastern side of the pavement that these deposits of this age were not targeted during the Phase II excavations.

A dense and artifact-rich Early Archaic component was represented in the lowest most part of geoarcheologically defined Unit 3, the brown (10YR 5/3) clay loam Bk soil horizon, primarily on the western side of the pavement. Some cultural materials were mixed in with geoarcheological Unit 4, the pale brown (10YR 6/3) coarse sandy loam 2Bk soil horizon. The depth of the cultural material varied from 50 to 130 cmbd, which followed the uneven basal gravel deposit. Block A captured a part of this lowest component that contained at least nine different types of projectile points.

In the following four chapters each recognized component is presented individually, with detailed descriptions and discussions of the materials recovered, together with analytical and technical results that pertain to material from that component, followed by a summary at the end of the chapter.

8.0 THE TOYAH COMPONENT

J. Michael Quigg

8.1 INTRODUCTION

The Toyah component was first identified during the initial phase of data recovery investigations (Lintz et al. 2002). Initial mechanical stripping revealed that, in addition to scattered burned rocks and butchered bones on the disturbed surface, these same material categories were encountered in the fine sediments immediately beneath the surface and represented Late Prehistoric occupation of the site. Subsequent Gradall® stripping and hand-excavations revealed a loose concentration of deer and bison bones (Feature 2), a burned rock cluster (Feature 3), eight Perdiz points, several arrow point fragments, six prehistoric pottery sherds, and other associated cultural debris near the surface on both sides of Ranch to Market Road. These cultural materials were in a brown (10YR 4/3) clay loam layer of overbank deposits, which corresponds to Depositional Unit 1. This 20 to 30 cm thick deposit extended over most of the southern end of the first terrace and the current right-of-way. The bottom of this cultural zone exhibited an abrupt smooth lower boundary demarcating a time hiatus, but not a sterile zone above the lower cultural deposits (Lintz et al. 2002).

The Phase II investigations yielded a large sample of Toyah materials from Blocks A and B. In Block A, the entire vertical Holocene deposit was sampled through the hand-excavations of 83 m² which captured the Toyah

component in the upper 30 cm. The initial two backhoe trenches (BTs 1 and 2) and subsequent mechanical stripping of the top deposits during Phase I across much of Block A, made it difficult to determine the exact elevation of the surface of this component. Block B only targeted the shallow Toyah component, which was just beneath the surface, much of which was covered by a lens of gravel emplaced by recent TxDOT activities. The Toyah component was mostly in a loose brown (10YR 4/3) sediment between 0 and 35 cmbs, with an abrupt lower sediment boundary. Some Toyah materials had filtered downward a few centimeters in the profile into the dark black buried A horizon that contained mostly a Late Archaic component.

The chronometric age of the Toyah component is derived primarily from radiocarbon dating of 21 organic-rich samples recovered from this cultural component across both excavation blocks (Table 8-1). Radiocarbon dates on one burned rock (#1030-5-3-2c; 11,690 ± 40 B.P.) extracted from Feature 38 and two of four dated ceramic sherds (#159-5-8-1a and #987-8-1a; 930 ± 40 B.P. and 26,960 ± 40 B.P.) are obviously much too old and beyond the realm of any reasonable possibility, and are not acceptable (Table 8-1). Three other samples, two charcoal (#843-5-7-1a and #1055-5-7-1a) and one ceramic sherd (#118-8-1a), yielded radiocarbon ages that are less than 200 years old and are also not acceptable for this component. Two charcoal dates of 920 ± 40 B.P. (Beta-175399) and 940 ± 40 B.P. (Beta-175398) from the lowest and best defined stratigraphic context in the Toyah component, that in Feature 36 (an occupation zone, see below) along the western margin of Block A, are older than the presumed age for Toyah events and younger than the well-dated Late Archaic component that is older than 1,700 B.P. Therefore, these two ca. 930 B.P. ages may be dating an unrecognized Late Prehistoric event or component that dates to slightly earlier than the Toyah occupation.

Table 8-1. Radiocarbon Dates from the Toyah Component

Fea. No.	Catalogue #	Blk.	Unit No.	Depth (cm)	Material Dated	Wgt (g)	Lab No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
2	525-5-7-1a (102-1b)	A	N106/E54	35-40	1 charcoal	0.1	Beta-170401	290 ± 40	-25.2	290 ± 40	Cal AD 1490 to 1660
8	843-5-7-1A	B	N118/E70	10-20	1 charcoal	0.1	Beta-175405	40 ± 30	-22.5	80 ± 30	Cal AD 1680 to 1950
8	865-5-4-7-1a	B	N119/E70	10-20	1 charcoal	0.2	UGA-12726	640 ± 40	-26.7	620 ± 40	Cal AD 1290 to 1410
8	865-5-7-1c	B	N119/E70	10-20	2 charcoal	0.2	Beta-183626	570 ± 40	-26.2	570 ± 40	Cal AD 1300 to 1430
8	865-5-4-7-1d (1217)	B	N119/E70	10-20	1 charcoal	0.2	UGA-12732	630 ± 40	-26.6	600 ± 40	Cal AD 1290 to 1420
9	830-5-4-1	B	N117/E71	14-22	3 charcoal	0.1	Beta-175404	660 ± 40	-25.0	660 ± 40	Cal AD 1280 to 1400
21	78-5-7-1b	A	N100/E50	+5 to 10	1 charcoal	0.1	Beta-183623	360 ± 30	-24	380 ± 30	Cal AD 1440 to 1630
21	78-5-7-1a	A	N100/E50	+5 to 10	1 charcoal	0.1	UGA-12707	380 ± 40	-24.9	380 ± 40	Cal AD 1440 to 1640
21	78-5-7-1c (1219)	A	N100/E50	+5 to 10	1 charcoal	0.1	UGA-12734	300 ± 40	-24.7	300 ± 40	Cal AD 1480 to 1670
25	1025-5-7-1a	B	N126/E75	20-30	4 charcoal	0.2	UGA-12728	320 ± 40	-24.8	320 ± 40	Cal AD 1470 to 1660
25	1055-5-7-1A	B	N127/E75	25-35	7 charcoal	6.0	Beta-175401	170 ± 60	25.4	170 ± 60	Cal AD 1640 to 1950
27	739-5-7	A	N109/E56	30-40	1 charcoal	0.1	Beta-175409	550 ± 40	-25.1	550 ± 40	Cal AD 1310 to 1430
36	158-5-7-1A	A	N101/E47	20-30	1 charcoal	0.1	Beta-175397	420 ± 40	-26.5	400 ± 40	Cal AD 1430 to 1530
36	159-5-7-1A	A	N101/E47	30-40	1 charcoal	0.1	Beta-175398	950 ± 40	-25.5	940 ± 40	Cal AD 1010 to 1190
36	160-5-7-1A	A	N101/E47	40-50	1 charcoal	0.1	Beta-175399	930 ± 40	-25.6	920 ± 40	Cal AD 1020 to 1210
36	159-5-8-1a	A	N101/E47	30-40	1 sherd	3.2	UGA-12710	2930 ± 40	-15.5	3080 ± 40	Cal 1440 to 1210 BC
38	1030-5-7-1A	B	N126/E76	35-50	7 charcoal	6.0	Beta-175400	390 ± 60	-25.3	390 ± 60	Cal AD 1420 to 1650
38	1030-5-3-2c	B	N126/E76	30-40	1 burned rock	10.3	UGA-12729	11,690 ± 40	-7.1	11,980 ± 40	Cal 13,300 to 12,700 BC
na	987-8-1a	B	N125/E73	10-20	1 sherd	3.1	UGA-12727	26,510 ± 40	2	26,960 ± 40	Cal 25,100 to 24,920 BC
na	1089-8-1a	B	N129/E71	30-35	1 sherd	2.7	UGA-12730	190 ± 40	-17.8	310 ± 40	Cal AD 1480 to 1660
na	1118-8-1a	B	N120/E71	20-30	1 sherd	0.8	UGA-12731	21 ± 40	-22.8	60 ± 40	Cal AD 1680 to 1930

Beta = Beta Analytic, Blk. = Block, Cal. = Calibrated, Con. = Conventional, Fea. = Feature, UGA = University of Georgia, Wgt = Weight

Consequently, 35 percent of the obtained radiocarbon ages from the Toyah component are considered unacceptable, whereas 65 percent provide a time range in which these Toyah events probably occurred. The 13 acceptable radiocarbon dates, all on wood charcoal, reveal a time range between 290 to 660 B.P. (Table 8-1), or A.D. 1280-1660, calibrated.

In an effort to investigate the possibility of using OSL as a dating technique in alluvial deposits, two sediment samples (#1237 and #1238) in thick plastic tubing from two opposite sides of the investigated Toyah component were collected. Sample #1237 was collected from a dark brown (10YR 3/3) clay loam on the very western edge of Block A in Unit N104/E47 between 24 and 36 cmbs. Sample #1238 was collected from the same dark brown (10YR 3/4) clay loam on the very eastern edge of Block B in Unit N125/E75 between 22 and 26 cmbs. These two samples were analyzed and dated by the OSL technique to compare with the many charcoal dates obtained from this component. The detailed methods and results of the OSL technique are presented in Appendix L and only a summary is presented in this chapter.

These two OSL samples did not yield many coarse grains to measure (less than 200 per sample). Of those present, many coarse grains failed to yield a measurable signal. Only 39 percent of the measured single grains in sample #1237 (UW1047), and six percent of the measured grains in sample #1238 (UW1048) were dated (Appendix L). The central age determination from the fine grains was also explored. The latter provided two average ages of $1,030 \pm 230$ years before A.D. 2004 for sample #1237 and $1,130 \pm 186$ years before A.D. 2004 for sample #1238. These two average OSL age determinations on fine grains appear quite reasonable when compared to the charcoal dates documented for cultural materials in that same sediment and that definitely post dated the sedimentation.

8.2 TOYAH COMPONENT FEATURES

8.2.1 Introduction

Eleven clusters of cultural material were recognized and assigned feature numbers in the field and assigned to the Toyah component (Figures 8-1 and 8-2). These features were classified into four categories based on a combination of visible attributes and material present. The categories include a bone cluster ($n=1$), general refuse dumps ($n=3$), hearths ($n=4$), and occupation zones ($n=3$). Bone clusters are locations where bones were concentrated and indicate a particular *in situ* activity, in contrast to a broad scatter of bones across an occupied surface. General refuse dumps are definable areas where multiple classes of material (burned rocks, lithic debitage, broken tools, etc.) appear concentrated and inferably were purposefully discarded or dumped in one spot. Burned rock clusters reveal more concentrated burned rocks, but again lack indications that heating occurred in that spot. Hearths are areas where intentional *in situ* burning was evidenced by the presence of oxidized earth, ash, and/or charcoal lenses. Hearths may exhibit excavated basins, pits, or flat surface fires and may or may not contain burned rocks or other materials.

Occupations zones are broad scatters of various classes of material without well-defined boundaries or specific concentrations of material. These zones can usually be defined vertically, but unless exceptionally large areas are opened through excavations, exhibit ill-defined and irregular horizontal margins.

The features were numbered as they were found. Additional detailed documentation was completed, and a suite of samples was collected from most features. Eleven features were discovered over a broad area in both excavation blocks.

Figure 8-1. Distribution of Toyah Features Across Block A

Figure 8-2. Distribution of Toyah Features in Block B

Features 8, 9, 25, 30, and 38 were in Block B, whereas Features 2, 18, 21, 22, 35, and 36 were in Block A. These are described individually below according to the aforementioned four categories.

8.2.2 Bone Clusters ($n=1$)

8.2.2.1 Feature 2

Feature 2 was exposed during Phase I investigation by the backhoe as sediment was being stripped from the top of the deeper, targeted burned rock midden deposit. This near-surface feature was partially impacted by the mechanical scraping, but was still discernible as a cluster of butchered bison bones, several burned rocks, lithic debris, a few tiny chunks of charcoal, and stone tools across much of Unit N106/E54 from 5 to 10 cmbs (Figure 8-3). Since the upper deposits were removed before identification, the top could not be precisely defined. The exact bottom of the feature was not clear either as some cultural material continued deeper than this 5 cm thick zone assigned to Feature 2. No precise boundaries were evident, and boundaries are perforce arbitrary.

Sixty-three percent of the bones are small, unidentifiable fragments less than 3 cm long. Some pieces are identifiable as to an element, or type, and a few to a specific species. These pieces include rib fragments and a deer mandible fragment. About 36 percent of these fragments are burned black or a black and brown color. These colors indicate heating the bones to temperatures of no more than about 400 degrees Celsius (Nicholson 1993). None of the bones were articulated. A bone fragment (#525-5-2-1a) from this cluster was submitted to Geochron Laboratories in Cambridge for stable carbon and nitrogen isotope analyses. The laboratory results indicate a carbon isotope value of -8.6‰ on collagen, a nitrogen isotope value of 5.1‰, and a carbon isotope value -4.0‰ on bioapatite. These values indicate an animal, probably bison,

Figure 8-3. Overview of Bone cluster, Feature 2

which ate nearly 80 percent C_4 vegetation, presumably grasses.

Several tools were encountered in Feature 2. Tools within the same unit and level include one Perdiz point (#525-10), one Frio dart point fragment (#525-13), one untypable arrow point fragment (#525-11), and one edge-modified flake (#525-12). Fifty-four pieces of lithic debitage were also recovered. Ten burned rocks that weighed just slightly over 1 kg were scattered in the vicinity of the bone fragments.

Tiny chunks of charcoal were scattered in the vicinity of the bones. One chunk (0.1 g) of charcoal from near the bones was sent for radiocarbon dating and yielded a $\delta^{13}C$ corrected (-25.2‰) AMS radiocarbon date of 290 ± 40 B.P. (Table 8-1: Beta-170401). A

piece of that dated sample (#525-5-7-1b) was identified as oak wood (Appendix I).

This loose cluster of burned and unburned bone fragments, scattered charcoal, and other cultural debris appears to represent part of a broader spread of occupational debris. As individual events were not identifiable following the mechanical stripping conducted during Phase I, it is unclear if other bone concentrations were in the vicinity or which other Toyah features may directly relate to Feature 2.

8.2.3 General Refuse Dumps ($n=3$)

8.2.3.1 Feature 8

Feature 8 was detected in Block B across parts of three adjacent units, including N118/E70, N119/E70, and N119/E71, between 0 and 22 cmbs. This feature included diverse types and quantities of cultural debris concentrated in an area measuring approximately 150 by 200 cm with an average thickness of about 10 cm (Figure 8-4). No obvious definable edge could be defined, and there was no sign of *in situ* heating such as oxidized matrix or lenses of charcoal. However, one small pocket of ash, 10 cm in diameter and was recovered from Unit N119/E70. Most debris was contained within an 8-cm-thick layer, but under the central part of this cluster was a of burned rocks that covered an area of about 100 by 90 cm. Parts of this concentration were cross-sectioned along the excavation grid lines, but no basin or pit was detected, and the cultural debris appeared to rest on a relatively flat plane.

This feature contained diverse cultural debris including large quantities of small burned rocks ($n=289$) (Table 8-2), many pieces of lithic debitage ($n=294$), scattered charcoal pieces, several stone tools ($n=14$), a few pieces of pottery ($n=4$), sparse mussel shell fragments ($n=2$), and relatively limited quantity of smashed bone fragments ($n=135$).

The 289 pieces of burned rocks ranged in size from 1 to nearly 15 cm in diameter with their weight varying from 5 to 455 g. About 85 percent were in the small 0 to 4 cm size class, with another 10 percent in the 4.1 to 9 cm size class, and only five percent were in the 9.1 to 15 cm size class (Table 8-2). The average weight of an individual piece was a low 65 g. Seventy percent were classified as tabular in their overall shape. All the pieces were identified as limestone.

A sample of six burned rock pieces, three each from two adjacent units, was analyzed for lipid residue. Drs. Malainey and Malisza's detailed findings and interpretations are presented in Appendix G with a summary of the results presented here (Table 8-3). One sample (#865-5-3-1a) yielded moderate to high fat content. Another sample (#865-5-3-2a) yielded borderline medium and moderate to high fat content. Two samples (#865-5-3-3a and #843-5-3-2a) yielded high fat content implying plant residue. Two more samples (#843-5-3-1a and #843-5-3-3a) yielded residue of large herbivores. The variation in the lipid interpretations from the burned rocks implies that the rocks were used to cook multiple types of foods. These results also indicate that the rocks probably were used in several different cooking events, possibly in more than one cooking feature.

The isotope results from the same four burned rock pieces used in the lipid analysis yielded $\delta^{13}\text{C}$ values from -18.4 to -26.1‰ indicating C_3 plants or animals that ate C_3 plants (Table 8-4). The $\delta^{15}\text{N}$ values vary from -4.2 to 5.7‰ and reflect similar plants. The low $\delta^{15}\text{N}$ value of -4.2‰ from sample #865-5-3-1b indicates a C_3 plant similar to various species of legumes, or potentially like the small bulb *Herbertia drummondii* (Quigg et al. 2002). The broad range of values indicates that these rocks apparently cooked multiple plants.

Figure 8-4. Planview of Features 8 and 9 in Block B

Table 8-2. Burned Rock Characteristics from Features 8 and 18

Fea. No.	Unit	Level	Cat. #	Size (cm) and Weight (g)								Material Type ¹				Fracture Type ²			Total Wgt (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.	
8	N119/E70	0-10	864	104	4,000	18	2,200	11	5,000	0	0	133		12		121	133	11,200	
8	N119/E70	10-20	865	30	500	1	200					31		31			31	700	
8	N118/E70	13-16	843	93	3000	9	2,250	3	1,250	0	0	105		24		81	105	6,500	
8	N119/E71	10-20	867	18	125	2	250							20			20	375	
	Total			245	7,625	30	4,900	14	6,250	0	0	269	0	0	0	202	289	18,775	
18	N106/E55	5-10	533	2	100	1	150					3		1		1	3	250	
18	N106/E55	10-20	534	17	1500	3	1,000					20		5	3	12	20	2,500	
18	N107/E55	3-20	602	2	100	4	300	1	600			7		5		2	7	1,000	
	Total			21	1,700	8	1,450	1	600	0	0	30	0	0	0	3	15	3,750	

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Table 8-3. Lipid Residue Results from Burned Rock Samples from the Toyah Component

Lab. No.	Cat. #	Fea. No.	Material	Wgt (g)	Interpreted Lipid Residue Results
4VG 9	865-5-3-1a	8	Limestone	33	Moderate-high fat content
4VG 10	865-5-3-2a	8	Limestone	33	Borderline medium and moderate-high fat content
4VG 11	865-5-3-3a	8	Limestone	58	High fat content
4VG 12	843-5-3-1a	8	Limestone	35	Large herbivore –somewhat fatty
4VG 13	843-5-3-2a	8	Limestone	40	High fat content – plant
4VG 14	843-5-3-3a	8	Limestone	53	Large herbivore –fat meat
4VG 15	830-5-3-1a	9	Limestone	46	Borderline medium and moderate-high fat content – plant
4VG 16	830-5-3-2a	9	Limestone	61	Large herbivore –fat meat, possibly plant
4VG 17	830-5-3-3a	9	Limestone	77	Large herbivore + plant or bone marrow
4VG 18	830-5-3-4a	9	Limestone	76	Borderline medium and moderate-high fat content – plant
4VG 33	534-5-3-1a	18	Limestone	37	Moderate-high fat content – plant
4VG 34	534-5-3-2a	18	Limestone	18	Moderate-high fat content – plant
4VG 30	79-5-3-1a	21	Limestone	55	Moderate-high fat content – plant
4VG 31	79-5-3-2a	21	Limestone	23	Medium fat content – plant
4VG 32	79-5-3-3a	21	Limestone	45	Moderate-high fat content – plant
4VG 19	1051-5-3-1a	25	Limestone	17	High fat content – plant
4VG 20	1051-5-3-2a	25	Limestone	18	Borderline medium and moderate-high fat content – plant
4VG 21	1051-5-3-3a	25	Limestone	15	Large herbivore - somewhat fatty, possibly plant
4VG 22	1051-5-3-4a	25	Limestone	14	Moderate-high fat content – plant
4VG 27	158-5-3-1a	36	Limestone	37	Borderline moderate-high and high fat content – plant
4VG 28	158-5-3-2a	36	Limestone	55	Borderline moderate-high and high fat content – plant
4VG 29	158-5-3-3a	36	Limestone	24	Moderate-high fat content – plant
4VG 23	1030-5-3-1a	38	Limestone	12	Large herbivore – somewhat fatty, possibly plant
4VG 24	1030-5-3-2a	38	Limestone	21	Large herbivore – somewhat fatty, possibly plant
4VG 25	1030-5-3-3a	38	Limestone	37	Moderate-high fat content – plant
4VG 26	1030-5-3-4a	38	Limestone	56	High fat content – plant
4VG 35	1005-3-1a	NA	Limestone	23	Borderline moderate-high and high fat content – plant
4VG 36	79-3-1a	NA	Limestone	27	Borderline medium and moderate-high fat content – plant
4VG 37	79-3-2a	NA	Limestone	35	High fat content – plant

Table 8-4. Isotope Results from Burned Rocks in Toyah Context

Cat. #	Unit No.	Depth (cmbs)	Fea. No.	Wgt (mg)	N Wgt (μg) ¹	δ ¹⁵ N (‰)	C Wgt (μg)	δ ¹³ C (‰)
843-5-3-1b	N118/E70	13-16	8	5.316	49.1	5.75	730.7	-18.43
865-5-3-1b	N119/E70	10-20	8	40.381	19.3	-4.21	354.8	-26.11
865-5-3-2b	N119/E70	10-20	8	7.623	88.4	5.61	1293.5	-21.84
865-5-3-3b	N119/E70	10-20	8	12.374	114.1	4.99	1416.1	-23.93
830-5-3-2b	N117/E71	10-22	9	41.813	36.7	3.83	522.2	-23.57
830-5-3-3b	N117/E71	10-22	9	4.438	33.0	6.44	413.3	-25.75
830-5-3-4b	N117/E71	10-22	9	12.351	83.3	6.67	1015.1	-20.97
534-5-3-1b	N106/E55	10-20	18	26.876	54.9	1.89	1572.9	-27.99
534-5-3-2b	N106/E55	10-20	18	15.539	275.7	7.92	2384.6	-25.29
79-5-3-2b	N100/E50	10-22	21	5.808	35.3	2.80	368.5	-21.16
79-5-3-1b	N100/E50	10-22	21	7.805	39.1	3.59	706.9	-24.80
79-5-3-3b	N100/E50	10-22	21	42.012	28.4	3.56	417.9	-24.87
1055-5-8-1b	N127/E75	32-38	25	40.322	11.6	-2.59	215.8	-27.18
1051-5-3-1b	N127/E74	25-35	25	3.849	54.3	5.42	649.8	-25.02
1051-5-3-2b	N127/E74	25-35	25	23.835	244.4	4.85	3837.7	-18.45
1051-5-3-3b	N127/E74	25-35	25	17.353	145.7	6.41	2660.6	-20.45
1051-5-3-4b	N127/E74	25-35	25	42.672	129.8	2.02	1984.4	-25.70
158-5-3-1b	N101/E47	20-30	36	15.883	122.3	6.08	1575.3	-24.31
158-5-3-2b	N101/E47	20-30	36	42.373	15.9	3.40	203.0	-24.78
158-5-3-3b	N101/E47	20-30	36	39.406	74.9	5.94	951.1	-24.80
1030-5-4-8-1b	N126/E76	25-35	38	40.237	8.7	2.80	122.5	-24.27
1030-5-3-1b	N126/E76	25-35	38	30.632	247.4	5.25	1520.4	-18.58
1030-5-3-2b	N126/E76	25-35	38	13.640	221.2	4.21	1808.5	-22.07
1030-5-3-3b	N126/E76	25-35	38	2.983	0.5	11.36	6.1	-23.23
1030-5-3-4b	N126/E76	25-35	38	30.794	17.1	-2.19	221.9	-20.32
900-8-1b	N122/E70	0-10	na	41.861	33.1	6.90	532.2	-27.23
965-8-1b	N124/E74	10-20	na	19.270	12.1	-1.08	219.5	-27.63
1157-8-1b	N131/E73	10-20	na	38.133	19.6	5.02	320.1	-24.97
1005-3-1b	N126/E71	8-20	na	4.901	71.6	4.80	1121.9	-21.45

1. Values below 10.0 make the results suspect

2. C = Carbon; N = Nitrogen

The $\delta^{13}\text{C}$ value of -18.4‰ falls in the range of rabbits, but generally these small herbivores yield isotopic signatures similar to the plants they consume.

The 14 identified stone tools include eight edge-modified flakes (#687-5-10, #687-5-11, #864-5-10, #864-5-11, #864-5-12, #843-5-10, #843-5-13, and #843-5-14), one perforator (#867-5-10), one medial late-stage biface fragment (#843-5-11), one complete late stage biface (#843-5-12), two unidentifiable distal arrow point fragments (#864-5-14 and #864-5-15), one distal fragments of an end-scraper (#864-5-13), and one small hammerstone (#864-5-16).

In addition to lithic materials, four ceramic sherds were encountered in Feature 8. Three (#867-5-8) of the four bone tempered sherds were assigned to Vessel Group 3, and the other sherd (#865-5-8) was assigned to Vessel Group 1. The latter sherd was the largest at just over 2 cm in diameter and exhibits a polished interior and exterior, and contains gray and white bone temper. Vessel Group 3 sherds exhibit a polished reddish yellow (7.5YR 7/6) exterior. The interiors exhibit smoothing marks creating a slightly rough surface. A tiny sherd (#867-5-8) 6.1 to 6.6 mm in diameter, with a reddish yellow (7.5YR 7/6) exterior, a pink (7.5YR 7/4) interior, a light brown (7.5YR 6/4) core, and representing Vessel Group 3, was subjected to INAA. The INAA results on #867-5-8 or TRC277 indicate that this sherd did not fit into any previously defined cluster of sherds and is not similar to other sherds analyzed from the Varga site or any other site (Appendix N).

The bone fragments, weighing 114.4 g, are mostly small, less than 3 cm long, unidentifiable long bone fragments. Nine pieces, or nearly 7 percent, which weigh 49.4 g, represent bison-size elements. Of those, 67 percent are in the 0 to 3 cm size, one 6 to 9 cm long, and two 3 to 6 cm long. All nine pieces are unburned fragments. The remaining 93 percent were unclassifiable pieces less than 3 cm long. Two

small fragments of tooth enamel were also identified. Nine pieces of bone, or seven percent, are burned to a black or brown color. This color reflects a general heating to less than 400 degrees Celsius (Nicholson 1993). Several chunks of charcoal were encountered in Feature 8, with individually collected chunks of charcoal sent for radiocarbon dating. One piece of oak wood (#865-5-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-26.2‰) AMS radiocarbon date of 570 ± 40 B.P. (Beta-183626). A second oak piece (#865-4-7) was split into two parts and both were sent to the same laboratory for dating. One-half (#865-4-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-26.7 ‰) AMS radiocarbon date of 620 ± 40 B.P. (UGA-12726; Table 8-1). The other half (#865-4-7-1d) yielded a $\delta^{13}\text{C}$ corrected (-26.6 ‰) AMS radiocarbon date of 600 ± 40 B.P. (UGA-12732; Table 8-1). This split charcoal piece is statistically identical and provides verification of the reliability of laboratory processing techniques. These three radiocarbon dates on wood charcoal establish a relatively early Toyah age for Feature 8.

In addition to radiocarbon analysis, several sediment samples were collected from this feature for flotation. Ninety-one liters of matrix, which were collected from around and under the burned rocks, were collected and floated. Forty-eight liters of matrix (#865-5-4) from between 10 and 20 cmbd in Unit N119/E70 yielded considerable quantities of diverse cultural debris. This included 1,848 burned rock fragments weighing 2,217.3 g, 943 chert flakes and fragments weighing 97 g, 459 tiny charcoal pieces weighing 3.7 g, 51 more or less complete small snail shells weighing 4.9 g, and 431 bone fragments weighing 49.4 g. Some 93 bone fragments or 21.6 percent are burned. Identifiable bones include one bison element, one rabbit metapodial, and one rodent long bone fragment. Also included was one pottery sherd. The 2.9 liters of light fraction from three separate flotation samples and five individual chunks of charcoal were processed by Dr.

Dering (Appendix I). These samples contain nine wood species including; oak, juniper, agarita, *Condalia*, elm, buttonbush, mesquite, and another woody legume—possibly leadtree or acacia, with lotebush and agarita being the most common wood (Appendix I). A single, charred littleleaf walnut shell was also present.

This amorphous concentration of diverse cultural debris lacks any sign of *in situ* burning or a formal basin or pit, implying that these items are a secondary deposit in a general surface refuse area. This, plus the range of debris classes present, indicates that this feature does not represent a primary-use event. Further, multiple dumping events are supported by the diversity in the identified charcoal pieces and the lipid residue results on the burned rocks that indicate the rocks were used to cook different types of foods—meat and plants. This refuse area may potentially have been on the periphery of a primary activity area or areas from which the debris originated. The appearance of a second layer of burned rocks implies at least two or more dumping episodes.

8.2.3.2 Feature 18

Feature 18 was discovered in Block A in Unit N106/E55 between 3 and 13 cmbd and into the southern half of Unit N107/E55 between 3 and 20 cmbd. The recovered cultural debris was near the present surface which was previously mechanically stripped during Phase I investigations. This feature appeared as a nearly flat and ill-defined scatter of diverse cultural debris. In Unit N106/E55 (#533 and #534), this included burned rocks ($n=23$), bone fragments ($n=200$), lithic debitage ($n=124$), 14 edge-modified flakes, one Perdiz arrow point (#533-17), and one Scallorn arrow point (#534-14). Within Unit N107/E55 (#602) were burned rocks ($n=7$), bone fragments ($n=174$), lithic debitage ($n=42$), five edge-modified flakes, two medial biface fragments (#602-13 and #602-14), two nearly complete Perdiz points (#602-17 and

#602-18), two unclassifiable arrow point fragments (#602-15 and #602-16), and one unidentifiable dart point fragment (#602-19).

These diverse items were loosely associated with no clearly discernible margin over an area that measured about 60 by 150 cm. Feature boundaries were poorly defined with no sign of a pit or basin (Figure 8-5), implying that this feature is actually a relatively concentrated accumulation of materials within a broader spread of cultural debris. *In situ* burning was not indicated, as no oxidized matrix, charcoal, or ash concentrations were observed, though scattered pieces of charcoal were present. The surrounding sediment was a dark grayish brown (10YR 3/2) compact clay loam. Flotation samples were collected and processed.

The 30 burned rocks were limestone with 70 percent in the 0 to 4 cm size class and 27 percent in the 4.1 and 9 cm size class (Table 8-2). These weighed a total of 3,750 g for an average rock weight of 125 g.

Figure 8-5. Planview of Feature 18 in Block A

Two burned rock pieces were analyzed for lipid residue. Whereas a detailed report of the findings by Drs. Malainey and Malisza is presented in Appendix G, a summary of the results presented here (Table 8-3). Both pieces (#534-5-3-1a and #534-5-3-2a) yielded moderate to high fat content interpreted to represent plants. These interpretations imply that these rocks were used to cook plants only and may reflect a single cooking event. The isotope results from #534-5-3-2b with $\delta^{13}\text{C}$ value of -25.3‰ and $\delta^{15}\text{N}$ value of 7.9‰ indicate a C_3 plant (Table 8-4). The low $\delta^{15}\text{N}$ value of 1.9‰ from sample #534-5-3-1b indicates a C_3 plant similar to acacia beans.

The bones collected from Feature 18 included 18 bison-size fragments weighing 65.7 g, which were mostly long bone fragments with one rib and a bison tooth fragment. Deer are represented by three lower premolars, and a calcaneum epiphysial cap. Deer/antelope-size pieces weighing included a burned black dewclaw, a distal phalange, and a first phalange that was burned black and brown. Five rabbit size pieces weighing were identified, which include maxillary fragments and jackrabbit-size long bone pieces. Unidentifiable fragments ($n=344$, weighing 149.2 g) generally less than 3 cm in length dominate the bone assemblage.

Eleven liters of matrix (#533-5-4) from between 8 and 13 cmbd in Unit N106/E55 were collected for floatation. The 0.3 liters of light fraction yielded 25 pieces of oak wood (Appendix I). The cultural debris greater than 6.4 mm includes 10 tiny burned rock fragments 29 pieces of lithic debitage, 3 tiny bits of charcoal, 20 complete small snail shells weighing, 222 bone fragments, and one tiny point fragment.

The presence of multiple types of cultural debris comprised mostly of lithic debris and bone scraps indicate this concentration reflects a refuse-dumping locality representing a secondary deposit rather than a primary activity area.

8.2.3.3 Feature 25

Feature 25 was a scatter of burned rock mixed with other cultural debris scattered across four adjacent units—N126/E74, N126/E75, N127/E74, and N127/E75—in Block B towards the eastern margin of this project and immediately west of hearth Feature 38. Feature 25 is distinguished from Feature 38 based on the well-defined cluster of material in Feature 38 compared to the scattered nature of Feature 25. The cultural debris in Feature 25 covered an area measuring about 160 by 190 cm, with most items at depths between 21 and 33 cmbs. The right-of-way fence line was 20 cm east of the excavation units and thus, these materials may have extended further east. The telephone line trench truncated the western margin (Figure 8-6).

All four units yielded diverse debris that lacked any detectable patterning or form in their distribution, although some smaller areas within in the feature boundaries showed clustering of materials (Figure 8-6). Debris included burned rocks ($n=542$), abundant lithic debitage ($n=1,046$) and bone fragments ($n=1,328$), many stone tools ($n=56$), ceramic sherds ($n=8$), one bone bead blank (#1054-21), and very sparse mussel shell fragments ($n=2$).

Some 542 burned rocks, weighing 25,100 g, were collected from these four units. The burned rocks showed some varied in size from 1 to 15 cm in diameter. However, 85 percent fell into the smallest size class, with less than one percent larger than 9.1 cm (Table 8-5). Limestone was the only rock type identified with at least 88 percent exhibiting broken angular shapes. The average rock weight was a low 46 g. Parts of four burned rocks were selected for lipid residue and stable carbon and nitrogen analyses.

Figure 8-6. Planview of Features 25 and 38 in Block B

Table 8-5. Burned Rock Characteristics of Feature 25

Unit No.	Level	Cat. #	Size (cm) and Weight (g)								Material Type ¹				Fracture Type ²			Total Wgt (g)
			0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.	
N126/E74	20-25	1021	36	250	5	250					41				41			500
N126/E75	0-10	1023	57	2,300	10	1,800					67				56	10	1	4,100
N126/E75	10-20	1024	59	2,800	16	3,000					75				63	11	1	5,800
N126/E75	20-30	1025	29	1,000	9	1,200					38				28	9	1	2,200
N127/E74	15-25	1050	53	250	2	250					55				55			500
N127/E74	25-35	1051	92	800	13	1,350					105				102	3		2,150
N127/E75	0-7	1052	9	150	5	600					14				11	3		750
N127/E75	7-18	1053	53	2,400	13	1,700	2	2,000			68				55	11	2	6,100
N127/E75	18-24	1054	28	1,000	6	700	1	1,000			35				26	9		2,700
N127/E75	32-38	1055	43	200	1	100					44				41	3		300
Total			459	11,150	80	10,950	2	2,000	0	0	542	0	0	0	478	59	5	25,100

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Drs. Malainey and Malisza's detailed findings and interpretations are presented in Appendix G, with a summary of the results presented here (Table 8-3). Each sample yielded slightly different results. One sample (#1051-5-3-1a) yielded high fat content interpreted as representing plants. Sample #1051-5-3-2a yielded borderline moderate to high fat content, also interpreted as plant. A third sample (#1051-5-3-3a) represented large herbivore, and was somewhat fatty indicating intermixture with plant residue. The last sample (#1051-5-3-4a) yielded moderate to high fat content interpreted as plant residue. The variation in the interpretations of the lipid residues from the four burned rocks implies that the rocks were used to cook multiple foods. This supports the idea that the burned rocks probably were used in multiple cooking events.

The $\delta^{13}\text{C}$ values from these same burned rocks range from -18.5 to -27.2‰, whereas the $\delta^{15}\text{N}$ values range from 2.0 to 6.4‰ (Table 8-4). All the $\delta^{13}\text{C}$ values imply these burned rocks cooked C_3 plants. The low $\delta^{15}\text{N}$ value (2.6‰) from sample #1055-5-8-1b is suspect, as the measured nitrogen weight is lower than the expectable range. The isotope values from #1051-5-3-2b may represent rabbit, for which the meat often reflects values similar to the plants the rabbit ate. Sample #1051-5-3-3a yielded possible large herbivore lipid residues with isotope values that can be interpreted several ways. If the residues are considered to represent meat, then the species was probably deer or pronghorn or, possibly, javelina, based on the obtained isotope values. Other possible interpretations are presented in Appendix G.

The 1,328 bone fragments weigh 1,101.5 g, revealing the very fragmented nature of the bones with an average weight of 0.8 g and lengths generally less than 3 cm. Identifications include bison and bison-size pieces ($n=84$ pieces, weighing 452.8 g), deer/antelope-size pieces ($n=68$ pieces, weighing 55.6 g), two

unburned snake vertebrae (weighing 0.2 g), two rabbit-size long bone fragments, and 1,171 unidentifiable fragments weighing 592.6 g. One right bison scaphoid, one bison-size hyoid, two deer/antelope caudal vertebrae, and one antelope 1st phalange were the only elements identifiable as to species. Nearly all the fragments are long bone splinters, with rib and spine sections, and a few pieces of tooth enamel also present. Just over 16 percent of the fragments are burned, with four percent of the total being calcined. The calcined bones indicate temperatures in excess of about 700 degrees Celsius, and the brown and black colors are indications of temperatures less than about 400 degrees Celsius (Nicholson 1993).

The stone tools from these four units include 36 edge-modified flakes including a perforator (#1050-10), spokeshave, a graver (#1053-12), seven projectile points including a proximal Clifton point fragment, six scrapers, two unifaces, two bifaces, two cores, and one drill. The spokeshave (#1024-11) and one complete end-/side-scraper (#1023-12) were subjected to use-wear analysis. The spokeshave revealed use residues in the form of wood fragments, and exhibited high silica polish with striations parallel and perpendicular to the long axis that implies use on wood (Appendix C). The end-/side-scraper revealed high silica polish and edge rounding to indicating planing of hard, high silica material (Appendix C). The proximal Clifton point fragment (#1054-16) was sent for INAA.

The eight potsherds were all assigned to Vessel Group 1 based on visual characteristics. The largest sherd (#1055-5-8-1a), about 40 mm in diameter, was sent for lipid residue analysis. The obtained lipids indicate borderline moderate to high and high fat content interpreted to represent plant products (Appendix G). Following decalcification, ground matrix from that same sherd was sent to the isotope laboratory for stable carbon and nitrogen isotope

analysis. The derived $\delta^{13}\text{C}$ value is -27.2‰ and the $\delta^{15}\text{N}$ value is -2.6‰. As noted above, the latter value is somewhat suspect because of the very low proportion of the nitrogen. If the $\delta^{15}\text{N}$ value is accepted, the combined values indicate C_3 plants, probably legumes, were cooked in this vessel. Potential legumes include acacia and mesquite beans. Part of another sherd (#1054-8-1b) was subjected to petrographic analysis. The overall results document the paste is tempered with bone and limestone. The clay body matrix is tan to greenish gray and anisotropic. This sherd was assigned to Paste Group, B-c, based on 17.5 percent bone, 8.5 percent limestone, 8.5 percent ferrous iron, four percent calcite, 3.5 percent clay balls, 2.5 percent quartz, and 1.5 percent orthoclase (Appendix D). A second part of that same sherd (#1054-8-1a) was sent for INAA. The INAA results indicate that this sherd (TRC270) together with two other sherds (another Vessel Group 1 sherd [#1030-8-a = TRC271], and a Vessel Group 3 sherd [#840-8-1 = TRC276]) form a separate and distinct chemical group currently assigned to Varga-1, distinguishable from all other INAA analyzed pottery sherds from across Central Texas (Appendix N). These data indicate clay from a source area that has not been previously identified for the manufacture of other Toyah pottery.

Charcoal was abundant across these four units and two samples were sent for AMS radiocarbon dating. Four pieces (#1025-5-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-24.8‰) AMS radiocarbon date of 320 ± 40 B.P. (UGA-12728). Seven tiny pieces of mesquite (#1055-5-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-25.4‰) AMS radiocarbon date of 170 ± 60 B.P. (Beta-175401). These two dates indicate relatively recent occupation(s).

Five liters of sediment matrix from 25 to 35 cm in Unit N127/E74 were floated. The heavy fraction (#1051-5-4) yielded 181 pieces of debitage less than 6.4 mm in length and 360 tiny bone fragments. Fifty-five of the bone

fragments (15 percent) were burned. The 0.1 liters of light fraction yielded tiny pieces of wood charcoal identified as cottonwood/willow, elm, oak, sycamore, mesquite, and juniper (Appendix I), with mesquite the most abundant. Littleleaf walnut shell fragments were also identified.

The multiple classes of cultural debris in this feature are taken to indicate secondary deposit of cultural debris at a refuse-disposal locality. All the material came from one occupational event, but represents a variety of activities. This feature represents the cleaning and maintenance of other primary activity areas in the general camp.

8.2.4 Hearths ($n = 4$)

8.2.4.1 Feature 9

Feature 9 was discovered in Block B in Unit N117/E71, slightly over one meter southeast of the debris dump labeled Feature 8. It consisted of a few tightly spaced burned rocks and large charcoal chunks within a semi-circular area measuring 44 by 56 cm and situated about 22 cm below the surface. Thickness of the feature was approximately 8 cm (Figure 8-4). No oxidized matrix or ash was observed. The cross section did not reveal a basin configuration, but showed all materials to be resting on a level plane that indicates placement on a flat surface. The charcoal pieces were found mainly between the burned rocks. The surrounding matrix was a very dark grayish brown (10YR 3/2), whereas the matrix between the burned rocks was a dark yellowish brown (10YR 4/4).

The 28 burned rocks were of various sizes with 50 percent in the smallest size class of 0 to 4 cm in diameter (Table 8-6). The average rock weight was 375 g. Four of the larger burned rocks were complete, rounded water worn cobbles. Six larger pieces exhibited 1 to 3 breaks, but none of the smaller pieces refit to

Table 8-6. Burned Rock Characteristics of Features 9, 21, 30, 38, and 35

Fea. No.	Unit No.	Level	Cat. #	Size (cm) and Weight (g)								Material Type ¹				Fracture Type ²			Total Wgt (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.	
9	N117/E71	10-22	830	14	1,000	4	1,250	4	3,250	6	5,000	28				11		17	28 10,500
	Total			14	1,000	4	1,250	4	3,250	6	5,000	28	0	0	0	11	0	17	28 10,500
21	N100/E50	10-22	79	6	100	34	5,500	13	5,750	0	0	53				43	10		53 11,350
21	N100/E51	0-10	87	6	100	17	3,250	2	1,250	0	0	25				24	1		25 4,600
	Total			12	200	51	8,750	15	7,000	0	0	78	0	0	0	67	11	0	78 15,950
30	N99,100/E53	11-20	31, 109	0	0	34	8,600	11	6,000	0	0	23				29	3	13	45 14,600
	Total			0	0	34	8,600	11	6,000	0	0	23	0	0	0	29	3	13	45 14,600
38	N126/E76	25-35	1029	19	500	4	200					23				15	2	6	23 700
38	N126/E76	35-50	1030	17	250	26	4,750	6	4,000	3	5,000	52				18	9	25	52 14,000
	Total			36	750	30	4,950	6	4,000	3	5,000	75				33	11	31	75 14,700
35	N99/E54	10-20	41	76	1250	14	2,000	0	0	0	0	12							90 3,250
35	N100/E54	1	119	37	250	24	3,500	6	3,000	0	0	3							67 6,750
	Total			113	1,500	38	5,500	6	3,000	0	0	15	0	0	0	0	0	0	157 10,000

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

these pieces. Three pieces appeared quite similar in color, angularity and shape, but could not be refit.

Four burned rocks were selected for lipid residue and isotope analyses. Dr. Malainey and Malisza's detailed findings and interpretations of the lipid residues are presented in Appendix G, and a summary is presented here (Table 8-3). Two samples (#830-5-3-1a and #830-5-3-4a) yielded borderline medium and moderate to high fat content, interpreted as plant residue. Sample #830-5-3-2a yielded residue of either a large herbivore with fatty meat or plant. The final sample (#830-5-3-3a) represented large herbivore plus either plant or bone marrow. The slightly different results indicate that these burned rocks were used to cook a variety of foods. The isotope results from three of the same burned rock pieces used in the lipid analysis yielded $\delta^{13}\text{C}$ values ranging from -21.0 to -25.8‰, indicating C_3 plants or animals that ate C_3 plants (Table 8-4). If the interpretations from the lipid residues are correct and indicate large herbivore meat, then it would most likely represent deer or pronghorn. However, the isotope values are not clear indicators of this. The $\delta^{15}\text{N}$ values range from 3.8 to 6.7‰ (Appendix H). These values are not clear indicators of what specific foods were cooked, and more likely represent a mixture of foods.

Individual pieces of charcoal were sent for identification, and some were radiocarbon dated. Three chunks of oak charcoal (#830-5-4-1a) yielded a $\delta^{13}\text{C}$ corrected (-25.0‰) AMS radiocarbon date of 660 ± 40 B.P. (Beta-175404).

Feature matrix was sampled at two levels. Eighteen liters were collected from 10 to 20 cmbd and floated (#830-5-4-1). The cultural materials greater than 6.4 mm (1/4 in) in size included 93 burned small burned rock fragments, five pieces of lithic debitage and one bone fragment. The heavy fraction sample (#830-5-4) yielded 24 tiny burned rock

fragments, 40 pieces of lithic debitage, 37 tiny charcoal pieces weighing 0.6 g, and 17 very small bone fragments. The 0.3 liters of light fraction (#830-5-4-1) yielded diverse species of charcoal including agarita, lotebush, cottonwood/willow, juniper, oak, sycamore, Mexican buckeye, pinyon, and a woody legume (Appendix I).

Three liters of matrix (#830-5-4) from 12 to 15 cmbd was also floated. The cultural material greater than 6.4 mm included 20 burned rock fragments, five pieces of lithic debitage, and four bone fragments. The heavy fraction yielded six tiny burned rock fragments, 22 pieces of lithic debitage, 28 tiny charcoal pieces, and seven bone fragments.

The matrix around the burned rocks was not oxidized and no pit was detected, but the tight clustering of burned rocks directly associated with relatively large and numerous chunks of charcoal supports an interpretation that this feature was the location of an *in situ* burning event. The lack of oxidation probably indicates a short-term burning episode.

8.2.4.2 Feature 21

Feature 21 was discovered in Block A in Units N100/E50 and N100/E51 between 7 and 17 cmbs. It consisted of a tight cluster of burned rocks and many pieces of charcoal mixed together in an oval-shaped area (Figure 8-7). The variable depths of the burned rocks and the slightly deeper pieces of charcoal indicate a shallow basin beneath the burned rocks. This cluster measured 62 by 68 cm in diameter and about 8 cm thick. Tiny rootlets were the only observed disturbance in the feature. Cactus root and rodent burrows were detected in the northwestern quadrant of Unit N100/E51, but outside the feature. Only a few centimeters vertically separated the base of this feature from the underlying burned rock lens (Feature 1) dated to the Late Archaic period.

Figure 8-7. Planview of Feature 21 in Block A

A total of 78 burned rocks, all angular limestone fragments and weighing 15,950 kg, was recovered from this feature. Nearly 65 percent were in the 4.1 to 9.0 cm size class with the remaining pieces nearly equally divided into two other size classes (Table 8-6). Three burned rocks (#79-5-3-1a, #79-5-3-2a, and #79-5-3-3a) were analyzed for lipid residues (see Appendix G for detailed information). Two samples (#79-5-3-1a and #79-5-3-3a) yielded moderate to high fat content interpreted as plant residue. The third piece (#79-5-3-2a) yielded medium fat content, also interpreted as plant. The slightly different results imply that these burned rocks were used to cook different plant foods. The isotope results on these same three burned rock pieces yielded $\delta^{13}\text{C}$ values from -21.2 to -24.9‰ with $\delta^{15}\text{N}$ values from 2.8 to 3.6‰ (Table 8-4). The $\delta^{13}\text{C}$ values are interpreted to reflect C_3 plants or animals that ate C_3 plants. The $\delta^{15}\text{N}$ values also indicate the cooking of plants, with various nuts and seeds falling into to these isotope ranges.

About 111 liters of sediment matrix from four proveniences around the burned rocks was collected and floated in the laboratory. Eighteen liters of sediment from the top 10 cmbd of Unit N100/E50 (#78) were floated. The cultural debris greater than 6.4 mm in size includes 94 tiny burned rock, 50 pieces of lithic debitage, 145 tiny bits of charcoal, 23 complete small snail shells, and 97 bone fragments. Eighteen or the bone fragments are burned. Two stone tool fragments are present. The heavy fraction yielded 71 tiny burned rock fragments, 596 pieces of lithic debitage, 60 tiny charcoal pieces, five mostly complete snail shells, and 388 bone fragments. Seventy-one, or 18.3 percent, of the bone fragments are burned. The tiny bone fragments include a single small unburned fish vertebra.

The 83 liters of matrix from the lower part of Unit N100/E50, between 10 and 20 cmbd, were floated. Cultural materials greater than 6.4 mm in size includes 276 tiny burned rock fragments, 65 pieces of lithic debitage, 197 tiny bits of charcoal, 50 complete small snail shells, and

86 bone fragments, which includes a burned deer dewclaw. Nineteen pieces of bone are burned. The heavy fraction yielded 317 tiny burned rock fragments, 623 pieces of lithic debitage, 1,795 tiny charcoal pieces, and 495 bone fragments. Eighty-two bones are burned.

Twenty-seven liters of sediment from Unit N100/E51, between 0 and 10 cmbd, yielded cultural debris greater than 6.4 mm in size, including 21 tiny burned rock, 34 tiny chert fragments, 48 tiny charcoal pieces, 17 more or less complete snail shells, and 27 bone fragments. Eight flakes and nine bone fragments are burned. The bones include one turtle shell fragments and one rodent long bone. The heavy fraction yielded 14 tiny burned rock fragments, 439 pieces of lithic debitage, 116 tiny charcoal pieces, 3 mostly complete small snail shells, and 168 very small bone fragments. The charcoal pieces include a thin burned nutshell fragment. The bones include a tiny fish vertebrae and a distal humerus of a rabbit. Thirty-eight bone fragments are burned.

Still in Unit N100/E51, but slightly lower, between 10 and 15 cmbd, the four liters floated (#88) yielded cultural debris greater than 6.4 mm in size consisting of 67 tiny burned rock fragments, 71 tiny charcoal pieces, five complete snail shells, and four bone fragments. One bone fragment was burned black. Larger chunks of charcoal were added to the light fraction for identification. The heavy fraction yielded 74 tiny burned rock fragments, 62 pieces of lithic debitage, 116 tiny charcoal pieces, and 50 bone fragments. Six pieces, or 12 percent, of the bone fragments are burned.

The 2.2 liters of light fraction from the four samples and six individual charcoal pieces were sent to Dr. Dering for identification of macrobotanical materials. These samples contained seven wood types including *Carya* family (possibly pecan), mesquite, oak, elm, woody legume (leadtree or acacia), and juniper

(see Appendix I). Oak is the most abundant wood followed by juniper and both woods are well-suited for use as fuel. Littleleaf walnut and pecan nut fragments, as well as stool/yucca/agave caudex (stem) fragments, were also identified. The charred stem fragments may represent food remains that were accidentally burned, as they are not good fuel sources. The nutshell fragments may or may not be food resources, with the walnut providing very minimal meat compared to pecan nut.

Chunks of charcoal were abundant and pieces were sent for AMS radiocarbon dating. One large chunk of juniper wood was split into three pieces to obtain three individual dates from two laboratories. One piece (#78-5-7-1b) yielded a $\delta^{13}\text{C}$ corrected (-24.0‰) AMS radiocarbon date of 380 ± 30 B.P. (Beta-183623). A second piece (#78-5-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-24.9‰) AMS radiocarbon date of 380 ± 40 B.P. (UGA-12707). The third piece (#78-5-7-1c) yielded a $\delta^{13}\text{C}$ corrected (-24.7‰) AMS radiocarbon date of 300 ± 40 B.P. (UGA-12707; Table 8-1).

The hint of a basin under this tight concentration of burned rocks, coupled with quantities of chunks of charcoal, implies that Feature 21 was an *in situ* burning event, which lacked visual signs of oxidation. This hearth is thus interpreted as representing a primary activity locus in the Toyah component dating to about 300 to 400 years B.P. Although this was an *in situ* hearth feature, incidental cultural debris of various classes (i.e., lithic debris and bones) was discarded into it.

8.2.4.3 Feature 30

Feature 30 was a loose cluster of limestone burned rocks that straddled the north-south boundary of Units N99/E53 and N100/E53 in Block A (Figure 8-8). This cluster was in an irregular oval, which measured 87 by 110 cm in diameter and was about 6 to 8 cm thick. Light charcoal staining was present between the rocks and in the profile, indicating a shallow basin

with a flat bottom and moderately steep walls. The scattered charcoal defined the basin-shaped base, which was not easily detected. The burned rocks were predominately in one layer, but occasionally one burned rock was atop another. Rodent and root disturbances were noted, but had not significantly disturbed the feature.

Forty-five burned rocks, weighing 14,600 g, dominated the feature fill, with 75 percent in the 4.1 to 9 cm size range (Table 8-6). Surprisingly, no burned rocks were in a smaller size class, possibly the result of a biased collection or recording process. The average rock weight was 324 g. No burned rocks were sampled for their lipid residue contents.

Fourteen flakes, one edge-modified tool (#109-5-10), and four bone fragments were in the fill. The four bone fragments were all less than 3 cm in diameter, with two taxonomically unidentifiable pieces and two falling within the deer/antelope size range. One piece was burned black and brown, and another was black and white in color.

Six liters of feature fill (#109-5-4) from 11 to 22 cmbd in Unit N100/E53 were floated. The heavy fraction yielded 15 tiny burned rock fragments, 32 pieces of lithic debitage, 88 tiny charcoal pieces, and nine bone fragments. Three bones and a tiny nutshell fragment were burned.

About 0.1 liters of light fraction yielded oak and mesquite wood, a mesquite seed fragment, and eight tiny pieces of slag (Appendix I). The burned mesquite seed may or may not indicate that mesquite seeds were being processed as food, since seeds potentially were attached to mesquite wood being used as a fuel wood.

Outside the northern edge of Feature 30 in Unit N100/E53, material including burned rocks ($n=35$; weighing 5850 g), charcoal, bones ($n=65$), lithic debris ($n=77$), and stone tools were recovered. The tools include one medial section of an untyped dart point (#109-10) and two edge-modified flakes (#109-11 and #109-

Figure 8-8. Planview of Feature 30 in Block A

12). Outside the southern edge, in Unit N99/E53, were scattered burned rocks

($n=15$; weighing about 500 g) another 56 pieces of debitage, and 12 bone fragments. These items indicate that various other activities were carried out immediately adjacent to this hearth. The concentration of burned rocks in direct association with charcoal, in what appeared to be a shallow basin, indicates this feature represents primary *in situ* heating.

8.2.4.4 Feature 38

Feature 38 was along the very eastern edge of the right-of-way, immediately under the fence line in Block B, and immediately east of burned

rock scatter Feature 25 (Figure 8-6). It was in Unit N126/E76, of which the western 30 cm section was excavated (the only part of this unit within the highway right-of-way). Initially, a row of three burned rocks were exposed in the very eastern edge of Unit N126/E75, all resting at the same elevation in the wall profile, which hinted at some type of feature within the adjacent unit. The 30 cm east-west width by the one-meter long unit proved to contain a tight cluster of burned rocks, dense charcoal, many bone fragments, and lithic debitage distributed in an arcuate pattern. This arc of burned rocks extended across the entire unit with cultural debris found in the 15 to 18 cm thickness that bracketed the top and bottom of the feature. Although not obvious, slight elevation differences in the bottoms of the burned rocks marked the base a shallow pit or basin. The matrix directly above the feature was a dark yellowish brown (10YR 3/4) compared to the internal feature matrix that was a very dark gray (10YR 3/1). The feature's maximum dimensions and shape are unknown, and the material frequencies are for an undetermined percentage of a larger feature.

This arc shaped part of Feature 38 that covered an area 30 cm wide, 100 cm long, and about 20 cm in depth yielded 75 limestone burned rocks weighing 14,700 g. Forty-eight percent of the burned rocks were within the 0 to 4.0 cm size class and 40 percent within the 4.1 to 9.0 cm size class (Table 8-6). The average burned rock weight was 196 g.

Parts of four selected burned rocks were sent for lipid residue and stable isotope analyses. Drs. Malainey and Malisza's detailed findings on the lipid residues and their interpretations are presented in Appendix G, with a summary of the results presented here (Table 8-3). Two burned rocks (#1030-5-3-1a and #1030-5-3-2a) yielded residues interpreted as representing large herbivore. However, it is possible that the somewhat fatty residues might reflect plant

residues. A third piece (#1030-5-3-3a) yielded a moderately high fat content interpreted as plant. The fourth piece (#1030-5-3-4a) yielded high fat content interpreted as plant. The different results imply that these burned rocks were used to cook various plant foods, and possibly meat of a large herbivore.

The isotope results on these same burned rock pieces yielded $\delta^{13}\text{C}$ values from -18.6 to -24.3‰ with $\delta^{15}\text{N}$ values from -2.2 to 11.4‰ (Table 8-4). The $\delta^{13}\text{C}$ values are interpreted to reflect C_3 plants or animals, which ate C_3 plants. The $\delta^{15}\text{N}$ values also imply that plants were cooked. Nuts and seeds from a variety of plants would fall within these isotope ranges.

One fragment of burned limestone (#1030-5-3-2c) was selected for radiocarbon dating. This yielded a $\delta^{13}\text{C}$ corrected (-7.1‰) AMS radiocarbon date of $11,980 \pm 40$ B.P. (UGA-12729;

Table 8-1). Obviously this is not the true age of Feature 38 since this date did not apparently capture the organic residues thought to be present from this recent Toyah event. This date is not acceptable, as it is much too old for this component. Obviously, much older residues resided in this burned rock matrix and were not destroyed during the Toyah heating event that must have occurred.

About 12.7 g of charcoal was recovered from Feature 38. Many pieces were relatively large chunks between 5 and 20 mm in length. Selected charcoal pieces were radiocarbon dated and identified as to species represented. Seven pieces of wood charcoal (#1030-5-7-1a) from the lower part of this feature were sent for radiocarbon dating. These pieces yielded a $\delta^{13}\text{C}$ corrected (-25.3‰) an AMS radiocarbon age of 390 ± 60 B.P. (Beta-175400; Table 8-1). This is an acceptable date for this Toyah feature as it fits well with most of the other radiocarbon dates obtained from Toyah components at this and other Toyah sites. The wood was identified as willow/cottonwood (Appendix I).

Bone fragments ($n=104$), lithic debitage ($n=7$), ceramic sherds ($n=4$), and stone tools ($n=3$) were scattered among the burned rocks and charcoal chunks. The stone tools include a complete Padre point (#1030-5-10) and two edge-modified flakes (#1030-5-11 and #1030-5-12). The Padre point was submitted for use-wear analysis, which revealed oblique striations and polish plus plant fragments in the haft area that show this specimen was hafted. However, the inferred use and contact material are unknown (Appendix C). Small, unidentifiable bone fragments (94 percent) dominated the sample of 104 recovered pieces. Nearly 10 percent ($n=10$) were burned black, and nearly 11 percent ($n=11$) were burned to a black and brown color. Five pieces fall into the bison size range.

The four potsherds discovered in this feature were assigned to Vessel Group 1 based on visible characteristics. This vessel group generally exhibits a dark unpolished exterior with a roughly finished interior. Petrographic analysis on a sherd from Vessel Group 1 indicates a locally manufactured vessel. These four sherds are larger than most of the other sherds collected from the Varga Site. The largest sherd, weighing 10 g (#1030-5-4-8-1a), was sent for lipid residue analysis. The lipid results yielded moderate to high fat content that is interpreted as indicating plant residues (Appendix G). Ground matrix extracted from the interior of that same sherd (#1030-5-3-1b) was sent for stable carbon and nitrogen isotope analysis. The $\delta^{13}\text{C}$ value is -14.3‰ and is interpreted to reflect use of C_3 plants or animals that ate C_3 plants. The $\delta^{15}\text{N}$ value is 2.8‰ , but is suspect as the measured nitrogen weight was quite low. These values generally appear to indicate the cooking of plants. A second sherd (#1030-8-a), weighing 1.6 g, and from just outside the feature, was sent for INAA. The INAA results indicate that this sherd (TRC271) together with two other sherds (#1054-8-1a or TRC270 and #840-8-1a or TRC276) form a group from this one location designated as

Varga-1 (Appendix N), quite distinct from other analyzed Toyah sherds from Central Texas.

Nineteen and one-half liters of matrix (#1030-5-7) from around the burned rocks in Feature 38 were collected for flotation. The material over 6.4 mm long included 151 pieces of lithic debitage, 28 tiny burned rock fragments, 130 tiny charcoal pieces, 52 more or less complete *Polygyridae* and *Helicinidae* snail shells, 10 *Rabdotus* snail shells, 203 tiny bone fragments and one tiny tip of a stone tool. The heavy fraction yielded 74 tiny burned rock fragments, 508 tiny pieces of lithic debitage, 242 tiny charcoal pieces, two ceramic sherds, seven seeds, 7 small more or less complete *Polygyridae* and *Helicinidae* snail shells, and 543 tiny bone fragments. The 0.4 liters of light fraction yielded two burned prickly-pear seeds and three carbonized sotol-yucca-agave leaf fragments, plus five burned cottonwood/willow pieces, five milliliters of buttonbush, 24 oak pieces, five juniper pieces, and 14 woody legume charcoal pieces (Appendix I). The largest sotol-yucca-agave leaf fragment, measuring 11 by 22 mm, was most likely a part of the basal portion of a sotol leaf.

The observed pattern of distribution in the burned rocks, coupled with the relatively high quantities of charcoal between the rocks, indicates this feature was probably an *in situ* hearth. However, the presence of other forms of cultural debris creates some uncertainty in this interpretation, since the accumulation of a variety of debris might indicate trash-disposal. If multiple occupations with overprinting of activities took place, the result could well account for the somewhat ambiguous character of this hearth-like feature. It is also possible that the lithic debitage and bones were discarded into a hearth during its period of use.

8.2.5 Occupation Zones ($n = 3$)

8.2.5.1 Feature 22

Feature 22 was encountered at 20 to 21 cmbd in Unit N107/E55 within Block A and is considered part of a broader spread of occupational debris. The material in Feature 22 consisted of scattered chunks of charcoal and relatively dark-colored sediment in a 3 cm thick zone across the southern third of the unit. This 3 cm thick zone was detected a few centimeters below the north part of Feature 18. The charcoal-rich area measured about 37 cm north south by 85 cm east west. No evidence of a pit or basin was observed around or beneath the charcoal staining, and no oxidized matrix was detected. Several small bone fragments ($n=6$), and lithic debris ($n=7$) were in this same unit. Burned rocks were not in direct association, although two burned rocks were immediately to the north, but at slightly lower elevations. Since the stratigraphy appears compressed here it is not clear which materials were associated with other materials, or the exact age of this charcoal.

Two liters of matrix (#603-4-1) from 17 to 22 cmbd in the area of the charcoal were collected for flotation. The heavy fraction yielded 29 tiny pieces of lithic debitage, 17 tiny pieces of charcoal g, and 57 tiny bone fragments. Ten bone fragments were burned. The less than 0.1 liters of light fraction yield 13 pieces of charcoal that could not be identified as to species (Appendix I).

It is not clear what this scattered charcoal area represents. This is due in part to the fact that it occurred just a few centimeters below and to the north side of burned rock dump Feature 18, which lacked any sign of *in situ* burning or basin. This may be the remains of a scattered surface hearth, part of the overlying occupation zone, or the remnant of another occupation not well represented across this area.

8.2.5.2 Feature 35

Feature 35 was located along the southern margin of Block A in Units N99/E54 and N100/E54 between 10 and 25 cmbd (Figure 8-9) and is considered part of a broader occupation zone. The southern edge of the Unit N99/E54 was partially disturbed as it lay along the northern margin of the bladed dirt entrance road to adjacent private property. Mechanical stripping of the ground surface during the initial investigations may have damaged this near-surface feature.

Figure 8-9. Planview of Feature 35 in Block A

These two units revealed a loose distribution of diverse cultural debris, which represents 2 m² of a broader area of occupational debris. This was immediately east of Feature 30; a shallow basin-shaped hearth that contained mostly burned rocks and charcoal.

Scattered burned rocks dominated this area, and chunks of charcoal, lithic debitage, and bone fragments were found scattered across the two units (Figure 8-9). A modern fence post about 25 cm in diameter was detected along the western edge of Unit N99/E54, which caused some disturbance to the archaeological deposits, as did rodent and root activities. The matrix was a dry and crumbly light brownish gray (10YR 6/2) clay loam.

Level 2 of Unit N99/E54 yielded 71 bone fragments, 123 pieces of lithic debitage, chunks of charcoal, one edge-modified tool (#41-10), and 90 burned rocks weighing 3,250 g. Level 2 of Unit N100/E54 yielded three bone fragments, 67 pieces of lithic debitage, and 98 burned rocks weighing 7,250 g. These two levels yielded 157 burned rocks weighing 10,000 g that ranged in size from 1 to 15 cm in diameter. The small 0 to 4 cm size class dominated with 72 percent, followed by 24 percent in the 4.1 to 9 cm size class (Table 8-6). The average burned rock weight is 64 g.

The 74 pieces of bones include one deer ulna notch, six bison-size long bone fragments, two bison tooth fragments, one rabbit-size long bone fragment, and 90 unidentifiable fragments. Fifteen of the unidentifiable fragments were burned black and brown, with another 12 burned to a gray color. The gray-colored fragments reached temperatures between 400 and 600 degrees Celsius (Nicholson 1993). The bison long bone fragments were the largest fragments, with the largest piece measuring nearly 9 cm in length.

Eight liters (#119-5-4) of matrix from 10 to 20 cmbd in Unit N100/E54 were collected and

floated. The heavy fraction yielded 45 tiny burned rock fragments, 191 tiny pieces of chert, 140 tiny pieces of charcoal, 31 tiny burned clay pieces, and 50 tiny bone pieces. Sixteen bones, including a rabbit tooth and a rodent humerus, were burned. The 0.2 liters of light fraction yielded charred sotol-yucca-agave type caudex fragments plus oak, juniper, and woody legume charcoal (Appendix I). The woody legume dominated the sample.

This scattered and diverse cultural debris in no detectable pattern was part of the broader Toyah component that extended across much of the excavated area. This debris does not represent one specific recognizable activity, but rather general range of camp activity.

8.2.5.3 Feature 36

Feature 36, part of a more general zone of occupational debris, was detected in three adjacent units—N101/E47, N102/E47, and N103/E47—at the southern end of a one-meter wide north-south strip between BT 1 and the right-of-way fence line at the western edge of Block A. The occupation zone was easily recognized here through the high density of cultural debris, which drops sharply toward the northern limit of Unit N103/E47. This buried zone lies between 29 and 35 cmbd, and was at elevations similar to those of other Toyah features and material across the site. In this zone three distinct 1 to 2 cm-thick lenses of cultural debris were detected; one at 33 cmbd, a second at 35 to 36 cmbd, and another at 38 to 39 cmbd. Each thin lens contained cultural debris lying relatively flat and extended across the entire unit, indicating that three separate occupations were present. North-south BT 1, excavated during Phase I, truncated the eastern side of these three units, which contained the thin lenses. East of BT 1 these individual lenses were not individually recognized in the broader block excavations. They potentially merged, or had been disturbed beyond recognition, outside

this one limited area along the right-of-way margin, where deposition was the greatest and the deposits were the least disturbed.

The dense cultural debris from these three units includes 372 burned rocks, 1,362 small bone fragments, 1,212 pieces of lithic debitage, 74 stone tools, nine ceramic sherds, two mussel shell fragments, and charcoal. In this zone four small clusters of material were recognized in Unit N101/E47. One cluster consisted of burned bone fragments, which encompassed an area about a 20 cm diameter around a relatively large burned rock. A second cluster consisted of bones fragments and lithic debitage between 34 and 36 cmbd and encompassed an area of about 30 by 40 cm. A third cluster, which consisted of bone fragments and small burned rock pieces in an area of about 20 by 30 cm, was in an apparent rodent burrow at 33 to 40 cmbd. The forth cluster consisted of mostly lithic debris, a large beveled biface, and a Perdiz point between 33 and 39 cmbd, and scattered over an area of about 35 by 20 cm. These small dumps of diverse debris may represent discarded materials from primary activity areas in adjacent areas on the site.

Charcoal samples believed to represent each of these three thin, but recognizable cultural lenses across the southern two units were selected for radiocarbon dating to document the age range of these three Toyah events. The shallowest, piece of oak charcoal (#158-5-7-1a), yielded a $\delta^{13}\text{C}$ corrected (-26.5‰) AMS radiocarbon age of 400 ± 40 B.P. (Beta-175397). The charcoal piece from the middle lens (#159-5-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-25.5‰) AMS radiocarbon age of 940 ± 40 B.P. (Beta-175398). The lowest piece (#160-5-7-1a), a mesquite chunk, yielded a $\delta^{13}\text{C}$ corrected (-25.6‰) AMS radiocarbon age of 920 ± 40 B.P. (Beta-175399; Table 8-1). The highest piece reveals the youngest age and fits well with the other Toyah component assays obtained here and documented elsewhere from other sites. The

two lower pieces are older than documented Toyah occupations and may represent some earlier use of the site. Root and rodent disturbances were detected in these two units and it is possible that some mixing of charcoal occurred. However, a cultural component that dates to about 900 to 1,000 B.P. was not otherwise clearly defined at this site. A couple of arrow points recovered, including one Scallorn and one Edwards point, may indicate that an occupation did take place. In any case, the two older dates do not represent the Toyah component.

The 372 burned rocks exhibit a size range from 1 cm to just over 15 cm in length. The smallest size range comprises 56 percent of these, followed by nearly 38 percent in the 4.1 to 9 cm size class, with only five percent greater than 9.1 cm (Table 8-7). The average rock weight is a relatively light 80 g.

Three burned rocks (#158-5-3-1a, #158-5-3-2a, and #158-5-3-3a) were analyzed for their lipid residues. Details of findings and interpretations are presented in Appendix G, and a brief summary is offered here (see also Table 8-3). Two samples (#158-5-3-1a and #158-5-3-2a) yielded borderline moderate to high fat and high fat content, both interpreted as representing plant matter. The third piece (#158-5-3-3a) yielded moderate to high fat content, also interpreted as plant. The slightly different results imply that these burned rocks may have been used to cook various plant foods.

The isotope results on the same three burned rocks yielded $\delta^{13}\text{C}$ values from -24.3 to -24.8‰ with $\delta^{15}\text{N}$ values from 3.4 to 6.1‰ (Table 8-4). The $\delta^{13}\text{C}$ values are fairly uniform and are interpreted to reflect C_3 plants or animals that ate C_3 plants. The $\delta^{15}\text{N}$ values show some variation, but generally indicate cooking of plants. Nuts and seeds from a variety of plants would fall within these isotope ranges.

Table 8-7. Burned Rock Characteristics of Feature 36

Unit No.	Level	Cat. #	Size (cm) and Weight (g)								Material Type ¹				Fracture Type ²			Total Count	Total Wgt (g)
			0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.		
N101/E47	20-30	158	21	250	21	4,500	1	1,250		43				40		3	43	6,000	
N101/E47	30-40	159	75	750	16	1,250	1	250		92				90		2	92	2,250	
N101/E47	40-45	160	30	1,000	24	1,500	2	500		56				54		2	56	3,000	
N102/E47	10-20	260	8	250	14	2,000	3	1,000		25				22	3		25	3,250	
N102/E47	20-30	261	16	750	27	3,500	1	500	1	45				43	2		45	5,750	
N102/E47	30-35	262	24	250	5	500	1	500		30				30			30	1,250	
N103/E47	20-30	350	16	250	21	2,500	8	4,000									45	6,750	
N103/E47	30-35	351	19	500	15	750	2	250									36	1,500	
Total			209	4,000	143	16,500	19	8,250	1	1,000	291	0	0	0	279	5	7	372	29,750

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Small fragments dominate the 1,362 bone fragments weighing 1,128.7 g. Some six percent are identifiable to five different size groups or recognizable species. Bison and bison size pieces are represented by 69 pieces weighing 464.4 g, and include one left bison acetabulum, one 2nd phalanx, one cuneiform, many long bone and rib fragments, and a few tooth fragments. Four bison-size long bone fragments were burned to a black and brown color. Deer/antelope size pieces are represented by 14 pieces weighing 59.5 g, and include tooth fragments, two deer inner ear elements, one distal left deer humerus, one deer cuneiform, one deer 3rd phalange, one dewclaw, and many long bone and rib fragments. A single skull fragment was attributed to an antelope. Also identified were one proximal metapodial of a rabbit, one rabbit-size long bone fragment, one bird-bone element, one turtle carapace fragment, and one proximal canid metapodial. The 94 percent unidentifiable fragments weighing 595.4 g were mostly tiny scraps, with eight percent burned to a black, or black and brown, color.

The 75 stone tools include 52 edge-modified flakes, 13 projectile points and point fragments, four bifaces including one complete four-beveled knife, three cores, one drill, and one uniface. The projectile points, all arrow points, consist of three Perdiz, two Bonham, and eight untypable fragments.

The nine sherds include seven pieces assigned to Vessel Group 4, and one each assigned to Vessel Groups 1 and 3. All pieces are less than 3 cm in diameter. Two liters of matrix (#262-5-4) from 30 to 34 cmbd in Unit N102/E47 were collected and floated. The less than 0.1 liters of light fraction yielded oak and juniper charcoal (Appendix I). Individual charcoal chunks were identified as mesquite (#160-5-7-1b) and oak (#158-5-7-1b) (Appendix I). The heavy fraction yielded 14 tiny burned rock pieces weighing 0.8 g, 130 tiny chert pieces weighing 2.0 g, 23 tiny charcoal pieces weighing 0.2 g, and

153 tiny bone fragments weighing 3.6 g. Fifteen of the tiny bones were burned to a black and brown color.

This Toyah component lies immediately atop a Late Archaic burned rock midden dating between ca. 1,700 and 2,200 B.P. The Toyah burned rocks were noticeably smaller and the lithic debitage is much more extensive than the lower Late Archaic component. The Toyah cultural materials lie at the base of geomorphic Unit I, which is a loose, unconsolidated, very dark grayish brown (10YR 3/2) clay loam with very few natural inclusions. Below that is Depositional Unit II, a black granular matrix, which contained the Late Archaic materials. The break between the two geomorphic units is quite distinct and may represent an unconformity.

A barbed wire fence was located immediately along the western edge of the hand-excavations and vertical fence posts have penetrated the subsurface. This disturbed part of the occupation zone. An occasional metal fence staple and metal nail were found mixed in with cultural materials. A modern entrance road into the adjacent property has destroyed the deposits at the south edge of Unit N101/E47 and truncated the upper cultural deposits at that end of the excavations. Rodent activity was noted in some limited areas.

8.2.6 Summary and Discussion of Features

These 11 Toyah component features undoubtedly reflect multiple camping events as indicated by the age differences reflected in the 15 acceptable radiocarbon dates (Table 8-1). The 15 radiocarbon dates from eight features indicate a general time age between about 170 to 660 B.P. This range does not consider the old wood factor that might have played a role in some age differences, or the possibility of mixing from modern activities, especially in a single feature. For example, the 80 B.P. date

(Beta-175405) derived from charcoal from Feature 8 is much too recent for this prehistoric component, especially since this same feature also yielded three earlier dates that average about 600 B.P. This young charcoal is assumed to date a modern piece that became intermixed with the prehistoric materials.

These 11 features show some variability in on-site activities. The four hearths represent *in situ* heating, are nodal points of primary activity areas. The individual burned rocks in these primary heating features have an average weight of over 200 g whereas those in Feature 9 average 375 g. The specific function served by the hearths is unclear, though cooking is certainly a likely candidate. The one identified bone pile and burned rocks scatters reflect minimally two other activities. The bone pile may reflect the location of various activities that included, but are not limited to, bones set aside for defleshing, bones set aside for marrow and/or grease extraction, or simply discard.

The burned rock piles and scatters may reflect different events, such as discard piles of one or more events, or other related cooking activities. The burned rocks in the three dumps average less than 125 g, and generally less than 75 g, a much lighter weight than those in the identified hearths. The dumping of unwanted diversified cultural debris (i.e., Feature 8 and 25) probably reflects the cleaning of primary activity areas and secondary disposal in one specific area. The latter type of cleaning activity may reflect a relatively extended stay in this campsite, since the cultural material must initially accumulate in primary use areas and then outlast is usefulness, prior to cleaning and removal of excess material to another location in the camp.

Botanical identifications of charred materials from about 299 liters of floated matrix extracted from 10 features and individual pieces of burned macrobotanical remains indicate a variety of exploited resources and correspondingly show something about environmental resource mosaic.

Minimally, 18 plant species were identified and include the only samples of pinyon wood, Mexican buckeye, elm, sycamore, cottonwood/willow, cheno-am, hickory, and agarita in the site. These eight species were not identified in earlier contexts at the Varga Site. This may be an indication that the environment changed over time, or that at least the selection process by the human groups became more diversified. Ten other plant species were also identified and include buttonbush, *Condalia* or buckthorn, woody legume, littleleaf walnut, juniper, mesquite, oak, lotebush, prickly pear seeds, and sotol-yucca-agave. These latter plant species were identified in earlier components and indicate some continuity of the available plant resources over time. Regardless of what the local environment was like, the Toyah peoples used diverse plant resources to fuel their fires and as part of their food consumption.

The interpretations from the lipid residue analyses imply that only about 27 percent of the 29 individual samples indicated large herbivore meat, and 57 percent of those could actually represent plant signatures (Table 8-3). The 27 percent figure for meat residue seems low when one examines the quantity of bone recovered. This low percentage interpreted in the lipid residues may be influenced by how the meat, marrow, etc. from the animals was processed. It may be that much of the meat, marrow, etc. was consumed without cooking by hot rocks. Many ethnographic and historic accounts indicate that peoples ate meat without cooking it, but other means of cooking meat are possible without the direct use of hot rocks. In contrast few plants can be directly consumed without cooking or preparation (seeds, nuts, and berries being exceptions), and this may be what is reflected in the lipid residue analyses. Most burned rocks yielded quantities of moderate to high fat residues interpreted as representing from plants; medium to borderline medium fat content is present in about

21 percent of the burned rocks, whereas the rest have higher fat content.

In two instances, a burned rock scatter (Features 8 and 25) was next to an *in situ* heating element/hearth (Features 9 and 38). In each case these apparently paired features (Features 8 and 9, and Features 25 and 38) contained some burned rocks, which yielded residues that were interpreted as indicating large herbivore meat. These were only recovered from Block B, whereas no identified features in Block A yielded burned rocks with residues interpreted as representing large herbivores. This horizontal difference may signal specific activity localities, or different activities in different occupational episodes.

8.1 CHIPPED STONE TOOLS

The 207.75 m² excavated area produced a range of informal tools, including 1,380 edge-modified flakes that include utilized flakes, graters, rejuvenation flakes, spokeshaves, etc., as well as numerous formal stone artifacts, including 229 projectile points, 96 bifaces, 65 scrapers, 37 cores, 16 drills, seven unifaces, one anvil, and one hammerstone, and 26,323 pieces of lithic debitage, 18,698 bone pieces, 15,934 burned rocks, 115 ceramic sherds, and 45 mussel shell fragments. Each major class of lithic artifacts is described and discussed below.

The number of stone tools, formal and informal, totals 1,832. Individual attributes and metric characteristics are recorded for each piece, excepting edge-modified flakes. Summaries of attributes and metric measurements are provided for each tool class. The projectile point class is subdivided into identifiable point types to provide more detailed descriptions and characteristics. Tool classes are generally thought to represent specific activities, but several individual specimens from various tool classes were arbitrarily selected for use-wear analyses to investigate tool specific functions. Individual use-wear findings are presented

following each class summary. Each group is presented below, beginning with the identifiable types of projectile points.

8.1.1 Projectile Points

Projectile points are subdivided into 216 arrow points and 13 dart points. Seventy-six of the arrow points can be typed. They fall into nine existing typological groups (53 Perdiz, 10 Clifton, five Bonham, two Scallorn, two Guerrero, one Edwards, one Cuney, one Harrell, and one Padre), accounting for 35 percent of the arrow points, with remaining 140 (65 percent) consisting of untypable fragments. The 13 dart points, which make up slightly more than five percent of the total points, include four Frio, one Group 2, one Merrill, one Baker, and six unidentifiable dart point fragments. The nine different recognizable arrow point types are presented below as groups in order of their frequency. The dart points, Archaic-era objects assumed to have been either stratigraphically displaced or, alternatively, to have been picked up and used/discarded by Late Prehistoric site occupants, are subsumed under discussions of earlier components, according to their estimated chronological ages.

The 53 Perdiz points dominate (70 percent) the sample to typable arrow points (Figure 8-10). All recovered Perdiz points were from the Toyah component, including one that was found in backdirt. All were manufactured from fine-grained chert, with no cortex remaining on any of the thin flake preforms employed for their production. Only one point exhibits surface patination. Heat-treatment was not observed on any specimen. Only one specimen exhibits edge beveling. Thirty-eight percent are more or less complete, with 36 percent are proximal fragments, 19 are percent medial fragments, and nearly eight percent are distal segments. Many lateral edges were damaged with those still intact exhibiting mostly straight edges. Use is believed to have caused all of the observed breakage.

Figure 8-10. Selected Perdiz, non-Perdiz, and Clifton Arrow Points

Left to Right: Top Row: #726-011, #922-016, #158-021, #405-016, #159-025, #930-016, #534-014;
Second Row: #526-010, #302-021, #602-017, #945-016, #176-015, #405-015, #1098-010;
Third Row: #406-010, #1030-005-01, #473-010, #882-011, #1092-015;
Forth Row: #814-016, #12-010, #1154-010, #1183-010, #914-011, #943-018, #913-017

The metric measurements reveal size variability among the Perdiz points (Table 8-8). A complete Perdiz point (#441-16) and a Perdiz base with a reworked tip (#726-10) were subjected to use-wear analysis.

Specimen #441-16 revealed hard, high-silica polish on the stem, which is an indication of haft wear. Use-wear was evident from hard, high silica polish, indicating use on hard, high-silica material plant material. Specimen #726-10 is considered complete, although it exhibits a heavily reworked tip that has been narrowed to a fine point just above the shoulders. The use-wear analysis with high-power microscopy indicates this was a hafted graver and probably used once as a drill against hard contact material (Appendix M). The graver tip is broken, probably during use, with some abrasion on the tip. The contracting stem has deliberately ground edges.

Seven Perdiz specimens (#302-21, #482-10, #525-10, #526-10, #825-10, #1031-13, and

#1162-11) were subjected to for INAA. The results indicate that these were manufactured from Edwards chert obtained from the general Edwards Plateau region.

Ten Clifton points comprise 13 percent of the identifiable arrow points from the Toyah component, and with two were recovered from immediately underlying Late Archaic component. These two points were probably originally associated with the Toyah component, but were subsequently displaced into the earlier context. Metric data for the Clifton points is summarized in Table 8-9, with data on individual specimens in Appendix O. All were manufactured from fine-grained cherts and lack any sign of cortex or heat-treatment. Seventeen percent are complete, with the remaining 83 percent consisting of proximal ends. All breaks have probably occurred during use (Figure 8-9). Seventeen percent exhibit unifacial-beveled edges. The lateral edge shape varies from straight to slightly excurvate. All stems are contracting.

Table 8-8. Metric and Non-metric Observations on Perdiz Projectile Points from 41ED28

Characteristics	Range	Mean	Standard Deviation
Maximum length	23 - 40.8	30.5	5.8
Maximum width	10.1 - 26.7	16.7	3.9
Maximum thickness	2.1 - 5.5	3	0.6
Blade length	9.1 - 31.3	21.4	5.1
Blade width	2.6 - 25.5	14.4	4
Shoulder width	11.3 - 26.7	17.7	3.8
Left notch depth	1.7 - 7.6	4.1	1.4
Right notch depth	1.3 - 6.6	4.1	1.4
Left notch width	5.4 - 11.7	8	1.8
Right notch width	4.7-13.2	8.1	2.1
Left notch angle	10 - 45	29	7
Right notch angle	13 - 37	26	7
Stem length	4.8 - 14.9	8.6	2.5
Distal stem width	4.3 - 10.4	6.9	1.6
Proximal stem width	1.3 - 8.6	4.2	1.7
Stem thickness	1.1 - 3.2	2.3	0.5
Measurements in mm			

Table 8-9 summarizes metric and non-metric observations to provide for a general size range of Cliffton points. Four Cliffton points were selected for use-wear analysis to determine if these points showed signs of use as tools (other than as projectile points), or that they were preforms lacking use-wear. Specimen #22-14 is the proximal end of a Cliffton point with a contracting stem and a use break. Analysis revealed abraded ridges in the haft area that indicate it hafting in undetermined material (Appendix C). Specimen #1154-10 is the proximal end of a Cliffton point with a contracting stem and an apparent use break. Striations were observed on the stem, inferably from hafting, but no other use-wear was detected. Specimen #914-11 is complete, and has a contracting stem and some unifacial beveling along one edge. Hard, high silica polish was detected on the stem and use-related residue in the form of wood fragments was also detected along one edge. Striations in multiple directions indicate this specimen was use to cut wood (Appendix C). Specimen #943-18 is the

proximal section of a Cliffton point with a use break and two excurvate lateral edges. Plant fragments and striations in multiple directions were observed on the contracting stem. Observation indicates that this tool was hafted, probably with a plant binding, but the use and contact material are unknown (Appendix C). The use-wear analysis on these four Cliffton points indicates that the specimens in this type category functioned as tools. The use-wear data do not support the assumption that Cliffton points are Perdiz preforms, so they probably can be viewed as part of the functional tool assemblage.

Parts of four Cliffton points (#913-17, #967-24, #1002-13, and #1054-16) were sent for INAA to investigate source localities. The results consistently indicate manufacture from Edwards chert originating in the general Central Texas region (Appendix F).

Table 8-9. Metric and Non-metric Observations on Cliffton Points from 41ED28

Characteristic	Counts	Range	Mean	Standard Deviation
Maximum width	11	16.6 - 24.2	20.5	2.9
Maximum thickness	10	1.9 - 17.4	5.2	4.4
Blade length	11	14.5 - 22.7	18.9	2.9
Shoulder width		17 - 24.2	20.9	2.7
Left notch depth		1.4 - 3.8	2.4	0.9
Right notch depth		1.1 - 4.2	2.3	1.2
Left notch width		3.6 - 12.1	9.5	3
Right notch width		4.0 - 11.1	8.3	2.7
Left notch angle		27 - 47	38	6
Right notch angle		19 - 54	33	12
Stem length		3.5 - 8.4	6.1	1.5
Distal stem width		6.0 - 14.2	9.3	2.4
Stem thickness		1.6 - 3.7	2.4	0.6

Measurements in mm

Five Bonham point fragments, or 6.6 percent of the identifiable arrow points, were recovered from the Toyah component, whereas two other complete Bonham points recovered from immediately underlying immediately matrix. All Bonham point metrics attributes are summarized here, and the metric data on individual specimens may be found in Appendix O. The seven fragments include one distal end, two proximal pieces, and four complete specimens (Figure 8-10). One proximal (#282-17) and a distal end (#159-23) refit to form a fifth complete specimen. All were manufactured from fine-grained cherts, and the finished points lack any trace of cortex. No specimens appear heat-treated, and none are patinated. The overall shape is triangular with variously shaped lateral edges that exhibit rounding. The stems are straight, distinguishing them from contracting-stem Perdiz specimens.

The Bonham point measurements are summarized in Table 8-10. A complete Bonham

point (#473-10) with a straight stem and straight lateral edges (Figure 8-10) was submitted for use-wear analysis. Resin and polish were detected on the stem. This, coupled with a small impact fracture, indicates this was a hafted point with unknown contact material (Appendix C).

Four Bonham point fragments (#220-13, #262-20, #282-17, and #562-10) were subjected to INAA. The results indicate that these points were manufactured from Edwards chert from the general surrounding region (Appendix F).

Eight other identifiable arrow points, or 10.5 percent of the sample, were found within the Toyah component, but no more than two specimens are of any one type. These include two Scallorns, two Guerreros, one Edwards, one Cuney, one Harrell, and one Padre (Figure 8-10). Sufficient data are not available to meaningfully characterize any one type, though metric data on individual specimens are in Appendix O.

Table 8-10. Metric and Non-metric Observations on Bonham Projectile Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	26.8 - 40.2	32	6.1
Maximum width	11.2 - 20.8	17.1	3.7
Maximum thickness	2.5 - 3.5	3	0.4
Blade length	18.6 - 32.3	24.4	6.1
Blade width	11.0 - 20.1	15.1	4
Shoulder width	17.6 - 20.8	19.3	1.6
Left notch depth	3.2 - 6.4	5.1	1.7
Right notch depth	3.7 - 5.6	4.8	1
Left notch width	5.4 - 8.7	6.6	1.8
Right notch width	6.6 - 8.8	7.7	0.9
Left notch angle	14 - 47	29	17
Right notch angle	20 - 27	24	3
Stem length	7.2 - 8.2	7.7	0.4
Maximum stem width	5.3 - 6.4	5.9	0.6
Proximal stem width	5.3- 6.7	6.1	0.5

Measurements in mm

The two Scallorn points (#534-14 and 1092-15) were manufactured from fine-grained cherts. Their slightly differing metric attributes are presented in Appendix O. Specimen #1092-15(TRC257) revealed a chemical signature that is similar to other Edwards cherts from this southwestern area of the Edwards Plateau (Appendix F), suggesting that it was a locally produced point.

The two Guerrero points (#291-14 and #406-10) are small triangular pieces manufactured on flakes of fine-grained, unheated cherts. Both are quite small (Appendix O; Figure 8-10).

The Edwards point (#783-10) is a proximal fragment that exhibits a use break. It was manufactured from a fine-grained, unheated chert (Appendix O; Figure 8-10).

The Cuney point (#349-13) is complete and made from a flake of a fine-grained chert with straight lateral edges that are slightly worn or rounded. The point has a straight stem that is wedged shaped in cross section. The INAA results (TRC223) indicate a chemical signature that is similar to other Edwards chert from this southwestern region, generally similar to the sources in Kerr County (Appendix F). Therefore, the material appears to be from local sources.

The Harrell point (#882-11) exhibits a use break. It was manufactured from a fine-grained chert.

The Padre point (#1030-5-10) is complete and manufactured from a fine-grained, unheated chert. This small, complete bi-pointed point from Feature 38 has edge rounding on excursive lateral edges (Figure 8-10). Use-wear analyses revealed oblique striations, polish, and plant fragments in the haft area, which indicates this bipointed tool was hafted and used on unidentified plant material (Appendix C).

Sixty-five percent, or 140 total of all arrow points recovered from the Toyah component, cannot be assigned to types, largely because of

fragmentation. These fragments are quite similar in overall form and style to the Perdiz, Clifton, and Bonham points. However, they lack specific morphological attributes, most notably the stem, to permit type identification. Of the 140 specimens, 45 percent represent distal fragments, 42 percent are medial fragments, nine percent are proximal fragments, nearly three percent are complete, but not assignable to type, and less than one percent are small indeterminate pieces. One complete specimen (#967-23) is somewhat similar to a Clifton, but the stem is broader than is generally the case with Clifton points (Figure 8-11). A second complete specimen (#303-15) is larger than most Perdiz, and the stem does not have the contacting form that characterizes the Perdiz type (Figure 8-11).

Figure 8-11. Selected Other Late Prehistoric Arrow Points

Left to Right: #303-015, #967-023

It is similar in overall form to a Bonham, but is much larger than other Bonham points. It has also been slightly reworked along some of the margins. Both of these points have ultraviolet fluorescence that is similar to the known Edwards chert colors. It is assumed that both materials were locally derived.

Three arrow point fragments (#572-15 = TRC229, #845-10 = TRC237, and #1101-13 =

TRC258) were selected for INAA. The INAA results indicate that these pieces were manufactured from Edwards chert from the general region (Appendix F).

Thirteen dart points were recovered from the Toyah component. This includes four Frio points (#220-14, #525-5-13, #526-11, and #916-10) that are of Late Archaic age. These probably did not originate from this component, but were displaced from the underlying Late Archaic component. The data on these points are presented in the Late Archaic component section. One Group 2 dart point (#324-16), one Baker point (#653-12), and one Merrell point (#157-11) are Early Archaic types that may have been curated items or displaced from the Early Archaic component, where all these types are represented. Six other unidentifiable dart point fragments were also recovered from the Toyah component.

8.1.2 Bifaces

Another class of chipped stone tools is bifaces. The 96 bifaces were all manufactured from fine-grained cherts with cortex remaining on less than four percent (Appendix O). About five percent were heat-treated with another 17.5 percent burned. Seventeen percent are complete and unbroken, whereas 30 percent are distal fragments, 25 percent are medial fragments, 10 percent are proximal fragments, and nine percent are from indeterminate portions of the original artifacts. Forty-four percent exhibit use breaks, 15 percent have breaks of indeterminate origin, 17 percent are unbroken, 17 percent were thermally broken, and only seven percent were broken during manufacturing. Sixty-nine percent are late stage bifaces, 19 percent are middle stage, and only five percent are early stage, with another five percent indeterminate in terms of stage of manufacture (Figure 8-12). These bifaces show no rejuvenation scars, but seven percent exhibit some beveling along their edges. Five percent exhibit some patination, which includes two

pieces that have completely patinated surfaces: one piece that is about 75 percent patinated and two that are about 25 percent patinated. Patination on material this relatively young age is unusual. It is possible that these five pieces were displaced from older contexts or were older pieces collected and brought into the site.

Only limited metric measurements could be made on these bifaces since 83 percent are fragments. Measurements that are available provide some indication as to the average size and range of variability. The lengths range from 40 to 123.5 mm, with 20 measurements providing an average of 65.6 mm (Appendix O). The widths range from 21.3 to 58.3 mm, with 43 pieces and providing an average of 34.4 mm. The thicknesses range from 3.6 to 24 mm, with 81 pieces yielding an average of 8.4 mm.

Five bifaces were selected for use-wear analysis. Specimen #159-5-28 is a complete, late stage biface that has alternate, unifacial beveling. This is a typical four-beveled knife that is often thought of as representative of the bison-processing during the Toyah phase. Wood residue and striations parallel and perpendicular were observed on the proximal end. Use-residue in the form of hair fragments and starch grains plus hard, high silica polish indicate multiple uses that included cutting and possibly piercing on high-silica plants and possibly animals (Appendix C).

Specimen #220-15 is the distal end of a late stage biface with a use break and no evidence of reworking. Residue in the form of feather barbules and wood coupled with striations to the edge and light polish indicate cutting of wood and possibly bird (Appendix C). Specimen #903-22 is a complete early stage biface with alternately beveled unifacial edges. Wood residue was observed and hard, high silica polish indicates whittling of wood (Appendix C). Specimen #934-19 is a late stage distal section with a use break.

Figure 8-12. Selected Toyah Phase Bifaces

Left to Right: Top Row: #1256-005-011, #1085-013, #159-005-28, #1041-014;
Second Row: #878-021, #835-013, #244-013, #969-020, #945-011

Wood tissue and hard, high silica polish indicates cutting action on wood (Appendix C). Specimen #937-10 is a proximal section of an early stage biface with unifacial edge beveling and a use break. Wood fragments and hard, high silica polish indicate scraping of wood (Appendix C).

Five bifaces (#159-5-28 = TRC214, #220-15 = TRC218, #903-22 = TRC243, #934-19 = TRC246, and #1041-14 = TRC253) were submitted for INAA. The chemical signatures appear to represent the Edwards chert group and are considered locally derived from the region.

8.1.3 Scrapers

Of a total of 65 scrapers, 69 percent are end-scrapers, 22 percent are side-scrapers, and eight percent are combination end- and side-scrapers. Less than one percent cannot be assigned to any of these groupings (Figure 8-13; Appendix O). All were manufactured from fine-grained cherts with about eight percent appearing to have been heat-treated. Only five percent exhibit any sign of patination, whereas 30 percent exhibit some remaining cortex. The three partially patinated specimens probably do not originate in this component and may reflect specimens that were displaced from older components. Sixty-three

percent are complete, 25 percent are distal fragments, eight percent are proximal fragments, two percent are medial fragments, and three percent are indeterminate fragments. Only three percent exhibit rejuvenation scars. The scrapers are in a variety of basic shapes with 33 percent indeterminate, 20 percent irregular, 14 percent ovate, nine percent lanceolate, eight percent teardrop, six percent round, and nine percent other shapes. Of the 14 broken specimens, 71 percent were apparently broken during use, 14 percent by thermal fracturing, seven percent have breaks of indeterminate origin, and seven percent were broken during manufacture. Fifty-three percent exhibit a single working edge (bit), 27 percent have two worked edges, 16 percent have three, and five percent have four working edges. Edge rounding was observed on 67 percent.

Table 8-11 provides a summary of metric measurements from the scrapers to provide information on their size range, variability, and specific attributes. The secondary working edge (bit 2) is located on 73 percent of the specimens, along the lateral side, on 13 percent along the distal end, and is along the lateral/proximal area on ten percent. The shape of the secondary working edge is straight on 60 percent of the specimens, excurvate on 30 percent, and incurvate on 10 percent. That working edge is regular and continuous on 60 percent, irregular and continuous on 30 percent, and discontinuous on 10 percent. The secondary working edge is also summarized in Table 8-11.

Six scrapers were selected for use-wear analyses. Specimen #800-11 is a complete, irregularly shaped end-scraper. Resin and striations were observed on the edge, coupled with hard, high silica polish indicating planing and scraping of hard, high-silica material such as bone, antler, or wood. Specimen #888-14 is a complete, teardrop-shaped end scraper. Resin and striations were seen on the proximal end, and plant fibers, striations parallel and

Table 8-11. Metric and Non-metric Observations on Scrapers from 41ED28

Characteristic	Range	Mean
Maximum length	32.5 - 108.4	65
Maximum width	21.6 - 84.3	44.2
Maximum thickness	5.2 - 26.5	12.7
Weight	8 - 187.7	45.4
Worked edge 1 - length	16.8 - 123.5	47.6
Worked edge 1 - thickness	2.4 - 16.5	6.9
Worked edge 1 - angle	44 - 8	68
Worked edge 2 - length	9.4 - 53.9	29.6
Worked edge 1 - thickness	1.2 - 7.4	3.8
Worked edge 1 - angle	38 - 77	59

Measurements in mm

perpendicular to the edge, together with high, hard silica polish indicate planing on a hard, high-silica plant (Appendix C). Specimen #903-12 is a complete, irregularly shaped side scraper with residue and soft polish indicating scraping of soft material (Appendix C). Specimen #903-24 is a distal section of an end-side scraper. Plant tissue and starch grains were observed together with hard, high silica polish and striations parallel and perpendicular to the edge that indicate planing hard, high-silica starchy plants starch (Appendix C). Specimen #1023-12 is a distal section of an end-side-scraper. Hard, high silica polish and edge rounding was observed and indicates planing hard, high-silica material (Appendix C). Specimen #1132-10 is a complete, teardrop shaped side-scraper. Hair and edge rounding and marginal polish indicate scraping of hide (Appendix C). The scrapers were apparently were frequently used for working plant and animal products, and were not restricted to scraping hides, as is often assumed.

Five scrapers (#800-11 = TRC231, #888-14 = TRC239, #903-12 = TRC242, #903-24 = TRC244, and #1132-10 = TRC259) were sent for INAA. The chemical results indicate these were part of the known Edwards chert group from the southwestern area of the Edwards Plateau (Appendix F).

Figure 8-13. Selected Toyah Phase Scrapers

Left to Right: Top Row: #1052-012, #1270-010, #1041-013, #116-010;
Second Row: #967-021, #952-012, #982-012, #1002-019

No specimens appear to have originated from outside the region and therefore, the chert was considered locally derived. One specimen (#888-14 = TRC239) has a chemical signature that is towards the currently known southwestern edge of the Edwards Plateau (Edwards and Val Verde counties), but does not reveal the same yellow to orange ultraviolet fluorescence known for other Edwards chert. This dark green chert exhibits a dark purple fluorescence. This is one of the few pieces of chert that does not look like Edwards chert but that is in fact indicated to be such, based on INAA.

8.1.4 Unifaces

The seven unifaces exhibit most of one face completely worked and are a separate tool class from scrapers, as these tools do not exhibit a steep working edge (Figure 8-14). These unifaces include two specimens that are complete, two indeterminate sections, and one distal, one medial, and one proximal section (Appendix O). Eighty-six percent of the unifaces are of fine-grained chert, with the other an unidentified kind of fine-grained rock. No specimen exhibits any cortex or patination. The edge flaking is quite variable as is the location of the worked edge(s). Forty-three percent have two worked edges. Their overall size varies in

Figure 8-14. Selected Toyah Phase Unifaces

Left to Right: Top Row: #990-015, #196-011, #1171-013;
Second Row: #1022-005-010, #159-005-27, #1055-013

length from 47.9 to 53.2 mm, with an average of 50.2 mm. The width ranges from 23.7 to 64.4 mm, with an average of 37 mm. The thickness ranges from 3 to 11.7 mm, with an average of 6.4 mm.

A single lateral, uniface fragment (#159-5-27) was sent for use-wear analysis. This piece has two worked edges, one with irregular continuous flake scars along an excurve lateral edge and one edge with regular discontinuous flake scars along an excurve edge. The observed plant fiber and starch grains are use-residue together with hard, high silica polish that indicates scraping of hard, high silica plants with starch (Appendix C). No unifaces were sent for INAA.

8.1.5 Drills

The 16 drills were all manufactured from fine-grained chert, none of which appears to be heat-treated, and only 12.5 percent of which exhibits small areas of cortex (Appendix O). Ninety-four

percent were manufactured from thin flakes (Figure 8-15). Only one specimen is complete, 25 percent are distal fragments, 31 percent are proximal fragments, and 37.5 percent are medial fragments. The break shapes indicate that these drills were broken during use. On the specimens with measurable sections, the metric attributes provide a general understanding of their size and shape. The six pieces with measurable proximal ends indicate an average length of 18.8 mm, average stem width of 17.6 for nine pieces, and an average thickness of 4.2 mm on 13 specimens. Sixteen pieces indicate an average bit width of 6.1 mm.

Two drills were subjected to use-wear analysis. Specimen #800-10 is a proximal section including part of the bit, with edge rounding and a use break. Plant fragments and light polish were observed, but the action is undetermined (Appendix C). Specimen #893-16 is a distal bit, which revealed hard, high silica polish and light

Figure 8-15. Selected Toyah Phase Drills

Left to Right: Top Row: #1054-019, #859-016, #837-011, #726-010, #989-010, #875-018;
Second Row: #260-014, #624-014, #827-012, #1074-015

polish indicating a hafted tool used for cutting unknown material (Appendix C).

Two drills (#895-12 = TRC241 and #974-11 = TRC247) were also sent for INAA. Results indicate that these two specimens were manufactured on Edwards chert, probably from the general region of the Edwards Plateau (Appendix F).

8.1.6 Edge-Modified Flakes

A total of 1,380 edge-modified flakes were identified and represent a wide range of shapes, sizes, and tool functions.

One unique edge-modified flake (#869-10) is manufactured from a 4.6 g piece of glass that exhibits a crushed platform and a tapered distal end with one relatively straight lateral edge that is partially modified (Figure 8-16). This piece measures 28.1 mm long, 25.7 mm wide, 6.2 mm

thick and was recovered from 10 to 20 cmdbd in Unit N119/E72.

Thirty-three edge-modified flakes of various sizes and shapes, with different flake scar patterns, probably functioned variously as graters, spokeshaves, cutting and scraping edges, were selected for use-wear analyses (Appendix C). Specimen #109-11 has hard, high-silica polish that indicates scraping hard, high silica material. Specimen #168-10 revealed wood fragments and hard, high-silica polish indicating it was used to scrape wood. Specimens #207-11 and #281-15 reveal hard, high-silica polish and edge rounding implying scraping of hard, high silica plant material. Specimens #314-10 and #781-10 reveal hard, high silica polish plus striation perpendicular and parallel to the edge, indicating whittling of hard, high-silica plant (wood?) material. Specimen #781-10 exhibits striations in multiple

Figure 8-16. Miscellaneous Toyah Phase Artifacts

Clockwise from Top Left: #1025-013, #1042-006, #79-005-002-015, #1054-021, #481-015, #1075-006, #869-010

directions and hard, high silica polish from hafting, and soft polish indicative of scraping soft material. Specimen #800-12 exhibits hard, high silica implying cutting of hard, high silica material. Specimen #806-17 reveals hair with scales and medulla plus oblique striations indicating slicing of animal hide. Specimen #837-19 is a perforator with striations in multiple directions and hard, high silica polish implying boring of hard, high silica woody material. Specimen #881-17 has wood fragments, hard, high silica polish, and micro-scarring implying whittling of wood. Specimen #885-10 also has wood fragments, edge rounding, and oblique striations indicating slicing wood.

Specimen #931-11 reveals hard, high silica polish that implies whittling of hard, high silica material. Specimen #999-10 reveals hair and possible blood residue plus oblique striations indicating hide scraping. Specimen #1019-10 exhibits hard, high silica polish and striations indicative of slicing hard, high silica material. Specimen #1019-18 exhibits a polish that implies scraping soft material. Specimen #1020-

10 reveals wood fragments and hard, high silica polish indicating scraping of wood. Specimen #1029-5-11 has hard, high silica polish with striations parallel and perpendicular to the edge, implying scraping of hard, high-silica material. Specimen #1032-10 exhibits hard, high silica polish indicating scraping of hard, high silica material. Specimen #1074-11 has plant tissue and high silica polish indicating whittling of hard, and high-silica material. Specimens #1190-10 and #1194-10 show hard, high silica polish implying planing of hard, high silica material.

Three edge-modified pieces, which are classified as spokeshaves, were examined for use-wear. Specimen #358-10 has plant fibers and hard, high-silica polish that indicates scraping hard, high silica plant material. Specimen #1024-11 exhibits wood fragments, hard high silica polish, and striations parallel and perpendicular to the working edge implying use in scraping wood. Specimen #1036-15 also has wood fragments, oblique striations parallel and perpendicular to the edge, indicating use in the planing of wood.

Five edge-modified pieces are classified as rejuvenation flakes because they appear to have been removed as part of the rejuvenation of the tool edge. These edge-modified flakes were subjected to use-wear analyses. Specimen #805-13 is unifacial, with regular continuous scars along one excurvate edge. Use-wear exhibits hard, high polish that indicates planing hard, high silica material. Specimen #811-12 is a bifacial edge with irregular continuous flake scars and edge rounding, along one excurvate edge. It exhibits hard, high polish that indicates scraping hard, high silica material. Specimen #841-13 is unifacial with regular continuous flake scars along a straight edge. It exhibits soft polish and striations parallel and perpendicular to the edge, indicating scraping of soft material. Specimen #999-13 is unifacial with regular continuous flake scars along a straight edge with edge rounding. Use-wear is present in the form of hard, high silica polish and striations parallel and perpendicular to the edge indicating scraping hard, high silica material. Specimen #1038-12 is unifacial with regular continuous flake scars along three bits. It exhibits hard, high silica polish implying scraping hard, high silica material.

Three edge-modified pieces, which are classified as gravers, were subjected to use-wear analyses. Specimen #836-10 is the distal end with three worked sections and a use break. It has hairs and striations in multiple direction and soft polish, which indicates cutting of animal parts. Specimen #934-11 exhibits abraded flake-scar ridges indicating hafting plus hard, high silica polish, striations in multiple directions implying a hafted scraping tool used on a hard, high silica material. Specimen #1088-10 exhibits plant cells with striations that indicate slicing wood (Appendix C).

Specimen #837-11 exhibits a very short stem section with a relatively large base creating the appearance of a stubby, projectile point (Figure 8-15). The use-wear analysis revealed

this functioned as a hafted graver (Appendix M). The graver tip is still present, and slightly rounded with striations in several directions at the edge, indicating a rotary motion. The contact material was soft to medium soft such as deciduous wood. The haft area exhibits striated use plating wash typical of wood contact (Appendix M).

Eight edge-modified flakes were sent for INAA. All specimens appear to have chemical signatures similar to known Edwards cherts from the southwestern region (Appendix F). It is assumed these pieces were all from locally available Edwards chert sources.

8.1.7 Anvils

The one anvil (#405-17) is an irregularly shaped, complete water-worn limestone. Most of one face exhibits two or three areas less than 10 mm in diameter that appear to be artificial pits. These are relatively shallow and of ill defined shape. Much of this same face is generally pitted. The opposite face and part of the lateral edges are also pitted, but that face has a more natural appearance. No flake scars or impact fractures are apparent that would indicate this cobble was used as a hammerstone. It measures 10.9 mm long, 90.9 mm wide, 41.3 mm thick, and weighs 538.4 g.

8.1.8 Hammerstones

The one hammerstone (#864-16) is a complete, rather round, limestone cobble. It exhibits two worked areas on either end. One end exhibits an area about 18 mm wide and 50 mm long that is rough and pitted compared to the other natural surfaces. The opposite end exhibits one or two points where impact has resulted in the removal of some of the limestone. This impact area is about three centimeters in diameter. The overall cobble measures 60.4 mm long, 55.5 mm wide, 40.6 mm thick, and weighs 167.3 g. The hammerstone was recovered from 0 to 10 cmbd in Feature 8, in Unit N119/E70 of Block B.

8.1.9 Cores

Thirty-seven cores were recovered from Blocks A and B. Eighty-one percent are complete, 11 percent are exhausted, and 5.4 percent are fragments (Appendix O). Bifacial cores account for 56.7 percent, multi-directional cores account for 40.5 percent, and unifacial cores account for 2.7 percent. All are of fine-grained cherts with 83.8 percent exhibiting some cortex. The cortex is smooth and water-worn, indicating the pieces were collected from alluvial contexts rather than upland locales. About six percent appear to have been heat-treated to improve their knapping quality. The complete cores range in length from 57.6 to 138.9 mm with an average of 89.4 mm. The width ranges from 39.1 to 77.3 mm with an average of 68.5 mm. The thickness ranges from 19.6 to 57.8 mm with an average of 43.2 mm. No cores were subjected to any technical analyses.

8.2 DEBITAGE

8.2.1 Unmodified Debitage

Just over 26,000 pieces of lithic debitage were recovered from this component, and this represents about 41 percent of the total cultural materials recovered from this component. If the bone class is subtracted from the total to enable comparisons with components without bone, then the lithic debitage represents about 59 percent of the non-perishable remains.

Each of the two excavation blocks in the Toyah component was sampled to determine what, if any, activity areas may be definable. About 10 percent (n=1036) of the debitage from Block A was analyzed to determine which stages of raw material reduction and tool production, manufacturing, and maintenance processes are represented. The selected sample was derived from eight different units across the southern half of the block where cultural context was clearest.

About 84 percent of the sample from Block A exhibits some evidence of heat alteration in the form of spalling and cracking due to exposure to excessive heat. Blades are nearly non-existent in the sample, with only three identified. Early stage biface manufacturing flakes comprise 14 percent of the analyzed debitage, whereas the late stage biface flakes represent 20.8 percent. A moderately high frequency of angular debris/shatter is represented by 20.2 percent. Tertiary thinning and retouch flakes are moderately represented by 16.3 percent. Indeterminate pieces account for about 10.5 percent. The core reduction flakes, which reveal minimally 50 percent cortex, are represented by about 17.9 percent.

This sampled assemblage indicates moderate frequencies of unintentional heat alteration, which is difficult to explain. Only one unit of the sample was immediately adjacent to a hearth feature (Feature 21), but minimally five sampled units yielded relatively high frequencies of heat-altered flakes. The relatively moderate representation of core flakes, early stage biface flakes, and thinning flakes indicates that cobbles with cortex were reduced and roughed out into bifaces, which were then thinned. The relatively high frequency of late stage biface flakes and angular debris further support the complete processing of tools, from the initial cobble reduction to finished forms. The near absence of blades indicates that the cores were reduced in a random and multidirectional fashion, without attention to the production of regularly shaped blades. No uniface resharpening flakes were identified in the sample.

In Block B, just over nine percent of the debitage (n=1447) was analyzed to determine which stages of raw material reduction and tool production, manufacturing, and maintenance processes are represented. The selected sample was derived from 23 of the 125 units from across the entire block where context was best defined.

Nearly 88.4 percent of the pieces exhibit some form of heat alteration, which is very similar to that detected in Block A. Relatively high frequencies of late stage biface flakes are present as indicated by the fact that these comprise 32.4 percentage of the sample. A moderate to high incidence of tertiary thinning and retouch flakes are represented by 22.1 percent. Moderate frequencies of the early stage biface thinning flakes are 15.1 percent of the total. Core reduction flakes represented by 10.4 percent, angular debris represented by 9.7 percent, and indeterminate pieces represented by 10.2, all relatively low percentages.

The frequencies represented here indicate a focus on late stage biface production. Bifaces appear to have been made from both flakes and cobbles, and the early stages of bifacial reduction, including initial cobble reduction, were conducted in this area. Flakes were also produced from cores. In general, similar types of core reduction flakes, biface production flakes, tool finishing and resharpening flakes occurred across Blocks A and B. The major difference is that some stages of the production sequences are higher in frequencies in some areas and lower in others.

8.2.2 Toyah Rejuvenation Flakes

The Toyah assemblage includes 28 pieces classified as rejuvenation flakes (Figure 8-17). These parts of chipped stone tools were intentionally removed from the parent tool as a step in resharpening the edge. These pieces generally show a small segment of the parent tool edge from which they were removed. Block A yielded 13 specimens compared to 15 specimens from Block B, which encompassed nearly 2.2 times the volume as Block A. Five rejuvenation flakes were selected for use-wear analysis. All pieces are fine-grained cherts with mostly regular and continuous retouch along one edge. Three of the old worked edges exhibit some edge rounding.

Specimen #805-13 was removed from a uniface and exhibits hard, high silica polish interpreted as a result of use in a planing action (Appendix C). Scraping actions are inferred based upon polishes exhibited on specimens #811-12, #999-13, and #1038-12. Specimen #841-13 exhibits similar hard, high silica polish consistent with use on soft material. The polish observed on these tool fragments generally indicates a dulled edge, primarily from scraping hard or soft materials, and therefore, supports their classification as rejuvenation flakes. The high frequency of dulled edges and intentional rejuvenation, indicates intensive use of scraping tools followed by resharpening and reworking of the new edge for continued use of the tool.

At least 25 percent of the rejuvenation flakes were removed from the steep faces of unifacial scrapers. The point of impact appears to have been directed into the face of the worked end of the working bit, thus removing part of the steep tool edge. The flat ventral surface is present on these pieces.

Figure 8-17. Selected Toyah Phase Rejuvenation Flakes

Left to Right: Top Row: #999-017, #943-015, #999-013;
Second Row: #1078-014, #1008-015, #841-013, #393-017;
Third Row: #376-012, #805-013, #1038-012, #324-011,
#811-012

Some 13 pieces, from 12 different units, were identified in the 83-m² of Block A. Another 15 were recovered from 14 units in the 124.75 m² of Block B. In Block A, these rejuvenation flakes were concentrated (92 percent) within a 3-m-wide area just south of the BT 2 and may reflect a locus of stone tool maintenance activities or a general discard area. These pieces were not in direct association with the two burned rock features in the southern part of this block. A high percentage of those in Block A are the lateral edges of thin, edge-modified pieces. In Block B, none of the 15 pieces were encountered directly in either of the proposed discard areas (Features 8 and 25). Ten, or 67 percent, were discovered in the northern part of the block with only one unit that yielded more than one. The remaining five pieces were in the southern part of the block in five different units with minimally one meter between them. No apparent pattern was determined from their distribution across Block B. Minimally, 50 percent of these in Block B are steep unifacial edges removed from scrapers.

8.3 MISCELLANEOUS ARTIFACTS

Seven artifacts comprise this group, which includes three bone tools, one piece of drilled freshwater mussel shell, one drilled marine shell bead, one ground marine shell fragment, and a clay figurine-like object. Each item is described below, and this is followed by a general discussion.

The drilled mussel shell fragment (#1042-6) was discovered in Unit N127/E71 in Block B at 20 to 26 cmbs. It measures 11.1 mm in diameter by 1.2 mm thick (Figure 8-15). Along one broken edge is about one half of a drilled hole that measures 3.1 mm in diameter. The hole appears to have been drilled from one side, the concave, or interior, side, and is slightly tapered. Both the current interior and exterior surfaces are bright and shiny and exhibit no other alterations. This mussel shell was perhaps a pendant or a bead.

Specimen #1025-13 is a well made marine shell bead from Unit N126/E75 in Block B at 20 to 30 cmbs. It measures 8.05 by 8.16 mm in diameter, is 1.27 mm thick with a 2.73 mm diameter hole in the middle (Figure 8-16). The hole is not tapered, although the edges on both surfaces are rounded. The outer edge is also rounded. This bead appears to be a trade item from the Gulf coast, given that it was made from a marine shell.

Specimen #1075-6 is a marine shell fragment discovered in Unit N128/E72 in Block B at 30 to 35 cmbs. It measures 9.8 mm long, 9.1 mm wide, 1.6 mm thick, and weighs 0.1 g (Figure 8-16). It is slightly curved with part of one edge artificially rounded. The other three edges are all broken. The broken edge opposite the rounded edge exhibits a two-layered appearance, indicative of the internal structure of the shell. The layer towards the interior side is relatively flat in cross section, whereas the outer layer is quite rough and jagged. It is not clear what the completed shell looked like. Often traded shell is used as a decorative ornament, which may be the case with this specimen.

Specimen #79-5-2-15 is the distal end of a well-formed bone awl that was encountered in Feature 21, in Unit N100/E50 of Block A, at 12.5 cmbs. A piece of charcoal (#78-5-7-1b) from Feature 21 was radiocarbon dated to 380 ± 30 B.P (Beta-183623). This pointed awl section measures 41.3 mm long, 5.8 mm wide near the broken proximal end, 4.0 mm thick near the middle of the segment, and tapers to a point of 1.3 mm thick at the distal end (Figure 8-16). The awl is ovate in lateral cross section, and the pointed distal end is missing the very tip. This awl is very smooth with polish over most of the surface. Microscopic observation reveals grinding/sanding striations over most all surfaces and only slight, shallow root etching. Along one of the flatter sides, a series of eight intentional cut marks are present perpendicular to the long axis. This edge reflects the interior

of the bone fragment once containing cancellous tissue and exhibits a slightly rough surface. The cuts completely traverse the one flat surface and extend slightly onto the lateral edges, though they do not circumscribe the tool. These cut marks are not spaced evenly and vary in technique from one to the next. Beginning at the pointed distal end each cut line will be described. The first cut is a single line that extends along about half of the tool circumference. The second is a single cut line that extends to about half the circumference. The third looks like a mis-start, as it is a short single cut at the edge of the flat surface. The fourth line appears as multiple cuts in the same place that extend slightly farther around the circumference than the first two cuts. The fifth line is a series of four cuts that are not as deep or well-executed as the fourth, and do not extend onto the lateral sides. The sixth line is two, and possibly three cuts, not quite as deep as the fourth, and extends onto the lateral sides. The seventh and eighth cut lines are two closely spaced single, shallow cuts, which extend just onto the lateral edges. The broken proximal end exhibits a fry bone break that is stepped. It is not clear how the steps were created.

Specimen #481-15 is a distal end of pointed bone tool that was recovered Unit N105/E56 in Block A between 10 and 20 cmbs. This is a long bone splinter that measures 46.0 mm long, 13.2 mm wide, 12.2 mm thick, and weighs 7.0 g (Figure 8-16). The thickness indicates that it is probably bison bone. The two opposite sides are broken edges, but they are quite flat. This breakage has yielded a relatively square four-sided tool that tapers to a blunt end. Minimal polish covers the high spots on all sides. The blunt end does not appear to have been prepared, as no grinding striations are present. The broken proximal end exhibits an unknown break type with a slightly high spot near the middle.

Specimen #1054-21 is a bone bead blank discovered in Unit N127/E75 in Block B

between 20 and 30 cmbs. It measures 39.4 mm long, 8.9 mm wide, 7.3 mm thick, and weighs 2.1 g (Figure 8-16). The bone exhibits a 4.7 mm wide cavity at the broadest end and tapers to 3.3 mm at the opposite end. Based on its general shape, the bone resembles a jackrabbit tibia, although the diagnostic articular ends are missing. Most surfaces exhibit a polish, and the bone has been deeply incised by three cuts dividing it into four nearly equal sections. The ends of each section exhibit deep grooving that encircles the bone and cuts through most of the cortical wall; one of the grooves cuts through the cortical wall into the cavity. The deep grooves vary in thickness from about 0.9 to 1.6 mm wide. Remnants of similar grooves are located at each end of the bone indicating that other pieces were removed. Each potential bead is about 8.9 mm long.

Specimens #840-8 and #891-10 are two parts of the same well-made clay object with an unknown function (Figure 8-18). The smaller piece (#840-8) was discovered in Unit N118/E69 and the larger piece (#891-10) was found in Unit N120/E74. Together the two broken objects measure 42.9 mm tall, 30.3 mm wide, and weigh 22.1 g. These two pieces were located 1 to 2 m apart and may reflect post depositional displacement. Combined, the two pieces represent about 95 percent of one unique clay object with a somewhat flat to irregular base, a bulbous main section that constricts to a narrower terminus (Figure 8-18). The very top is broken off, much of one side is missing, and two breaks are present on the opposite end. One break is located on what appears to be some type of an extension or protrusion extending beyond the main body. The other break appears to have removed part of the body. The shape provides few clues about the function of the object. The exterior surface is reddish brown (2.5YR 5/6), the core is gray (10YR 5/1), and the interior surface is grayish brown (10YR 5/2).

Figure 8-18. Unique Toyah Phase Clay Object

The interior reflects an irregular, slightly triangular concavity that is about 19.0 mm tall, about 16.5 mm wide, and is slightly offset from the center of the object. This interior concavity appears to have been intentionally shaped, but is not smoothed or polished and lacks any indication as to how it was formed.

The exterior is smooth, but bears three or four sets of very thin and faint striations that may be the result of a smoothing technique. The break located at the junction of the base and side, at

what appears to be a protrusion, is about 12.6 mm tall by 11.4 mm wide. A finished area measuring about 6.5 mm wide separates one break from the other. The second break, also along the bottom edge juncture, covers an area measuring 14.1 by 12.5. Aplastic inclusions are not macroscopically visible on the surfaces.

The smaller fragment was cut into two parts. One fragment (#840-8-1b) was subjected to INAA, and the other (#840-8-1a) was used in petrographic analysis. The petrographic results

indicate this piece was tempered with 10 percent bone, significantly less frequent than the ceramic sherds from the Toyah component. Ferrous iron is the most abundant aplastic at 16 percent, followed by coarse silt and fine sand size particles of indeterminate mineralogy, presumably a natural clay resident. This mineral was not found in any of the examined potsherds from the site. This clay object is assigned to a separate and unique paste, Group—B-b. Other natural clay inclusions include 7.5 percent quartz, significant amounts (16 percent) of hematite, traces of limestone and orthoclase, and an unidentified mineral indicative of a non-local origin. The clay matrix is light tan to greenish gray and isotropic (Appendix D).

The INAA (TRC279) determined that this piece is chemically and statistically (less than 4 percent probability of membership) different from all Toyah potsherds from the Varga Site, the 201 sherds composing the Central Texas reference groups 1 and 2, as well as analyzed samples of historic native pottery from Mission San Juan and Mission San Lorenzo (Appendix F). It is currently unassigned to any known chemical group in this database, in accord with the petrographic analysis results, which separate this piece from all other pieces analyzed here, and establish a separate paste group (Appendix D). The combined petrographic and INAA results, thus appear to indicate that this piece was not manufactured in the same locales places as the other ceramics, suggesting that it was obtained through some avenue of exchange of trade.

8.4 VERTEBRATE FAUNAL REMAINS

The 207.75 m² of hand-excavations of Toyah component yielded a total of 20,438 vertebrate specimens weighing 17,348.9 g. This includes the bone fragments discovered directly associated with various Toyah events and most of the bone fragments from the upper part of the Late Archaic burned rock feature resting immediately under the Toyah component.

During excavation it was apparent that many small bone fragments had been displaced down profile into the matrix between the Late Archaic burned rocks. Virtually no bone was detected in the lower part of the Late Archaic component at or near the base of Feature 1. Most bone fragments recovered from the Late Archaic component are in the same condition as the bones from the Toyah component. Identical preservation, including size and color of the fragments combined with the type and species of bones recovered, was found in both components despite an age difference of nearly 1,000-radiocarbon years between the two components.

One long bone fragment (#89-5-2-1), recovered 20 to 30 cmbd in Feature 1a in Unit N100/E51, was assigned to the Late Archaic component and was radiocarbon dated. This specimen exhibits a somewhat dark color, as though lightly burned, and bears acid etching on its interior and exterior surfaces. Cortical thickness ranges from 3.1 to 3.9 mm within the range of deer or antelope. This bone yielded a $\delta^{13}\text{C}$ corrected (-31.6‰) AMS radiocarbon age of 890 ± 40 B.P. (Table 8-1: UGA-12708), older than the Toyah component by some 300 years and some 800 years younger than the dates for the Late Archaic component. An extremely negative $\delta^{13}\text{C}$ value of -31.6‰ is nearly 10.0‰ more negative than expected for deer or antelope bones and indicates some type of contamination. This isotope value has caused the reported radiocarbon date to be younger than a bone with a more acceptable $\delta^{13}\text{C}$ value of -21.0‰. A second long bone sample (#293-2-1) that was recovered from the Late Archaic context at 20 to 30 cmbd in Unit N102/E52 yielded a $\delta^{13}\text{C}$ corrected (-9.8‰) AMS radiocarbon date of 860 ± 40 B.P. (Table 8-1: UGA-12713), a nearly identical result. Although the light-colored appearance of this bone indicated it was potentially of Toyah, the assay is again around 300 years older than the Toyah component, but still much younger than the dated Late Archaic component. The isotope value of -9.8‰ implies

this bone was from an animal that had consumed mostly C₄ grasses, which is indicative of a bison. The results of these two radiocarbon dates, the observations in the field, and the appearance of the fragments themselves guided our interpretation that most yellowish and fresh appearing bone fragments recovered from the Late Archaic component were originally associated with the Late Prehistoric component—Toyah materials. Inferable, they appeared to be associated with the Late Archaic burned rocks as the result of what amounts to minor downward translocation.

Generally, the Toyah bone assemblage was recovered from within 30 cm of the ground surface, except along the very eastern and western margins of the right-of-way next to the fence lines, where deposits were as much as 40 to 50 cm deep. This near surface assemblage appears to have suffered some from modern right-of-way maintenance activities and possibly also from cultivation. An unknown part of the Toyah component was also affected by mechanical trenching and ground stripping carried out over much of Block A during Phase I investigations. These presumed destructive activities may account for some of the fragmentation of this assemblage, so that the small size of much of the bone sample may not reflect prehistoric behavior.

Bone preservation was fair to good with some splitting and exfoliation caused from weathering, dry bone fracturing/exfoliation, and extensive root-etched surfaces. Most unburned bone is pinkish gray (5YR 7/2) in color. When burned, the colors vary from a dark brown, black, a combination of brown and black, to gray, or white depending on the temperatures the elements reached (Nicholson 1993). Although the bone sample is sizeable, the combined effects of prehistoric processing and possible modern mechanical breakage have resulted in considerable fragmentation. Ninety-six percent of the bones are less than 3 cm in length and less

than one percent is complete elements. The largest pieces measure between 12 and 15 cm long, even though bison bones are often represented. This very fragmented assemblage is reflected in the average weight of a bone fragment being less than one gram.

Many tiny fragments could not be identified to species or assigned to general animal size classes. Unclassifiable pieces account for about 90 percent by number or about 54 percent by weight. Bison, deer, antelope, cottontail, jackrabbit, a canid/carnivore like coyote, turtle, snake, hawk size bird, and fish bones are positively identified. Individual species or groupings according to animal sizes are discussed in greater detail below.

8.4.1 Bison Remains

A total of 1,481 pieces weighing 6,268.9 g represent size class 6, or bison size pieces. These 1,481 pieces represent about 7.3 percent of the total Toyah vertebrate assemblage by number, but comprise about 36 percent by weight. Sixty-seven percent are less than 3 cm long with less than one percent greater than 12 cm, leaving about 30 percent in the 3 to 9 cm size category. Only 54 pieces, or 3.7 percent, were burned, and these weigh about 205 g or about 3.8 g per fragment. The appearance of most (76 percent) of the burned pieces is a combination of black and brown colors on the same bone fragment. Only one piece is all white, five are completely black, one piece is black and white, and six are brown. Heat intensity is the primary determinant of coloration, with less than one percent revealing intensive heating.

The identifiable elements in size class 6 include all major parts of the bison, but their fragmentary nature limited the identifiable elements to just a few pieces. The majority of specimens are long bone fragments, although a few cancellous tissue lumps were recognized, of which many are rib fragments. Occasionally

other elements have been identified. Many identifiable elements are small, dense bones such as carpals, tarsals, sesamoids, and phalanges.

The axial skeleton is represented by a couple of caudal (tail) vertebrae, a few vertebrae fragments, one complete left acetabulum, a couple of other pelvic fragments, and tooth fragments. Tooth fragments are numerous and include incisors, premolars, and molars, although whole teeth exceptional and are often badly damaged. Both maxillary and mandibular teeth are present. The more seasonally sensitive deciduous teeth, or third molars, were not recognized. Other than teeth, skull parts were not identified, with the exception of the inner ear. Four nearly complete inner ear elements were identified, including two lefts and two rights. This element indicates the minimum number of individual bison is two. Thoracic spines were recognized in a few instances, but many pieces closely resemble the rib fragments, which, given the fragmentation factor, makes identification difficult. Only two rib heads are identified.

Scapula fragments, a right distal humerus fragment, a left proximal radius fragment, an ulna fragment, a right magnum, and a right scaphoid represent the appendicular skeleton. A proximal femur, a proximal tibia, a left distal tibia, a left patella, a right lateral malleolus, and a right navicular-cuboid represent rear legs. Other appendicular elements include distal metapodial fragments, sesamoids, and phalanges.

With the sample representing the entire skeletal anatomy, it can be inferred that the entire bison carcass was brought to camp and then further processed. However, the fragmentary condition of the bones precludes identification of a butchering sequence. In general, it can be assumed that, following the kill, skins were removed, then the meat was stripped from the skeleton, and finally the bones were broken for

marrow removal and perhaps for bone-grease rendering. A couple of long bone fragments reveal impact fractures near their mid-shafts, but the root-etching has probably obscured evidence of stone-tool cut marks. The highly fragmentary nature of the bones may be partly attributable to smashing for marrow extraction and subsequent rendering of bone grease.

Fifty-four fragments (3.7 percent of the sample) of this size class were burned to varying degrees. This includes 41 pieces that are both black and brown, six pieces that are brown, five pieces that are black, one that is white, and one that is both black and white. As already noted, these color differences reflect burning at a fairly wide range of temperatures.

The identifiable teeth represent at least one medium-aged individual, judging by tooth wear. Individual tooth exhibit wear with their styles worn to loops. One upper molar that was badly preserved appears to be cupped and representative of a much older individual. Therefore, a middle-aged and mature adult are minimally represented.

A bison bone fragment (#525-5-2-1a) from Feature 2 was submitted for stable isotope analyses. Geochron Laboratory reported that the stable carbon isotope on collagen was -8.6‰, the nitrogen isotope was 5.1‰, and the stable isotope on bioapatite was -4.0‰. These values indicate the bone was bison that had consumed about 80 percent C₄ plants (grasses).

8.4.2 Deer and Antelope Remains

In most instances in this very fragmentary assemblage, specific elements representing one or the other of these two medium sized ungulates could not be distinguished. The more complete the element the greater chance to identify a particular species. First, we address the class as a whole, with more specific information on the individual species to follow.

A total of 496 pieces, weighing 1,668.6 g, were assigned to size class 5, accounting for about 2.4 percent of the total Toyah assemblage by number and nearly 9.6 percent by weight. Again, the pieces are highly fragmented, as indicated by the fact that 88 percent are less than 3 cm in length, and none measure greater than 9 cm in length. Some 67 pieces weighing 70.6 g, or 13.5 percent, were burned.

Small fragments identified as ribs, long bones, teeth, and articular ends of long bones are represented. Most parts of the skeleton, and apparently, the entire animal(s) was brought to camp for processing.

Teeth and a few fragmentary elements represent deer species. Individual elements identified as deer, including 12 pieces of first, second, and third phalanges, a distal metapodial, a right and left navicular-cuboid, seven fragments of inner ear bones, one lumbar vertebra, two right astragali, a cuneiform pes, an ulna notch, a left distal humerus, a complete scaphoid, and various teeth including a complete third molar and maxillary teeth. A complete, burned dewclaw (recessed third phalanx) was recovered from the flotation sample (#79-4) extracted from a hearth, Feature 21. Minimally two deer are represented based on two right astragali. Minimally one is a mature adult as indicated by a massive, worn third molar (#32-2). The massive size of this third molar is in the size range of a mule deer. Minimally one adolescent is indicated by a complete deciduous third premolar (#1103-2). This deciduous tooth is close to an animal in the age range of 1.5 years (Ramsey and Shult 1990). Using the tooth eruption and wear data presented by Ramsey and Shut (1990), the third molar would indicate an animal in the range of about 4.5 years old. However, recent studies by Gee et al. (2002) and others have cast considerable doubt on Severinghaus' (1949) original criteria for aging deer using tooth eruption. Therefore, the ages of these two individuals are only tentative.

Several first phalanges were butchered to remove the tiny bit of marrow from the inside cavity and/or to facilitate grease rendering. A medial section of a distal humerus shaft reveals an impact fracture, again direct evidence that long bones were intentionally broken open for marrow extraction. Many identifiable deer specimens are larger than the modern whitetail deer in Quigg's comparative collection from Central Texas and may represent the larger mule deer.

Antelope remains are recognized through teeth and a few individual elements. The identified elements include a right astragalus, scapula fragments, a left proximal metapodial, a lunated, first and third phalanges, occipital condyles, and the inner ear. Minimally one individual represented. One antelope first phalange was butchered indicating that the tiny lump of marrow in this cavity was sought. This element was recovered from Feature 25 in a good Toyah context.

Two fragments, both less than 2 cm long, appear as possible fetal bones, as they lack solidified cortical walls and exhibit a honeycomb bony structure. However, they are too small and lack sufficient characteristics to clearly allow assignment to one of the specific ungulate species identified here. One piece (#1187-2) is similar in size and shape to a fetal deer radius, with an ovate cross section that slightly expands toward one end. It measures 12.3 mm wide by 8.0 mm thick toward the articular surface and weighs 0.7 g. The other fragment is approximately 15 mm long by about 5 mm wide and expands slightly at both ends. This tiny piece appears to have two and possibly three short, potential cut marks on the mid-shaft, indicating it is definitely cultural. If these two elements represent fetal bison, then that would indicate a possible February to March death period for the female carrying the fetus. If they actually are from fetal deer or antelope, then

they may represent a death period more later in the spring.

8.4.3 Other Faunal Remains

This general group includes 49 fragments representing a variety of other, non-ungulate species. They comprise a mere 0.2 percent of the total Toyah bone assemblage. Because of their very limited frequency, their very small size, and the potential for small bones to be naturally deposited in the stream alluvium, it is not certain that these few fragments represent human procurement/processing as opposed to naturally deposited remains.

Turtles are represented by two each of plastron (#43-2 and #58-2), and two carapace (#324 and #119-2) fragments. Specimen #119-2 is burned to a brown color and includes a small part of the vertebra on its interior, supporting human use/processing of at least one turtle. A tiny fragment of turtle shell was recovered from float sample (#87) obtained from hearth Feature 21 in Unit N100/E50/51. Minimally, two turtles are represented.

Snakes are represented by six tiny, unburned vertebrae (#119-2, #919-2, #1021-2, #1039-2, #1055-2, and #1197-2). Two unburned snake vertebrae were recovered from a float sample (#185) recovered from 0 to 10 cm bdb in Unit N100/E51. Minimally two snakes are represented.

A large unknown bird of raptor/hawk (possibly a red-tail hawk) size is represented by a large 23.5 mm long, complete third phalanx (#377-2). A small hole on one side appears similar to a tooth puncture. This element is not burned, but does exhibit a light polish or shine over its surface. Three other thin, medial long bone fragments (#159-5-2, #219-2, and #1088-2) may represent birds, but identification is uncertain.

Four medial long bone fragments (#955-2, #971-2, #981-2, and #1137-2) one of which is burned to a brown color, were assigned to size class 4

that could include animals such as dogs and coyotes, though positive identification is not possible. One or more of these fragments may be from a slightly smaller animal in size class 3. A second phalanx (#981-2) is the size of a coyote or dog. A petrous or inner ear bone (#981-2) may also be from a dog or coyote size animal. One coyote or dog is believed to be represented.

Two medial long bone fragments (#78-5-2 and #1084-2) were assigned to the size class 3 or 4, one of which was burned to a brown color. Size class 3 includes animals about the size of raccoons, and could also include small canids.

Thirty-three very thin, medial long bone are assigned to size class 2, which includes animals in the size range of rabbits. These long bone shaft fragments are broad enough to possibly represent jackrabbits or reflect various species of birds. Without the more diagnostic articular ends, it is impossible to identify long bones to a species. A cottontail rabbit is represented by a left mandible fragment (#526-2) and a maxilla fragment (#533-2). One proximal metapodial fragment (#159-5-2) is from a jackrabbit. As mentioned above, a bone bead blank (#1054-21, see description below) is also a tibia midsection from a jackrabbit-size animal. The heavy fraction of float sample (#87-4) from hearth Feature 21 also yielded a tiny distal end of a rabbit humerus. A rabbit metapodial was recovered from a float sample (#843-5-4) from the debris dump, Feature 8.

8.4.4 Discussion

Fish are represented by two skull elements (#109-2). Two tiny, unburned fish vertebrae were recovered from the heavy fractions of float samples (#78 and #87) from hearth Feature 21.

In summary, the very fragmented vertebrate remains indicate only one or two animals in the different groups or size categories. Minimally two deer, one bison, one antelope, one canid,

one jackrabbit, one cottontail, two turtles, and possibly snakes, fish, and birds contributed to human subsistence. Potentially, multiple animals are represented for each taxon, but the limited numbers of bones identified for any one animal indicate that the occupants were not conducting massive communal type kill operations directed toward any one species. Individual stalking and hunting tactics directed towards the larger ungulates appear to have been the main targets of the Toyah occupants of this site. Smaller game, such as rabbits and turtles, were may have been procured with traps. It also appears that regardless of size, entire carcasses were to camp for processing. The findings imply that both bone marrow extraction and probably bone grease rendering were carried out.

A hint at seasonality is based on two small fragments of fetal bones, which are not identified to a specific species. These specimens indicate a spring to early summer kill, while deer tooth eruption and wear patterns may indicate a late fall (i.e., November through December) event. Since a series of Toyah occupations were recognized here, the different projected seasons of occupations are not in conflict. Seasonality has often been difficult to decipher in other relatively limited assemblages.

The Toyah-phase occupants of the Varga site focused their meat consumption on three ungulates, deer, antelope, and bison, and augmented these with small game such as turtles, canids, birds, fish, etc. This apparent subsistence regimen, is to other those indicated by findings at other Toyah sites investigated across Texas (Steele 1986; Scott and Creel 1990; Treece et al. 1993b; Masson and Holderby 1994; Shaffer 1994; Quigg and Peck 1995; Henderson 2001). Not only is the subsistence resource base similar in most Toyah components, the discarded faunal assemblage is also similar insofar as vertebrate remains are highly fragmented and frequently burned, with the

fragmentation inferably reflecting marrow extraction and grease rendering activities.

Most investigated Toyah components have yielded a relatively limited number of individual animals, indicating the hunting technique and practice was often limited to stalking or trapping the animal by one or a few hunters. An exception is found at the Toyah component at the Mustang Branch site (41HY209T) where some 19 adult deer, eight antelope, and two bison were identified within the limits of a processing area (Masson and Holderby 1994). The deer population at Mustang Branch was determined to characterize a catastrophic kill episode, implying a communal effort requiring a relatively large group of individuals. Although communal hunting does not appear as a common practice for the Toyah population, apparently the Toyah people did understand sometimes practice this kind of procurement strategy.

8.5 MUSSEL SHELL REMAINS

Mussel shell fragments were quite limited in number and in size, with only 19 individual pieces collected from the Toyah component. In a few instances during field excavations, tiny shell fragments were observed, but not collected, as they were often just tiny, thin flakes. The 19 collected fragments weigh 25.5 g and consist of two umbo sections, a fragment of the lateral teeth. The rest are tiny unidentifiable fragments. One umbo fragment resembles *Lampsillis* sp., but this identification is inconclusive. A second umbo (2.8 g) exhibited characteristics similar to the Tampico pearl mussel (*Cytonaisa tampicoensis*), a species native to the Rio Grande, Nueces, Frio, San Antonio, Guadalupe, and Brazos river systems (Howells et al. 1995:48). Both species tolerate diverse habitats. The limited number of shell specimens indicates that this resource was not being intensively sought as a food or other resource. It is quite possible that many of the pieces recovered were natural occurrences in the alluvial deposits. However, the presence of one or two culturally

altered pieces of shell indicates mussel shell was at least used in limited ways. It was not a significant part of the dietary repertoire.

8.6 CERAMIC ASSEMBLAGE

A total of 119 ceramic sherds, weighing 270.4 g, were collected from the Varga Site. Of those, 115, were directly recovered from the Toyah component. Three sherds (#1261) were collected from the surface, and one (#962) was recovered from the Late Archaic context in Block B (presumably displaced).

Sherds are small, with an average diameter of 19.8 mm, with an average weight of 2.1 g, reflecting their very small size. A few pieces were too small to record basic attributes and assign to a vessel group. The entire sherd assemblage has been sorted into five vessel groups (1 through 5) based on a combination of observed attributes of color, paste, texture, interior and exterior surface treatment, thickness, and aplastic inclusions. Some sherds were easily assigned to one group or another, whereas others shared similarities with two groups. While a number of attributes were taken into consideration for sorting, in some instances one obvious and prominent attribute formed the primary criterion for placement of a given sherd into a group. For example, the Vessel Group 2 contained tiny black bone temper, whereas in most other sherd groups the bone temper was white. However, given the small size of most sherds, improper assignment of some specimens is quite possible. The sorting of the sherds was done to facilitate the selection of samples for the various technical analyses. Selecting sherds from the different vessel groups would help insure that technical analyses were conducted on a representative sample of ceramic vessels. The creation of these groups also permits and approximation of the number of vessels represented. The five sherd groups should probably be considered as representing a minimum of five vessels, since we believe it is possible that more than one vessel is represented

in Groups 1, 3 and 4. Appendix O provides metric and non-metric attributes for individual sherds as the basis for their assignment to groups. The vessel groups are discussed below, followed by a general discussion of the ceramic assemblage.

Special technical analyses were conducted on a few selected sherds from different vessel groups. Organic residues in four sherds were AMS dated. Parts of 10 sherds were examined through petrographic analysis to investigate the production technology and range of variation in the clay and temper being employed. Parts of eight sherds were subjected to INAA to determine if they were manufactured using local or non-local clays, as well as to determine the number of source areas for clays. Six sherds were used for lipid residue analysis to ascertain the basic kinds of foods that may have been cooked in these vessels. Parts of the same sherds used in the lipid residue studies were also used to determine stable carbon and nitrogen isotope values, which aids in narrowing the range of foods groups identified in the lipid residue analysis. In a few instances a single sherd was broken into multiple pieces for use in the different technical analyses to reinforce confidence in the overall results. Where that was not possible, a sherd with similar visual characteristics from the same vessel group was used for the different types of analyses.

8.6.1 Vessel Group 1

Forty-six body sherds were assigned to Vessel Group 1 (Figure 8-19). Sherds are mostly quite small (average diameter is 20.1 mm), with an average thickness of 5.2 mm. Sherds #1030-8-1 (10 g) and #1055-8-1 (8.8 g) were sent for lipid residue analysis, small fragments of sherds #1030-8-a (TRC271) and #1054-8-1 (TRC270) were sent for INAA, and less than 1 g of each interior of the two sherds used for lipid analysis (#1055-5-4-8-1a and #1030-5-4-8-1a) were also subjected to stable carbon and nitrogen isotope analyses. Sherd #1089-8-1a (2.7 g) was sent for

Figure 8-19. Selected Vessel Group 1 Sherds

Left to Right: Top Row (Interior Surface): #1081-008, #843-008, #841-008-1, #1162-008-3;
Second Row (Interior Surface): #845-008, #1030-005-008, #1030-005-004-008-2, #1050-008-2
Third Row (Exterior Surface): #841-008-2, #1008-008-2, #999-008, #1050-005-008-1
Forth Row (Exterior Surface): #1023-008-2, #996-008, #865-005-008

radiocarbon dating of inclusive organic residue (see discussion below).

8.6.1.1 Shape

The overall vessel shape is cannot be determined, since very few of the small sherds could be refit to obtain a reliable impression of curvature or vessel form. Most sherds have minimal curvature, but an unusually large body sherd (# 1054-8-2) suggests a vessel diameter about 28 cm. Sherd thickness measurements range from 3.9 to 7.1 mm, which is quite variable and may indicate that multiple vessels

are represented or, that the different parts of the same vessel—base and body—are present in this group. Five sherds have thickness measurements over 6.0 mm, whereas only two sherds have thickness measurements less than 4.0 mm. The thickness variation indicates that a thick bottom may be represented.

8.6.1.2 Construction

Most broken edges are angular and indicate clean, sharp, generally perpendicular breaks without indication of breakage along coil lines. However, two sherds (#1050-5-8-1 and -2) that

refit, exhibit an angled break along the common edges. Sherd #1162-8-3 exhibits one angled break that might also be considered indicative of a possible coil edge, but the very edge is not rounded. A third sherd (#1008-8-2) exhibits two opposite edges that are angled at nearly 60 degrees and parallel one another. This sherd also exhibits a narrow, low, rounded ridge on the interior surface, which is equi-distant between the two angular breaks. The broken edges opposite the angled breaks hint at the presence of the margins of the welded coil by slight changes in the paste. If these two angled breaks, coupled with the low interior ridge and hint of the coil in the profile, actually represent the nearly obliterated margins of welded coils, then the width of the welded coil is about 8 to 9 mm. These observations at least indicate that this vessel was constructed with coils and subsequently smoothed with nearly total obliteration of evidence of the original coils.

8.6.1.3 Exterior Surface

Seventy-four percent of the sherds exhibit smooth, plain exterior surfaces, whereas 26 percent exhibit polished/burnished surfaces (Figure 8-19). Often tiny temper particles are visible on the surface. Surface colors vary from olive (5YR 5/4), to pale olive (5YR 6/4), to olive gray (5YR 5/2), to gray (10YR 5/1), to brown (7.5YR 5/2) to light brown (7.5YR 6/4). Some dark surfaces may represent firing clouds, but the small sherd size hinders definition of cloud edges. The largest sherd (#1054-2) exhibits two different colors, clearly indicating fire clouding. It also exhibits faint horizontal smoothing as indicated by very shallow grooves of various widths between very low ridges across the surface, but the subsequent smoothing process has made them nearly invisible. The tool that produced these mostly obliterated marks cannot be identified.

8.6.1.4 Interior Surface

Interior surfaces also vary, with 63 percent smooth, 33 percent rough, and four percent polished. The rough interiors exhibit a variety of conditions. The above-mentioned sherd (#1008-8-2) with the hint of coil breaks, has a narrow, low rounded ridge parallel to the possible coil breaks that could be the partially smoothed edge of a wedged coil. It also exhibits thin striations parallel to the low ridge and slight concave surfaces between the low ridge and the broken margins. Sherd #1030-5-4-8-1a exhibits mostly a rough interior with very low, subdued ridges, thin striations, and an uneven surface. The largest sherd (#1054-2) exhibits a slightly irregular interior surface with faint horizontal and parallel wiping ridges. Two refit sherds (#1050-5-8-1 and 2) show a slightly irregular surface with a slightly concave area and drag marks made on a tacky surface. The variability in interior surface treatments hint at multiple vessels, although one vessel possibly was finished differently depending on the ease of access to the interior. Infrequently, a fingertip size concave area was observed. Interior colors vary from reddish brown (5YR 5/3), to pinkish gray (7.5YR 6/2), to reddish yellow (5YR 6/6).

8.6.1.5 Paste

The paste color varies from a dark gray (10YR 4/1), to gray (5YR 5/1), to reddish brown (5YR 5/3), to a very pale brown (10YR 7/4) with some that appear banded. In the banded cases, the innermost core is the darkest, although in two sherds, #865-5-8 and #1023-8, colors become lighter toward the central core. The dark interior core reflects the temperatures reached during the firing process and perhaps the organic content of the clay.

Petrographic analysis was conducted on two body sherds (#1089-8-1b and #1054-8-1b) from Vessel Group 1. Sherd #1054-8-1b is tempered with 28 percent bone and 8.5 percent limestone. Distinctive clay aplastic inclusions include

quartz (2.5 percent quartz), iron (8.5 percent), tiny clay nodules (3.5 percent) and a trace of orthoclase (1.5 percent). The clay matrix is tan to greenish gray and anisotropic (Appendix D). Sherd #1089-8-1b was quite similar and is tempered with crushed bone (24 percent) (no bone in previous sherd??), limestone (9.0 percent), tiny clay nodules (0.5 percent) and orthoclase. The matrix is moderate, greenish gray to gold, and isotropic (Appendix D). Both sherds were subsequently assigned to the same Paste Group—B-c, since they exhibited the same aplastics in similar quantities. The bone inclusions are calcined and generally quite tiny, although an occasional piece is relatively large, at up to 3 mm in diameter (#865-5-8).

8.6.1.6 Distribution

Only two sherds, or about four percent of Vessel Group 1, were recovered from Block A. Each of these was found in a separate unit, one on each side of the southern end of BT 1 (Figure 8-20). Nearly 96 percent of Vessel Group 1 sherds were widely scattered in Block B. Seventeen units yielded single sherds, with seven units yielding multiple sherds. The highest concentration was in and around Features 25 and 38 (Figure 8-21). No other sherds from other vessel groups were located in, or immediately adjacent to, these two features. Another four sherds were located in the adjacent unit that contained Feature 38. Feature 8, about 8 m to the southwest, also yielded one sherd from this group.

8.6.1.7 Discussion

Petrographic analyses on two sherds (#1054-8-1b and #1089-8-1b), assigned to Vessel Group 1, confirmed their similarity. Subsequently, they were assigned to the same Paste Group—B-c. The petrographic results also indicate that the two analyzed sherds and, by implication, all of Vessel Group 1, were manufactured locally. This same paste group is quite similar to a Toyah vessel from 41CC131 at O. H. Ivie

Reservoir 180 km to the north, a vessel from 41HY209 at Onion Creek 210 km to the east, and a historic sherd from Mission San Lorenzo about 40 km to the south (Appendix D). The implication of this is not clear, though it is possible that the results reflect the movement of people across the Central Texas landscape.

The INAA on two Vessel Group 1 sherds (#1054-8-1a = TRC270 and #1030-8-a = TRC271) determined both to be part of a limited number of analyzed sherds ($n=3$) composing the Varga-1 chemical group (Appendix F). This group is chemically and statistically (less than 4 percent probability of membership) different from most other Toyah sherds from the Varga Site and the Central Texas 1 and 2 reference groups. This indicates that these two specific sherds and, by implication, all of Vessel Group 1 sherds, were manufactured from clay sources other than those identified previously from the ca. 200 INAA samples from the Central Texas region. The INAA chemical findings thus do not parallel the petrographic findings that indicate similarity in pastes with sherds from other Toyah sites. This suggests that the petrographic analysis may simply be tracking coincidental similarities in paste constituents, as opposed to identifying meaningful commonalities among Toyah pottery. Lipid-residue analysis on two sherds from this group (#1055-5-4-8-1a and #1030-5-4-8-1a) produced only slightly different results. Sherd #1055-5-4-8-1a indicates borderline moderate-to-high and high fat content interpreted to reflect plant products (Appendix G). Sherd #1030-5-4-8-1a indicates moderate to high fat content interpreted to reflect plant products (Appendix G). Both outcomes support the conclusion that plants were being cooked in this vessel.

The stable isotope analysis on the two sherds revealed nitrogen isotope results of -2.6 and 2.8‰ from very low amounts of measured nitrogen, which make the results suspect.

Figure 8-20. Distribution of Vessel Group Sherds in Block A

Figure 8-21. Distribution of Vessel Group Sherds in Block B

The two carbon isotope values of -27.2 and -24.3‰ indicate very high levels of C₃ contributions to the materials cooked. The isotope values support the lipid residue analysis and indicate that plants, possibly C₃ legumes such as mesquite beans, were cooked in this vessel.

Sherd #1089-8-1a (2.7 g) from Block B was sent for radiocarbon dating and yielded a $\delta^{13}\text{C}$ (-17.8‰) corrected age of 310 ± 40 B.P. (UGA-12730) (Table 8-1). This age calibrates to the Sixteenth Century, at the temporal boundary of the Prehistoric and the Protohistoric periods.

In summary, the 46 sherds assigned on the basis of macroscopic observation to Vessel Group 1 may represent multiple vessels. Their thicknesses reveal a range that might suggest that at least two vessels are represented. In support of multiple vessels present in Vessel Group 1 is the stable isotope data that reveals differences in the organic residues in the two analyzed sherds. In addition, the lipid residues from the two sherds were slightly different. The fact that only four percent of these sherds were in Block A may also imply multiple vessels are represented. In contrast, the petrographic findings and the INAA indicate that the two Vessel Group 1 sherds analyzed were assigned to the same paste group and the same chemical group, respectively. Therefore, if more than one vessel is represented in this group they were very much alike, and apparently were manufactured from similar materials from similar sources.

8.1.1 Vessel Group 2

Twenty-five body sherds were assigned to Vessel Group 2 (Figure 8-22). Sherds are, again, quite small, with the largest (#965-8) measuring 39.4 mm in diameter. Sherds #936-8-a and #1181-8-1 refit. Two sherds from the same provenience in #1096-8 also refit, as do two sherds in a second provenience #984-8. Sherds #799-8-2a and #1181-8-1b were

subjected to petrographic analyses. Two sherds, #936-8-a and #1129-8-1a, were sent for INAA. Two sherds, #965-8-1a and #1157-8-1a, were analyzed for lipid residue and less than 1 g of each was submitted for stable carbon and nitrogen isotope analyses. Sherd #987-8-1a was sent for AMS radiocarbon dating. Sherds in this group were rather widely scattered, and two specimens were found 8-9 meters apart (#936-8-a from Unit N123/E72 and #1181-8-1 from Unit N132/E75).

8.1.1.1 Shape

Vessel shape is indeterminate, with only a couple of refits providing any indication of curvature. Curvature varies, with some sherds showing greater curvature than others. Sherd thickness measurements range from 4.8 to 8.1 mm, with the average thickness 1.0 mm greater than that of Vessel Group 1. Only 21 percent of Group 2 sherds have thickness measurements less than 5.5 mm, whereas 21 percent have thickness measurements greater than 6.7 mm. Therefore, 58 percent have thickness measurements between 5.5 and 6.7 mm. The different thicknesses and the different curvatures may indicate a shouldered vessel.

8.1.1.2 Construction

The edges of sherd are perpendicular to the interior and exterior surfaces. Four sherds exhibit one or more edges that are not quite perpendicular and hint at a curved, or possibly a welded, coil edge. The 3.3 mm variation in thickness measurements probably represents different parts of the same vessel.

8.1.1.3 Exterior Surface

The exterior surfaces are all quite similar and exhibit smooth, polished surfaces with no decorations, few imperfections or striations, and almost no visible particles of temper. Sherd #1000-8-1 is the exception with a very pitted

Figure 8-22. Selected Vessel Group 2 Sherds

Left to Right: Top Row (Interior): #908-008, #856-008, #1187-008;
Second Row (Interior): #781-008, #992-008, #842-008-1;
Third Row (Exterior): #977-008, #945-008, #984-008-1;
Forth Row (Exterior): #1000-008, #1008-008-1, #1096-008-3

surface. Surface colors are also quite similar and generally are pink (7.5YR 7/4), to reddish yellow (7.5YR 7/6), to light yellowish brown (10YR 6/4). Some dark surfaces (gray; 5YR 6/1) are present on minimally three sherds (#984-8 and #1187-8) and may represent firing clouds.

8.1.1.4 Interior Surface

The colors of the interior surfaces vary from pink (7.5YR 7/4), to light brown (7.5YR 6/4), to light reddish brown (5YR 6/4), to pale yellow (5YR 7/3). Three sherds (#856-8, #1008-8-2, and #1187-8) also exhibit what appear to be burned areas or firing clouds that are light reddish brown (5YR 6/4). Interiors are quite smooth; some are polished and some are not. Slight imperfections are present, but they are tiny and exhibit no patterning or identifiable tool marks. Tiny dark temper particles are scattered across most interior surfaces.

8.1.1.5 Paste

Interior paste color is similar to the interior and exterior surfaces. It varies from pink (5YR 7/4 and 7.5YR 7/4), to light reddish brown (5YR 6/3), to gray (5YR 5/1), to very pale brown (10YR 7/4). Two colors are visible in 33 percent of the sherds.

Two body sherds from Vessel Group 2 (#799-8-2a and #1181-8-1b) were subjected to petrographic analysis. Sherd #799-8-2a is heavily tempered with 28 percent bone, 11.5 percent limestone, and 2.5 percent calcite. It exhibits low frequencies (12.5 percent) of voids and iron stains (4.5 percent). The matrix is greenish brown to gold and anisotropic (Appendix D). Sherd #1181-8-1b was quite similar to the first sherd and is heavily tempered with 28 percent bone, 10 percent limestone, and 4.5 percent calcite. Scarce voids and limited iron stains are present. The clay matrix is medium greenish brown to gold, and anisotropic (Appendix D). Both sherds were assigned to

Paste Group—B-a. The bone temper is burned to a dark gray or black color with only a few white calcined pieces.

8.1.1.6 Distribution

No sherds from this vessel group were recovered from Block A. The sherds were in Block B, widely distributed from the very northern end to the southern end and scattered through 21 different units (Figure 8-21). Only two units, N125/E72 and N129/E73, yielded more than one sherd. Only one recognized feature, Feature 8, yielded a sherd from this group.

8.1.1.7 Discussion

This relatively small group of sherds appears to represent a single vessel with a rather homogenous color, except for the smudges and consistent dark-colored bone temper that stands apart from the other calcined/white bone tempering in other vessels. The petrographic analysis placed both assigned sherds of this group into Paste Group—B-a. This paste group is similar to petrographically analyzed sherds from sites 41RN3 and 41CN95 at O. H. Ivie Reservoir, two sherds from 41HY209 at Onion Creek, and one sherd from San Felipe Springs that is 65 km to the southwest (Appendix D).

The INAA on two Vessel Group 2 sherds (#936-8-a = TRC272 and #1129-8-1a = TRC273) determined that they are chemically part of the same Varga-2 chemical group together with sherds from Vessel Group 4 and the natural sediment sample (#1259 = TRC280) collected from 65 to 70 cmbd in the Bk soil horizon (Appendix F). This group is chemically and statistically (less than 4 percent probability of membership) different from Vessel Group 1 sherds from the Varga Site and the Central Texas 1 and 2 reference groups. This indicates that these two sherds, and by implication all of Vessel Group 2 sherds, were manufactured from different clays than currently identified from the ca. 200 reference group samples for the Central

Texas region. The INAA chemical findings partially support the petrographic findings of these two sherds, which were placed in the same Paste Group—B-a. The INAA chemical results support the petrographic observations that Vessel Groups 1 and 2 are different. This indicates they were probably manufactured in different localities, used different clay sources, and are also different from the Central Texas reference group. These two sherds exhibit chemical similarity to the natural sediment sample analyzed (#1259-4b = TRC280) and were probably locally manufactured. The divergence from all other Central Texas reference groups indicates that Toyah pottery may have generally been locally manufactured and that vessels were not widely transported.

The lipid residue analysis on two sherds (#965-8-1a and #1157-8-1a) revealed very similar results. Sherd #965-8-1a revealed moderate-to-high fat content that is interpreted as indicating plants were cooked in the vessel (Appendix G). Sherd #91157-1a revealed borderline moderate-to-high fat and high fat content that is also interpreted as indicating plants were cooked in the vessel (Appendix G). Plants appear as the principal products cooked in this vessel.

The nitrogen isotope values from sherds #965-8-1b and #1157-8-1b yielded values of -1.2 and 5.0‰, respectively. The negative value indicates that legumes were probably cooked in the vessel. The relatively large difference indicates that different foods in the same vessel. The carbon isotope values of -27.6 and -25.0, respectively, indicate nearly total contributions from C₃ plants or animals. These isotope values coupled with the lipid residue results indicate that C₃ plants, most likely some type of legumes, were being cooked in this vessel.

Sherd #987-8-1a was sent for AMS radiocarbon dating and yielded a $\delta^{13}\text{C}$ (2‰) corrected age of 26,960 ± 40 B.P. (UGA-12727; Table 8-1). This age is well beyond the temporal range of known prehistory and is therefore, unacceptable. Most

likely, some unidentified substance that was not removed during the laboratory cleaning process contaminated the sample.

In summary, the 25 body sherds visually assigned to Vessel Group 2 are quite homogenous and probably represent a single vessel. The black bone particles in these sherds set this group apart from most Toyah vessels, which exhibit white/calcined bone temper. The petrographic analysis place both analyzed sherds in Paste Group B-a. The INAA findings place the two analyzed sherds in the same chemical group. While the lipid residues and stable isotope results yielded somewhat different findings, but both indicate that plants, probably legumes, were cooked in this vessel.

8.1.2 Vessel Group 3

A total of 30 sherds, one rim sherd (#782-8-1) and 29 body sherds, were assigned to Vessel Group 3 (Figure 8-23). Sherds are very small, with an average diameter measures of only 14.7 mm, Average thickness is 6.0 mm. None of the sherds could be refit. Sherds #900-8-1 (3.4 g) and #901-8-1 (3.3 g) were sent for lipid residue analysis, and a small part of each interior was sent for stable carbon and nitrogen isotope analyses. Sherd #1118-8-1a was used in procuring an AMS radiocarbon date (see discussion below). Sherds #840-8-1a (TRC276; 1.2 g) and #867-8-1a (TRC277; 1.0 g) were submitted for INAA.

Figure 8-23. Selected Vessel Group 3 Sherds

Left to Right: Top Row (Interior): #1036-008, #881-008, #879-008;
Second Row (Interior): #875-008, #1044-008, #1100-008;
Third Row (Exterior): #1133-008, #880-008, #884-008;
Forth Row (Exterior): #782-008-1 (Rim), #782-008-2, #949-008

8.1.2.1 Construction

The broken edges are perpendicular to the two surfaces, with one apparent exception. Sherd #880-8 exhibits a twisting and curved break along two opposing edges. Linear impressed lines on the interior surfaces of sherds #879-8 and #881-8 may be signs of imperfectly welded coil margins. The broken edges of both sherds also hint at possible welded coil locations. Thickness measurements range from 4.4 to 7.5 mm and reflect unevenness over a single vessel or that more than one vessel is represented.

8.1.2.2 Exterior Surface

The exterior surfaces are all quite similar with smooth, sometimes polished, surfaces that exhibit no decorations or finishing striations, and only a few temper particles exposed on the surfaces. One exception is sherd #880-8 that exhibits a badly pitted and scored surface, which has removed the majority of the exterior surface. Surface colors range from pinkish gray (5YR 6/2), to light reddish brown (5YR 6/4), to reddish yellow (5YR 7/6), to brown (7.5YR 5/2), to light brown (7.5YR 6/4), to gray (10YR 5/1), to light yellowish brown (10YR 6/4). Dark surfaces (gray; 5YR 6/1) are present on three sherds (#984-8 and #1187-8) and appear to be small areas of firing clouding.

8.1.2.3 Interior Surface

The interior surfaces are somewhat more variable, with some polished and some with tiny striations, but most are smooth. Sherd #879-8 exhibits what appears to be a line demarking the edge of a partially welded coil, whereas the rest are smooth and finished, and lack polish. A second sherd (#881-8) exhibits a long, narrow linear line that may also represent the edge of a partially welded coil. In this instance the rest of the interior is polished to a high sheen, and lacks any visible temper. Sherd #862-8 exhibits possible smoothing or wiping striations across a

dull, smoothed surface, which exhibits two temper particles. Sherd #405-8 also exhibits possible wiping striations across a well-finished and polished surface. The interior of the rim sherd (#782-8-1) is well finished and polished. A few tiny striation lines occur just below and parallel to the rim, and tiny pits are visible. The colors range from light reddish brown (5YR 6/3), to pink (5YR 7/4), to brown (7.5YR 5/2), to dark brown (7.5YR 5/4), to light yellowish brown (10YR 6/4), to gray (10YR 5/1).

8.1.2.4 Paste

The paste color is quite similar to the interior and exterior surfaces. It varies from pink (5YR 7/4 and 7.5YR 7/4), to light reddish brown (5YR 6/3), to gray (5YR 5/1; 10YR 5/1), to grayish brown (10YR 5/2), to brown (7.5YR 5/4). These colors are found in sherds that have traces of firing clouds on either the interior or exterior surfaces.

Two body sherds from Vessel Group 3 (#481-8-1b and #937-8-1b) were subjected to petrographic analysis. Sherd #481-8-1b contains 39 percent bone temper, eight percent quartz, five percent limestone, four percent ferrous iron, one percent calcite, and less than one percent ooids. It also exhibits low frequencies (five percent) of voids in a matrix that is reddish tan to gold and anisotropic (Appendix D). This sherd was assigned to Paste Group—B-c. Sherd #937-8-1b is tempered with 38.5 percent bone, 10 percent limestone, 10 percent quartz, eight percent ferrous iron, 2.5 percent calcite, and one percent ooids. Minimal amounts (7.5 percent) of voids are visible within a reddish gray and brown matrix that is isotropic (Appendix D). This sherd was assigned to Paste Group—B-a. Even though Dr. David Robinson assigned these two sherds to different paste groups, the reported data concerning each is quite similar with only slight percentage differences. The bone tempering particles are tiny, and are burned to a white (calcined) color. Sherd #481-8-1b

assigned to Paste Group—B-c is similar to a vessel from 41CC131 at O.H. Ivie Reservoir, a sherd from 41HY209 at Onion Creek, and a sherd from the Lower Pecos region (Appendix D).

8.1.2.5 Distribution

Three sherds, or about 10 percent of this vessel group, were recovered from three units in Block A that were around the southern end of BT 1 (Figure 8-20). Ninety percent were widely scattered across Block B in some 23 different units. Only three units yielded more than one sherd in this Group (Figure 8-21). Although no Vessel Group 3 sherds were in Feature 8, eight sherds were found in the surrounding units. The one rim sherd (#782-8-1), together with one other sherd from this group, and a single sherd assigned to Vessel Group 2, were recovered from Unit N114/E75 in the very southeastern corner of Block B.

8.1.2.6 Discussion

The petrographic analysis on two sherds visually assigned to Vessel Group 3 indicated these two analyzed sherds were actually part of different paste groups. This indicates that more than one vessel may be represented in this group, or that one of the two sherds was miss-assigned to this group. Petrographically, sherd #937-8-1b was assigned to the same paste group as the Vessel Group 2 sherds. Sherd #481-8-1b was assigned to the same paste group as the Vessel Group 1 sherds. Both petrographic paste groups probably were locally manufactured, just with slightly different tempering agents, but both contained primarily bone temper.

The INAA on two Vessel Group 3 sherds (#840-8-1a = TRC276 and #867-8-1a = TRC277) determined that they are chemically different from each other. The former sherd shares chemical similarities with sherds from Vessel Group 1, and is part of Varga-1 chemical group (Appendix F). Sherd #867-8-1a is unassigned to

a specific chemical group since it is an outlier from all other sherds. It is not chemically or statistically similar to any of the ca. 200 Central Texas reference group sherds previously analyzed. The INAA chemical findings on the latter sherd may indicate it represents a totally different vessel from Vessel Group 3, to which it was initially assigned. The INAA chemical results partially support the petrographic observations that Vessel Group 1 and 3 are similar. This indicates they probably were manufactured from similar sediments, but they do not match other analyzed Central Texas samples.

Lipid residue analysis on two sherds (#900-8-1a and #901-8-1a) produced very similar results. Sherd #900-8-1a indicates borderline moderate-to-high and high fat content, which is interpreted as representing plants (Appendix G). Sherd #901-8-1a indicates borderline moderate-to-high and high fat content, also interpreted as representing plants (Appendix G). As with Sherd Groups 1 and 2, the lipids indicate that plants were the primary food products being cooked in this vessel.

The carbon isotope value from sherd #900-8-1b is -27.2‰, indicating nearly complete C₃ contributions. The corresponding nitrogen isotope value of 6.9‰ would support an interpretation of an animal consuming predominately C₃ plants contributed to this residue. The carbon isotope value, coupled with the lipid residue values, document that C₃ plants were cooked in this vessel. The nitrogen value appears to reflect a plant in the range of huisache bean (Quigg et al. 2002). These chemical results support an interpretation that seeds/nut meat from C₃ plants was likely cooked in this vessel.

Sherd #1118-8-1a was selected for AMS radiocarbon dating. This sherd yielded a $\delta^{13}\text{C}$ (-22.8‰) corrected age of 60 ± 40 B.P. (UGA-12731; Table 8-1). This age is too young to be considered acceptable, and was perhaps contaminated with an unknown substance. At

230 B.P., the early end of the calibrated 1-sigma age range does fall within the Colonial period, so it is possible that this data may have validity.

In summary, the 29 body sherds and one rim sherd visually assigned to Vessel Group 3 represent more than one vessel. The exteriors are quite similar, with more variability exhibited on sherd interiors. Possible welded coil lines are present on the interiors together with wiping or finishing marks. The petrographic analysis assigned each of the two analyzed sherds to different paste groups, with only minor differences in the observed additives. The INAA findings placed each analyzed sherd into different chemical groups. The lipid residue results and stable isotope analysis provided slightly different findings also, but both indicate that C₃ plants, some probably legumes, were cooked in the vessel(s).

8.1.3 Vessel Group 4

Ten body sherds, one cut or rim simulated sherd, and one possible base sherd were assigned to Vessel Group 4 (Figure 8-24). Sherds are small, with an average diameter of only 23.3 mm. Average thickness is 7.6 mm. The single largest sherd (#618-8-1) measures 33.3 mm in diameter. No refits were possible. Three sherds, #159-5-8-1, #168-8-1 and #799-8-1 were sent for petrographic analysis. About 1 g each of sherds #272-8-a (TRC274) and #159-5-8-1c (TRC275) were sent for INAA. The cut piece appears similar to a rim because the cut edge has been slightly rounded, creating an appearance similar to a rim. The darker core with lighter margins is an obvious indication that this specimen is not a true rim. Sherd #159-5-8-1a was submitted for AMS dating with inclusive organics.

8.1.3.1 Shape

The overall shape is indeterminate, since most sherds are too small to indicate vessel curvature/form. The curvature of the largest sherd (#206-8-1) is very slight, indicating a

medium-size to large vessel. The cut sherd exhibits a slight curvature, representing a diameter of 14 to 16 cm. Sherd thickness measurements range from 5.2 to 9.0 mm, with only 17 percent revealing thickness measurements under 6.4 mm, and 67 percent having thickness measurements greater than 7.3 mm. This indicates these sherds are part of a thicker vessel than the other vessel groups, or that these sherds are part of a thick base. Sherd #159-8-2, which appears similar to a rim section, is the thinnest, and may not belong to this vessel group or, alternatively, may represent another section of this relatively thick-walled vessel.

8.1.3.2 Construction

The broken edges are generally perpendicular to the interior and exterior surfaces, with one possible exception on one edge on the largest sherd (#206-8-1), which about a 60 degree angled break. This is the only edge break that might that a coiling technique was employed to construct this vessel. Most sherd interiors in Vessel Group 4 are not as well finished as in the other vessel groups, and it is not clear if this indicates that these represent the base of the vessel, or they are from a separate, thicker vessel. The cut sherd (#159-8-2) indicates reuse or rejuvenation through an attempt to salvage the vessel by creating a new rim area, or use of the sherd as some sort of a tool. The cut is at a 50 to 60 degree slope towards the exterior, and the interior and exterior edges were rounded off.

8.1.3.3 Exterior Surface

The exterior surfaces are all similar, with smooth surfaces exhibiting no decorations or finishing striations, very few temper particles, and few imperfections. Surface colors range from pink (5YR 7/3), to light brown (7.5YR 6/4), to grayish brown (10YR 5/2). The color, coupled with an absence of polish, set these sherds apart from the other vessel groups.

Figure 8-24. Selected Vessel Group 4 Sherds

Left to Right: Top Row (Interior): #206-008, #618-008, #159-005-008-3, #159-005-008-4
Second Row (Exterior): #799-008-1, #159-005-008-2 (Cut-Edge), #159-005-008-5

8.1.3.4 Interior Surface

Interior surfaces are more variable than the exterior surfaces, with some rough and others smooth. The thicker sherds, such as #210-8-1 and #206-8-1, exhibit considerable tiny white bone temper particles, whereas most others do not show such particles. The largest sherd exhibits very faint wiping marks in the form of very shallow troughs parallel to very slight ridges. The cut sherd has a relatively uneven interior surface with two or three small, irregular pits or imperfections. The interior colors range from light reddish brown (5YR 6/3), to brown (7.5YR 5/4), to light brown (7.5YR 6/2), to pink (7.5YR 7/4), to grayish brown (7.5YR 5/2).

8.1.3.5 Paste

The interior paste color is similar to the interior and exterior surfaces. It varies from dark gray

(5YR 4/1), to gray (10YR 5/1). These colors are found on sherds that exhibit firing clouds on either the interior or exteriors. The cut section exhibits a dark gray (5YR 4/1) core that contrasts with brown (7.5YR 5/4) surfaces, whereas most other sherds have cores with colors similar to those of the interior and exterior surfaces.

Three sherds, #159-5-8-1, #168-8-1 and #799-8-2a were employed in the petrographic analysis. Sherd #159-5-8-1b reveals 47 percent bone, 10 percent quartz, 4 percent limestone, 3 percent calcite, and 2.5 percent ferrous iron. These particles are in a light greenish tan colored paste with 6.5 percent voids and considered isotropic (Appendix D). Sherd #168-8-1b is tempered with 52.5 percent bone, 5 percent limestone, 4 percent quartz, 2 percent calcite, 1.5 percent ferrous iron, and 1.5 percent orthoclase. It also exhibits 11 percent voids in a matrix that is light

greenish tan and is anisotropic. Sherd #799-8-2a reveals 28 percent bone temper, 11.5 percent limestone, 6 percent ooids 5.5 percent quartz, 2.5 percent calcite, 2.5 percent ferrous iron, and 2 percent iron stains. These particles were in a greenish brown to gold matrix that is anisotropic with 2.5 percent voids. Sherds #159-5-8-1b and #168-8-1b were assigned to the Paste Group—B-c, whereas #799-8-2a was assigned to the Paste Group—B-a. The difference between the two paste groups is the slight variations in the amounts of non-bone aplastic particles (see Appendix D).

8.1.3.6 Distribution

Ninety-two percent of Vessel Group 4 sherds were recovered from Block A, including the cut sherd (#159-005-008-2). Of those, nearly 64 percent were from one unit, N101/E47, with the others about 6 m north and 3 to 6 m east of this one apparent concentration. Only a single sherd from this group was recovered from Block B in the southern part, Unit N115/E73 (Figure 8-21).

8.1.3.7 Discussion

Cut sherds are not unknown in Toyah ceramic assemblages across Texas. A grooved and snapped edge was discovered on a relatively large sherd (213P2) from the Rush Site (Quigg and Peck 1995). Nearly a quarter of a bone tempered plainware globular jar, Vessel C at 41RN169 in O. H. Ivie Reservoir also exhibits a grooved and snapped section that appears to reflect rejuvenation of the lower section of a vessel (Treece et al. 1993b:78-80). The petrographic analysis indicates that the two analyzed sherds from Vessel Group 4 were part of the same paste group, and similar in paste to Vessel Group 1 sherds (Appendix D).

The INAA on two Vessel Group 4 sherds (#272-8-a = TRC274 and #159-5-8-1 = TRC275) determined both to be part of a limited number of sherds ($n=5$) composing the Varga-2 chemical

group, which also includes sherds from Vessel Group 2 (Appendix F). This group is chemically and statistically different from Vessel Group 1 sherds from the Varga Site and the Central Texas 1 and 2 reference groups. The INAA chemical results do not support the petrographic observations indicating similarities with Vessel Group 1 sherds. This indicates that these two sherds and, by implication, all of Vessel Group 4 sherds, were manufactured from different clays than currently identified in the ca. 200 samples for the Central Texas region. The similarity with the local sediment sample (#1259-4b = TRC280) indicates that these sherds come from locally manufactured vessels.

Sherd #159-5-8-1a was sent for AMS radiocarbon dating and yielded a $\delta^{13}\text{C}$ (-15.5‰) corrected age of $3,080 \pm 40$ B.P. (UGA-12710; Table 8-1), much too old to be considered acceptable for this component. It was undoubtedly contaminated with an unknown substance that was not removed during the cleaning process by the laboratory. This was the second sherd that yielded an AMS date that was considered much too old for this component, hinting at inherent problems in the dating residues in potsherds.

In summary, the 10 body sherds, one cut sherd, and one basal sherd assigned to Vessel Group 4 represent more than one vessel. The exteriors are quite plain, smoothed but not polished, and similar to one another, with more variability visible on the interiors. The petrographic analysis assigned one of the analyzed sherds to Paste Group—B-c, and one sherd to Paste Group—B-a, although only minor differences in the percentage of bone additives were detected. The INAA findings placed each analyzed sherd into the same chemical group, which also contains sherds from Vessel Group 2. Vessel Group 4 sherds were made from local clays, based on comparison with the matrix samples recovered from the Varga Site.

8.1.4 Vessel Group 5

Only two tiny body sherds (#1261-8-2 and -3a) comprise this group, and they fit together. The combined refit measures about 24 mm long with a thickness that measures 3.1 mm. The sherds were recovered from the disturbed surface, and it is unclear if they once belonged to the Toyah component or represent some other event. One piece (#1261-8-3a) was sent for INAA (TRC278) and the other (#1261-8-2a) was sent for petrographic analysis.

8.1.4.1 Shape

The shape of this vessel could not be determined. These sherds reveal almost no curvature, since they are extremely small.

8.1.4.2 Construction

The broken edges are nearly perpendicular to the two surfaces, but exhibit no obvious sign of breakage along coils. The walls are quite thin at 3.1 mm and may indicate these pieces represent something other than a cooking vessel, possibly a small cup.

8.1.4.3 Exterior Surface

The exterior is dull and rough. The color is a reddish brown (5YR 5/3).

8.1.4.4 Interior Surface

The interior is smooth with no indications of the smoothing process. The color is a yellowish red (5YR 5/6).

8.1.4.5 Paste

The core color is black (7.5YR N/2). Sherd #1261-8-2 exhibits no bone temper and the additives are unlike those from the other Toyah pottery from this site. The additives include various volcanic rocks and minerals including 27.5 percent orthoclase, 5.5 percent microcline, 5.5 chlorite, 4 percent granite, 2 percent biotite, and 8 percent iron (Appendix D). The

17.5 percent quartz grains are mostly weathered, but it is not clear if the quartz grains were part of the additives or resident within the original clay. The matrix is a greenish gray to black and anisotropic. This sherd was assigned to Paste Group—B-a with no other sherds petrographically investigated assigned to this group. This granitic rock temper is considered non-local.

8.1.4.6 Distribution

These two pieces were recovered from repositioned backdirt along the western edge of Block A. Since the backdirt was often moved by heavy equipment from the sites' surface next to the roadway, the original location of these sherds is not clear.

8.1.4.7 Discussion

It is clear that these two refit sherds, with their very thin walls, igneous temper, light exterior color, and black core, represent a unique vessel, unlike the other Toyah ceramics. Therefore, the vessel represented by these sherds is not likely part of the Varga Site Toyah component. The igneous additives indicate this vessel was not locally manufactured and was transported here from an area rich in volcanic rocks. That region may be to the southwest, possibly in the Big Bend region where volcanic rocks are concentrated, or even further west in the El Paso region where volcanic activity has created greater access to these rocks. Currently much of the El Paso Polychrome wares have been shown to be manufactured in the area of El Paso (Speakman and Glascock 2005). The recovery of these sherds from the surface makes it unclear how recent an event they be, but they are probably not associated with the prehistoric Toyah component.

The INAA on one Vessel Group 5 sherd (#1261-8-3a = TRC278) determined it was chemically associated with the El Paso Polychrome reference group as it plots consistently in the

90 percent confidence ellipse (Appendix F). The chemical analysis agrees with the petrographic analysis, which identified igneous temper in this same sherd. This was not a locally vessel, and it was quite distinct from Toyah phase pottery.

El Paso Polychrome wares terminate at ca. 500 years ago in western Texas. The charcoal radiocarbon dates from the Toyah component indicate just over 50 percent of the assays are younger than 400 years old. This would place minimally one of the events included in the Toyah component slightly before those dates. It is not clear if the El Paso Polychrome vessel was procured via trade by the site's Toyah occupants, or if it represents a different group of people not otherwise detectable in the material-culture assemblage.

8.1.5 Radiocarbon Dating of Pottery Sherds

The AMS radiocarbon dating of pottery sherds was a new and direct approach to try and refine the time frame in which the Toyah ceramic tradition was in operation, and to investigate its continuation into the Protohistoric and Historic periods. Direct AMS radiocarbon dating of prehistoric ceramic sherds has previously been conducted on El Paso brownware sherds from the El Paso region. In that study, nine of the 10-brownware sherds AMS dated by Beta Analytic provided assay results in or near the projected and established time range for that ware (Quigg et al. 2002b).

With that success in mind, it was anticipated that Toyah sherds, which are thought to represent cooking vessels containing sufficient organic food residues, would provide useful radiocarbon dates. This direct dating would enable the specific ages of pottery use at the Varga Site and at other Toyah pottery sites (i.e., Buckhollow), to be identified. Consequently, four sherds (#159-5-8-1a, #987-8-1a, #1089-8-1a, and #1118-8-1a) from four of the five vessel groups

(1, 2, 3, and 4) defined for the Varga Site, were sent to The University of Georgia (UGA), Center for Applied Isotope Studies, for processing and AMS dating.

All four Varga Site sherds yielded sufficient organic carbon to provide AMS results. However, they provided mixed results. From Vessel Group 1, a bone tempered sherd (#1089-8-1a) yielded an AMS radiocarbon date of 310 ± 40 B.P. (Table 8-1: UGA-12730). This is an acceptable age for a Toyah phase manufactured vessel. From Vessel Group 2, a bone tempered sherd (#987-8-1a) was AMS radiocarbon dated to $26,960 \pm 40$ B.P. (Table 8-1: UGA-12727), an unacceptable result that is considerably outside the range for any known human presence. The age is potentially contaminated with much older organic matter. From Vessel Group 3, bone tempered sherd (#1118-8-1a) produced an AMS radiocarbon date of 60 ± 40 B.P. (Table 8-1: UGA-12731). This result is also unacceptable as the sherd is thought to be prehistoric in age, or minimally 200 years or older, though, as noted above, the early end of the calibrated age range does fall slightly earlier than that age. From Vessel Group 4, a bone tempered sherd (#159-5-8-1a) yielded an AMS radiocarbon date of $3,080 \pm 40$ B.P. (Table 8-1: UGA-12710), is much too old to be reflecting Toyah age organic residues and therefore unacceptable.

Two, or one-half, of the dated Toyah period sherds provide AMS results that are not within the acceptable age range for this prehistoric Toyah assemblage. Both are much too old, thus indicating problems of contamination with older organics. A 50 percent success rate seems less than desirable, and further work is necessary to try and resolve problems related to contamination by older organics. Perhaps sample preparation was inadequate and did not allow sufficient time for all the inclusive carbonates to completely dissolve. Vessel Groups 2 and 3 belong to petrographically

identified bone Paste Group—B-a, which had significant amounts of limestone and other carbonates. Possibly, extended time in the dissolving of the carbonates and other potential age-distorting inclusions is required to ensure complete and thorough elimination of any non-cultural organic inclusions.

As an ancillary aspect of our research, we dated three bone tempered potsherds from the Toyah component at Buckhollow (41KM16, sherds #25, #385, and #481), two non-bone tempered sherds (41RE1, artifacts #1872-6a and #1872-48a) from Mission San Lorenzo located 29 km south of the Varga Site, and two bone tempered sherds (41BX5, artifacts #13002c and #130011-a) from Mission San Juan in San Antonio. The results from these seven sherds are presented in Table 8-12. The three bone tempered pottery sherds from Buckhollow yielded results from 850 to 1,200 B.P., all several hundred years too old in comparison to most accepted radiocarbon dates for Buckhollow and other Toyah phase sites. The two non-bone tempered sherds from Mission San Lorenzo range from 1,200 to 2,500 B.P., much too old for this Colonial-era mission site. The two bone tempered sherds from Mission San Juan range in age from 490 to 1,900 B.P. and are again too old. It is clear, then, that the radiocarbon results are not dating organic matter relating to the cultural events of which the sherds were a part. The radiocarbon results are unacceptable and are not useful in defining or refining the age of Toyah ceramic technology. Additional research would be needed to determine the causes of these erroneous results.

8.1.6 Ceramic Discussion

The 115 sherds from the Toyah component, representing a minimum of five and possibly as many as eight vessels, may also represent multiple occupations during the Toyah interval. If this is the case, the ceramic assemblage is not a major part of the Toyah material culture, given that not many individual vessels are represented

for this component, or for any one episode of occupation. The moderate frequency of 184 sherds recovered from the Rush Site, or four sherds/m², represents 1.1 percent of the total Occupation 4 assemblage, reflecting a similar use pattern in a cooking and bone grease processing activity area (Quigg and Peck 1995; Quigg 1997b). Vessel/sherd frequency may be greater at sites that represent multiple events and/or a specific activity that involved intensive use of ceramic vessels.

The Toyah component sherds at the Varga Site are tempered with about 35 to 38 percent ground bone particles, with the exception of the one figurine-like object (#840-8-1), which only has about 10 percent ground bone. The 35 to 38 percent bone tempering is common to petrographic findings at other Central Texas Toyah components (Reese-Taylor 1993, 1995; Reese-Taylor et al. 1994; Kittleman 1994; Robinson 1999). However, the average amount of bone, near 36 percent, for the Varga Site Toyah sherds is some 12 percent higher than that detected at the Rush Site, O. H. Ivie Reservoir sites, and the Onion Creek sites, where the average is about 24 percent, with a standard deviation of five percent (Reese-Taylor 1995).

The shared paste groups identified in the petrographic analysis for the Varga Site Toyah sherds indicate similarity of technology (Appendix D). The current evidence supports a widely employed and basic Toyah technology that employed bone temper across most of Central Texas. Variations in the amounts of bone temper and other additives reflect minor construction variability from the acquisition of materials used. Bone is definitely a characteristic of the Toyah ceramic assemblage, with variations in the amounts potentially reflecting behavioral variation between individual potters, vessel function, and/or clay conditions.

Table 8-12. Radiocarbon Results on Pottery Sherds from Buckhollow and Mission Sites

Fea. No.	Catalogue #	Unit No.	Depth (cm)	Material Dated	Wgt (g)	UGA Lab. No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
Room 31	BX5 - 13002c	21	1	1 Mission sherd	5	12735	1760 ± 40	-16.4	1900 ± 40	Cal AD 20 to 240
Room 31	BX5 - 13011-a			1 Mission sherd	10	12736	360 ± 40	-17.1	490 ± 40	Cal AD 1320 to 1480
Lot 25, V7	KM16 - 25			1 Toyah sherd	3.7	12737	810 ± 40	-22.5	850 ± 40	Cal AD 1040 to 1280
Lot 385, V2	KM16 - 385			1 Toyah sherd	5.2	12738	980 ± 40	-22.2	1030 ± 40	Cal AD 890 to 1160
Lot 481, V6	KM16 - 481			1 Toyah sherd	5.3	12739	1140 ± 40	-21.5	1200 ± 40	Cal AD 690 to 750
Struct 7	RE1-1872-6a			1 Mission sherd	3.9	12740	2420 ± 40	-19.9	2500 ± 40	Cal 800 to 410 BC
Struct 7	RE1-1872-48a			1 Mission sherd	5.5	12741	1100 ± 40	-18.9	1200 ± 40	Cal AD 690 to 960

Con. Age = Conventional Age; Fea. = Feature; Struct = Structure; Wgt = Weight

The results of INAA indicate that the Varga Site Toyah sherds are not chemically similar to the ca. 200 samples currently part of the database that constitute most of Central Texas 1 and 2 reference groups (Appendix N; Creel 2002, 2003). The Varga Site Toyah sherds have less than a four percent probability of being part of INAA Central Texas 1 and 2 reference groups. One anomalous sherd from Vessel Group 5 (#1261-8-3a = TRC278) recovered from the disturbed surface is chemically similar to the El Paso Polychrome reference group identified for far-western Texas. The ten other INAA samples from the Varga Site sherds resulted in the formulations of two separate and very distinct chemical groups—Varga-1 and Varga-2 with two unassigned Varga samples (Appendix N). Varga-1 is composed of three sherds, two from Vessel Group 1 and one from Vessel Group 3. Varga-2 is composed of four sherds, two sherds from Vessel Group 2, two sherds from Vessel Group 4, plus one local sediment sample. This appears to indicate that minimally two vessels represented in Vessel Groups 2 and 4 were manufactured using local clay sources. Two Varga Toyah sherd samples were unassigned to either one of these two particular Varga Site chemical groups. One sample represents the figurine-like object (#840-8-1b = TRC279) and one is from Vessel Group 3 (#867-8-1 = TRC277). The INAA indicates the two Varga Site compositional groups and the two unassigned sherds are chemically separate from the eight historic Mission sherds analyzed here (Appendix N). The five Mission San Juan sherds are chemically separate and distinct from the three Mission San Lorenzo sherds. These findings all combine to indicate that Native ceramic production in the Central Texas Late Prehistoric involved widely shared technological procedures that were carried out largely within the localized operational areas around specific occupation sites.

Paste groups recognized in the petrographic studies by Dr. Robinson (Appendix D) indicate

that only the one sherd that constitutes Vessel Group 5 at the Varga Site did not contain bone temper. The lack of bone temper and its non-local igneous additives combined with the chemical INAA indicate this sherd, which is definitely not part of the Varga Site Toyah component, falls within the El Paso Polychrome reference group (Appendix F). Thus, this sherd probably represents a trade vessel. Other investigated Toyah components have also yielded ceramic sherds that are considered to be non-Toyah in origin. An example includes Vessels 12 and 13 at the Buckhollow Site, thought to reflect Apachean or Puebloan groups (Johnson 1994:203). Caddoan pottery was identified at the Mustang Branch and Barton sites on the eastern margin of the Edwards Plateau (Ricklis 1994; Reese-Taylor et al. 1994). At the Rush Site, Vessel 6 was considered non-Toyah as it contained volcanic rock as part of the tempering agent, indicating a non-local origin (Reese-Taylor 1995).

The INAA of the figurine-like object (#840-8-1b = TRC279) indicates this piece is chemically distinct from the identified Varga-1 and Varga-2 compositional groups, and the Central Texas 1 and 2 reference groups (Appendix N). It is also chemically distinct from the local sediment sample, which means it was probably not manufactured from local clays. Most likely this was a trade item, but the manufacturing locality is not known. As this object has a chemical signature tending only very weakly towards the Central Texas 1 and 2 reference groups. Therefore, we suggest that this object arrived at the Varga Site from some origin other than Central Texas.

The INAA appears to be separating different clay sources/manufacturing localities for these various sherds and vessels. Now it is the archeologist's responsibility to find and sample the source localities for these various pastes to begin to trace the movements of these peoples and their vessels across the landscape.

Interestingly, the five Mission San Juan sherds petrographically analyzed also reveal relatively high percentages of bone temper in the range of 23 to 30 percent (Appendix D). The INAA indicate these five mission sherds were all part of the same chemical compositional group. Although not identical in thickness, paste, or amount of bone temper, these attributes still support a connection to the construction process employed in the prehistoric Toyah phase vessels. The use of bone temper during the manufacture of Toyah phase sherds was definitely carried forward into the Historic period in the production of the Mission San Juan pottery. One may conclude that the Natives who manufactured the bone-tempered pottery during the Historic mission period were descendants of the people who produced Toyah ceramics.

The three Mission San Lorenzo sherds analyzed here did not reveal any bone temper whatsoever. The lack of bone temper, the employment of igneous inclusions as additives, and the slightly higher quantities of silicates including quartz inclusions, indicate the Native Americans manufacturing these sherds had different approached to tempering clay. The INAA on two of the three analyzed sherds from Mission San Lorenzo form a completely separate chemical composition group than those from Mission San Juan. The other Mission Lorenzo sherd (#1872-6c = TRC263) was unassigned to a particular chemical group. Spanish Mission San Lorenzo de la Santa Cruz, founded in A.D. 1762, was established specifically for the Lipan Apache Indians (Tunnell and Newcomb 1969). Consequently, the two missions housed predominately two different Native populations, and this seems to be reflected by differences in ceramics.

The pottery sherds from the two Mission sites petrographically analyzed here documents the essentially contemporaneous use of two different kinds of aplastic additives. If the different additives reflect a cultural, and not functional

difference, then the difference in the two Mission samples implies that two separate Native American groups occupied the two missions. The non-Toyah phase sherd of Vessel Group 5 from the Varga Site is more closely related to the Mission San Lorenzo sherds, based on the additives, than any other group of sherds.

The lipid residue analysis on six sherds, two each from Vessel Groups 1, 2, and 3, reveals very similar results. The detected residue signatures were interpreted as ranging from borderline moderate-to-high and high fat content implying that fatty plant parts were cooked in these vessels. These results, combined with the stable carbon isotope values that range from -24.3 to -27.6‰ and nitrogen isotope values that range from -2.6 to 6.9‰ imply that some plants cooked in these vessels were probably legumes such as mesquite beans, whereas in one case the nitrogen isotope value (6.9‰) supports a plant that is in the range of huisache bean. The detected carbon isotope values of -27.2‰, plus the nitrogen isotope value of 6.9‰, are very close to the carbon isotope value of -27.3‰ and nitrogen value of 6.2 and 7.5‰ derived from modern huisache bean meat from Maverick County, Texas (Quigg et al. 2002a). The products cooked in the vessels appear to reflect fatty plants rather than animals, even though a relatively large and fragmented bone assemblage was recovered from this Toyah component.

8.2 BURNED ROCKS

Large quantities of scattered burned rocks, plus 10 burned rock features, were encountered in this component. The burned rocks total 15,934 pieces and weigh 1,082,147 g, including those in features, which account for 1,635 pieces that weighed 145,352 g. The feature rocks account for only 10.3 percent by count of the total count, and 13.4 percent by weight of the total weight. Clearly, the greatest percentage was encountered outside the recognized features.

The average density of burned rocks was about 77 pieces per m².

The scattered burned rocks total 14,299 pieces weighing 936,795 g, for an average burned rock weight of 65.5 g. The scattered burned rocks are comprised mostly of the smallest size class with 76.5 percent by count, followed by the next smallest size class at 28.8 percent, then 1.7 percent in the next size class, and less than one percent in the largest size class. This indicates the scattered burned rocks were quite small with less than two percent greater than 9 cm in diameter.

The average burned rock weight in the features was 89 g compared to about 66 g for those scattered outside features. Whereas this is not a great difference, it may in fact reflect the type of features discovered. Most features were interpreted as discard areas or parts of the broader component, rather than discrete, intact hearths. Only four hearths, Features 9, 21, 30, and 38, were identified, and these yielded average burned rock weights of 375 g, 204 g, 324 g, and 196 g, respectively. These four hearths provide an overall average rock weight of 274 g, which is four times the weight of the average rock amongst the scattered burned rocks. This significant size difference is the result of large rocks breaking apart during use and prior to discard.

8.3 MACROBOTANICAL REMAINS

The carbonized plant remains from this component were abundant in comparison to the older components, presumably a factor of lesser preservation with greater age. Most identified burned rock clusters, hearths, dumps, other features, and the general occupation areas yielded charcoal chunks, but well-defined charcoal lenses were absent.

During the hand excavations individual charcoal samples were often plotted and bagged separately, but in recognizable features the entire

feature matrix was often collected and floated. Individual samples and float samples are available for dating and identification. Eleven light fractions from Features 8, 9, 18, 21, 22, 25, 26, 30, 35, 36, and 38 were submitted to Dr. Phil Dering for identification of charred remains. Individual pieces of charcoal were also sent for identification, including parts of the pieces that were radiocarbon dated (Appendix I).

About 196 g of carbonized plant remains were recovered (Table 8-13). From the Toyah component seventeen radiocarbon dates were obtained. This includes multiple dates from a single piece of carbonized plant material. The radiocarbon analysis yielded 75 percent acceptable dates between 290 and 660 B.P. Two samples, or 12.5 percent, were older than this range and dated to the 920 to 940 B.P. time period. Two other samples dated yielded ages younger than 290 B.P., though the age ranges on these samples may fall within the recent end of the Toyah interval once they are calibrated. The ages indicate that some mixing has occurred, or that the burning of old wood might be a factor.

Dr. Dering's identifications indicate that at least 17 species were burned, implying their cultural use. These species include agave heart and leaves (likely sotol or yucca), agarita, buttonbush, cheno-am seeds, condalis, elm, juniper, littleleaf walnut, lotebush, mesquite, Mexican buckeye, oak, pecan, pinyon, prickly pear seeds, sycamore, and willow/cottonwood (Appendix I). The agave pieces were recovered from three different hearth-like features (Features 21, 35, and 38). Their presence may indicate accidentally burned food remains, use as fuel, or use as packing or protective wrap around other foods. The littleleaf walnut is only identified from charred nutshells and not charred wood. The lack of burned walnut wood implies the walnuts were not attached to wood burned for fuel.

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
31-007	N99/E53	14-20		0.1		
41-007	N99/E54	10-20	35	3.2		
52-007	N99/E55	0-10		1		
52-007-1a	N99/E55	0-10		0.1	Sent to Dering for ID	Oak (n=7)
53-007	N99/E55	10-20		1		
78-007	N100/E50	0-10		5	Sent to Dering for ID	Juniper (n=1), sycamore (n=7), mesquite (n=17), oak (n=9), indeterminate (n=16)
78-5-7-1	N100/E50	10-20	21	0.9	Sent to Dering for ID	Juniper (n=4), mesquite (n=2), oak (n=7), elm (n=2),
78-5-7-1a	N100/E50	0-10	21	0.1	C ¹⁴ dated to 380 + 40 B.P.	
78-5-7-1b	N100/E50	0-10	21	0.1	C ¹⁴ dated to 380 + 30 B.P.	
78-5-7-1c	N100/E50	0-10	21	0.1	C ¹⁴ dated to 300 + 40 B.P.	
78-5-4-1	N100/E50	10-20	21	0.9	Light fraction sent to Dering for ID	Oak (8 ml), hickory family (n=3), juniper (n=9), lotebush (n=6), indeterminate (4 ml), pecan (cf) nut shell (n=3)
79-005-004-007-1a	N100/E50	10-20	21	1	Sent to Dering for ID	Juniper (n=2)
79-5-4-1	N100/E50	10-20	21	5.1	Light fraction sent to Dering for ID	Oak (9 ml), elm (4 ml), mesquite (n=14), juniper (15 ml), woody legume (n=1), indeterminate (n=20), cheno-am seed (n=2)
79-005-007	N100/E50	10-22	21	2		
87-005-007	N100/E51	10	21	1.7		
87-5-4-1	N100/E51	10	21	6.2	Light fraction sent to Dering for ID	Agave heart (n=13), juniper (n=21), indeterminate (n=7), elm (n=9), hickory family (n=9), woody legume (n=5), pecan (cf) nut (n=2), walnut nut (n=1), lotebush (n=17)
87-5-4-1	N100/E51	10-20	21	6.4	Light fraction sent to Dering for ID	Oak (10 ml), elm (n=2), lotebush (n=2), juniper (13 ml), indeterminate (11 ml). Woody legume (n=5)
97-007	N100/E52	0-10		1.9		Walnut nut (n=1)
109-007	N100/E53	19	30	1		
109-007-1a	N100/E53	19	30	1	Sent to Dering for ID	Juniper (n=1), mesquite (n=4), indeterminate (n=5)
109-5-4-1	N100/E53	19	30	1.2	Light fraction sent to Dering for ID	Oak (n=8), mesquite (n=2), indeterminate (n=21), mesquite seed (n=1), slag (n=8)

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
119-005-007	N100/E54	15	35	4.7		
119-005-007-1a	N100/E54	10-20	35	0.1	Sent to Dering for ID	Oak (n=7)
119-5-4-1	N100/E54	10-20	35	1.4	Light fraction sent to Dering for ID	Indeterminate (8 ml), oak (n=2), woody legume (n=12), juniper (n=1), agave heart (n=4),
158-005-007	N101/E47	20-30	36	2.1		
158-005-007-1a	N101/E47	20-30	36	0.1	C ¹⁴ dated to 400 + 40 B.P.	
158-005-007-1b	N101/E47	20-30	36	0.1	Sent to Dering for ID	Oak (n=3)
159-005-007	N101/E47	30-40	36	12.6		
159-005-007-1a	N101/E47	30-40	36	0.1	C ¹⁴ dated to 940 + 40 B.P.	
159-005-007-1b	N101/E47	30-40	36	0.1	Sent to Dering for ID	
160-005-007	N101/E47	40-50	36	0		
160-005-007-1a	N101/E47	40-50	36	0.1	C ¹⁴ dated to 920 + 40 B.P.	
160-005-007-1b	N101/E47	40-50	36	0.1	Sent to Dering for ID	Mesquite (n=3)
168-007	N101/E50	20-30		0.1		
176-007	N101/E50	0-10		0.2		
186-005-007	N101/E51	10-20		0.4	No Feature; not handled	
186-007	N101/E51	10-20		0.5	No Feature	
196-007	N101/E52	10-20		1.4		
232-007	N101/E55	10-20		0.3		
262-005-007	N102/E47	30-40	36	0.8		
262-5-4-1	N102/E47	30-40	36	0.2	Light fraction sent to Dering for ID	Oak (n=5), juniper (n=2)
292-007	N102/E52	10-20		0.1		
313-007	N102/E54	30-40		0.1		
314-007	N102/E54	40-50		0.1		
348-007	N103/E47	0-10		0.2		
349-007	N103/E47	10-20		1.7		
350-007	N103/E47	20-30		0.1		
358-007	N103/E51	10-20		0.1		
376-007	N103/E52	0-10		0		
377-007	N103/E52	10-20		0.1		
377-007-1a	N103/E52	10-20		0.1	Sent to Dering for ID	Oak (n=1)

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
405-007	N104/E47	10-20		0.5		
406-007	N104/E47	20-30		0.2		
407-7-1a	N104/E47	30-40		0.7	Sent to Dering for ID	Oak (n=3)
450-007	N105/E52	0-10		0		
450-007-1a	N105/E52	0-10		0.1	Sent to Dering for ID	Mesquite (n=1)
466-007	N105/E54	0-10		0.1		
481-007	N105/E56	10-20		0		
481-007-1a	N105/E56	10-20		0.1	Sent to Dering for ID	Indeterminate (n=17)
490-007	N106/E47	20-30		0		
490-007-1a	N106/E47	20-30		0.1	Sent to Dering for ID	Juniper (n=1)
525-005-007	N106/E54	35-40	2	0		
525-005-007-1a	N106/E54	35-40	2	0.1	C ¹⁴ dated to 290 + 40 B.P.	
525-005-007-1b	N106/E54	35-40	2	0.1	Sent to Dering for ID	Oak (n=1)
533-007	N106/E55	3-20	18	3.6		
533-5-4-1	N106/E55	3-20	18	0.2	Light fraction sent to Dering for ID	Oak (n=25)
534-007	N106/E55	10-20		0.5		
550-007	N107/E47	20-30				
550-007-1a	N107/E47	20-30		0.1	Sent to Dering for ID	Oak (n=1)
573-007	N107/E51	10-20		0		
573-007-1a	N107/E51	10-20		0.1	Sent to Dering for ID	Oak (n=4)
594-007	N107/E54	40-50		0.1		
603-5-4-1	N107/E55	17-22	22	0.2	Light fraction sent to Dering for ID	Indeterminate (n=13)
739-5-7	N109/E56	30-40	27	0.1	C ¹⁴ dated to 550 + 40 B.P.	
748-007	N110/E54	0-10		0		
748-007-1a	N110/E54	0-10		0.1	Sent to Dering for ID	Juniper (n=1), oak (n=5)
749-005-007	N110/E54	10	32	0.2		
800-007	N115/E73	10-20		0		
800-007-1a	N115/E73	10-20		0.1	Sent to Dering for ID	Oak (n=2)
825-007	N117/E69	0-10		0		
825-007-1a	N117/E69	0-10		0.1	Sent to Dering for ID	Willow/cottonwood (n=2)

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
830-5-4-1	N117/E71	12-22	9	4.4	Sent to Dering for ID	Agarita (n=11), lotebush (n=7), cottonwood/willow (n=10), juniper (n=9), sycamore (n=4), oak (n=30), buckeye (9 ml), woody legume (n=9), pinyon (n=1), indeterminate (n=1)
830-005-004-007-1a	N117/E71	12-22	9	0.1	C ¹⁴ dated to 660 + 40 B.P.	Oak (n=4)
830-005-004-007-1b	N117/E71	12-22	9	0.1	Sent to Dering for ID	Oak (n=21)
830-005-007	N117/E71	12-16	9	0.9		
830-005-007-1a	N117/E71	12-16	9	0.1	Sent to Dering for ID	
841-007	N118/E69	10-20		1		
841-007-1a	N118/E69	10-20		1	Sent to Dering for ID	Indeterminate (n=2), mesquite (n=4), oak (n=3)
842-007	N118/E70	0-10		0.4		
843-005-007	N118/E70	10-20	8	3.4		
843-5-4-1	N118/E70	10-20	8	3.6	Light fraction sent to Dering for ID	Lotebush (10 ml), buttonbush (n=8), juniper (n=3), woody legume (n=5), indeterminate (n=6)
843-005-007-1a	N118/E70	10-20	8	0.1	C ¹⁴ dated to 80 + 30 B.P.	
843-005-007-1b	N118/E70	10-20	8	0.2	Sent to Dering for ID	Walnut shell (n=1)
843-005-007-2a	N118/E70	10-20	8	0.1	Sent to Dering for ID	Indeterminate (n=7), oak (n=6)
844-007	N118/E71	0-10		0.7		
847-007	N118/E72	0-10		0.1		
848-007	N118/E72	10-20		12.8		
848-007-1a	N118/E72	10-20		2	Sent to Dering for ID	Oak (n=4), mesquite (n=15)
863-007	N119/E69	10-20		0.3		
865-005-004-007-1a	N119/E70	10-20	8	0.1	From heavy fraction; C ¹⁴ dated to 620 + 40 B.P.	
865-005-004-007-1b	N119/E70	10-20	8	0.1	From heavy fraction; sent to Dering for ID	Oak (n=1)
865-005-004-007-1c	N119/E70	10-20	8	0.1	From heavy fraction; C ¹⁴ dated to 570 + 40 B.P.	
865-005-004-007-1d	N119/E70	10-20	8	0.1	From heavy fraction; C ¹⁴ dated to 600 + 40 B.P.	
865-005-007	N119/E70	14	8	1.1		
865-5-4-1	N119/E70	14	8	0.5	Light fraction sent to Dering for ID	Lotebush (n=9)

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
865-005-007-2a	N119/E70	14	8	0.1	Sent to Dering for ID	Indeterminate (n=4)
866-007	N119/E71	0-10		0.1		
867-005-007	N119/E71	10-20	8	2		
867-005-007-1a	N119/E71	10-20	8	2	Sent to Dering for ID	Green condalis (n=3), juniper (n=3), mesquite (n=5), elm (n=5), indeterminate (n=4)
867-5-4-1	N119/E71	10-20	8	6.6	Light fraction sent to Dering for ID	Oak (n=10), agarita (n=25)
899-007	N122/E69	20-30		0		
899-007-1a	N122/E69	20-30		0.1	Sent to Dering for ID	Juniper (n=1)
912-007	N122/E74	0-8		0.2		
919-007	N123/E68	19-29		0.6		
944-007	N123/E74	26-35		0		
944-007-1a	N123/E74	26-35		0.1	Sent to Dering for ID	Mesquite (n=1), oak (n=26)
980-007	N125/E71	0-10		0.4		
984-007	N125/E72	10-20		0.6		
991-007	N125/E74	18-28		0.1		
1006-007	N126/E71	20-26		0.2		
1021-005-007	N126/E74	20-25	25	8		
1021-005-007-1a	N126/E74	20-25	25	2	Sent to Dering for ID	Mesquite (n=11), juniper (n=4), indeterminate (n=2)
1025-005-007-1	N126/E75	20-30	25	5.2		
1025-005-007-1a	N126/E75	20-30	25	0.1	C ¹⁴ dated to 320 + 40 B.P.	
1025-005-007-1b	N126/E75	20-30	25	0.1	Sent to Dering for ID	Mesquite (n=1)
1025-005-007-2	N126/E75	30	25	6.6		
1030-005-007-1	N126/E76	35-50	38	8		
1030-005-007-1a	N126/E76	35-50	38	0.1	C ¹⁴ dated to 390 + 60 BP	
1030-005-007-1b	N126/E76	35-50	38	0.1	Sent to Dering for ID	Willow/cottonwood (n=2)
1030-005-007-2	N126/E76	30-40	38	0.4		
1030-005-007-2a	N126/E76	30-40	38	0.1	Sent to Dering for ID	Woody legume (20 ml)

Table 8-13. Toyah Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
1030-5-4-1	N126/E76	30-40	38	4	Light fraction sent to Dering for ID	Oak (<i>n</i> =24), buttonbush (5 ml), cottonwood/willow (<i>n</i> =5), juniper (<i>n</i> =5), indeterminate (<i>n</i> =8), woody legume (<i>n</i> =14), agave leaf (<i>n</i> =3), prickly pear seed (<i>n</i> =2), indeterminate seed (<i>n</i> =1)
1050-005-007	N127/E74	15-27	25	0.6	Feature 25 in NW corner	
1051-005-007	N127/E74	27-30	25	1.8	Inside Feature	
1051-5-4-1	N127/E74	27-30	25	1.7	Light fraction sent to Dering for ID	Cottonwood/willow (<i>n</i> =5), juniper (<i>n</i> =1), elm (<i>n</i> =1), oak (<i>n</i> =11), mesquite (<i>n</i> =15), indeterminate (<i>n</i> =24), sycamore (<i>n</i> =2), walnut nut (<i>n</i> =3)
1054-007	N127/E75	20-30	25	6.3		
1055-005-007	N127/E75	25-35	25	20.6	Lower part of Feature	
1055-005-007-1a	N127/E75	25-35	25	6	C14 dated to 170 + 60 BP	
1055-005-007-1b	N127/E75	25-35	25	2	Sent to Dering for ID	Mesquite (<i>n</i> =1)
1123-007	N130/E72	30-35			Modern tree root sample	54.5 g
1123-007-1a	N130/E72	30-35			Sent to Dering for ID; modern tree root	9.0 g

Pecan nuts, represented by a few thin shells, provide sufficient meat to imply use as food, with discard of shells into fire as a means of disposal. Burned cheno-am seeds (goosefoot or pigweed) and prickly pear seeds, each from single proveniences, were also identified, though in very limited numbers.

The one burned mesquite seed in Feature 30 may be an indication that this resource was processed for food. Mesquite wood was identified from the same feature as the mesquite seed, indicating the seed probably was just part of the fuel wood. It is uncertain if these different seeds were accidentally burned or if they truly represent the preparation of food.

The identifications of carbonized remains document a tremendous range of woods employed for what is thought to be fuel for fires.

The 17 species represented reflect both upland and riparian environments, and thus, the use of diverse environmental zones and non-specific selection. This broad diversity is not just a reflection of the number of features present at this site, since a few individual features yielded seven to eight different species (i.e., Features 8, 9, and 21). Dr. Dering interprets the abundance and diversity of woods to indicate repeated use of these features (Appendix I). This may be a correct interpretation in the case of dumps such as Features 25 and 28, but Features 9 and 21 are tight clusters of burned rocks that would imply a single use episode of fairly short duration. It appears that the occupants did not select a single species of wood for fuel.

8.4 TOYAH SUMMARY AND DISCUSSION

This horizontally extensive and dense component was recognized through many stone tools, quantities of lithic debitage, quantities of bone fragments, thousands of burned rocks, and a number bone and burned rock features. These cultural materials were partially exposed on the disturbed surface, but were mostly in a loose, brown (10YR 4/3) clay loam layer of overbank deposits, which correspond to Depositional Unit 1. This mostly 12- to 18-cm-thick deposit extends over most areas investigated on both sides of the pavement. General TxDOT road maintenance activities, bladed access roads to private properties, and Phase I backhoe trenching all impacted the original surface and the top part of this component. An abrupt, smooth lower boundary and soil color change demarcated the base of Depositional Unit 1, which lay immediately atop the Late Archaic cultural deposits that contained the burned rock concentration, designated as Feature 1. A few Toyah age materials were had moved downward to become mixed with Late Archaic materials.

The hand-excavated 207.75 m² yielded 26,323 pieces of lithic debitage; 20,438 bones; 15,934 burned rocks; informal tools including 1,380 edge-modified flakes; formal tools including 216 arrow points (140 unidentifiable fragments, and 53 Perdiz, 10 Clifton, five Bonham, two Scallorn, two Guerrero, one Edwards, one Cuney, one Harrell, and one Padre); 13 dart points (four Frio, one Group 2, one Baker, one Merrell, and six unidentifiable fragments); 96 bifaces; 65 scrapers (one missing); 37 cores; 16 drills; seven unifaces; one anvil; and one hammerstone. Also recovered were 115 ceramic sherds, 196 g of carbonized plant remains, and seven relatively unique artifacts of various materials.

8.4.1 Chronology Issues

The chronometric age is derived through radiocarbon dating of 21 samples recovered

from this cultural zone. Two radiocarbon dates, one on burned rock (#1030-5-3-2c) at 11,980 B.P. and one of three dated ceramic sherds (#987-8-1a) at 26,960 B.P., are obviously much too old and beyond the realm of any realistic cultural association (Table 8-1). The four dated Toyah sherds plus, the Toyah burned rock, yielded ages that appear contaminated in one way or another. The burned rock assay is so far beyond the known range of human occupation that it surely is contaminated. Three, or 75 percent, of the dated Toyah sherds provide AMS results that are largely or completely outside the acceptable age range for this prehistoric Toyah assemblage.

The dating results from four Varga Site Toyah sherds, and the sherds from other context, were intended to enable us to address the arrival and use of ceramics in the region, to investigate their continued use into the Historic period, and to assist in refining the age range of Toyah components. The mixed results from our efforts to directly date the sherds prevent us from addressing these and other questions, which were proposed in the research design.

Three samples, two charcoal dates of 80 B.P. and 170 B.P. (#843-5-7-1a and #1055-5-7-1a) and one ceramic sherd date of 60 B.P. (#118-8-1a), which is suspect to begin with, yielded ages that are less than 200 years old. These three ages are considered too recent and unacceptable for this Toyah component. However, both produce calibrated age ranges that, at one sigma, fall within decades of A.D. 1700, indicating that they may be accurate indicators of an Early Historic, Toyah or Toyah-like cultural component at the site.

Two other charcoal dates of 920 B.P. (Beta-175399) and 940 B.P. (Beta-175398) from Feature 36 (a dense occupation zone) along the western margin of Block A, are older than the presumed age for Toyah and younger than the well-dated Late Archaic component here. These two ca. 930 B.P., even when calibrated, are pre-

Toyah in age, indicating the possibility of an unrecognized cultural occupation just before the Toyah events and associated with one or more of the non-Perdiz arrow points recovered. It is also possible that these may reflect some naturally burned wood.

Overall, 35 percent of the radiocarbon ages on materials derived from the Toyah component are considered marginal or unacceptable for this particular cultural component. The 13 acceptable radiocarbon dates, which comprise 65 percent of the Toyah samples, reveal a time range from 290 to 660 B.P. (Table 8-1), with a calibrated 1-sigma range of A.D. 1280-1660. Acceptable assays were all derived from wood charcoal. Forty-six percent fall between 400 and 660 years B.P. Fifty-four percent, or seven wood charcoal dates, are less than 400 B.P. These seven dates indicate that the Toyah occupations at the site could easily have extended into the Protohistoric period. The glass edge-modified flake (#869-10) together with two Guerrero points, adds support to the Protohistoric event(s) at the Varga Site. The two mentioned late radiocarbon ages that both have early-end calibrated ranges in the late Seventeenth Century, could easily represent occupation of the site during this time period.

A total of 229 projectile arrow points and arrow point fragments were recovered from this component, with nearly 61.4 percent consisting of untypable fragments. The single most frequent identifiable point type is Perdiz, which accounts for 70 percent of the identifiable specimens. Clifton points follow in frequency at 13 percent, Bonham points at 6.6 percent, Frio points at 5.3 percent. Less than six percent of the total identifiable arrow points are represented by seven other point types that include Scallorn, Edwards, Guerrero, Cuney, Harrell, Padre, and a Group 2 (Early Corner-Notched) dart point.

The one Edwards and two Scallorn points account for less than four percent of the

identifiable arrow points and are considered just slightly older than other points recovered from the Toyah component. The Rainey Site, just to the east in Bandera County, provides absolute radiocarbon dates and good stratigraphic context to document that Scallorn and Edwards points are slightly older than the Perdiz points (Henderson 2001). At the Rainey Site the Scallorn and Edwards point types are associated with absolute radiocarbon dates that range from about 800 to 1,400 B.P. These three points recovered from the Varga Site may indicate a limited use period just before the Toyah component. The above-mentioned charcoal radiocarbon ages of 920 and 940 B.P. (Beta-175399 and Beta-175398) from the lowest part of the Toyah component, three radiocarbon dates from the Late Archaic component from two bone dates of 860 and 890 B.P. (UGA-12713 and UGA-12708), plus a charcoal date from Feature 1d of 1,390 B.P. (UGA-12704), are considered too recent for the Late Archaic and too old for the Toyah component. These seven absolute dates from the Varga Site may well represent a use period by group(s) using the Scallorn and/or Edwards points, unrecognizable due to admixture with non-contemporaneous materials.

8.4.2 Subsistence Issues

Although only about three percent of the Toyah chipped stone tools were analyzed for use-wear, a wide range of organic materials detected on their surfaces supports diverse uses. The detected materials include wood, starchy plants (possibly roots or tubers), mammals, birds, and other various plants. These detected resources do not clarify which specific plants and animals were consumed, but document a wide range of resources were procured and processed. From this finding, it is assumed that both meat and plant products were part of the subsistence economy.

Bison, deer, antelope, cottontail, jackrabbit, a canid/carnivore like coyote, turtle, snake, hawk-

size bird, and fish bones are positively identified. Minimally two bison, two deer, one antelope, two turtles, two snakes, one bird, one coyote/dog, one cottontail rabbit, one jackrabbit, and one fish are represented. It is not clear if all these species were directly part of the Toyah subsistence base. Several of these species could be intrusive, natural occurrences, especially those species represented by less than four identified pieces. Bison, deer, antelope, and rabbits are definitely part of the cultural food resources. In terms of meat weight, it is apparent that bison was the greatest contributor, possibly more so than all other mammals combined.

About 196 g of carbonized plant remains were recovered. Identifications indicate that at least 17 species were burned, implying use by humans. The burned species include agave heart and leaves (likely sotol or yucca), agarita, buttonbush, cheno-am seeds, condalis, elm, juniper, littleleaf walnut, lotebush, mesquite, Mexican buckeye, oak, pecan, pinyon, prickly pear seeds, sycamore, and willow/cottonwood. Although these species were present, it is unclear which specific ones represent food consumption. The most likely candidate is the agave heart, as the ethnographic record documents considerable use of this part of the plant for food. The littleleaf walnut is also a possibility, but it actually has limited meat inside the small, dense shell, although it does contain some valuable oils. The cheno-am seeds and prickly pear seeds are two more possibilities for food given that they are known to have served as food products. Most other species probably did not serve as foods, with the majority of these being tree parts, which would have been used as fuel for fires. Even though the wood probably was so used, the presence of mesquite, juniper, and prickly pear would have provided other parts, which could have served as food resources.

The lipid residue analyses on 29 burned rocks and six ceramic sherds indicate that only about 24 percent of the samples yielded residues interpreted as reflecting large herbivore or javelina meat. None of the potsherds bore residues that reflect the cooking of large herbivore meat. The sherd residues were characteristic of moderate-high fat content foods likely to be of plant origin. Overall, approximately six percent of the residues were similar to fatty or somewhat fatty meat prepared alone. Just over 11 percent of the residues resemble somewhat fatty large herbivore meat prepared with plants. Nearly three percent of the residues are similar in composition to large herbivore meat prepared with moderate-fat-content plant or bone marrow. The remaining 76 percent are interpreted to reflect plant residues. None of the Toyah burned rocks contained residues identified as very high-fat-content foods. The relatively high fat content residues indicate that seeds and nuts are likely candidates for being cooked in the pots or by using heated rocks.

The stable isotope analysis on the same sherds and burned rocks generally supports the lipid residue analysis, and reveals that all the plants appear to represent C₃ type plants. Not surprisingly, the carbon isotope values obtained from these samples show no sign of corn/maize. Even the large herbivore represented appears to have been consuming mostly C₃ plants. The large herbivore interpreted in the lipid residues is associated with carbon isotope values of -18.4‰ or more negative. These values indicate that if bison were present, as indicated in the bone assemblage, they were consuming nearly equal amounts of C₃ and C₄ vegetation. However, a bison bone (#525-5-2-1) recovered from Feature 2 (a bone cluster) in the Toyah component yielded a $\delta^{13}\text{C}$ value of -8.6‰ and a $\delta^{15}\text{N}$ value of 5.1‰. These isotopic results indicate bison meat should have reflected carbon isotope values in the range of about -13 to -14‰. These more positive carbon isotope

values are not reflected in the isotope values derived from either the ceramic sherds or the burned rocks. Therefore, the $\delta^{13}\text{C}$ values that are more negative than -18.4‰ and derived from samples interpreted as large herbivore residues are most likely deer/pronghorn meat. It is not clear why the carbon isotopes from the burned rocks and ceramic sherds did not reflect any values that would indicate that bison meat was cooked. The obvious interpretation would be that bison meat was not cooked in the pots or by the use of hot rocks.

The Varga Site subsistence for this Toyah component reflects a mixture of plant and animal resources with diversity in both groups. The seasonality for these multiple events is not clear. The site was potentially used during spring and late summer/fall, based on the presence of plant resources (i.e., nuts) with many of the identified animal resources available year round.

8.4.3 Technology Issues

Technology issues are addressed through the preserved materials; however, only a small (but unknowable) percentage of the total cultural assemblage is preserved. The stone tool assemblage is plentiful, with many formal and informal tools recovered, but not it shows little formal diversity. Burned rocks, ceramic sherds, and bone tools were also recovered. Many diverse daily tasks such as resource procurement, processing, and consumption are represented and will be discussed below.

8.4.4 Resource Procurement Issues

Plant and animal procurement is primarily interpreted from the recovered stone tools. The relatively extensive bone assemblage ($n=20,438$) that represents minimally five and potentially 15 individual animals combined with the high frequency of projectile points (13.1 percent of the total tools) indicates the killing/procurement of animal resources. Use-wear analyses on a

few selected arrow points did not reveal the specific material that the points came in contact with. However, this is consistent with their use as projectile points, where contact with the use-material is very brief and does not often leave sufficient indicators (polish and/or striations) for determination of contact matter. Most points show some form of modification to the proximal end to facilitate hafting. The use-wear analyses support this observation with evidence of hafting in the form of plant fibers involved in binding, use of resin as mastic, and abraded flake scar ridges from movement against the haft material (Appendix C). The hafting was done to a small diameter shaft, confirming use of arrows propelled with a bow in contrast to the larger shafts (i.e., darts) used with an atlatl or spear-throwing stick. Based on the minimum numbers of individual animals documented in the Toyah component ($n=5$ to 15), the principal hunting strategy was directed towards procurement of individual animals, rather than groups of animals, which would necessitate communal operations that potentially involved traps or pounds. This individual killing strategy goes for all species identified, from small rabbits to the large bison. Based on the percentage of projectile points compared to the total number of stone tools recovered, in combination with abundant evidence for plant cooking, this procurement strategy appears to represent only one aspect of the subsistence strategy employed by Toyah occupants of the site.

Other food resource procurement activities probably occurred, such as trapping individual animals with snares or nets, or digging up of tubers with a digging instrument, but the direct evidence is lacking. Many potential foods such as berries, seeds, nuts, prickly pear fruits, and various other natural resources such as mussels, rocks, and wood require no formal tools to acquire. Consequently, the lack of stone tools designed for such purposes does not indicate that such activities were not undertaken as parts of a broader pattern of subsistence.

Lithic resources for the manufacture of stone tools and clay resources for the manufacture of ceramic vessels were procured as evident by the quantities of artifacts and manufacturing residues of these materials. Perishable tools such as wooden or antler digging sticks were probably used, but were not recovered from this component. It can be assumed that wood was one resource procured for use as handles for many of the stone tools, the construction of a multitude of various objects including, but not limited to, bows and arrows, traps, awls, pins, gaming pieces, and digging sticks. Most projectile points exhibit alterations to facilitate hafting, some 15 percent of the tools that were analyzed for use-wear exhibited evidence of wood fibers supporting the processing of wood products. The use-wear analysis also revealed that a small percentage of the tools actually were hafted. Wood is also presumed to have been a substance that would leave a hard high silica polish, which was identified on minimally 30 percent of the analyzed stone tools.

As part of the procurement of natural resources, whether it was wood for fires and other uses, or plants and animals for food, it was first necessary to produce the required equipment to acquire these various resources. The recovered assemblage is composed of non-perishable cultural materials from which insights into the production of implements to acquire other resources are gained. The cores indicate that raw tool stone was collected and used. The collected chert cobbles were reduced and flakes from those cobbles were manufactured into various stone tools, including points and bifaces that were then used to procure other natural resources. The different stages of biface production represented in the collected assemblage, from the initial alteration to the finished form, documents the manufacturing of this specific tool class. Use-wear analysis reveals this tool class was used in the acquisition and processing of various resources. The large suite of arrow points (about 13 percent of the

total tools) is another example of a general class of tools, which were undoubtedly manufactured here to facilitate the procurement of animal resources. Multiple lines of evidence indicate production of primary tool classes, which once produced, were employed in the acquisition of other resources.

8.4.5 Processing and Consumption Issues

The general classes of stone tools represented, such as the points, scrapers, bifaces, edge-modified flakes, and drills, demonstrate a wide range of processing activities/tasks. If these broad classes of stone tools represent general tasks, then the edge-modified flake class, which represents diverse tasks (at 76.8 percent of the total tools), was by far the most dominant. This broad, general class is followed in abundance by projectile points (12.8 percent), bifaces (5.3 percent of the tools), scrapers (3.6 percent of the tools), and drills (0.9 percent), with the few other tools combined representing less than one-half percent. The frequency of tools in a class is generally used as an indication of the amount of activity/tasks performed at the locality. However, the use-wear analyses on a suite of formal and informal tools documented a variety of different uses for each general tool class. For example, scrapers were used exclusively for scraping and planing, but worked a variety of materials that included both plant and animal products. Edge-modified flakes exhibit a wide range of use-actions which include scraping, planing, whittling, slicing, and cutting. Bifaces were used on a similarly wide range of materials, with a variety of use actions. High-powered use-wear analysis has demonstrated that formal tool classes were not used exclusively for only one task or on one kind of material.

The use-wear analyses generally documented a higher frequency of plant processing (72 percent) than meat/hide processing (14 percent) on the 59 analyzed tools. Edge-

modified flakes dominated the analyzed group of tools. The different contact materials include plants, meat, bone/antler, mineral, wood, hide, hard and soft material, and completely unidentified materials. Since tool selection for use-wear analyses was biased and represents only 3.3 percent of the total tool assemblage, the frequencies of contact materials cannot be used for projecting the frequency of the type of resources processed. Based on their form, only one or two formal tools may be indirectly linked to plant processing. Again this indicates our inability to address plant use based on tool forms.

Two small, sharply pointed stone tools (#726-10 and #837-11) were selected for use-wear analysis because it was thought they might relate to specific tasks/functions. Both items were identified, according to their shapes, as hafted gravers, presumably used on wood (Appendix M). Specimen #726-10 was originally a Perdiz point that exhibits a distal end reworked a tiny sharp point which was subsequently broken in use. The second graver was a small flake with a pointed tip. These two items are believed to represent engraving action on wooden items.

In addition to the two gravers discussed above, an additional 15 tools have been shown, through use-wear analysis, to have been hafted. These include all four Clifton points, one Padre point, one graver, two bifaces, one Perdiz point, one Bonham point, one scraper, one drill, and one edge-modified flake tool. The scraper was secured to its haft with resin mastic, and at least one of the Clifton points was secured with a plant binding. These observations indicate that many different types of tools were hafted with in various ways. The hafting was not limited to the formally shaped and notched tools that are recognized as projectile points, but extended to even some edge-modified flake tools.

One of our specific research questions was to determine the function of so-called Clifton

points. Were these items actually Perdiz performs, as is often assumed, (e.g., Turner and Hester 1993), or were they actually used as finished tools? High-powered use-wear and residue analyses on four Clifton pieces served to address this question, showing that all four of the examined specimens bore some type of haft wear. One piece also revealed wood fragments and striations in multiple directions implying that it was used to cut wood. The three other pieces revealed no observable use-wear, thus indicated no discernible kind of utilization. Nonetheless, the hafting wear documented on all four specimens does indicate some sort of use, indicating that these items cannot be assumed to be unused performs. Possibly, the three specimens lacking observable wear patterns in fact served as arrow points, given that such use could be short-term and episodic so as to leave no discernible evidence of wear.

Twenty-eight pieces were classified as rejuvenation flakes. As the name implies, these pieces are the result of the intentional rejuvenation of worn-out chipped stone tools rather than unintentional breakage from use. Thus, tool resharpening occurred as worn tool edges were intentionally refurbished. The identified specimens appear to have been removed primarily from unifacial side- and end-scrapers. The high-powered use-wear analyses on five rejuvenation flakes indicate that all five pieces have worn edges once used in scraping and/or planing tasks. Four analyzed specimens were used on hard-high silica plant materials, and one on soft material such as hide.

The extensive faunal bone assemblage that consists of 20,438 specimens weighing 17,348.9 g, reflects extensive animal processing activities. However, the extremely fragmentary nature of most of the sample places constraints on taxa identifications, with nearly 90 percent of the fragments unidentifiable. While the modern mechanical disturbances of the Toyah component, discussed previously, may account

for some of the breakage, the consistently small size of the bone fragments indicates that prehistoric human behavior was also a significant taphonomic factor. Thus, the high degree of bone fragmentation is interpreted to represent intentional breakage for marrow extraction and, significantly, for the rendering of bone grease, an action posited for bone samples at other Toyah sites in Central Texas (e.g., Ricklis 1994b; Masson and Holderby 1994).

The occupants of the Varga site also used long bone splinters for the production of bone tools. Two bone tools, one narrow awl-like object and one thick, pointed punch-like object, were probably used in the manufacture and processing of other cultural items such as clothing.

Clothing was not, of course, preserved, but items that might have decorated their clothing were present in the artifact assemblage. A bone bead blank used in the manufacturing of short bone beads was present. The intended beads may have been for the adornment of clothing, in addition to use as beads in necklaces and/or bracelets. A drilled mussel shell and a very thin marine shell bead were also recovered, which were doubtless also ornaments. Potentially, other bone tools were manufactured, but still functioning tools were probably curated and removed from the site upon abandonment.

The extensive presence of burned rock assemblage ($n=15,934$) suggests that hot rocks were employed for much of the cooking and heating carried out at the site. As discussed above in Section 8.11.2, this is supported by the analyses of the lipid residues extracted from 29 burned rocks from hearths and discard locations. The exact techniques of cooking are not identified, but likely included boiling, roasting, and/or grilling. Four identified hearths represent *in situ* heating and the location of primary activity areas. The burned rocks in these primary heating features averaged greater than 200 g, with those rocks in Feature 9 somewhat larger, averaging 375 g. Burned

rocks found in clusters interpreted as discard locations, all probably used in cooking tasks, were on average smaller, with average weights of less than 125 g, indicating that the functional usefulness of the rock had been exhausted at the time of discard. Presumably, the discarded rocks had been heated and cooled multiple times, with repeated heating and fracturing reducing the size of the fragments.

Although not plentiful, the 115 ceramic sherds, representing some five to eight vessels, also testify to cooking activity, given the organic lipid residues extracted from a sample of six sherds. The interpretations of Drs. Malainey and Malisza, that the lipid residues from the majority of sherds and burned rocks indicate cooking of plants, are a significant contribution to a more realistic assessment of Toyah phase adaptive patterns than is the assumption that large herbivore meat was consistently of primary dietary importance (see Appendix G). Judging from the ubiquity of burned rocks across the Toyah component, along with the general scarcity of pottery, it may be suggested that most cooking was carried out through the use of hot-rock technology. This combined use of ceramic vessels and burned rocks to cook foods has been observed at other Toyah campsites such as the Rush Site (Quigg and Peck 1995) and the Mustang Branch Site (Ricklis 1994b).

Sufficient organic residues were detected in the sherds to provide interpretations as to the type of foods cooked in ceramic containers. Although the use of the ceramic vessel cooking technology might be assumed to be functionally superior to the pre-existing use of hot rocks, it is clear that the introduction of ceramic technology did not replace the long-standing use of hot-rock cooking. The ceramic vessels were perhaps only gradually integrated into technological behavior, or perhaps even more likely, pottery containers were utilized for specific and limited kinds of food preparation.

The minor variations observed and detected in the paste constituent of the five different vessel groups are mostly attributed to slight differences in the clay sources, tempering agents, and variability in the behavior of individual potters. Although the petrography detected variations in the clay sources and aplastic additives, stylistic differences are not detected in the Toyah assemblage. The INAA reveals that different paste groups originated from both local and non-local source areas, though the non-local category remains only vaguely defined. Local clays were used to make at least Vessel Groups 2 and 4 probably were manufactured using local clay sources.

The clay figurine-like object is a rare piece and has no clearly identifiable function. The petrographic results indicate this piece was tempered with only 10 percent bone, significantly less than the percentage of bone temper in vessels from the Toyah component. The mineral content identified in this object indicates this piece was not locally manufactured, and that it was not manufactured from the same clays the vessels, indicating that it was a traded object. It may be an item that had significance outside of the technoeconomic dimension as an artifact associated with either leisure or ritual.

General camp maintenance activities are visible through the identification of debris dumps, such as Features 8 and 25 in Block B. These areas contained diverse classes of cultural detritus believed to reflect multiple cleaning activities within the surrounding habitation area. Although not visibly identified during the excavations, areas for different activities including tool production area, animal processing, food preparation, and cooking are all envisioned to have been maintained through collecting unwanted materials from these different areas and dumping them in selected discard locations.

8.4.6 Intra-Component Patterning

The ca. 370-years of documented radiocarbon time, the discovery of potentially three vertically separated occupation events in a small part of this component, combined with the probability for surface and subsurface disturbances to this shallow deposit, make interpretations of horizontal patterning of the cultural items a challenging task. However, the examination of the spatial patterns in the excavated area may provide insight into some of these questions. To examine the spatial relationship in the Toyah component, it is assumed that all the cultural materials represent a synchronous time unit. Each class or functional unit in the assemblage reflects a task, some phase of a task, or a group of tasks conducted by a particular segment of the resident population. The overall spatial relationships among the activity areas in a single component define the structure of the component, and contribute to an understanding of site function.

The conceptual underpinnings for the spatial analyses presented here are provided in the research design and in the method chapters. Analyses were conducted on the two block excavation areas for this component. Contour maps of density-corrected artifactual data for Block B were generated for each variable (Figures 8-25 through 8-35), using Surfer (version. 5.01) mapping software. These maps serve as visual references to aid in the interpretation of the spatial distribution of each artifact category, and augment interpretation of the results of the principal component analyses. The locations of individual recognized features are also plotted on the density-contour maps as part of the spatial juxtapositions of various materials.

Figure 8-25. Contour Map of Bone Density in Block B

Figure 8-26. Contour Map of Lithic Debitage Density in Block B

Figure 8-27. Contour Map of Edge-Modified Flake Density in Block B

Figure 8-28. Contour Map of Scraper Density in Block B

Figure 8-29. Contour Map of Biface Density in Block B

Figure 8-30. Contour Map of Uniface Density in Block B

Figure 8-31. Contour Map of Lithic Core Density in Block B

Figure 8-32. Contour Map of Drill Density in Block B

Figure 8-33. Contour Map of Burned Rock Density in Block B

Figure 8-34. Contour Map of Sherd Density in Block B

Figure 8-35. Contour Map of Point Density in Block B

In Block B, four features, Features 8, 9, 25 and 38, which formed two separate clusters, potentially had some functional relationship (Figure 8-25). Features 8 and 9 were less than 1 m apart in the southern part of the block. Feature 9 was a small, tight cluster of burned rocks that contained lumps of charcoal indicating a short-term heating element, or hearth. Feature 8 was a nearly 1.5 m wide area with irregularly shaped boundaries that contained a variety of cultural debris, including numerous small pieces of burned rocks, lithic debitage, broken stone tools, scattered ceramic sherds, fragmented bones, and bits of charcoal. This is interpreted as a dump or discard area. Features 8 and 9 are less than 100 radiocarbon years apart in age, with similar diverse wood charcoal types identified from each. The similarity in wood types and the closeness of their ages may link these two features together.

Features 25 and 38 are also less than 1 m apart. They are located in the northeastern part of Block B about 6 m north of Features 8 and 9. Feature 25 reflected a nearly 1.5 m-diameter debris dump, which is similar to Feature 8, with quantities of small burned rocks, lithic debitage, broken stone tools, a few ceramic sherds, fragments bones, and charcoal chunks. Feature 38, although only partially excavated, is interpreted as a heating element, or hearth, with diverse cultural material in direct association. The ages of Features 25 and 38 are less than 100 radiocarbon years apart with similar types of wood charcoal represented. These similar findings may connect Features 25 and 38 together. In both pairs of features, a heating element was less than 1 m east of an irregular debris dump. These two pairs of features both represent hearth-refuse couplets, suggested a recurrent pattern of debris disposal near hearths which may have been nodal points of domestic activity.

Bone awls, choppers, and gouges were excluded from the spatial analysis due to the non-

occurrence of these artifacts in this component in Block B. The resulting data matrix consists of 12 variables (artifact categories) and 125 rows (1m² excavation units). The principal component analysis extracted a five-factor solution representing a cumulative total of 61.74 percent of the variability present in the array of data. The matrix of correlation coefficients is presented in Table 8-14, and the factor solution is presented for modified flakes, and scrapers—collectively composing 19.63 percent of the total variance in the matrix of correlation coefficients (Table 8-15). All four variables exhibit moderate to strong positive factor loadings ranging from .564 to .858; none of the diagnostic variables in Factor 1 are negative.

The association of lithic debitage and edge-modified flakes may be best explained by the assumption that both artifact categories are derivative of the primary task of lithic reduction (i.e., lithic flakes were produced from cores and subsequently modified for expedient use in various cutting and scraping tasks). Whether lithic reduction strategies in this context are oriented toward producing flakes specifically for modification and use, or the flakes simply represent secondary byproduct of producing other tool forms, such as bifaces, is unclear. For spatial studies, no differentiation was made among various flake or core types such as might add clarity to this issue. It is tempting to include the scrapers in this discussion, but scrapers have not been associated with the lithic reduction/debitage/edge-modified flake continuum in any of the other analyzed components, so there seems to be no *a priori* reason for assuming it here. Furthermore, in this study, scrapers are by definition formal tools as opposed to expedient tools such as edge-modified flakes, and the results of the spatial analysis seems to provide a quantitative basis for treating them as separate tool types that do not share a common manufacturing-use-discard trajectory. In any case, six recognizable high-density peaks of lithic debitage are recognizable

across Block B. Although there are only four or five recognizable edge-modified flake high-density peaks, they largely overlap the areas where debitage is particularly abundant, suggests that edge-modified flakes were expediently manufactured from discarded debitage, used, and discarded in more or less the same place. Thus, the production and use of edge-modified flakes as tools is a good example of a least-effort, opportunistic behavioral strategy. Despite the preceding argument about scrapers, four of the six identified high-density peaks of scrapers coincide with debitage peaks, possibly hinting at a degree of expediency in scraper production/use, as well. Finally, faunal bone was recovered from across the entire extent of Block B, but only three, or possibly four, high-density peaks are represented. Three peaks coincide with concentrations of the three other artifact categories constituent of this factor. The factor is interpreted to represent specialized activity areas in which animal resource processing activities occurred and involved the manufacture and use of small cutting and scraping implements. At least three or four such areas are represented, spaced at intervals of three to four meters. One or more of these concentrations presumably corresponds to cultural features identified in this cultural component.

Factor 2 is composed of two diagnostic variables—bifaces and unifaces—collectively composing 10.74 percent of the total variance in the matrix of correlation coefficients (Table 8-15). Both variables exhibit moderate to moderately strong positive factor loadings of .572 and .706. To some extent, the spatial association of these two variables would appear to be somewhat specious, as 60 bifaces and only five unifaces were recovered from the Late Prehistoric component of Block B. Five clearly distinguishable concentrations of bifaces occur across the block spaced, once more, at intervals of three to four meters.

Table 8-14. Correlation Matrix for Block B—Toyah Component

Category	Category											
	Burned Rocks	Faunal Bone	Ceramic Sherds	Groundstone	Cores	Debitage	Bifaces	Drills	Edge-Modified Flakes	Projectile Points	Scrapers	Unifaces
Burned Rocks	1.000											
Faunal Bone	-.060	1.000										
Ceramic Sherds	.207	.304	1.000									
Groundstone	.217	.001	.046	1.000								
Cores	-.007	.109	.009	-.040	1.000							
Debitage	-.111	.550	.334	.115	.193	1.000						
Bifaces	-.089	.110	.123	-.063	.000	.155	1.000					
Drills	.067	.049	-.012	-.028	.161	.034	.051	1.000				
Edge-Modified Flakes	.013	.363	.140	-.081	.154	.557	.166	.047	1.000			
Projectile Points	-.110	.137	.144	.138	.080	.236	-.024	.128	.086	1.000		
Scrapers	.015	.214	.049	.104	.097	.426	-.018	.035	.202	.071	1.000	
Unifaces	-.069	.137	.037	-.018	.105	.200	.192	.205	.013	.074	-.002	1.000

Table 8-15. Principal Component Matrix for Block B—Toyah Component

Variable	Factor ¹				
	1	2	3	4	5
Burned Rock	-.076	-.118	.116	.892	-.081
Faunal Bone	.699	.217	-.009	.021	.104
Ceramic Sherds	.376	.376	-.193	.508	.165
Groundstone	-.021	-.203	-.080	.397	.628
Cores	.260	-.166	.658	-.044	-.111
Debitage	.858	.119	.064	-.026	.223
Bifaces	.156	.706	-.038	-.026	-.155
Drills	-.064	.171	.758	.095	.112
Edge-Modified Flakes	.738	.053	.083	.010	-.204
Projectile Points	.157	.058	.103	-.195	.760
Scrapers	.564	-.377	.112	-.005	.124
Unifaces	.016	.572	.420	-.102	.205
% Variance	19.63	10.74	10.64	10.60	10.13
Cum. % Variance¹	19.63	30.37	41.01	51.61	61.74

¹ Rotation method—Varian with Kaiser normalization

² Based on rotation sums of squared loadings

Two to three of these concentrations correspond to the locations of artifact clusters associated with Factor 1, including faunal bone, lithicdebitage, and edge-modified flakes in one instance; lithicdebitage and faunal bone in a second instance; and possibly scrapers in a third instance. Three “clusters” of unifaces occur in Block B, although only one of these “clusters” contains more than one item. Two of these “clusters” correspond to biface concentrations, whereas the third is located at the northern end of the block, more or less isolated from every other artifact class in the Toyah component. The associations of these formal tool types with areas that exhibit relatively clear functional associations with resource processing suggest that they formed part of a generalized tool kit designed to process animal and/or other types of resources. The tendency for spatial co-occurrence implies horizontal overlapping of activity areas and a corresponding absence of

well-defined spatial segregation of activities, as would be expected in a multifunctional and short-term camp occupied by a more or less highly mobile population.

Factor 3 is also composed of two diagnostic variables—lithic cores and drills—collectively composing 10.64 percent of the total variance in the matrix of correlation coefficients (Table 8-15). Both variables exhibit moderately strong positive factor loadings of .658 and .758. Three to four concentrations of lithic cores occur in Block B scattered across the Toyah component. It is notable that the locations of these concentrations of lithic cores do not appear to correlate with either lithicdebitage or edge-modified flakes. Drills are scattered somewhat ubiquitously across Block B, but two concentrations of drills are discernable, and these two concentrations correlate with the locations of lithic cores. Although it is possible

that drills, as relatively formal implements, and cores, one of the end results of lithic reduction, are simply indicative of lithic reduction activities, it is also possible that these artifacts are markers of activity areas that are spatially segregated from the resource processing activity areas reflected in Factor 1. At the same time, the two items cannot be construed as serving common functions, once again indicating spatial overlap of discrete activities.

Factor 4 is similarly composed of two diagnostic variables—burned rocks and ceramic sherds—collectively comprising 10.60 percent of the total variance in the matrix of correlation coefficients (Table 8-15). Both variables exhibit moderate to strong positive factor loadings of .508 and .892. Although multiple high-density peaks of both artifact types occur in Block B, the highest concentration of these two materials co-occurs in the vicinity of Feature 38. This feature has been interpreted as an *in situ* hearth feature, though it extends under the fence line marking the edge of TxDOT's right-of-way and could not be fully exposed. The association of burned rocks and ceramic sherds, both believed to have been associated with cooking, in this area reinforces this interpretation. Furthermore, high-density, discrete concentrations of scrapers, animal bone, lithic debitage, projectile points, unifaces, and bifaces all occur within two meters of this feature, suggesting the presence of a multi-purpose activity area associated with processing of animal (and possibly other) resources. Additional concentrations of burned rocks occur near the west-central edge of Block B. They also occur across a broad area in the south part of the northern unit of the block, and two to three more concentrated clusters of burned rocks are present near the southern end of the block. Interestingly, the association of these two variables in this factor is probably mainly a function of their co-occurrence in Feature 38, as the three or four discernable concentrations of sherds in the rest of Block B

do not appear to correlate with burned rock concentrations very closely.

Factor 5 is composed of two diagnostic variables—groundstone and projectile points—collectively composing 10.13 percent of the total variance in the matrix of correlation coefficients (Table 8-15). Both variables exhibit moderate to moderately strong positive factor loadings of .628 and .760. As only one groundstone item was recovered from the Toyah component of Block B, and this item was recovered from Unit N119/E69, the center of the densest concentration of projectile points, this factor is probably largely spurious and not very meaningful. Projectile points form six to seven discernable concentrations across Block B, but they are scattered across the entire block in low numbers. In some cases, a projectile point cluster correlates with a concentration of another artifact category, though rarely twice with the same artifact category. Centered on Unit N119/E69, points appear to be most strongly associated with lithic debitage, and in the southeast corner of Block B points are loosely associated with lithic cores and lithic debitage, possibly suggesting that at least two tool manufacturing loci are represented. One cluster of projectile points is located about 1 m south of Feature 38, and may represent activity around that campfire. Points and scrapers are loosely associated in the southwestern corner of the northern part of Block B, which may represent a specialized activity that was spatially segregated from others represented (assuming contemporaneity of use and discard).

Contour maps of density-corrected artifactual data for Block A were generated for each variable in this component (Figures 8-36 through 8-46), again using Surfer (version 5.01) mapping software. The locations of four individual features (Features 2, 18, 21, and 30) are also plotted on the contour maps as potential parts of the spatial relationship of the activities.

Figure 8-36. Contour Map of Sherd Density in Block A

Figure 8-38. Contour Map of Lithic Debitage Density in Block A

Figure 8-37. Contour Map of Lithic Core Density in Block A

Figure 8-39. Contour Map of Edge-Modified Density in Block A

The figure is a topographic map of a study area. It features a grid with North coordinates ranging from 98 to 112 and East coordinates ranging from 46 to 58. Shaded regions represent different topographic elevations, with contour lines indicating specific values. A dashed circle marks a specific location within the grid. A scale bar in the bottom right corner indicates a distance of 1 meter. The map is labeled with 'North' and 'East' axes.

This topographic map displays the study area with a grid system. The vertical axis is labeled 'North' and ranges from 98 to 112. The horizontal axis is labeled 'East' and ranges from 46 to 58. The map features contour lines representing elevation, with labels such as 400, 600, 800, 1000, 1200, 1400, 1600, 1800, 2000, and 2400. Shaded regions indicate different elevation zones. Building footprints are shown as black outlines. A legend at the bottom left indicates that a dashed circle with a dot represents a 'Feature'. A scale bar at the bottom right indicates a distance of 1 meter.

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Figure 8-44. Contour Map of Uniface Density in Block A

Figure 8-46. Contour Map of Scraper Density in Block A

Figure 8-45. Contour Map of Awl Density in Block A

Feature 2 represented a loose concentration of bone with irregular and ill-defined boundaries. Feature 18, less than one meter away, was interpreted as a small dump containing lithic debitage, charcoal, broken formal tools, and burned rocks. Feature 21 was about a 70 cm diameter hearth, filled with burned rocks and limited charcoal, in a shallow, poorly defined basin. Feature 30 was a burned rock cluster in an ovate area.

The Toyah component in Block A covers a total area of 79.68 m² and had a total excavated volume of 11.67 m³ of sediment. Choppers and gouges were excluded from the analysis due to the non-occurrence of these artifacts in this component in Block A. The resulting data matrix consists of 13 variables (artifact categories) and 86 rows (1 m² excavation units). The principal components analysis extracted a five-factor solution representing a cumulative total of 61.11 percent of the variability present in the data array. The matrix of correlation

coefficients is presented in Table 8-16, and the factor solution is presented in Table 8-17.

Factor 1 is composed of four diagnostic variables—ceramic sherds, cores, debitage, and edge-modified flake tools—collectively composing 16.25 percent of the total variance in the matrix of correlation coefficients (Table 8-17). All four variables exhibit moderately strong positive factor loadings ranging from .566 to .756; none of the diagnostic variables in Factor 1 are negative. The association of lithic cores, debitage, and edge-modified flakes may be best explained based on the assumption that all three artifact categories reflect the task of lithic reduction; specifically, producing lithic flakes from cores and subsequently modifying some of the flakes for use in various cutting and scraping tasks. Whether lithic reduction strategies in this context are oriented toward producing flakes specifically for modification and use, or the flakes simply represent a byproduct of producing other tool forms, such as bifaces, is unclear. For spatial studies, no differentiation was made among various flake or core types that might clarify this issue. Examination of density maps for these artifact categories suggests that lithic debitage and edge-modified flakes, and to a lesser extent cores, do show a marked tendency to co-occur in well defined, high-density peaks located along the east edge of Block A, the southeast corner of BT 2, just east of the intersection of BTs 1 and 2, and in the general vicinity of the southwest corner of Block A. Cores also have a high-density peak in the northwest corner of Block A, an area where the other three variables composing this factor are largely absent. The association of ceramic sherds with this cluster of variables appears to be largely a function of a primary high-density peak of sherds in the southwestern corner of Block A, and a secondary peak along the east edge. These two sherd high-density areas correlate directly with two debitage high-density peaks, and the eastern peak correlates with an edge-modified flake

high-density peak. A moderate-density core peak occurs near the latter area. The patterning of this four-variable suite suggests that activity areas associated with these artifact categories are indicated in Block A. Although the association of the three lithic categories appears to reflect lithic reduction activity areas, with subsequent transformation and utilization of the byproducts of flint knapping, the distribution of ceramic sherds appears to be more closely associated with lithic debitage and edge-modified flakes, which may suggest that resource processing activity areas are present in at least two specific parts of Block A; specifically, in the southwest corner (centered on Units N100/E47 and N101/E47) and along the east edge (centered on Units N106/E56 and N107/E56). Whether these patterns are indicative of primary use areas versus disposal areas is less clear, though it does raise the possibility that flint knapping and at least some resource processing or preparation activities co-occurred spatially in Block A.

Factor 2 is composed of four diagnostic variables—burned rock, faunal bone, bifaces, and projectile points—collectively composing 15.79 percent of the total variance in the matrix of correlation coefficients (Table 8-17). All four variables exhibit moderately strong positive factor loadings ranging from .538 to .748; none of the diagnostic variables in Factor 2 are negative. The generalized variability represented by this suite of variables actually appears to consist of differential spatial pairing among subsets of the individual variables across Block A. For example, faunal bone, bifaces, and projectile points co-occur in a cluster in the southwestern corner of Block A. Faunal bone, burned rocks, and bifaces co-occur in two high density clusters in the south half of the block. Faunal bone and projectile points co-occur in two clusters, including the one in the southwest corner and in a second cluster in the northeastern quadrant of the block.

Table 8-16. Correlation Matrix for Block A—Late Prehistoric Component

Category	Category												
	Burned Rocks	Faunal Bone	Ceramic Sherds	Groundstone	Cores	Debitage	Awls	Bifaces	Drills	Edge-Modified Flakes	Projectile Points	Scrapers	Unifaces
Burned Rocks	1.000												
Faunal Bone	.382	1.000											
Ceramic Sherds	.060	.420	1.000										
Groundstone	.013	-.046	.116	1.000									
Cores	.058	.296	.295	-.038	1.000								
Debitage	.228	.485	.368	-.054	.297	1.000							
Awls	.194	.037	.067	-.017	-.053	-.013	1.000						
Bifaces	.182	.317	.198	-.056	.025	.176	-.078	1.000					
Drills	-.045	-.050	-.001	-.024	-.076	.009	-.033	-.084	1.000				
Edge-Modified Flakes	.037	.272	.233	-.062	.177	.484	-.040	.178	.044	1.000			
Projectile Points	.357	.465	.286	.100	.074	.327	-.016	.161	-.035	.281	1.000		
Scrapers	.052	.208	-.009	-.033	.172	.093	.218	.036	.061	.153	.047	1.000	
Unifaces	.041	.225	.443	-.016	.093	.237	-.023	.090	.387	.081	.148	.179	1.000

**Table 8-17. Principal Component Matrix
for Block A—Late Prehistoric
Component**

Variable	Factor ¹				
	1	2	3	4	5
Burned Rock	-.114	.748	-.074	.297	.034
Faunal Bone	.487	.635	.065	.133	.005
Ceramic Sherds	.566	.251	.301	-.048	.413
Groundstone	-.055	.011	-.029	-.047	.832
Cores	.756	-.124	-.126	.140	.078
Debitage	.639	.398	.113	-.028	-.091
Awls	-.131	.106	-.049	.791	.092
Bifaces	.116	.538	.000	-.234	-.244
Drills	-.148	-.086	.822	.010	-.122
Edge-Modified Flakes	.576	.226	.061	-.094	-.273
Projectile Points	.199	.692	.058	-.039	.195
Scrapers	.279	-.044	.144	.677	-.202
Unifaces	.239	.111	.815	.055	.199
% Variance	16.25	15.79	11.53	9.86	8.68
Cum. Variance ² %	16.25	32.04	43.57	53.43	62.11

¹ Rotation method—Varimax with Kaiser normalization

² Based on rotation sums of squared loadings

Bifaces and burned rocks are strongly correlated in one high-density cluster in the south half of the block, and moderately associated in two clusters in the northwest quadrant of the block, an area where the other two artifact types are largely absent.

Finally, the strongest high-density peak of burned rock in the south half of Block A is not associated with any of the other three variables constituent of this factor. Although the associations among the categories in this variable cluster are provocative, it is also notable that lithicdebitage and cores, which display an association in Factor 1, do not appear to be

correlated with projectile points and bifaces. This implies that much of the flint knapping activity that occurred on-site either was oriented toward the production of expedient flake tool forms as opposed to bifaces, or that any bifaces utilized and discarded on-site were not found in exactly the same locations in which they were made. Of course, this variability occurs over a relatively small spatial scale (i.e., meters), so it would be unwise to overemphasize this point. Based on the small spatial scale over which spatial variability occurs in Block A, it is highly possible that patterns among burned rocks, faunal bone, bifaces, and projectile points expressed in this factor indicate specific activity areas relating to resource processing.

Factor 3 is composed of two diagnostic variables—drills and unifaces—collectively composing 11.53 percent of the total variance in the matrix of correlation coefficients (Table 8-17). Both variables exhibit strong positive factor loadings of .822 and .815, respectively. The artifact categories represented in this factor loading include a total of only six individual tools, including four drills and two unifaces. Spatially, each of the unifaces occurs within one meter of a drill in two areas—the southwest corner (N101/E47 and N102/E47) and in the south-central (N101/E52) part of Block A. The remaining two drills are scattered across the northern half of Block A. Both of the drill/uniface pairs occur near high-density peaks observed in some of the artifact categories composing Factors 1 and 2, reinforcing the idea that multi-task activity areas are present in these two areas. The fabrication and/or resource processing functions of drills and unifaces round out the generalized resource processing activities indicated by the previous two factors.

Factor 4 is composed of two diagnostic variables—awls and scrapers—collectively composing 9.86 percent of the total variance in the matrix of correlation coefficients (Table 8-17). Both variables exhibit moderately strong, to strong positive factor loadings of .791 and

.677, respectively. Only two awls and nine scrapers were recovered from the Toyah component in Block A. The awls are located along the east edge of the block and in the southwestern quadrant. The latter awl correlates with a cluster of scrapers present in this area. Two other high-density scraper clusters are present in the approximate center of BT 2, and along the west edge of the block north of center. With such low densities, it seems inadvisable to over-interpret the patterning represented by this factor. It may be more interesting to simply note the correlation of these fabricating and processing implements with multi-task activity areas suggested by high-density clusters exhibited by certain artifact categories discussed in Factors 1 and 2.

Factor 5 is composed of only one diagnostic variable—groundstone—representing 8.68 percent of the total variance in the matrix of correlation coefficients (Table 8-17). This variable exhibits a strong positive factor loading of .832. As only one piece of groundstone was identified in the Toyah component of Block A, the variability represented by this factor would not appear reliably meaningful. This specimen occurs in Unit N104/E47 in a part of Block A where no other artifact category so far discussed displays a high-density peak.

It is important to remember that demonstrable spatial associations of different variables, which form the basis of the preceding discussion, do not inherently indicate the nature of the relationships among some, or all, of the variables. The statistics reveal numerical tendencies among variables to co-occur or to co-vary in space. The statistics “force” patterning upon an assemblage of data, regardless of whether or not it innately existed in the dimension being examined. However, patterning is always present in archeological data, so it seems a minor crime to accentuate it where it exists in order to make the task of detection and interpretation easier. The analyst is responsible for inferring whether such

patterning may be indicative of past behavior, such as that reflected *in situ* activity or discard areas; post-depositional processes, such as plowing or erosion; or a combination of both.

Overall, the principal component analyses included in this spatial study have yielded relatively unambiguous patterning among artifact categories. Although the patterns appear to be constrained and influenced by different factors, several generalizations apply. First, the observed associations among artifact categories appear to be regular, patterned, and often exclusive of other categories. If post-depositional factors, such as erosion, plowing, or animal burrowing, had resulted in extensive mixing of sediments, one would expect there to be less distinctive patterning among specific classes of variables and more pervasive mixing of classes. Similarly, extensive mixing of deposits would tend to blur the relatively clear spatial clusters of cultural materials observed in this component. Thus, it appears that the sediment deposits containing the Toyah component are relatively intact, and that the spatial patterning apparent among artifact categories is referable more to the organization of the prehistoric human behavior than to post-occupational natural influences.

8.4.7 Extra-Local Interactions During the Toyah Interval

Although not numerous, the three marine shell pieces and the clay figurine-like object are non-local in origin, and indicate population movement and/or trading across a broad region. The marine shells undoubtedly originated along the Texas coast, at least 410 km to the southeast. The clay figurine-like object could have originated from a variety of localities, but it apparently did not come from Central Texas. Even though specific origins cannot be pinpointed for these objects, geographically extensive Toyah population interactions are apparent, regardless if they originated from trading connections and/or population

movements. Toyah material-culture assemblage has a very extensive distribution, from near the middle Texas coast (Ricklis 1996), across parts of South Texas (Black 1986), throughout Central Texas (Johnson 1994), and into Northeastern Texas, but apparently they did not west of the Edwards Plateau region, unless one considers the Cielo complex (Mallouf 1985, 1992) to be part of this pattern, not did it extend northward into the Texas panhandle.

One Harrell and one Padre point were recovered from the Varga Site. These same point types have been recovered in limited numbers from other Toyah components across Central Texas. For example, two Harrell points were associated with the main Toyah component at the Rush Site near San Angelo (Quigg and Peck 1995). Harrell points, and an associated material cultural complex, have a relative broad distribution across northwestern Texas. They are concentrated hundreds of kilometers due north of Edwards County, and are linked to the Garza complex (see Boyd 1997 for recent overview). Harrell points are thought to represent a separate and distinct plains group. The occurrence of a Harrell point at the Varga Site is near the southern known extent of the distribution of the type (Prewitt 1995:109). This point may have reached the site through trade or some other form of interaction with peoples to the north. One assumes some type of contact with peoples employing this point type, although it is possible that this was a curated item from a chance discovery.

The Padre point is a considerable distance from its normal distribution, given its documented distribution within a relatively localized area along the extreme southern portion of the Texas coastal zone (Prewitt 1995:124). If this was the normal range of the type, then either travel by individuals or exchange would have to account for this Padre point in Edwards County, some 350 km to the northwest. Although no specific mechanism can be identified, one may suggest that if the people associated with the Padre point

originated along the lower Texas coast then this specimen reached the Varga Site by a similar route and similar forms of interaction or travel as did the marine shell items. The Padre point and the marine shell do at least indicate some sort of interaction with peoples along the southern Texas Gulf coast.

The Cuney point type is generally concentrated in northeastern Texas, though its range extends southward into the middle coastal zone. The one recovered here is considered beyond the western limits of the type's primary distribution (Prewitt 1995). Its arrival at the Varga Site was likely either through trade or some form of direct contact with peoples from northeastern or middle-coastal Texas.

Guerrero points are generally thought to reflect the Protohistoric period, or the subsequent Spanish Colonial period (Turner and Hester 1993). This point type has most often been recovered from Spanish mission contexts across the southern part of Texas. Similar small triangular arrow points and one Perdiz point were recovered from the ca. 180-year old Mission San Lorenzo 40 km south of the Varga Site (Tunnell and Newcomb 1969) and from missions in the San Antonio area as well as to the east in coastal plain missions near Goliad (e.g., Ricklis 1999). The presence of Guerrero points may reflect more recent Protohistoric or Colonial-period occupation(s) which, though mixed with and indistinguishable from the main Late Prehistoric Toyah component, could also be represented by the small number of relatively recent radiocarbon dates with calibrated age ranges whose early ends fall within the late 1600s or the 1700s.

Harrell points are generally found farther north on the plains, the Cuney point from the northeast/east in Caddo country and the coastal plain, the Padre point, plus the marine shells, from the southeast along the lower coast. If the different projectile point types can be viewed as indications of the direction of contact and/or

trade, then the interactions were in various directions, excepting to the west and south. The presence of these, and other projectile point types such as the Bonham and possibly the Edwards points, may indicate broad regional interaction and/or inter-mixing of peoples. Although one Cuney point may indicate a possible interaction with peoples to the northeast, the lack of other obvious trade items such as corn or Caddo ceramic vessels implies that the interaction was not intensive or continuous. If the interactions with groups from other regions were limited to social events and non-perishable goods, then archeological visibility would be non-existent. Based on the very few points and limited other items represented in the recovered assemblage, in association with the dominant Perdiz and Clifton points, the social interaction appears to have been extensive, but limited.

The INAA on a sample of 10 ceramic sherds from the Varga Site was compared to the current INAA of some 200 sherds from Central Texas. The chemical results reveal that the four identified Varga Site Toyah vessels were not manufactured from the same clay sources that were used in the manufacture of most sherds from the Central Texas region. Apparently, the four Varga Site vessels were not manufactured and brought into this region or site from Central Texas. The Varga Site sherds formed two separate subgroups that indicate they were manufactured from at least two separate clay sources or regions. One subgroup was apparently manufactured from local clay sources, based on the fact that one clay sample from the Varga Site was within the limits of the one of the Varga subgroups. The other subgroup was manufactured from non-local clays. One other sherd and the clay figurine-like object were distinct from one another, and distinct from the two identified Varga subgroups. These latter two items were not assigned to any previously identified INAA ceramic group, probably indicating yet another clay source.

The petrographic analysis on the same sherds used in the INAA also reveals different paste groups that reflect acquisition of the raw clay materials from different sources. Comparisons with petrographic results from other Toyah sites reveal five identified paste groups that are shared among two or more Toyah archeological sites across the broader Central Texas region. Since sherds of the same paste groups appear in different archeological sites, this implies transport of vessels across the landscape. Some vessels from the Varga Site probably were locally manufactured, whereas other vessels were manufactured elsewhere, and brought to this site as finished products. From exactly where or how far these pots were derived cannot be ascertained, but continuing investigations into various natural clay source locals and continued INAA may eventually enable us to more better define such patterns.

The extreme scarcity of southwestern ceramic vessels, such as the El Paso brownwares, Chupadero Black-on-white, and various painted or corrugated wares from the Jornada region to the west, implies that western contacts were very limited. It is not clear if this paucity of interaction with populations to the west was due to a cultural or environmental barrier, or is simply a factor of distance. The Chihuahuan Desert to the west potentially contained low population density during Late Prehistoric times, which limited or restricted the interactions with groups in that region.

Interactions with Puebloan peoples from the northwest are not apparent. No obsidian or painted southwestern ceramic vessels were recovered from the Varga Site, or for that matter, at other sites along the western periphery of the Toyah area such as at the Rush Site (Quigg and Peck 1995) and at 41TG91 (Creel 1978).

The INAA on 48 Toyah phase tools indicate that the raw materials used in the manufacture of a broad suite of formal and informal tools have

chemical signatures that are similar to Edwards cherts, probably from the local southwestern outcrops of Edwards chert. Judging from the bivariate plots of principal components 1 and 2, none of the lithic materials originated in western Edwards County or in Val Verde County. Several pieces have chemical signatures similar to Edwards chert from Kerr County. A few pieces have signatures similar to chert gravels from the Nueces River bed near Camp Wood in southern Edwards County. The Cuney point (#349-13 = TRC223) yielded a chemical signature similar to Edwards chert found in the vicinity of the headwaters of Hackberry Creek near 41ED58. This implies that although the Cuney point type is most often found in more northeastern counties (see Prewitt 1995), this particular specimen was probably manufactured from local materials. Apparently, the regionally available Edwards cherts were plentiful and of such good quality that imported lithic materials were not needed or traded for. If trade was occurring with groups outside this immediate southwestern region, then trade goods coming into this region must have been in the form of perishable goods not visible in the archeological record. The chemical differences detected in the Varga Site lithic materials, and in the ceramic materials, indicate the Varga Site Toyah population was relying on multiple source areas in the general region. This indicates a restricted home range, or movement only within a relatively limited area.

8.4.8 Paleoenvironmental Conditions

The pollen data from the Toyah samples at the Varga Site reflects a mosaic of various plants, with a mixture of arboreal and grassland communities reflected in 10 identified taxa. Oak pollen is well represented, and pecan pollen is also present. Hackberry and walnut pollen were present in the lowest-oldest Toyah sample. The presence of *Apiaceae* pollen implies a riparian habitat, whereas the clumps of Cheno-am pollen

indicate that this taxon was common in the environs of the site.

The phytolith assemblage reflects a dominant C_3 (pooideae) grass community. *Stipa*-type (C_3) phytoliths reveal a dramatic increase to about eight percent of the total in the uppermost (most recent) sample. C_4 grasses, as indicated by saddle, lobate, and cross-shaped forms, also increased during this period.

The carbon isotope values on sediments also reflect a dominance of C_3 vegetation during this period. Minimally, 18 taxa were identified from the macrobotanical remains. These taxa were comprised mostly of tree species, including five potential food taxa. The density of these species, and the composition of the actual vegetation community are not clear, but a mixture of vegetation is represented by three or four nut-bearing trees, woody legumes, prickly pear, agave, agarita, and cheno-ams. The identified types provide a general picture of the plant community, which appears to have been rather similar to the modern vegetation mosaic. These data are supportive of the pollen and phytolith data and indicate a mixture of plant species. The vertebrate faunal remains, including bison, deer, antelope, and rabbits, also imply mixed vegetation in the immediate area. Fish, turtle, and mussel shells indicate that nearby Hackberry Creek was a perennial stream.

At Hall's Cave in adjacent Kerr County, Toomey (1993) documented a sharp increase in the Arizona Desert Shrew (*Notiosorex crawfordi*) after 1,000 B.P. and implies that this was related to drying trend. In the southern High Plains region of Northwestern Texas, Holliday (1995) sees some eolian deposition between 1,000 and 500 B.P. with a return to increased effective moisture around 500 B.P. In the Fort Hood region of Central Texas, Nordt (1992, 1993) detects no discernable shift in vegetation between about 400 and 2,000 B.P. based on carbon isotope data from alluvial sediments. In general, he detected a mixed

assemblage of C₃ and C₄ plant species contributing to the isotopic data throughout this time interval.

It is clear that additional data are needed to help clarify vegetation and climatic changes during this latest period of prehistory across Texas. Environmental data from different regions provide somewhat variable paleoenvironmental scenarios, and the examination of different kinds of data (e.g., phytoliths verses isotope data), have contributed to perceived differences.

In summary, this partially disturbed, but moderately rich Toyah phase/interval component may represent multiple episodes of Late Prehistoric occupation. The 14 radiocarbon dates indicate a nearly 300-year long period of intermittent occupation between 290 and 600 B.P. Analysis of horizontal patterns of debris-class distributions suggest that the component is reasonably intact, and that the spatial patterning apparent among artifact categories is potentially more reflective of the organization of the prehistoric occupations than to post-occupational natural influences. This location served as a campsite of limited duration in an unknown season(s). As noted, the overlaps in distribution of materials representing different activities indicate minimal spatial segregation in the organization of activities, as should be expected in the case of relatively short-term occupations by people whose adaptation entailed a correspondingly high degree of residential mobility. The extensive and diverse chipped stone tool assemblage reflects activities directed at the procurement and processing of tool stone, and plant and animal products (Tables 8-18, 8-19, and 8-20).

From this locality the Toyah population exploited a broad base of resources that included meat and other byproducts from deer, antelope, bison, rabbits, and possibly other animals as well as significant reliance on a range of plants including agave hearts, probably sotol or yucca leaves, littleleaf walnut, and prickly pear.

Table 8-18. Summary of the Toyah Assemblage from the Varga Site (41ED28) Investigations

Cultural Material Classes	Toyah Component (200 to 700 B.P.) Counts
Bone Fragments*	17,348.9 g, 18,698 pieces
Mussel Shell*	25.5 g, 45 pieces
Burned Rock	15.934
Features	11
Bone Cluster	1
General Refuse Dumps	3
Hearths	4
Occupation Zone	3
Dart Points and Fragments	13
Frio	4
Merrill	1
Baker	1
Group 2	1
Arrow Points and Fragments	216
Perdiz	53
Cliffton	10
Bonham	5
Scallorn	2
Guerrero	2
Cuney	1
Harrell	1
Padre	1
Bifaces	96
Scrapers	65
Drills	16
Edge-Modified Flakes	1,380
Lithic Debitage	26,323
Cores	37
Unifaces	7
Anvil	1
Hammerstone	1
Ceramic Sherds	115
Bone Tools	3
Clay Object	1
Exotic Materials - marine shells	3
Carbonized Plant Remains	196 g
Total Materials	64,679
Average Thickness (cm)	30
Spatial Extent Excavated (m ²)	207.75
Volume Excavated (m ³)	42.9

* Bone, mussel shell, and carbonized remain totals are weights in grams; ** Mussel shell from testing not weighed

This table does not include materials from float samples

Table 8-19. List of Faunal Species Identified in the Toyah Component

Animal/Species	Counts
Bison	1481 pieces MNI = 1
Deer/Antelope	496 pieces
Deer	12 pieces MNI = 2
Antelope	6 pieces MNI = 1
Turtles	4 pieces MNI = 2
Snake	6 pieces MNI = 2
Dog/Coyote	6 pieces
Small Mammal	33 pieces
Cottontail	2 pieces MNI = 1
Jackrabbit	1 piece MNI = 1
Fish	2 pieces

MNI = Minimum number of individuals

Table 8-20. List of Floral Species Identified in the Toyah Component

Agava heart and leaves
Agarita
Buttonbush
Cheno-am seeds
Condalis
Elm
Juniper
Littleleaf walnut
Lotebush
Mesquite
Mexican buckeye
Oak
Pecan
Pinion
Prickly pear seeds
Sycamore
Willow/Cottonwood

The people employed burned rocks and ceramic vessels to cook their foods. Much of the procured meat was apparently not cooked through the use of hot rocks and no meat was cooked in the ceramic vessels, since the chemical residues indicate that minimally 70 to 75 percent of the identified residues from burned rocks, and 100 percent of the residues from the vessels, represent plant matter. Poorly preserved burned rock hearths were present, as were general refuse dumps that contained diverse cultural debris. These dumps, presumably created from maintenance activities, combined with chipped stone tool manufacturing and maintenance tasks, and diverse vertebrate remains, reflect general camp activities.

The Varga Site Toyah populations apparently had limited contact with other peoples/groups from other regions, as indicted by the presence of a few projectile points that are of types characteristic of other regions. Contact, direct or indirect, occurred with coastal groups as indicated by the presence of three marine shell artifacts, and possibly by the Padre arrow point. Thus, although the Toyah population apparently operated within a limited home range, evidenced by the use of local and regional raw material sources for the manufacture of ceramic vessels and tool stones, they did maintain at least minimal contact with peoples in outside areas.

The pollen, phytolith, stable carbon isotope, and macrobotanical data sets from the Toyah age sediments reflect a vegetation community consisting of a mixture of arboreal and grassland communities. Oak, pecan, hackberry, and walnut were present, together with mostly C₃ grasses, although C₄ grass species were present in increasing numbers. The proposed vegetation community in which the Toyah people lived was similar to the current natural environment of the region.

9.0 LATE ARCHAIC COMPONENT

J. Michael Quigg

9.1 INTRODUCTION: IDENTIFICATION AND DATING OF THE LATE ARCHAIC COMPONENT

The Late Archaic component was first identified during the Phase I investigations, when a Frio point was found near the bottom of Feature 2 west of the road, and a possible Carrizo point was recovered from east of this road. No features or identifiable occupation zones associated with this time were identified during Phase I (Lintz et al. 2002).

Subsequently, Phase II investigations west of the road targeted the entire range of cultural deposits through the 83-m²-block excavation (Block A) that encompassed most of burned rock concentration designated Feature 1, which was determined to pertain to the Late Archaic, based on its association with projectile points of established Late Archaic types (three Frio, one Marcos, one Ensor, one Montell). The inferred Late Archaic ascription was later substantiated by eight radiocarbon dates. Stratigraphically, Feature 1 was situated immediately beneath the Late Prehistoric Toyah component within a very dark gray (10YR 3/1) to black (10YR 2/1) clay loam to silty clay loam. A sharp break in soil color and texture separated the two cultural components (Figure 9-1). As noted in the previous chapter, some mixing of materials had occurred, as evidenced by the presence of two Toyah phase potsherds, two Cliffton points,

minimally two pieces of dated charcoal, and quantities of tiny bone fragments that are confidently ascribed to Toyah component.

Late Archaic materials in Block A were concentrated in and immediately around Feature 1 and could not be traced more than a meter or so beyond that deposit of burned rock. The horizontally restricted Late Archaic occupation is mainly evidenced by the ca. 6 m diameter burned-rock concentration, Feature 1, secondary burned rock clusters, and a relatively small sample of lithic debitage and stone tools.

In Block B, east of the road, excavation targeted mainly the Late Prehistoric Toyah component in the upper 10 to 30 cmbs. However, during the hand-excavations many levels (35.5 m²) penetrated the very dark gray to black A horizon (detected between 8 and 30 cmbs) that signaled the older Late Archaic deposits and captured limited quantities of cultural materials attributed to the Late Archaic. These Late Archaic cultural materials from Block B are discussed in the descriptions and total counts below.

The chronometric age of the Late Archaic component has been determined through absolute dating of organic material retrieved from the cultural zone. Eleven radiocarbon ages fall within the relevant period, ranging from 1,700 to 2,310 B.P., presumably documenting the age range of the Late Archaic component (Table 9-1). A date on sediment organics of 1,900 B.P. (Beta-175390), from the black clay loam on the eastern side of the road, accords with and supports this age range for the Late Archaic cultural materials. Six of the eleven dated charcoal samples were on wood charcoal collected from Feature 1 (Table 9-1). The oldest radiocarbon age of 2,310 B.P. (Beta-175412), came from a single chunk of charcoal from between 26 and 46 cmdbd in Feature 1b in what is considered to be good Late Archaic context.

Figure 9-1. Late Archaic Component in Dark Buried A Horizon

The youngest radiocarbon date, 1,700 B.P. (Beta-175412), was derived from a single chunk of charcoal collected from 20 to 30 cmdb in Feature 1a and also in good context.

However, some vertical displacement of materials was evident in the Late Archaic deposits as well. The second oldest date, 2,290 B.P. (UGA-12716), was obtained from one deer/antelope bone fragment (#418-2-1) that was collected from between 50 and 60 cmdb in the Middle Archaic component. This bone is of Late Archaic age, but was apparently displaced downward into the lower component. Other evidence of displacement is detected in a charcoal chunk (#203-5-4-2-1) dated to the Late Archaic that came from burned rock Feature 39 in the Early Archaic component. It is unlikely the burned rocks in Feature 39 move downward, so we assume the tiny charcoal pieces were displaced downward.

Two other radiocarbon dates on charcoal pieces recovered from the Late Archaic component yielded ages of 550 ± 40 B.P. (#293-5-7-1a) and $1,390 \pm 40$ B.P. (#11-5-4-7-1a), which are not acceptable ages for this component. The 550 B.P. (UGA-12714) age was derived from tiny charcoal pieces from Feature 1c at an elevation of 20 to 30 cmdb. Apparently this

charcoal was displaced a few centimeters downward from the overlying Toyah component. The 1,390 B.P. (UGA-12704) age was also on charcoal at an elevation of 7 to 20 cmbs and originally was thought to be associated with Feature 1d. This charcoal piece may represent an occupation that occurred between the Late Archaic and the Toyah interval.

To evaluate the reliability of OSL dating of alluvial sediments, TRC personnel collected two sediment samples (#1239 and #1240) from two horizontally different parts of the Late Archaic component. Sample #1239 was collected from a brown (10YR 3/1) clay loam on the very eastern edge of Block B in Unit N125/E75 between 28 and 33 cmbs and stratigraphically just below the OSL Toyah sample. Sample #1240 was collected from a brown (10YR 2/1) clay loam on the very western edge of Block A in Unit N104/E47 between 36 and 42 cmbs and stratigraphically below the Toyah sample. These two samples were dated with the OSL technique. The detailed methods and results are presented in Appendix L, and only a summary is presented here. The two sediment samples from the Late Archaic context did not yield many single dateable quartz grains. Only 24 percent of the measured grains in sample #1239 or UW1049 and 15 percent of the measured grains in sample #1240 or UW1050 were dateable grains (Appendix L). The central age determination from the fine grains provided an average age for each sample. Sample #1239/UW1049 yielded an age of $2,210 \pm 392$ years before A.D. 2004. Sample #1240/UW1050 yielded an age of $2,400 \pm 399$ years before A.D. 2004. These two OSL age determinations on fine grains are congruent with the results from the charcoal assays for the Late Archaic component.

Table 9-1. Varga Site Radiocarbon Dates from the Late Archaic Component

Fea. No.	Catalogue #	Blk.	Unit No.	Depth (cm)	Material Dated	Wgt (g)	Lab. No.	Measured Age	¹³ C/ ¹² C Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
1	100-007-1	A	N100/E52	30-40	1 charcoal	0.1	Beta-175411	1770 ± 40	-26.7	1740 ± 40	Cal AD 220 to 400
1, central pit	171-007-1A	A	N101/E50	50-60	1 charcoal	0.1	Beta-175402	2120 ± 40	-23.7	2140 ± 40	Cal 360 to 50 BC
1a	89-007-1	A	N100/E51	20-30	1 charcoal	0.1	Beta-175412	1710 ± 40	-25.5	1700 ± 40	Cal AD 240 to 420
1a	89-5-2-1	A	N100/E51	20-30	1 bone	6.2	UG-				
1b	273-004-2-1	A	N102/E50	26-46	1 charcoal	0.1	Beta-175403	2300 ± 40	-24.5	2310 ± 40	Cal 410 to 240 BC
1c	293-5-7-1a	A	N102/E52	20-30	17 charcoal	0.8	UGA-12714	560 ± 40	-25.3	550 ± 40	Cal AD 1300 to 1440
1d	11-5-4-7-1a	A	N99/E51	7-20	6 charcoal	0.1	UGA-12704	1380 ± 40	-24.3	1390 ± 40	Cal AD 560 to 770
1, base	362-5-7-1a (100-1a)	A	N103/E51	40-50	charcoal	0.1	Beta-170400	2170 ± 40	-22.3	2170 ± 40	Cal 370 to 100 BC
1	179-5-4-7-1a	A	N101/E50	30-40	9 charcoal	0.1	UGA-12711	2240 ± 40	-21.7	2290 ± 40	Cal 410 to 200 BC
15w	801-5-4-7-2a	B	N115/E73	20-27	15 charcoal	0.1	UGA-12725	2130 ± 40	-24.5	2140 ± 40	Cal 360 to 40 BC
39	203-005-4-2-1	A	N101/E52	80-90	7 charcoal	0.1	Bea-175408	2180 ± 40	-21.9	2230 ± 40	Cal 390 to 190 BC
na	418-2-1	A	N104/E56	50-60	1 bone	2.4	UGA-12716	2230 ± 40	-21.5	2290 ± 40	Cal 410 to 200 BC
na	1211-4-A	B	BT 7	15-20	Sediment Ab	300.0	Beta-175390	1860 ± 60	-22.8	1900 ± 60	Cal 30 BC to AD 240

Beta = Beta Analytic, Blk. = Block, Cal. = Calibrated, Con. = Conventional, Fea. = Feature, UGA = University of Georgia, Wgt = Weight

9.2 LATE ARCHAIC FEATURES

9.2.1 Introduction

Nine clusters of burned rocks were recognized during the fieldwork, assigned feature numbers in the field, and assigned to the Late Archaic component. These features fall into two categories based on a combination of visible attributes and constituent materials. The categories include *in situ* cooking facilities ($n=1$) and burned rock dumps ($n=8$). Burned rock dumps consisted of concentrations of burned rocks, but lacked indications of *in situ* heating, indicating secondary that deposition, or discard, is represented. The cooking facility is so identified based on the presence of basins/pits, and burned rock concentrations associated with oxidized earth, ash, and/or charcoal lenses.

Features received more detailed documentation than scattered cultural materials through a suite of observations, measurements, and samples collected. The nine features were discovered in both excavation blocks. Feature 1 and its subdivisions 1a, 1b, 1c, and 1d were discovered in Block A. All four other features (7, 15, 28, and 29) were discovered in Block B below the Toyah component. The nine recognized features are described individually below.

9.2.2 Feature 1

Feature 1 and its subdivisions 1a, 1b, 1c, and 1d constitute one horizontally distributed burned rock lens that was the primary target of the Phase I investigations. Because this feature was originally thought to be a burned rock midden, TxDOT directed TRC to scrape off the overlying sediments, and to then excavate trenches into the “midden” in two directions in order to define its horizontal and vertical dimensions as well as to allow visual inspection and documentation of its form. BT 1, a north-south-trending backhoe trench, revealed a relatively thin lens of burned rocks with maximum thickness of 30 cm, which

was also visible in the intersecting, east-west-trending BT 2 (Figures 9-2 and 9-3). The initial exposure in the profiles in BT 1 revealed a nearly 15-cm-deep basin. The horizontal distribution of the highest concentration of burned rocks extended for about 6 m, as revealed in the wall profiles of the two trenches. The backhoe trenches removed a significant portion of feature.

During Phase I, two 50-by-50 cm test pits (N103/E51 and N101/E50) were excavated from the sides of BTs 1 and 2, into and through Feature 1. One projectile point, resembling the Pedernales type, point was collected from the burned rock zone as exposed in the eastern profile of BT 1. Quantities of burned rocks and a few tiny pieces of charcoal were recovered from the burned rock lens during the Phase I excavations. Cultural materials were also encountered in the fine sediments above and below the burned rocks, which prompted more extensive investigation during the Phase II excavations.

Eight liters of matrix (#370-5-4) from around and below the burned rocks at 28 to 40 cmbd in Unit N103/E51 were collected for flotation in the laboratory. The 6.4 mm-size fraction yielded six tiny burned rock pieces that weigh 44.8 g, four pieces of chert, 44 nearly whole snail shells g, and one small bone fragment. The heavy fraction yielded 41 tiny burned rock fragments that weigh 4.3 g, 112 chert pieces, four tiny charcoal pieces, 11 whole snail shells, and 48 bone fragments, seven of which are burned.

Phase II work continued the investigation of Feature 1, and the cultural zones above and below, through hand-excavations in Block A. These excavations showed the burned rock concentration to be unevenly dispersed across roughly 16 excavation units in the southwestern corner of Block A, south of BT 2 and on either side of the southern end of BT 1 (Figure 9-4).

Figure 9-2. Composite profile of Burned Rock Lens Discovered in Backhoe Trench 1 During First Phase of Investigations in 2002 (view west)

Figure 9- 3. Stratigraphic Profile of Backhoe Trench 1

Figure 9-4. Planview of Features 1a, 1b, 1c, and 1d in Block A

The excavations ultimately exposed a horizontally extensive burned rock feature that measured nearly 6 m in diameter. Although the maximum thickness was about 30 cm and as many as four rocks thick, this was the case in a restricted area less than 1 m in diameter. Most burned rocks were found within only a single layer that exhibited variable density across the relevant 16 units. Within the broader boundaries of Feature 1, small clusters of burned rocks less than 1 m in diameter were observed and designated 1a, 1b, 1c, and 1d. These smaller clusters were treated as subfeatures within Feature 1 in anticipation that these clusters might provide information that would contribute to functional interpretation of the larger feature. Each subfeature will be briefly discussed below, followed by a discussion of Feature 1 as a whole.

9.2.2.1 Feature 1a

Feature 1a, a cluster of 23 burned rocks, was detected in the southern part of Unit N100/E51 towards the southeastern side of the broader burned rock distribution (Figure 9-4). This oval cluster measured 42 by 47 cm in diameter and had a depth range of 19 to 26 cmbd. The burned rocks were located mostly in one layer, but several pieces were found below other rocks, generally near the middle of the cluster. No basin was detected, and no charcoal, ash staining, or oxidation was observed. The matrix that surrounded the burned rocks was a very dark grayish brown (10YR 3/2).

The 23 burned rocks collected from Feature 1a ranged in size from small (less than 4 cm in diameter) to larger pieces close to 15 cm in diameter. Nearly 65 percent of the burned rocks were in the 4.1 to 9 cm size class, but only two rocks were less than 4 cm in size (Table 9-2). The average burned rock weighed 196 g. All but one burned rock was angular in general shape with minimally five pieces representing

heat spalls. Hackled edges were observed on three pieces. A few pieces actually refit with other pieces, and in two instances three pieces fit together to form the parent rock.

Parts of three limestone burned rocks were sampled for lipid residues (Table 9-3). All three pieces (#89-5-3-1a, #89-5-3-2a, and #89-5-3-3a) yielded very high fat content that is interpreted as representing plants. The consistency in these results implies that a single kind of plant was cooked, possibly during one event. Parts of two of these rocks (#89-5-3-1b and #89-5-3-2b) were also sampled for stable carbon and nitrogen isotopes (Table 9-4), with nearly identical results, which show an average $\delta^{13}\text{C}$ value of -25.7‰. The average $\delta^{15}\text{N}$ value is 2.7‰, with both values relatively low. The isotope values generally indicate the presence of C_3 plants, possibly seeds, berries, and/or nuts.

Unit N100/E51 that contained Feature 1a also yielded several other cultural items including 42 pieces of lithic debitage, two bone fragments, a few *Rabdotus* snail shells, tiny chunks of charcoal, one nearly complete Frio projectile point (#89-10), and scattered burned rocks across the north part of the unit. The Frio point was recovered from about 20 cm east of the cluster and 3 to 4 cm below the burned rocks (Figure 9-1). One tiny piece of wood charcoal (#89-7-1) collected from just outside the clustered rocks was submitted for radiocarbon dating. It yielded a $\delta^{13}\text{C}$ corrected (-25.5‰) AMS radiocarbon age of $1,710 \pm 40$ B.P. (Table 9-1: Beta-175412). Part of that dated sample (#89-5-7-1b) was identified as mesquite wood (Appendix I).

Five liters of matrix collected from around and below the burned rocks between 19 and 26 cmbd in Unit N100/E51 was floated in the laboratory. The heavy fraction was sorted and the light fraction was sent to Dr. Dering for macrobotanical analysis.

Table 9-2. Burned Rock Characteristics for Features 1a, 1b, 1c, and 1d

Fea. No.	Unit No.	Depth (cm)	Cat. #	Size (cm) and Weight (g)								Material Type ¹				Fracture Type ²			Total Count	Total Wgt (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.		
1a	N100/E51	19-26	89	2	100	15	1,900	6	2,500	0	0	23			22	0	1	23	4,500	
	Total			2	0	15	1,900	6	2,500	0	0	23	0	0	22	0	1	23	4,500	
1b	N102/E50	20-40	273	8	250	41	7,500	4	2,900			53			18	5	30	53	10,650	
	Total			8	250	41	7,500	4	2,900	0	0	53	0	0	18	5	30	53	10,650	
1c	N102/E52	10-20	292	29	500	31	2,750	3	1,100	0	0				53	8	2	63	4,350	
1c	N103/E52	10-20	377	8	250	9	600	0	0	0	0				17	0	0	17	850	
1c	N102/E52	20-30	293	59	1,000	78	8,000	13	6,250	0	0	73			99	15	36	150	15,250	
1c	N103/E52	20-30	378	16	300	65	7,000	12	7,000	0	0				71	7	15	93	14,300	
	Total			112	2,050	183	18,350	28	14,350	0	0	73	0	0	240	30	53	323	34,750	
1d	N99/E51	11-24	11	0	0	23	4,000	7	2,250	0	0	30			13	1	16	30	6,250	
	Total		11	0	0	23	4,000	7	2,250	0	0	30	0	0	13	1	16	30	6,250	

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Table 9-3. Lipid Residue Results from Burned Rock Samples from Late Archaic Component

Lab. No.	Cat. #	Fea. No.	Material	Wgt (g)	Interpreted Lipid Residue Results
4VG 44	89-5-3-1a	1a	Limestone	74	Very high fat content – plant
4VG 45	89-5-3-2a	1a	Limestone	74	Very high fat content – plant
4VG 46	89-5-3-3a	1a	Limestone	52	Borderline high and very high fat content – plant
4VG 38	273-5-3-1a	1b	Limestone	38	Borderline moderate-high and high fat content – plant
4VG 39	273-5-3-2a	1b	Limestone	23	High fat content
4VG 40	273-5-3-3a	1b	Limestone	44	Borderline high and very high fat content – plant
4VG 41	293-5-3-1a	1c	Limestone	62	High fat content – plant
4VG 42	293-5-3-2a	1c	Limestone	22	Very high fat content – plant
4VG 43	293-5-3-3a	1c	Limestone	41	Borderline moderate-high and high fat content – plant
4VG 49	11-5-3-1a	1d	Limestone	45	High fat content – plant
4VG 50	11-5-3-2a	1d	Limestone	43	High fat content – plant
4VG 51	11-5-3-3a	1d	Limestone	60	Very high fat content – plant
4VG 57	263-5-3-1a	1	Limestone	56	Borderline medium and moderate-high fat content – plant
4VG 58	274-5-3-2a	1	Limestone	35	Borderline moderate-high and high fat content – plant
4VG 59	187-5-3-2a	1	Limestone	93	Very high fat content – plant
4VG 60	80-5-3-1a	1	Limestone	46	Very high fat content – plant
4VG 61	187-5-3-1a	1	Limestone	16	Medium fat content – plant
4VG 62	179-5-3-2a	1	Limestone	22	Low fat plant
4VG 63	98-5-3-1a	1	Limestone	19	Borderline medium fat content and large herbivore + plant
4VG 64	179-5-3-1a	1	Limestone	35	High fat content – plant
4VG 65	274-5-3-1a	1	Limestone	26	High fat content – plant
4VG 66	178-5-3-1a	1	Limestone	25	Borderline medium and moderate-high fat content – plant
4VG 67	370-5-3-1a	1	Limestone	14	Borderline moderate-high and high fat content
4VG 68	161-5-3-1a	1	Limestone	48	Borderline high and very high fat content – plant
4VG 69	352-5-3-1a	1	Limestone	32	Borderline high and very high fat content – plant
4VG 70	352-5-3-2a	1	Limestone	58	High fat content – plant
4VG 71	81-5-3-1a	1	Limestone	19	High fat content – plant
4VG 54	801-5-3-1a	15	Limestone	45	High fat content – plant
4VG 55	801-5-3-2a	15	Limestone	39	Moderate-high fat content –plant
4VG 56	801-5-3-3a	15	Limestone	55	Borderline moderate-high and high fat content – plant
4VG 52	941-5-3-1a	28	Limestone	34	Insufficient lipid for analysis
4VG 53	941-5-3-2a	28	Limestone	15	Very high fat content – plant
4VG 47	966-5-3-1a	29	Limestone	15	Very high fat content – plant
4VG 48	962-5-3-1a	29	Limestone	42	Very high fat content – plant

Table 9-4. Isotope Results from Burned Rocks in Late Archaic Context

Cat. #	Unit No.	Depth (cmbs)	Fea. No.	Wgt (mg)	N Wgt μg^1	$\delta^{15}\text{N}$ (‰)	C Wgt μg	$\delta^{13}\text{C}$ (‰)
80-5-3-1b	N100/E50	30-40	1	7.606	43.5	4.78	778.4	-23.88
81-5-3-1b	N100/E50	40-50	1	2.161	11.4	-3.15	180.4	-26.02
98-5-3-1b	N100/E52	10-20	1	16.006	130.1	7.65	1019.3	-24.19
161-5-3-1b	N101/E47	45-50	1	26.233	91.0	6.08	2569.7	-30.62
178-5-3-1b	N101/E50	20-25	1	30.115	41.5	5.22	642.5	-21.78
179-5-3-1b	N101/E51	30-40	1	8.294	98.0	4.55	1470.3	-24.67
179-5-3-2b	N101/E51	30-40	1	17.820	161.7	6.12	1841.0	-24.65
187-5-3-1b	N101/E51	20-30	1	42.543	145.3	3.91	2350.2	-25.47
187-5-3-2a	N101/E51	20-30	1	40.472	10.1	4.63	162.8	-23.45
263-5-3-1b	N102/E47	35-40	1	7.058	43.3	8.23	538.6	-24.13
274-5-3-1b	N102/E50	40-50	1	2.998	21.4	5.63	376.8	-23.69
274-5-3-2b	N102/E50	40-50	1	24.516	223.7	7.05	2656.4	-23.30
352-5-3-1b	N103/E47	35-40	1	40.293	171.1	2.00	2597.1	-26.33
352-5-3-2d	N103/E47	35-40	1	1.650	23.0	4.64	396.6	-24.63
370-5-3-1b	N103/E51	28-40	1	30.608	96.5	7.09	1254.1	-23.19
89-5-3-1b	N100/E51	20-30	1a	23.362	26.0	2.49	475.5	-25.97
89-5-3-2b	N100/E51	20-30	1a	8.625	51.4	2.89	840.2	-25.37
271-5-3-1b	N102/E50	10-20	1b	6.751	13.7	1.08	203.9	-25.66
273-5-3-2b	N102/E50	28-40	1b	19.183	182.6	5.93	2186.9	-25.09
273-5-3-3b	N102/E50	28-40	1b	30.054	79.7	6.81	1062.6	-22.55
293-5-3-1b	N102/E52	20-30	1c	3.645	17.3	5.78	370.4	-24.18
293-5-3-3b	N102/E52	20-30	1c	22.800	114.3	3.94	1746.7	-24.89
293-5-3-1b	N102/E52	20-30	1c	5.439	32.3	6.72	533.1	-24.54
11-5-3-1b	N99/E51	9-20	1d	40.574	66.5	7.83	1033.4	-23.24
11-5-3-2b	N99/E51	9-20	1d	30.178	376.7	3.41	2891.2	-24.97
11-5-3-3b	N99/E51	9-20	1d	47.687	26.0	3.17	516.7	-25.90
801-5-3-3b	N115/E73	20-27	15	32.874	164.6	7.92	2094.2	-23.21
801-5-3-1b	N115/E73	20-27	15	40.271	43.8	5.53	752.6	-24.48
801-5-3-2b	N115/E73	20-27	15	3.360	24.6	6.62	378.6	-25.34
941-5-3-1b	N123/E73	26-37	28	7.756	25.7	2.38	717.3	-24.69
941-5-3-2b	N123/E73	26-37	28	30.576	211.3	8.66	2010.8	-22.05
962-5-3-1b	N124/E73	20-30	29	1.346	16.3	5.68	313.9	-26.71
966-5-3-1b	N124/E74	19-31	29	12.626	6.1	-5.96	54.6	-28.39

1. Values below 10.0 make the results suspect

2. C = Carbon; N = Nitrogen

The 0.1 liters of light fraction (#89-5-4-1) yielded only 11 indeterminate charcoal flecks (Appendix I). The heavy fraction yielded four tiny burned rock fragments, 42 chert, 28 tiny charcoal pieces, and eight tiny bone fragments. The 6.4 mm mesh fraction yielded 10 burned rock pieces, one chert flake, two pieces of charcoal, four complete snail shells, and one small bone fragment.

A 4.5 cm-long bone fragment (#89-5-2-1) of deer/antelope size animal radiocarbon dated, producing a ^{13}C -corrected (-31.6‰) AMS radiocarbon date of 890 ± 40 B.P. (Table 9-1: UGA-12708). The age of this one bone is thus much younger than the charcoal dates obtained from elsewhere in Feature 1, and is considered unacceptable as the true age of Feature 1.

9.2.2.2 Feature 1b

Feature 1b, a cluster of 53 burned rocks, was identified in Unit N102/E50 towards the northern edge of the broader Feature 1 burned rock distribution (Figure 9-4). It was mostly recognized in the northeastern quadrant of Unit N102/E50, but part of it probably extended into the Phase I 50-by-50 cm test pit (the southwestern quarter of Unit N103/E50) along the southern edge of BT 2. This cluster is not easily distinguished from the rest of Feature 1 in this unit, but the burned rocks appeared to be somewhat more clustered. Most of the rocks were at a depth between 28 and 35 cmbd and formed a single layer. The general cluster was oval in outline and lacked any indication of a basin, charcoal or ash concentrations, or other signs of *in situ* heating.

Five limestone burned rocks were sampled for lipid residues. The detailed results are presented in Appendix G, with a summary presented here (Table 9-3). Samples #273-5-3-2a and #274-5-3-1a both yielded high fat content. Samples #273-5-3-1a and #274-5-3-2a yielded borderline moderate-to-high and high fat content, all

interpreted as representing plants. Sample #273-5-3-3a yielded borderline high and very high fat content also interpreted as representing plants. All five results are similar, implying that these rocks were used to cook similar plants. Parts of these same burned rocks (#271-5-3-1b, #273-5-3-2b, and #273-5-3-3b) were also sampled for stable carbon and nitrogen isotopes (Table 9-4). The three samples have an average $\delta^{13}\text{C}$ value of -24.5‰. The average $\delta^{15}\text{N}$ value is 4.6‰, with one very low value and two moderately high values. The isotope values generally indicate C_3 plants.

Following the removal of the burned rocks, the matrix from around the rocks was collected for subsequent flotation in the laboratory. Twenty-one liters of floated matrix (#273-5-4) from the upper part of this feature (between 26 and 38 cmbd) yielded a heavy and light fraction. The 6.4 mm-size mesh yielded 16 tiny burned rocks, 37 pieces of chert, one tiny fleck of charcoal, 11 snail shells, and eight tiny bone fragments that weigh 1.9 g. Two bones are burned a brown color. Ten, or 27 percent, of the flakes are burned. The heavy fraction yielded 108 tiny burned rock fragments, 138 chert pieces, 28 tiny charcoal pieces, three complete snail shells, and 96 tiny bone fragments. Twelve bones were burned. The 0.2 liters of light fraction yielded quantities of charcoal, which included 10 ml of juniper, three pieces of mesquite, one burned prickly pear seed, one buttonbush piece, one piece of oak, six agave leaf fragments, and 12 indeterminate pieces (Appendix I). A charred littleleaf walnut shell (#273-5-7) was found at the very top part of Feature 1b (Appendix I).

One tiny piece of charcoal (#273-4-2-1) yielded a $\delta^{13}\text{C}$ corrected (-24.5‰) AMS radiocarbon age of $2,310 \pm 40$ B.P. (Table 9-1: Beta-175403). This is an acceptable age for the Late Archaic.

The 12 liters of matrix from the lower part of the feature (#274-5-4-1) yielded a considerable quantity of cultural material. The 0.1 liters of light fraction yielded one piece of buttonbush, one piece of oak, 14 milliliters of juniper, and 12 pieces that were of indeterminate species (Appendix I). Juniper dominated the charcoal. The heavy fraction yielded 33 tiny burned rock fragments, 153 tiny chert pieces, 53 tiny charcoal fragments, five complete snail shells, and no bones. The 6.4 mm mesh fraction yielded 17 tiny burned rock pieces, five pieces of chert debris, 20 completed snail shells, but no bone fragments. Two chert flakes that were recovered from the float sample were burned.

Outside Feature 1b, the rest of Unit N102/E50 yielded nearly 39 pieces of lithic debitage, one bone fragment, five *Rabdotus* shells, and one edge-modified tool (#273-10). The lower level, between 40 and 50 cmbd, yielded the distal part of a late stage chert biface (#274-5-11), an edge-modified flake (#274-5-11), five pieces of chert debitage, and seven nearly complete *Rabdotus* shells.

9.2.2.3 Feature 1c

Feature 1c, a cluster of 323 burned rocks, was recognized in the northern half of Unit N102/E52 and the southern half of Unit N103/E52 along the northeastern edge of the broader burned rock distribution (Figure 9-4). Backhoe trench 2 truncated this cluster; therefore, the overall shape and original size is not clear. These burned rocks appeared more tightly clustered than surrounding burned rocks, but no obvious boundary or easy demarcation line was observed between these burned rocks and those in the broader Feature 1. This cluster appeared to extend to the west and north, but terminated near the eastern edge of Unit N103/E52. The excavated part measured 100 cm east west and 60 to 200 cm north-south, with most burned rocks between elevation 18

and 25 cmbd. These burned rocks primarily formed a single layer with only a few rocks lying on top of one another. No basin was detected, no charcoal, ash, or oxidized matrix was observed.

The 323 burned rocks are all limestone. Nearly 57 percent fell in the 4.1 to 9 cm size class, whereas nearly 35 percent were in the smallest, 0 to 4 cm size class. The average weight of the burned rocks was 108 g.

Three burned rocks from this cluster were sent for lipid residue analysis. The detailed results are presented in Appendix G, with a summary presented here (Table 9-3). All three yielded high fat content, again interpreted as representing plants. Similar results imply these rocks cooked the same plants. Parts of the same three burned rocks were also sampled for stable carbon and nitrogen isotopes (Table 9-4). The three samples have an average $\delta^{13}\text{C}$ value of -24.5‰. The average $\delta^{15}\text{N}$ value is 5.5‰, with one relatively low value and two moderate high values. The isotope values generally indicate C_3 plants.

Following the removal of the rocks, the remaining matrix that surrounded the burned rocks was collected and subsequently floated in the laboratory. The light fraction yielded no sign of charred material.

Unit N102/E52 yielded 47 pieces of lithic debitage, 39 bone fragments, two edge-modified flakes (#293-5-10 and 11), one middle stage biface (#293-5-12), one end-side scraper (#293-5-13), and three mussel shell fragments. The scraper and mussel shell came from the southern margin of this cluster.

A long bone fragment (#293-2-1a), weighing 6.8 g, was also found in Feature 1c. It is pinkish gray (5YR 7/2) in color, which implies that it was potentially part of the overlying Toyah component, and was submitted for radiocarbon

dating. This bone yielded a $\delta^{13}\text{C}$ corrected (-9.8‰) AMS radiocarbon date of 860 ± 40 B.P. (Table 9-1: UGA-12713). The carbon isotope value obtained on this element indicate that it is from a bison, which yields a significantly more positive carbon value than do deer or antelope bones. The probability of this bone representing a bison supports the belief that this bone originated in the overlying Toyah component and was not associated with the Late Archaic component. The date would indicate this bone came from an occupation younger than the Late Archaic component, was displaced downward, and again is not representative of the Late Archaic component.

9.2.2.4 Feature 1d

Feature 1d, a cluster of 30 burned rocks, was identified at the extreme southern edge of Feature 1 in the western half of Unit N99/E51 (Figures 9-4 and 9-5). Again, these burned rocks were closer together than those in the rest of the unit. This oval cluster measured 75 by 50 cm in diameter with depths concentrated between 12 and 23 cmbd. The burned rocks appeared to form two layers.

The matrix inside Feature 1d appeared similar to that outside. No matrix oxidation, ash or charcoal lens was detected, and no basin was discernible.

The 30 burned rocks collected from Feature 1d were all limestone and nearly equally divided into angular and tabular pieces (Table 9-2). Nearly 77 percent are in the 4.1 to 9 cm size class. The lack of any rocks in the smallest size class may indicate a biased collection procedure. The average burned rock weighs 208 g.

Three burned rocks from this cluster were sent for lipid residue analysis. The detailed results are presented in Appendix G, with a summary presented here (Table 9-3). All three samples (#11-5-3-1a, #11-5-3-2a, and #11-5-3-3a)

Figure 9-5. Planview of Feature 1d in Feature 1

yielded high fat content interpreted as reflecting plants.

The similar results imply that these rocks were used to cook the same plants, potentially during the same event. Parts of the same three burned rocks were also sampled for stable carbon and nitrogen isotopes (Table 9-4). The three samples have an average $\delta^{13}\text{C}$ value of -24.7‰ . The average $\delta^{15}\text{N}$ value is 4.8‰ , with two relatively low values and one moderate high value. The isotope values generally indicate C_3 plants.

Following the removal of the burned rocks, about nine liters of remaining matrix (#11-4-1) from between 11 and 24 cmbd was collected and floated in the laboratory. The 0.15 liters of light fraction was sent to Dr. Dering for analysis, but no charred remains were detected (Appendix I). The heavy fraction yielded seven tiny burned rocks, 63 chert pieces, one snail shell, and 21 tiny bone fragments. The 6.4 mm fraction yielded 14 tiny burned rocks, six chert pieces, and four complete snail shells.

Six tiny pieces of charcoal (#11-5-4-7-1a) yielded a $\delta^{13}\text{C}$ corrected (-24.3‰) AMS radiocarbon date of $1,390 \pm 40$ B.P. (Table 9-1: UGA-12704). This charcoal came from the floated matrix sample.

Unit N99/E51 yielded 48 pieces of lithic debitage, seven bone fragments, tiny charcoal chunks, three edge-modified flakes (#11-5-10, #11, and #12), one Gower point (#11-5-13), and one Edgewood point (#11-5-14). The Edgewood point was discovered at 19 cm bd and within the clustered burned rocks along the southern edge. The Gower point was probably displaced from lower in the profile, whereas the Edgewood point would fit well chronologically with the charcoal date. It was the only point of this type recovered at the Varga Site.

9.2.2.5 Flotation Results, Feature 1

These four subfeatures that exhibited slightly more clustering of constituent rocks, as compared to the rest of Feature 1, were part of the broader distribution of rocks that comprised the feature, which extended across 18 different 1-by-1 m hand-excavation units and an unknown distance to the west of the limits of the Block A excavation. The feature had an overall diameter of approximately 6 m and was irregularly elliptical in plan view. In total, 3,196 burned rocks that weighed 468.15 kg were recovered from Feature 1, including all four subfeatures (Table 9-5). This is a minimum number and weight, since part of Feature 1 was removed by BTs 1 and 2 (at least 6 m²), and since the feature was not entirely exposed. The average individual weight of the documented burned rocks was 146 g.

Parts of 15 other burned rocks that came from outside the small sub-feature clusters were also submitted for lipid residue analysis (see details in Appendix G). Only a summary of those findings is presented here (Table 9-3). Six pieces (#80-5-3-1a, #187-5-3-2a, #81-5-3-1a,

#179-5-3-1a, #274-5-3-1a, and #352-5-3-2a) yielded very high fat content interpreted as plant. Three pieces (#161-5-3-1a and #352-5-3-1a, #370-5-3-1a) yielded borderline high and very high fat content also interpreted as plant. One piece (#274-5-3-2a) yielded borderline moderate to high and high fat content interpreted as plant. Two pieces (#263-5-3-1a and #178-5-3-1a) yielded borderline medium and moderate to high fat content interpreted as plant. One piece (#98-5-3-1a) yielded borderline medium fat content and large herbivore plus plant residues. One other piece (#179-5-3-2a) yielded low fat content interpreted as reflecting plant. In sum, most pieces revealed moderate to high fat residues from plants. Only two pieces show low fat content and one yielded possible indications of large herbivore. The general consistency identified in 85 percent of the lipid residues implies that the majority of the burned rocks scattered around in Feature 1 were probably used to cook similar types of high-fat plants, the expected result from a single large cooking feature.

Tiny parts of these same 15 burned rocks analyzed for lipid residues, were also sampled for stable carbon and nitrogen isotopes (Table 9-4). The 15 samples yielded an average $\delta^{13}\text{C}$ value of -23.2‰. One sample (#161-5-3-1b) yielded a very negative $\delta^{13}\text{C}$ value of -30.6‰. Sample #178-5-3-1b yielded a $\delta^{13}\text{C}$ value of -21.8‰, which is toward the more positive end of these averages. The average $\delta^{15}\text{N}$ value for the 15 samples is 5.6‰. The isotope values generally indicate cooking of C₃ plants.

Individual charcoal pieces collected from across the 21 m² excavated in the southwestern corner of Block A and associated with Feature 1 were submitted to Dr. Dering for identification. The burned plants identified include mesquite,

Table 9-5. Burned Rock Characteristics for All of Feature 1

Unit No.	Depth (cm)	Cat. #	Size (cm) and Weight (g)										Material Type ¹				Fracture Type ²			Total Count	Total Wgt (g)
			0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.				
N99/E50	18-25	2 & 3	10	350	61	7,350	12	4,850			82	1			60	15	8	83	12,550		
N99/E51	9-30	11 & 12	3	100	62	9,550	7	2,250			72				32	4	36	72	11,900		
N100/E50	20-30	80	8	250	40	4,000	1	1,000			49				42		7	49	5,250		
N100/E51	20-30	89	9	250	67	7,150	7	3,250			83				76		7	83	10,650		
N100/E52	17-30	98 & 99	8	200	66	6,500	13	5,700	1	2,250	88				76	2	10	88	14,650		
N101/E47	45-50	161	65	1,750	82	9,750	19	7,500	0	0	166				138	4	24	166	19,000		
N101/E50	40-80	170-173			62	6,350	47	20,200	39	19,000	148							148	45,550		
N101/E50	25-39	178 & 179	36	600	94	17,000	53	32,000	0	0	183				41	0	56	183	49,600		
N101/E51	19-31	187	127	3,250	69	7,500	28	11,750	3	2,250	227				33	70	124	227	24,750		
N101/E52	18-30	197	55	1,000	55	6,000	5	2,250			115				72	10	33	115	9,250		
N102/E47	35-40	263 & 264	159	3,500	255	26,750	93	36,000	3	3,750	510				426	34	55	510	70,000		
N102/E50	28-40	273 & 274	32	1,000	161	29,250	42	22,650	2	1,500	237				187	4	43	237	56,900		
N102/E51	30-40	283	11	250	74	8,500	9	4,500			94				78		16	94	13,250		
N102/E52	20-30	293	59	1,000	78	8,000	13	6,250			150				99	15	36	150	15,250		
N103/E47	35-50	352, 3553	304	2,250	164	17,000	85	35,750	0	0	554				297	2	255	554	53,500		
N103/E51	30-40	361		1,500	53	6,000	21	5,500	1	1,000	75							75	14,000		
N103/E51	33-42	370 & 371	23	300	61	8,000	11	4,500			95				70	15	10	95	12,800		
N103/E52	20-30	378	16	300	65	7,000	12	7,000			93				71	7	15	93	14,300		
N104/E47	30-50	407, 408	35	750	46	5,250	6	2,000	87	8,000	174							174	16,000		
Total			960	18,600	1,615	196,900	484	214,900	136	37,750	3,195	1	0	0	1,798	182	735	3,196	469,150		

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other
2. Ang. = angular, Rnd. = round, Tab. = tabular

juniper, oak, green *Condalia*, and woody legume, with mesquite dominating. A total of 96 liters of floated matrix from 12 proveniences across Feature 1 yielded only 1.4 liters of light fractions. The light fractions yielded 183 individual pieces plus 19 milliliters of burned macrobotanical remains weighing 4.4 g (Appendix I). The identifiable charred plants include woods such as mesquite (37 pieces plus 34 ml weighing 16 g), juniper (34 pieces plus 14 ml, weighing a total of 2.7 g), oak (19 pieces) buttonbush, lotebush plus one burned mesquite seed from Unit N101/E47; four burned prickly pear seeds from Units N101/E50 and N102/E50; and nine burned sotol-yucca-agave leaf fragments from Units N101/E50, N102/E47, and N102/E50. One or all three of the latter plants, may have been food resources, especially the stool-agave-yucca leaves, which have been ethnohistorically documented as cooked in earth ovens. Mesquite wood was the dominant fuel source.

Bulk matrix samples from various locations within the broader Feature 1 were collected and floated. Along the southern margin in Unit N100/E50, six liters of sediment (#80-5-4) were collected for flotation from near the base of the burned rocks at between 20 and 30 cmbd. The less than 0.1 liters of light fraction yielded charcoal including one piece of mesquite, one piece of juniper, one piece of buttonbush, and 21 indeterminate pieces (Appendix I). The heavy fraction yielded 14 tiny burned, 74 chert debitage pieces, 24 tiny charcoal pieces, five complete snail shells, and 14 tiny bone fragments g. Two tiny walnut shell fragments were recognized in the charcoal. The 6.4 mm size mesh yielded 17 burned rock fragments, five pieces of chert debitage, five pieces of charcoal, and 10 complete snail shells.

In the next lower level, less than 0.1 liters light fraction (#81) yielded eight tiny indeterminate charcoal pieces. Heavy fraction yielded 32 tiny

burned rocks, 153 chert debitage pieces, 8 tiny charcoal pieces, and four tiny bone fragments. The 6.4 mm size mesh yielded four burned rocks fragments, and four complete snail shells. Two liters of matrix (#161-5-4) was collected from under and around the burned rocks in Unit N101/E47 along the very southwestern edge of Feature 1 for flotation. The 6.4 mm size mesh yielded only three chert flakes and five whole snail shells. The heavy fraction yielded 59 tiny chert pieces, six tiny charcoal flecks, and four whole snail shells. A tiny piece of burned walnut shell was present. The less than 0.1 liters of light fraction yielded one burned mesquite seed and eight indeterminate wood pieces (Appendix I). Also, a small pocket of ash or decaying limestone burned rock (#161-4) was in this same unit between 45 and 50 cmbd.

Just north of the previous unit, in Unit N102/E47, five liters of matrix (#263-5-4) from 30 to 40 cmbd was also collected and floated. The 6.4 mm size mesh yielded 15 tiny burned rocks, seven chert pieces, four charcoal pieces, 14 complete snail shells, and two tiny bone fragments. Two flakes were burned and two tiny burned walnut shell fragments were present. The heavy fraction yielded 34 tiny burned rocks pieces, 72 chert pieces, 21 tiny charcoal pieces, three complete snail shells, and 35 tiny bone fragments, two of which are burned. The less than 0.1 liters of light fraction yielded three types of wood that include one piece of mesquite, one lotebush, one agave leaf fragment, and 14 indeterminate pieces (Appendix I).

One meter north in Unit N103/E47, another float sample (#352-5-4) was collected from 30 to 40 cmbd at what appeared the northwestern edge of Feature 1. The less than 0.1 liters of light fraction yielded two oak wood fragments, eight juniper fragments, and 19 indeterminate pieces (Appendix I). The heavy fraction yielded 11 tiny burned rock fragments, 63 chert pieces,

61 tiny charcoal pieces, two complete snail shells, and 15 tiny bone fragments. Three of the chert pieces have been heat-altered. The 6.4 mm mesh yielded 24 tiny burned rock fragments, five chert pieces, four tiny charcoal pieces, and 15 complete snail shells. No bone was recovered from the floated matrix.

From along what appeared to be the southeastern rim of the possible central pit, two levels were sampled for floatation. A nine-liter matrix sample (#178-5-4) was collected from between 20 and 25 cmbd near the top of the feature. The 6.4 mm mesh fraction yielded 32 tiny burned rock fragments, 20 chert flakes, and 11 complete snail shells. Two of the chert pieces were heat-altered. The heavy fraction yielded another 29 tiny pieces of burned rock fragments, 126 chert pieces, 61 tiny pieces of charcoal, 11 complete snail shells, and 32 tiny bone fragments. Six of the bones recovered from the floated matrix were burned. The less than 0.1 liters of light fraction yielded 5 ml of tiny charcoal pieces that were not identifiable to species (Appendix D).

A 12 liter matrix sample (#179-5-4) was collected from between 25 and 39 cmbd in the lower level. The 6.4 mm size mesh yielded eight chert flakes, one tiny charcoal piece, and 13 complete snail shells. The heavy fraction yielded 41 tiny burned rock fragments, 163 chert pieces, 56 charcoal pieces, 11 complete snail shells, and 23 tiny bone fragments, of which two are burned. The 0.1 liters of light fraction yielded three prickly pear seeds, two agave leaf fragments, two pieces of oak wood, one piece of juniper, and 12 indeterminate plant pieces (Appendix I).

One meter east in Unit N101/E51, another float sample (#187-5-4) of about five liters was collected from 20 to 30 cmbd around and below the burned rocks. The 6.4 mm size mesh yielded 45 tiny burned rock fragments, 39 tiny pieces of

chert, one charcoal piece, 28 complete snail shells, and 39 tiny bone fragments. Nine bone fragments and four chert pieces recovered from the float were burned. The heavy fraction yielded 113 tiny burned rock fragments, 756 pieces of chert, 63 tiny charcoal pieces, four complete snail shells, and 517 tiny bone fragments, sixty-four of which were burned. One burned walnut and possibly one burned pecan shell are present. The 0.1 liters of light fraction yielded one piece of juniper, six pieces of lotebush, and 20 indeterminate pieces (Appendix I).

9.2.2.6 Discussion of Feature 1

With four recognizable clusters of burned rocks and areas nearly void of burned rocks all within Feature 1, the density of burned rocks was quite variable. The trench profiles revealed that the thickest section of Feature 1 was located near the eastern side of BT 1. The original 50-by-50 cm test pit in Unit N101/E50 encountered nearly 30 cm of stacked burned rocks in that small area. These dense concentrations indicate that Feature 1 may be an incipient burned rock midden. A basin was not detected in any of the individual excavation units, though burned rock lens does have a saucer-shaped profile.

The hand-excavations in Unit N100/E50 revealed a concentration of burned rocks that formed a broad curving arc. The rocks unit had an average weight of 362 g, and the average weight of the burned rocks in the 50-by-50 cm test pit were even greater, at 470 g. The average rock weights reveal that the burned rocks in this particular area were the largest pieces documented and may represent the central core area of the broader incipient midden (see Figure 9-4). If Feature 1 represents the remains of an earth oven and the shallow (15 cm deep), basin was used in the cooking process, then this would account for the broad scatter and a few clusters of burned rocks in the immediately

surrounding area. Based on the presence of at least four clusters of burned rocks, the quantities of burned rock present, the relatively small average size of the individual rocks (147 g), it is quite likely that this cooking feature was used on more than one occasion. As the limestone rocks were used over and over again, they fractured, resulting in smaller sizes (Leach et al. 1998).

Ten radiocarbon dates were obtained from Feature 1. If the three significantly younger dates (550 B.P., 890 B.P. and 1,390 B.P.) are assumed to be from intrusive materials, then the radiocarbon results indicate a 590-year time range, from 1,700 to 2,290 B.P., during which Feature 1 developed. The seven acceptable radiocarbon ages place the feature securely within the Late Archaic.

Nine dart points and two Clifton arrow points were recovered from the area Feature 1. The nine dart points include one Early Corner-Notched point (#283-14), one Marcos (#187-10), one Montell (#198-10), three Frio points (#22-15, #89-10, and #187-11), one Edgewood point (#11-14), one untyped Group 2 (#170-10), and one untypable dart point that is similar to a Frio or a Montell (#53-11). The two Clifton points (#12-10 and #22-14) are thought to have been displaced downward and are considered intrusive from the immediately overlying Toyah component. It is not clear if the Group 2 and Early Corner-Notched point is intrusive or a point that was picked up and used/curated during the Late Archaic. In addition to the projectile points, six bifaces (#2-12, #263-10, #178-10, #197-16, #283-15, and #293-12), three scrapers (#2-10, #3-10, and #293-14), four cores (#161-11, #162-14, #352-10, and #293-14), and 47 edge-modified flakes were scattered across the hand-excavated area of Feature 1. Light-colored and non-weathered bone fragments that are identical in appearance to the bones in the overlying Toyah component were also encountered in the top part of the Feature, and

these also indicate some downward translocation of materials.

If Feature 1 was the remains of a cooking feature, then the few leaf fragments of sotol-yucca-agave might be the best indication as to what was cooked. Plants of the agave family are best cooked in an earth-covered oven. Mesquite apparently was the principal fuel source, although other woods were also used. The inclusion of burned prickly pear seeds and mesquite beans may be accidental burning of other cooked food resources.

9.2.3 Feature 7

Feature 7 was discovered and excavated in the southeastern corner of Test Pit 5 as part of the Phase I investigation; a unit that was later designated Unit N118/E73 within Block B. It consisted of an irregularly ovate, loose cluster of 11 burned rocks measuring approximately 55 by 45 cm and resting between 26 and 30 cmbs (Figure 9-6).

Figure 9-6. Planview of Feature 7 in Block B

The 11 burned rocks were all limestone and formed a single layer. The rocks are nearly equally divided between the 4.1 to 9 cm and the 9.1 to 15 cm size classes (Table 9-6). The average weight of the rocks is 295 g.

No basin/pit, charcoal, or ash was noted among the burned rocks. Flotation samples and burned rock residue samples were not collected. The only artifacts found in proximity are chert flakes. Feature 7 appears isolated from other Late Archaic features, and probably represents a discard location.

9.2.4 Feature 15

Feature 15 was a small cluster of burned rocks located in Unit N115/E73 in Block B. It consisted of 31 burned rocks in an ovate area that measured 25 by 35 cm in diameter (Figure 9-7). The bottoms of the burned rocks were between 21 and 28 cmbs and appeared to have limited vertical displacement on an irregular surface, since no pit was detected. The 31 rocks were all limestone and in three different size classes with the larger 9.1 to 15 cm size class represented by the fewest pieces (Table 9-6). The specimens include seven spalls from larger rocks, three angular pieces, and two pieces that show no obvious fractures. No pieces refit to other pieces. The average rock weight is 126 g.

A very dark grayish brown (10YR 3/2) matrix surrounded the burned rocks and lacked visible charcoal or oxidation as would indicate in situ burning. No other cultural materials were observed between the burned rocks and very little was recovered from the rest of the unit. The matrix (#801-5-4) that surrounded the burned rocks at 20 to 27 cmbs was collected for flotation in the laboratory. The heavy fraction from the western side of Feature 15 yielded 16 tiny pieces of lithic debitage and one whole, but unburned, hackberry seed. The heavy fraction from the eastern side yielded six burned

Figure 9-7. Planview of Feature 15 in Block B

rock fragments, 23 pieces of lithic debitage, four tiny pieces of charcoal g, and 11 tiny bone fragments, two of which were burned. The 0.2 liters of light fraction failed to yield any charred organic remains (Appendix I). The 6.4 mm size fraction from the western side yielded two pieces of burned chert debitage and two nearly complete snail shells. The 6.4 mm size fraction from the eastern side yielded one piece of chert and 12 nearly complete snail shells.

One wood charcoal piece (#801-5-4-7-2a) from the floated matrix of Feature 15 yielded a $\delta^{13}\text{C}$ corrected (-24.5‰) AMS radiocarbon date of $2,140 \pm 40$ B.P. (Table 9-1: UGA-12725). This age determination documents Feature 15 as representing a Late Archaic event and is equivalent in age with Feature 1 in Block A.

Table 9-6. Burned Rock Characteristics of Features 7, 15, 28, and 29

Fea. No.	Unit No.	Depth (cm)	Cat. #	Size (cm) and Weight (g)								Material Type ¹					Fracture Type ²			Total Count	Total Wgt (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.	Tab.			
7	N118/E73	20-30	852			6	1,000	5	2,250			11			8	1	2	11	3,250		
	Total				6	1,000	5	2,250	0	0	11	0	0	0	8	1	2	11	3,250		
15	N115/E73	20-27	801	11	150	13	2,000	7	1,750	0	0	31			22	4	5	31	3,900		
	Total			11	150	13	2,000	7	1,750	0	0	31	0	0	22	4	5	31	3,900		
28	N123/E73	26-37	941	3	100	4	1,500	6	3,500	0	0	13			3	4	6	13	5,100		
	Total			3	100	4	1,500	6	3,500	0	0	13	0	0	3	4	6	13	5,100		
29	N124/E73	20-39	962 & 963	24	1,500	27	7,250	9	7,500	2	6,500	62			42	3	17	62	22,750		
29	N124/E74	19-31	966	2	750	5	1,750	7	6,750	2	11,000	16			11	1	4	16	20,250		
	Total			26	2,250	32	9,000	16	14,250	4	17,500	78	0	0	53	4	21	78	43,000		

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Parts of three burned rocks from this cluster were sent for lipid residue analysis. The detailed results are presented in Appendix G, with a summary presented here (Table 9-3). All three samples (#801-5-3-1a, #801-5-3-2a, and #801-5-3-3a) yielded high fat content, interpreted as representing plants. The similar results imply these rocks cooked similar kinds of plants. Parts of these same three burned rocks were also sampled for stable carbon and nitrogen isotopes (Table 9-4). The three samples yielded an average $\delta^{13}\text{C}$ value of -24.3‰ and an average $\delta^{15}\text{N}$ value of 6.7‰ indicating C_3 plants.

This cluster of burned rock is interpreted to represent discarded cooking rocks, rather than an *in situ* cooking facility. The lack of any appreciable amount of charcoal, or other evidence of *in situ* burning indicates these rocks

were dumped here. Based on the lipid residue results the rocks were used in cooking plants, mostly C_3 type plants.

9.2.5 Feature 28

Feature 28 was located in the southwestern corner of Unit N123/E73 in Block B and immediately beneath the overlying Toyah Component. This was a cluster of 13 burned rocks in no apparent pattern in an area that generally measured 40 by 50 cm in diameter (Figure 9-8). The burned rocks were at 28 to 36 cmbs, but did not appear in a basin. No charcoal, ash, or oxidized matrix was observed, and no matrix was collected. The 13 burned rocks were generally greater than 4 cm in diameter with an average rock weight of 392 g (Table 9-6).

Figure 9-8. Planview of Feature 28 and 29 in Block B

Parts of two burned rocks were sent for lipid residue analysis. The detailed results (Appendix G), are only briefly summarized here (see also Table 9-3). Sample #941-5-3-1a yielded insufficient lipids for analysis. Sample #941-5-3-2a yielded very high fat content interpreted as representing plants. Parts of the same two burned rocks were also sampled for their stable carbon and nitrogen isotopes (Table 9-4). The two samples have an average $\delta^{13}\text{C}$ value of -23.4‰ and an average $\delta^{15}\text{N}$ value of 5.5‰, indicating C_3 plants.

A few other burned rocks and five pieces of lithic debitage were scattered across the rest of this unit. The soil across this level was a very dark grayish brown (10YR 3/2), distinguishable from the soil that contained the overlying Toyah materials. This burned rock cluster, with its lack of a containing basin or other evidence of *in situ* burning, is interpreted as a result of discard of rocks used to cook plants with a very high fat content.

9.2.6 Feature 29

Feature 29 was discovered in Units N124/E73 and N124/E74 in Block B and roughly 65 cm north of Feature 28. It consisted of a loose cluster of 78 burned rocks with no clearly definable boundaries and an irregular outline. The average burned rock weighs 551 g (Table 9-6). The burned rocks were clustered in an area of about 100-by-90 cm, but a telephone line trench truncated the eastern margin (Figure 9-8). The burned rocks were located between 22 and 38 cmbs, but not in a visible basin or pit. No charcoal, ash, or oxidized matrix was observed.

Parts of two burned rocks were sent for lipid residue analysis (Table 9-3). Both samples (#966-5-3-1a and #962-5-3-1a) yielded a very high fat content interpreted as representing plants.

Parts of these same two burned rocks sampled for lipid residues were also sampled for stable carbon and nitrogen isotopes (Table 9-4). Sample #966-5-3-1b yielded a very limited nitrogen value, rendering the results suspect. The $\delta^{13}\text{C}$ value is -28.4‰ indicating a very negative C_3 value. This value indicates a C_3 plant. Sample #962-5-3-1b yielded a $\delta^{15}\text{N}$ value of 5.7‰ with a $\delta^{13}\text{C}$ value is -26.7‰.

A bone was plotted near the same depth of the burned rocks, but based on its macroscopic appearance, it is thought to be intrusive from the overlying Toyah component. No matrix samples were collected from this very dark grayish brown (10YR 3/2) soil.

Although some lithic debitage and tiny bone fragments were in the upper part of this zone, they probably were displaced downward from the overlying Toyah component. This cluster represents a dump of burned rocks from cooking activities, since no *in situ* burning or basin was apparent. The rocks may have come from a single event, since the lipid residues were identical.

9.3 STONE TOOL DESCRIPTIONS AND DISCUSSIONS

The 83-m² hand-excavated sediments in Block A, plus another 35.5 m² (3.5 m³) hand-excavated sediments in Block B, yielded 10 features including the four subfeatures in Feature 1 and 5,916 pieces of cultural material, including 1,801 pieces of lithic debitage, 3,965 burned rocks, 41 faunal bone fragments, 69 edge-modified flakes, 17 projectile points, 10 cores, nine bifaces, three scrapers, and one nutting stone. Each of these categories are described and discussed below, beginning with materials that appeared to be associated with the features.

The 109 formal and informal stone tools are presented below by class, with summaries of observed attributes and metric measurements. Individual artifact data is presented in tables in Appendix O. The exception is the data on edge-modified flakes, as only a select number of specimens were individually documented. The projectile point class is subdivided into identifiable point types. Formal tool classes are generally thought to represent specific tasks/activities. Many individual specimens from various tool classes were arbitrarily selected for use-wear analysis to investigate specific tool functions. Individual use-wear results are presented following each class summary.

9.3.1 Projectile Points

The 17 projectile points include seven, or 41 percent, that are diagnostic of other time periods, indicating mixing, curation of anachronistic items, and/or incorrect assignments in the field of levels from which these tools were collected. The non-Late Archaic points include two Clifton arrow points (#12-10 and #22-14) and one distal arrow point fragment (#378-10) that are of Toyah age, the presence of which is most easily explained by slight downward displacement, given that only a couple of centimeters separate the two components. Three other points are classified as Early Archaic points and include a Gower (#11-5-13) and two Group 2—Early Corner-Notched points (#283-14 and #370-10). It is possible that these Early Archaic point types were collected and curated by Late Archaic people. Another possibility is that in the preparation of a basin-cooking feature during Late Archaic times, sediments from deeper deposits that contained older artifacts were dug up, and thus redeposited. One Middle Archaic barb fragment from a Bell-like point (#807-10) was also recovered from the Late Archaic context from

east of the road in Block B, in quite shallow deposits that could have been displaced.

Ten, or 59 percent, of the points recovered from this component are attributable to the Late Archaic period, including one proximal Castroville fragment, one complete Edgewood, one proximal Ensor, three proximal Frio point fragments, one complete Marcos, one medial Montell fragment, and two untypable dart point fragments (Figure 9-9). The general characteristics of these items are summarized below, and data on specific specimens presented in Appendix O. All were manufactured from fine-grained cherts and lack any sign of cortex. None are patinated, and all breaks are attributed to use. No point appears to have been rejuvenated before discard, although the Edgewood, Marcos, and Ensor all exhibit beveled edges that may represent resharpening prior to final breakage. The Marcos and Montell points appear to have been made of heat-treated chert. One of the three Frio points was burned. Fifty percent potentially have edge-rounding, indicative of intensive use. The point diversity hinders any attempt to summarize the metric point data, except for the Frio points. These 10 points represent five different point types, but they all fit within the general Late Archaic time frame that is indicated by the 11 radiocarbon dates.

The entire Frio assemblage of seven points, four from the Toyah and three from the Late Archaic component, are summarized in here. Only one is complete. Of the six (86 percent) broken during use, proximal sections represent 57 percent. None have rejuvenation scars and only one exhibit edge beveling. All were manufactured from fine-grained cherts, and none retain traces of cortex. One specimen is burned, and none have been heat-treated. Fifty-seven percent exhibit a triangular blade with 14 percent lanceolate and 28 percent indeterminate. The flaking pattern is discernible

Figure 9-9. Selected Late Archaic Projectile Points

Left to Right: Top Row: #11-5-14, #691-011, #394-010, #187-010, #198-010;
Second Row: #22-015, #525-055-13 Joined with #526-11, #187-11, #89-010, #220-014

on 71 percent of the total with 80 percent of those exhibiting a subparallel flaking pattern. Fifty-seven percent of the edges show some rounding. Of the edges that were of sufficient length to observe their shape, 70 percent are straight, 20 percent are excurveate, and 10 percent are incurvate. All stems are markedly expanding, as is characteristic of this type.

Table 9-7 presents a summary of metric measurements concerning the seven Frio points to reveal their size variability. Only attributes with three or more values are presented.

The three Frio points from the Late Archaic component were within or near the outer edges of Feature 1. Two points (#339-10 and #22-15)

were along the eastern margin with #187-11 near the densest part of the burned rock. All three Frio points were between 25 and 30 cmbd. The Edgewood point (#11-5-14) was inside burned rock cluster Feature 1d at about 19 cmbd. The Montell point (#198-10) was found on the eastern edge of Feature 1. The Marcos point (#187-10) was recovered from amongst scattered burned rocks and only a few centimeters away from one of the Frio points.

Two Late Archaic points were subjected to use-wear analysis. The complete Edgewood point (#11-5-14) revealed polish and striations on the stem with use-residue in the form of wood fragments. The latter, coupled with hard, high silica polish, indicates use in cutting wood

Table 9-7. Metric Measurements on Frio Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length			
Maximum width	16.5 - 34.2	25.4	7.3
Maximum thickness	5.5 - 12.4	7.1	2.4
Blade length			
Blade width	13.3 - 31.2	22.8	7.7
Shoulder width	16.5 - 34.2	25.4	7.2
Left notch depth	2.3 - 9.6	5.2	3.3
Right notch depth	1.4 - 10.2	5.6	3.9
Left notch width	6.0 - 8.4	7.5	1.1
Right notch width	5.9 - 7.4	6.6	0.6
Left notch angle	57 - 78	67	8
Right notch angle	50 - 84	63	14
Stem length	8.7 - 13.1	10.8	1.5
Distal stem width	13.8 - 20.4	17	2.6
Proximal stem width	18.3 - 30.5	24.6	6.6
Average stem width	16.1 - 25.2	20.8	4.9
Stem thickness	3.4 - 6.2	5	0.9
Base depth	1.5 - 4.4	3	1
Base notch width	8.6 - 10.6	10	0.9

Measurements in mm

(Appendix C). The nearly complete Montell point (#198-10) revealed heavy polish in the stem area, and the impact fracture at the distal end indicates this was used as a projectile point (Appendix C).

Parts of five projectiles, three proximal Frio points (#22-15 = TRC196, #89-10 = TRC198, and #525-5-13 = TRC211), the complete Marcos (#187-10 = TRC200), and the proximal Ensor (#691-11 = TRC213) were subjected to INAA in an effort to identify material source locales. All the chemical signatures from these points are similar to those for Edwards chert from the southwestern region (Appendix F). Two of the three Frio points have relatively similar chemical signatures, whereas the third (#89-10 = TRC198) appears to be from a different Edwards source. One Marcos point (#87-10 = TRC200) was chemically different from cherts from

known source areas, as well as from the clustered chemical signatures of other analyzed Late Archaic pieces from the Varga site (Appendix F).

9.3.2 Bifaces

Nine specimens were classified as bifaces. All were manufactured from fine-grained cherts, and all lack patination (Appendix O). Five represent late stages of manufacturing and three represent the middle stage of biface reduction (Figure 9-10). One complete middle stage biface exhibits cortex over somewhat less than about 25 percent of its surface. Only two specimens, one late stage and one middle stage, are complete. None have been heat-treated to facilitate knapping. Nearly 63 percent probably have been manufactured from flakes. Overall shapes vary, and most exhibit random flaking patterns.

Figure 9-10. Selected Late Archaic Bifaces

Left to Right: Top Row: #2-012;
Second Row: #459-011, #293-005-012, #197-016, #274-005-011

None have been appear to have been resharpened, and none exhibit rejuvenation scars. The eight bifaces were horizontally more widely scattered more than other tools, and 25 percent were clearly beyond the margins of Feature 1. Bifaces resting within the boundaries of that feature were generally mixed in with dense rock accumulations, with nearly 38 percent of the specimens occurring within the smaller clusters of burned rock Features 1b and 1c. Specimen #293-5-12 from Feature 1c was burned, presumably because it was deposited within the matrix of the feature prior to its use as a heating element.

Four bifaces, including the two complete specimens, and two late stage fragments were

subjected to use-wear analysis. Use-wear analysis on a complete late stage biface (#2-12) revealed wood fragments. Combined with striations in multiple directions and invasive hard/high silica polish, it is concluded that this time was used in multi-directional cutting of wood (Appendix C). A complete middle-stage biface (#233-10) bore plant residues, and the heavy polish and edge rounding indicate scraping of hard, high silica plant(s) (Appendix C). A proximal fragment of a late stage biface (#263-10) revealed plant residues and possibly animal skin, which was accompanied by soft polish indicating the cutting of skin/hide (Appendix C). The distal end of a late stage biface #274-5-11 revealed a clear, additive residue and polish striations

parallel to the long axis of the haft and polish use-wear that indicating a hafted tool used on unidentified material (Appendix C).

Small pieces were removed from six bifaces (#2-12 = TRC193, #197-16 = TRC201, #233-10 = TRC204, #263-10 = TRC205, #274-5-11 = TRC206, #283-12 = TRC207, and #293-5-12 = TRC208) and subjected to INAA to identify the source locales of raw materials. All show chemical signatures resembling those of known Edwards chert sources (Appendix F). Biface #263-10 has a chemical signature that is close to signatures of some chert samples from Kerr County. Another specimen (#2-12) yielded a chemical signature similar to that of the Frio point #389-10, indicating that both and may have originated from the same source area.

9.3.3 Scrapers

Only three scrapers were recovered from the Late Archaic component. Two are complete, and one is the distal end, with fragmentation resulting from a use break. Metric and non-metric attributes are provided in Appendix O. The two complete specimens are side- and end-scrapers of similar size. All three were manufactured from fine-grained chert and all lack patination. All three retain water-worn cortex on some portion of the surfaces. None appear to have been flaked from heat-treated material, nor do any exhibit rejuvenation scars. The two scrapers from Unit N99/E50 (#2-10 and #3-10) may have been translocated from the overlying Toyah component, as some mixing of materials was noted in this unit that resulted from mechanical disturbance along the entrance road. Scraper #293-5-13 was located within Feature 1c along the northeastern margin of Feature 1 in what is believed to be a secure Late Archaic context.

All three scrapers were sent for use-wear analysis. Specimen #2-10 is the distal end of an end-scraper that revealed hard, high-silica

polish. It is interpreted as having scraped hard, high-silica material (Appendix C). Specimen #3-10 is a lanceolate shaped, complete end-side scraper that exhibits wood fragments and hard, high-silica polish that is interpreted as resulting from the planing of wood (Appendix C). Specimen #293-13 is an ovate complete end-side scraper that exhibits bore plant tissue and hard, high-silica polish and striations parallel and perpendicular to the edges that are interpreted as evidence for scarping action on hard, high-silica plant material such as wood (Appendix C).

All three scrapers were also sent for INAA. The three specimens (#2-10 = TRC191, #3-10 = TRC194, and #293-5-13 = TRC209) reveal chemical signatures similar to known Edwards chert (Appendix F). Scraper #293-5-13 (TRC209) did not have a signature that was similar to the other two scrapers. Its signature was similar to natural chert cobbles collected from the adjacent Hackberry Creek, and the material may have come from that local source.

9.3.4 Edge-Modified Flakes

The 69 edge-modified flakes include one spokeshave (#997-10) and three graters (#208-10, #491-10, and #543-12). From these 69 informal tools, nine were selected for use-wear analysis (Appendix C). Specimen #2-11 is an irregularly shaped tool made from, heat-treated chert, and exhibiting two worked edges that appear slightly rounded. It bore degraded hair and striations parallel and perpendicular to the long axis and is inferred to have been used to scrape hide. Specimen #94-10 is a unifacial rejuvenation flake that exhibits hard, high silica polish that indicates scraping of hard, high silica material. Specimen #98-11 is an ovate piece with three worked edges that exhibit light polish indicating use in cutting an unidentified material. Specimen #98-12 is a complete chert flake with two bifacial worked edges bearing irregular continuous flake scars. It has hair

fragments and light polish and is interpreted to have been used to scrape hide. Specimen #208-10 is a complete round chert graver with two pointed tips and as many as four worked areas. It exhibits plant fibers and hard, high-silica polish with striations parallel and perpendicular to the long axis. It was used in scraping/boring a hard, high silica plant. Specimen #283-12 is a complete, ovate chert flake with two worked bifacial edges. It reveals hard, high silica polish with striations interpreted to have resulted from the slicing of hard, high-silica material. Specimen #353-10 is an irregularly shaped flake fragment with two worked edges. It exhibits hard, high-silica polish that was used for whittling of a hard plant material. Specimen #491-10 is a complete secondary flake with a large platform, pronounced bulb, relatively parallel sides, an offset medial ridge, and a distal end worked into a point by removal of tiny retouch flakes. This flake exhibits soft polish and striations that indicate cutting of soft material. Specimen #543-12 is a burned graver with five worked edges. Plant fibers and raphides and hard, high-silica polish indicate scraping and whittling of hard plant material.

Seven edge-modified pieces were selected for INAA. These yielded chemical signatures similar to other known Edwards chert from the southwestern area of the Edwards Plateau, except for two pieces that exhibit signatures that do not resemble those from the known INAA database for Edwards chert (Appendix F).

9.3.5 Cores

Eight cores were recovered from Block A and two were found in Block B. Five of the eight from Block A were found within the margins of the burned rock concentration, Feature 1. Sixty percent of the total are complete, while 20 percent are exhausted and 20 percent are fragmentary (Appendix O). All were fine-grained cherts without any appearance of have

been heat treated. Fifty percent exhibit some remaining cortex that is smooth and water rounded. None are patinated. Fifty percent are multi-directional and 50 percent are bifacial. The six complete cores range in length from 86.9 to 107 mm, with an average of 96.6 mm. The widths range from 53.5 to 78.5 mm, with an average of 68.7 mm. The thickness ranges from 35.4 to 62 mm, with an average of 49.8 mm. The weight ranges from 220.5 to 512.3 g, with an average of 376.8 g. The exhausted pieces are approximately half the size of the average complete core. No cores were subjected to any type of chemical or residue analyses.

Block A yielded eight cores from seven different units. Four units in the southeastern side of Feature 1 yielded five cores, with three cores recovered from Feature 1c just south of BT 2. Two other cores were recovered from along the western margin of Feature 1. These cores were often from the same units that yielded edge-modified flakes. This general association may indicate that expedient flake tools were made, used, and discarded near the margins of Feature 1.

9.4 DEBITAGE

9.4.1 Unmodified Debitage

A total of 1,801 pieces of lithic debitage were recovered, which represents about 31 percent of the total cultural materials from this component. Roughly 26 percent of this debitage class from Block A was analyzed to determine which stages of raw material reduction and tool production, manufacturing, and maintenance processes are represented. The selected sample was derived from 11 different units across the main area encompassed by Feature 1 in the southwestern part of Block A. The Late Archaic materials were best defined in this area; and thus, these selected levels probably reflect this specific time period.

About 60 percent of the sample exhibited some evidence of heat alteration from being exposed to excessive heat. These pieces exhibit spalling and cracking that is considered not part of the intentional heat treatment process to increase their knappability. Blades are nearly non-existent in the sample with less than one percent identified. Early and late stage biface manufacturing flakes are nearly equally represented with 13.9 and 14.2 percent, respectively. A high frequency of angular debris/shatter is represented by 26.6 percent. Tertiary thinning and retouch flakes are moderately represented by 19 percent. Indeterminate pieces account for about 9.4 percent. The core reduction flakes, which reveal at least 50 percent cortex, are represented by about 16.5 percent.

This sampled assemblage indicates that considerable quantities of the debitage was heat-altered and may have been mixed in with the sediments surrounding the once hot rocks during actual cooking. It is also possible that lithic debitage was originally close to the fire that heated the rocks used in this cooking activity. The relatively moderate representation of core flakes indicates that cobbles with cortex were reduced here. The equal and moderate frequency of biface reduction flakes also indicates that some bifaces were manufactured in this area. These bifaces and other tools appear to have been worked into finished or nearly finished forms as indicated by the moderate frequencies of thinning and retouched flakes. The high frequency of angular debris reflects the reduction of cores and early stage biface thinning. Apparently, production of flakes from cores and bifaces occurred, and it may have been a goal to use them as small informal/expedient tools. Biface production also occurred, apparently from both cobbles and flakes. Evidence for the tool maintenance activities is minimal but present.

9.4.2 Late Archaic Rejuvenation Flakes

This assemblage does not include any pieces that were classified as rejuvenation flakes.

9.5 OTHER ARTIFACTS

One clast of ovate, dolomitic limestone, classified as a nutting stone (#1251-10) was recovered from the lower part of burned rock midden Feature 1, immediately on the southern edge of BT 2, at 47 cmbd in Unit N103/E50. This piece exhibits two pitted surfaces, possibly the result of chemical weathering (Figure 9-11). One corner, part of one lateral edge, and the center of both faces exhibit relatively deeper and larger areas of pitting that are probably artificial. The specimen measures 81.9 mm long, 60.5 mm wide, 39.4 mm thick, and weighs 215.1 g. The largest pitted area is on one face and measures 26.3 mm long, 20.4 mm wide, and roughly 3.3 mm deep. On the opposite face the central pit measures 19.3 mm long, 18.5 mm wide and about 3.6 mm deep. Specimens with similar pits have been referred to in the literature as nutting stones. Turner and Hester (1993) use the term “pitted stone” and state similar pieces probably were used for nut-cracking platforms, whereas Johnson (1962) suggests that they were possibly used as anvils in the bipolar-flaking technique. Turner and Hester (1993) indicate similar objects are concentrated in the northeastern corner of Texas.

9.6 VERTEBRATE FAUNAL ANALYSIS

The Late Archaic component yielded 41 vertebrate specimens weighing 13.6 g. Many more bone fragments were recovered from this component, but these are believed, based on their color and lack of weathering, to have originated from the immediately overlying Toyah component.

Bone fragments attributed to Late Archaic occupation are in fair to good condition with

Figure 9-11. Late Archaic Nutting or Anvil Stone

some splitting and exfoliation from weathering, moderately dry bone fractures, and extensive root etched surfaces. All fragments are less than 3 cm in length, with the average weight of 2.8 g reflecting their very small size. Nine pieces were burned brown to black in color and four pieces were burned to brown in color.

The majority of pieces (78 percent; $n=32$), weighing a total 8.3 g, were assigned to an unknown taxonomic category. Only three small tooth enamel sections were in the bison size class, and these probably do represent bison. Six long bone fragments were assigned to the deer/antelope size class. No other size classes or species were identified in this small sample.

9.6.1 Discussion

Since most bones recovered from this component are thought to actually pertain to the overlying Toyah component, the interpretive potential of the Late Archaic faunal material is quite limited. The burned rock Feature 1 that dominates the material remains in this component is thought to reflect cooking of plant foods. This is not to say that some animal bones were not discarded into, or were somehow functionally linked with this cooking feature. It is also possible that in the construction of this shallow basin shaped burned rock feature some older bones may have accidentally been incorporated into this feature.

It is not unusual to find a few bones scattered in similar burned rock features. A 2 m diameter burned rock feature, interpreted as the remains of an earth oven dating to this same general time period in the Blackland Prairie to the east of the Edwards escarpment, also yielded some 500 vertebrate remains. About 66 percent of those bones were burned (Brownlow 2003). How the bones arrived in this setting and their functional connection to this burned rock feature is still not clear.

9.7 MUSSEL SHELL REMAINS

The Late Archaic component only yielded two mussel shell fragments and one umbo (#293-6), both in Feature 1c. These are the only mussel shell pieces from this component, whereas some 19 pieces were in the Toyah component immediate above Feature 1. The fact that the charcoal from Feature 1c was dated to the Toyah component indicates these few shell fragments may have also been displaced downward from the overlying component as well.

9.8 BURNED ROCKS

A moderate number of burned rocks, mostly from within Feature 1 and its four subfeatures, were encountered. A total of 3,965 pieces that weighed 607,236 g were recovered from the features and non-features in Blocks A and B. The average weight was about 153 g with an average density of about 32 pieces per m².

Block A, dominated by Feature 1, yielded 3,390 pieces that weighed 492,250 g. Feature 1 contained 3,196 pieces (469,150 g), accounting for nearly 94 percent by count and 95 percent by weight of the burned rocks from Block A. The average weight of Feature 1 burned rock was about 147 g. The subfeatures recognized in Feature 1 (Features 1a, 1b, 1c, and 1d), yielded average burned rock weights of 295 g, 126 g, 392 g, and 551 g, respectively.

Although the Late Archaic component was not targeted in Block B, nearly 3.5 m³ were excavated below the overlying Toyah component, yielding 575 pieces of burned rock that weighed 114,986 g. Of the Block B burned rock total, about 23 percent by count and 48 percent by weight were recovered from four recognized burned rock features. The average rock from the features weighed about 415 g, compared to the average weight of 135 g for the scattered rocks outside the features. Again, the rocks identified as within features were about

three times the weight of the scattered burned rocks, implying that they were repeatedly utilized, and therefore highly fragmented rocks were scattered around the features after their functional utility had been exhausted.

9.9 MACROBOTANICAL REMAINS

Carbonized plant remains were quite sparse in this component. Most carbonized plant remains were derived from burned rock Feature 1, but this prominent feature lacked significant quantities of charcoal, recognizable lenses or pockets, or even burned matrix. With individual carbonized pieces scattered around or below the burned rocks, it was still uncertain as to how many of those filtered down from the younger and better-preserved Toyah component immediately above. The radiocarbon dating of individual pieces provided an excellent indication to the amount of Toyah charcoal moving down into this component, in addition to providing the age range of materials directly associated with this burned rock feature. Only one of nine dated samples (11 percent) from Feature 1 is of the Toyah age. Individual charcoal chunks were often piece-plotted in the field and bagged separately. Bulk matrix samples were also collected from different parts of Feature 1 and its subfeatures, and the floated material was inspected for carbonized plant remains. If the light fractions appeared to have potential for identifiable carbonized plant remains, the material was sent to Dr. Dering for taxa identification (Appendix I).

Only about 36 g of carbonized plant remains were recovered (Table 9-8). The species identified by Dr. Dering include agave leaves, oak, mesquite, juniper, woody legume, buttonbush, green *Condalia*, prickly pear seeds, and lotebush. The four burned prickly pear seeds came from two separate locations, which may support their direct association with the burned rock feature. These nine different types

of plants indicate diverse fuel sources and/or packing material, if an oven was used. The burned prickly pear seeds probably represent something other than fuel.

9.10 LATE ARCHAIC SUMMARY

The suspected large burned rock feature (subsequently labeled Feature 1) exposed on the surface was initially targeted by backhoe trenching during the initial mitigation phase. Following the excavation of Block A, Feature 1, which measured roughly 6 m in diameter by up to 30 cm thick and completely buried, was comprised mostly of burned rocks, and contained within a very dark gray (10YR 3/1) to black (10YR 2/1) clay loam to silty clay loam buried A horizon. Late Archaic materials in Block A were concentrated in and along the ill-defined margins of Feature 1, but could not be horizontally traced significantly beyond this rock deposit.

The 83-m² hand-excavations of the Late Archaic component in Block A yielded 1,685 pieces of lithic debitage, 3,402 burned rocks, 57 informal edge-modified stone tools, 26 formal chipped stone tools, 10 cores, 41 bone fragments, 10 burned rock features, three mussel shell fragments, one anvil/nutting stone, and two intrusive Toyah sherds (Table 9-9). The formal chipped stone tools include three Frio, one Castroville, one Edgewood, one Ensor, one Marcos, one Montell point, nine bifaces, and three scrapers, plus two intrusive Clifton arrow points, one unidentified arrow point, one intrusive Gower dart point, and two Group 2 dart points.

Table 9-8. Macrobotanical Remains from Late Archaic Component

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
2-007	N99/E50	10-20	1	0.2		
11-005-004-007-1a	N99/E51	11-24	1d	0.1	C ¹⁴ dated to 1390 ± 40 B.P.	No identifiable charcoal
80-5-4-1	N100/E50	20-30	1	0.6	Light fraction sent to Dering for ID	Juniper (n=1), mesquite (n=1), buttonbush (n=1), indeterminate (n=21)
81-007	N100/E50	30-40		0		
81-007-1a	N100/E50	30-40		0.1	Sent to Dering for ID	
81-5-4-1	N100/E50	30-40		0.1	Light fraction sent to Dering for ID	Indeterminate (n=8)
89-005-007	N100/E51	20-30	1a			
89-005-007-1a	N100/E51	20-30	1a	0.1	C ¹⁴ dated to 1700 ± 40 B.P.	
89-005-007-1b	N100/E51	20-30	1a	0.1	Sent to Dering for ID	Mesquite (n=5)
89-5-4-1	N100/E51	20-30	1a	0.1	Light fraction sent to Dering for ID	Indeterminate (n=11)
98-005-007	N100/E52	10-20	1	2		
98-005-007-1a	N100/E52	10-20	1	2	Sent to Dering for ID	Juniper (n=7), oak (n=8), woody legume (n=4), green <i>Condalia</i> (n=5)
98-007	N100/E52	10-20	1	0.1		
100-007	N100/E52	30-40	1	2		
100-007-1a	N100/E52	30-40	1	0.1	C ¹⁴ dated to 1740 ± 40 BP	
100-007-1b	N100/E52	30-40	1	1	Sent to Dering for ID	Mesquite (n=14)
120-007	N100/E54	20-30		3.3	Burned wood	
161-005-007	N101/E47	45-50	1			
161-5-4-1	N101/E47	45-50	1	0.1	Light fraction sent to Dering for ID	Mesquite seed (n=1), indeterminate (n=8)
162-007	N101/E47	50-60	1		Probably tree or root (14 g not cultural)	
162-007-1a	N101/E47	50-60	1	14	Sent to Dering for ID	Mesquite (34 ml)
171-005-007-1	N101/E50	50-60	1	0		
171-005-007-1a	N101/E50	50-60	1	0.1	C ¹⁴ dated to 2140 ± 40 BP	
171-005-007-1b	N101/E50	50-60	1	0.1	Sent to Dering for ID	Juniper (n=5),
171-005-007-2	N101/E50	50-60	1	0		
171-005-007-2a	N101/E50	50-60	1	0.1	Sent to Dering for ID	Juniper (n=1)
178-5-4-1	N101/E50	15-25	1	0.4	Sent to Dering for ID	Indeterminate (5 ml)

Table 9-8. Macrobotanical Remains from Late Archaic Component (Continued)

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
179-5-4-1	N101/E50	25-39	1	0.4	Sent to Dering for ID	Agave leaf ($n=2$), juniper ($n=1$), oak ($n=2$), prickly pear seed ($n=3$), indeterminate ($n=12$)
179-005-004-007-1a	N101/E50	25-39	1	0.1	C ¹⁴ dated to 2290 $\pm$ 40 B.P.	
187-005-007	N101/E51	27	1	0.5		
197-007	N101/E52	20-30	1	0.7		
203-007	N101/E52	80-90	1	1		
203-007-1a	N101/E52	80-90	1	0.1	C ¹⁴ dated to 2230 $\pm$ 40 B.P.	
203-007-1b	N101/E52	80-90		1.2	Sent to Dering for ID	Mesquite ($n=12$)
204-7-1a				0.2	Sent to Dering for ID	Oak ($n=6$)
263-5-4-1	N102/E47	30-40	1	0.5	Light fraction sent to Dering for ID	Mesquite ($n=1$), lotebush ($n=1$), agave leaf ($n=1$), juniper ($n=2$), indeterminate ($n=14$)
273-5-4-1	N102/E50	28-40	1b	0.3	Light fraction sent to Dering for ID	Prickly pear seed ($n=1$), agave leaf ($n=6$), juniper ($n=2$), mesquite ($n=3$)
273-5-7	N102/E50	28-40	1b	0.4		Walnut ($n=1$)
274-5-4-1	N102/E50	40-50	1b	1.4	Light fraction sent to Dering for ID	Juniper (14 ml), oak ($n=1$), buttonbush ($n=1$), indeterminate ($n=12$)
293-005-007	N102/E52	20-30	1c	1		
293-005-007-1a	N102/E52	20-30	1c	0.1	C ¹⁴ dated to 550 $\pm$ 40 B.P.	
293-005-007-1b	N102/E52	20-30	1c	0.1	Sent to Dering for ID	Juniper ($n=4$)
352-5-4-1	N103/E47	30-40	1	0.3	Light fraction sent to Dering for ID	Juniper ($n=8$), oak ($n=2$), indeterminate ($n=19$)
361-005-007	N103/E51	40-50	1	0		
361-005-007-1a	N103/E51	40-50	1	0.1	C ¹⁴ dated to 2170 $\pm$ 40 B.P.	
361-005-007-1b	N103/E51	40-50	1	0.1	Sent to Dering for ID	Juniper ($n=2$)
362-005-007	N103/E51	50-60	1b	0		
362-005-007-1a	N103/E51	50-60	1b	0.1	Sent to Dering for ID	Juniper ($n=2$)
407-007	N104/E47	30-40		0		
407-007-1a	N104/E47	30-40		0.1	Sent to Dering for ID	
801-005-004-007-1a	N115/E73	20-27	15E	0.1	From light fraction	No identifiable charcoal
801-005-004-007-2a	N115/E73	20-27	15W	0.1	From light fraction C ¹⁴ dated to 2140 $\pm$ 40 B.P.	

Table 9-9. Summary of the Late Archaic Materials from the Varga Site (41ED28) Investigations

Cultural Material Classes	Late Archaic Component (1,700 to 2,310 B.P.)
Bone Fragments*	13.6 g, 41 pieces
Bison size	3 pieces
Deer/Antelope size	6 pieces
Mussel Shell*	5.9 g, 2 fragments
Burned Rock	3,965 pieces, 607,236 g
Features	9
Cooking Facility	1
Burned Rock Dumps	8
Dart Points and Fragments	14
Frio	3
Marcos	1
Ensor	1
Montell	1
Untyped	1
Arrow Points (intrusive)	3
Cliffton	2
Bifaces	9
Scrapers	3
Drills	0
Edge-Modified Flakes	69
Lithic Debitage	1,801
Cores	10
Nutting Stone/Anvil	1
Unifaces	0
Gouges	0
Hammerstones/Choppers	0
Ceramic Sherds (intrusive)	2
Bone Tools	0
Socialtechnic Objects	0
Carbonized Plant Remains	36 g
Total Materials	5,931
Average Thickness (cm)	10
Spatial Extent Excavated	90
Volume Excavated (m³)	9.2

* Bone, mussel shell, and carbonized remain totals are weights in grams;

This table does not include materials from float samples

The 35.5 m² random and scattered hand-excavated units in Block B attributed to the Late Archaic component, plus the 5.0 m² from the Phase I investigations that penetrated the Late Archaic zone, yielded the partial remains of four burned rock features (Features 7, 15, 28, and 29), one Bell point barb fragment, 11 edge-modified flakes, two cores, and about 563 burned rocks.

9.10.1 Chronology Issues

This Late Archaic component was directly dated by 11 radiocarbon assays on wood charcoal and bone to a ca. 600-radiocarbon-year period from 1,700 to 2,310 B.P. (Table 9-1). A sediment sample from Depositional Unit 2, or the Ab soil horizon, and stratigraphically equivalent to this zone, yielded a mean age of 1,900 B.P. in accord with cultural radiocarbon ages from this component. Six of the eleven dates are from charcoal collected from Feature 1 context. The oldest radiocarbon date, 2,310 B.P. (Beta-175412), was on a single chunk of wood charcoal from Feature 1b that was recovered from what is considered a valid Late Archaic context. The youngest radiocarbon date, 1,700 B.P. (Beta-175412), was derived from a single chunk of charcoal that was recovered from Feature 1a and also in a valid context. We are unsure how much old wood might be contributing to the difference in the radiocarbon dates. The multiple projectile point types and multiple radiocarbon dates indicate that multiple occupational episodes may be represented, but the thinness of the Late Archaic deposits do not allow for corresponding vertical separation of the projectile points or other associated artifacts.

Evidence for some vertical displacement of dateable materials in this component is present. The second oldest date, 2,290 B.P. (UGA-12716), was obtained from one deer/antelope bone fragment (#418-2-1) retrieved from below the Late Archaic component. This bone was

encountered 50 to 60 cm deep in a level attributable to the Middle Archaic. Apparently this bone was displaced downward into the lower component. A chunk of wood charcoal (#203-5-4-2-1) dated to the Late Archaic was recovered from burned rock Feature 39 in the Early Archaic component. Two other radiocarbon dates (550 ± 40 B.P. [#293-5-7-1a] and $1,390 \pm 40$ B.P. [#11-5-4-7-1a]) on charcoal from an apparent Late Archaic context were derived from displaced charcoal that moved down in the profile. Two Toyah age Clifton points and two tiny ceramic sherds from the Toyah component were also recovered from this midden or mixed context. Also an Early Archaic Martindale point was recovered from the burned rock midden context from immediately west of Feature 1c.

Since the 11 radiocarbon dates document the absolute timing of this component to the Late Archaic period, the three Early Archaic and one Middle Archaic projectile points are assumed to be displaced from their original contexts. It is not clear if these four points were curated items brought in by Late Archaic peoples or displaced from their original deposits during post-depositional times. The three Toyah age arrow points are surely intrusive. Only the 10 Late Archaic points are thought to be associated with these dates. It is not clear if any of the multiple Late Archaic point types were intrusive or curated items, especially since only the Frio type is represented by more than one specimen. It is possible that the Frio type equates with one of the two clusters of radiocarbon dates, and most likely this would be the three dates falling at 1,700-1,900 B.P. However, association with the older set of dates is not impossible. "Pure" Frio components have not been excavated and radiocarbon dated, so the age range for this point type is not precisely established.

9.10.2 Subsistence Issues

The Late Archaic projectile points and other tool classes represented generally appear to indicate hunting and processing of animals. No direct evidence is present for plant collecting. The indirect evidence for plant use comes from use-wear analyses, which indicate hard, high silica plants, wood, and animals were all associated with Late Archaic tools (Appendix C). However, the mere fact that tools were used on these diverse materials does not directly connect the identified materials to actual food resources.

Late Archaic bone fragments consist of 41 vertebrate specimens weighing 13.6 g, 22 percent of which were burned brown to a black color and 10 percent of which were burned to a brown color. Seventy-eight percent could not be assigned to a general size category. Three tooth enamel sections are in the bison size class and probably represent bison. Six long bone fragments were assigned to the deer/antelope size class. No other species or size classes were identified. This limited bone assemblage may have originated from the immediately overlying Toyah component that contained quantities of animal bones including bison remains. However, these few fragments were assigned to the Late Archaic component on the basis of the depth of their recovery and upon observed characteristics. If this assessment is correct, then it can be inferred that meat was present and consumed.

Indirectly, burned rock Feature 1 indicates cooking bulk foods, most likely plant material. The roughly 6 m diameter size of Feature 1, the shallow basin detected in the backhoe trench profile, and the small clusters of burned rocks, which may represent dump locations, generally indicate that Feature 1 was a hot-rock oven. Ovens are generally thought to have been used for cooking bulk foods that require considerable cooking time, such as sotol, yucca, or

lechuguilla bulbs. Four burned prickly pear seeds, a burned mesquite seed, burned walnut shell fragments, and seven burned agave leaf fragments were recovered from various locations in direct association with burned rock Feature 1 (Table 9-10). The prickly pear seeds potentially were from roasting prickly pear fruit. Possibly the walnuts were boiled to render the oil. However, the nuts may have been accidentally burned as part of the fuel needed in the cooking process. The agave hearts identified in the macrobotanical remains would be the most likely candidate to require long-term cooking (24 to 48 hours) in an oven before consumption.

Three tiny mussel shell pieces were recovered from Feature 1c, which potentially represent one half of one shell. Thus, there is no reason to believe that mussels were procured on a regular basis as a source of meat

Proxy evidence from the lipid residue results on the burned rocks reflects intensive use (94 percent) of the burned rocks for cooking high fat content plants. Only two samples, or six percent, reflect medium to low fat content. A single sample (#98-5-3-1) yielded the only indication of large herbivore residue. The overall lipid residue results reveal the rocks cooked a narrowly focused food resource. Other chemical data in the form of stable carbon and nitrogen isotopes was combined with the lipid residue results to aid in the interpretations, but do not allow for specific identifications. The $\delta^{13}\text{C}$ values range from -21.8 to -30.6‰, with an average of -24.8‰. These carbon isotope values indicate that the plants represented by the lipid residues were all C_3 plants or animals that consumed C_3 plants. The isotope results do not support the use of C_4 prickly pear pads or fruit or lechuguilla as one of the targeted plants cooked in the oven. The single lipid residue that is interpreted as reflecting a large herbivore yielded a $\delta^{13}\text{C}$ value of -24.2‰ and a $\delta^{15}\text{N}$ value

Table 9-10. Floral Species Identified from the Late Archaic Component

Agave leaves
Buttonbush
Green <i>Condalia</i>
Juniper
Littleleaf walnut
Lotebush
Mesquite seed
Oak
Prickly pear seeds
Woody legume

of 7.7‰. Based on these isotope values, the large herbivore was probably deer or pronghorn.

Late Archaic human remains from Conejo Shelter in the Lower Pecos have revealed isotope evidence for a human diet rich (45 to 68 percent) in CAM/C_4 plants with roughly 32 to 55 percent of the diet comprised of C_3 plants or animals that consumed C_3 plants (Huebner 1991a; Bousman and Quigg 2006). The Conejo data supports the subsistence reliance detected at the Varga Site with deer meat supplying the C_3 meat component and agave (probably sotol) supplying the CAM plant portion of the diet. This mixed subsistence pattern is more similar to that of the Lower Pecos region, than to Late Archaic diet in the Central Texas region, which shows an increased reliance on C_3 plants and animals that ate C_3 plants at this time (Bousman and Quigg 2006).

9.10.3 Technology Issues

Technology issues can only be addressed from the preserved assemblage. Some daily tasks such as resource procurement, resource processing, and consumption are represented in the limited tool assemblage, as discussed below.

9.10.3.1 Resource Procurement Issues

Plant and animal procurement is generally interpreted here based on the recovered artifacts. The presence of a relatively high frequency of projectile points indicates that animals were hunted. Use-wear and the impact fracture detected on the Montell point document that this instrument was used as a projectile, though the actual contact material is unknown. Use-wear analysis, as in the case of the Edgewood point that was apparently used to cut wood, does indicate that some points were employed as multi-functional tools. The sparse bone assemblage could indicate that animal procurement did not play a major role at this location, or might simply reflect poor bone preservation.

The two projectile points submitted for use-wear, the Montell point with heavy polish and the Edgewood with polish and striations, both reveal hafting wear. One biface (#274-5-11) also reveals polish and striations plus clear additive residue that apparently resulted from hafting.

The raw lithic materials employed by the groups representing this component used Edwards chert exclusively as determined by INAA and macroscopic examination. The raw material employed in the manufacture of stone tools apparently came principally from water-rounded chert cobbles. Therefore, it is inferred that these chert cobbles were collected from surface outcrops such as streambeds rather than extracted from limestone bedrock sources. The presence of cores, the high frequency of core reduction flakes, the high frequency of angular debris, combined with the high frequency of early and late stage biface flakes documents that after tool stone cobbles were procured, they were reduced to produce finished tools at the site.

The natural limestone pieces employed in cooking activities probably were locally available and doubtless were collected from nearby outcrops.

9.10.3.2 Resource Processing and Consumption

Diverse processing activities are documented here through the different types of stone tools recovered which include bifaces, scrapers, anvil/nutting stone, and edge-modified tools. The small number of scrapers ($n=3$) and the absence of drills indicates that tasks associated with these tools probably were limited. Use-wear analyses on 17 Late Archaic stone tools comprised mostly of edge-modified flakes, represents a diverse range of processing tasks. Thirty percent of the inferred uses relate to scraping, 25 percent relate to cutting, 10 percent to whittling, and five percent indicate slicing, boring/drilling, planing, and/or other unidentified activities. Inferred contact materials include hard, high-silica plant material (44 percent), hide (17 percent), wood (17 percent), and unidentified materials (17 percent). The small remainder were used on unidentified soft material. No one tool class can be directly linked to one specific task on one material type. For example, the low frequency of formal scrapers does not indicate a paucity of scraping activity, since thirty percent of the analyzed tools reflecting scraping actions. Scraping tasks were performed with scrapers, edge-modified flakes, graters, and bifaces.

Actual use-residue was detected on nearly 56 percent of the tools analyzed. Nearly 28 percent revealed plant residues compared to just 11 percent that revealed animal residues. This difference may be connected to differential preservation of residues, rather than a proportional reflection of the intensity of a given processing task.

In the Lower Pecos region, where preservation in rockshelters is substantially better than at open camp sites, fiber nests (Features 2 and 24) were discovered at Wroe Ranch (Turpin 1998). These nests were constructed of twigs, agave leaves, grasses, and prickly pear pads and substantiate the collection and use of diverse plants during this same period. Such findings should caution against assumptions that could significantly underestimate the importance of intensive use of plant resources in surrounding regions where dry shelters are lacking.

The 3,965 burned rocks numerically dominate the cultural debris recovered in this component. Their presence also indicates that cooking was a major activity, and that cooking commonly involved on the use of hot rocks. Feature 1 is interpreted to represent an incipient burned rock midden. Although this feature was significantly impacted by two backhoe trenches dug during Phase I investigations, the configuration of the burned rocks indicates a shallow basin near the estimated center of the rock concentration. The presence of a central basin, the relatively large quantity of burned rocks encountered, the overall horizontal patterning of the burned rocks and the few burned prickly pear seeds and agave leaf fragments indicate Feature 1 was probably the remains of a rock oven employed to cook plant foods. This type of feature provides some indication of how foodstuffs were cooked and potentially the type of food(s) cooked, since certain foods are more efficiently cooked in rock ovens than others. Agave hearts were one of several foods that were often cooked in rock ovens. The fuel used in the heating of the rocks and/or cooking the food includes types, such as mesquite, juniper, and oak, and indicates that various woods were used as fuel. The prickly pear seeds may have been part of the insulation or packing materials used around the agave hearts during the actual cooking process (see Ellis 1997).

A small ovate nutting stone was recovered from just east of the projected central area of Feature 1. This item may have served as an anvil for smashing nuts. While no direct evidence exists to corroborate this suggestion, it may be relevant that burned walnut and pecans shells were recovered from this component.

The general scarcity of formal stone tools ($n=12$), other than projectile points ($n=13$) and informal edge-modified flakes ($n=69$), and the absence of rejuvenation flakes around the cooking Feature 1 implies that non-cooking activities were limited in the immediate area of Feature 1. The presence of broken dart points, broken bifaces, and a few cores indicate various retooling tasks, which may have been carried out during the duration of the plant cooking process. Discarded broken tools and debitage were found from amongst the discarded burned rocks. The presence of broken tools appears to reflect a pattern of concurrent discard of exhausted tools and burned rocks.

9.10.4 Intra-component Patterning

The 600-years of documented radiocarbon time for this thin vertical zone, coupled with the presence of six different point types indicate the potential for at least a couple of different occupational episodes, though a lack of stratigraphic separation hinders interpretation. Deciphering what activities may have been associated with one another is thus difficult, especially if multiple events are represented. Multiple events would seem to be indicated by the extended time span represented by the radiocarbon dates, and by the fact that several different dart point types were recovered. On the other hand, there is apparent logical patterning in the findings, implying the possibility of a single episode of site occupation during the Late Archaic.

The horizontal distribution of the small, identified burned rock clusters/piles (Features 1a, 1b, 1c, and 1d) within the overall boundaries of Feature 1 implies some type of discard or dismantling of exhausted rocks from Feature 1. This discard/dismantling is feasible in the case of a cooking oven, since the oven cover must be removed to retrieve the foodstuffs cooked inside. It is also possible that the interior of the oven, specifically the basin, was cleaned unwanted (i.e., functionally exhausted) burned rocks on occasion and prior to reuse. Such maintenance-oriented removal of rocks would have involved the dumping of those rocks that were sufficiently degraded so as to be longer functionally viable.

The tools and lithic debris potentially represent another event entirely, since it is not clear that the broken tools and other lithic debris were discarded concurrently with cooking activities. These objects may have already been on the ground at the time the shallow basin for the oven was constructed, or when the oven cover was dismantled. The horizontal distribution of the non-burned rock artifacts may have resulted from one or more of these activities. Eight-two percent of the formal tools were recovered from the defined limits of Feature 1, implying some correlation between the tools and the burned rocks. Only four formal tools appeared burned and two of those were older (Early Archaic). These heat-altered tools reflect either a direct discard into the oven or an accidental heating from a tool that was part of the sediments adjacent to the hot rocks or sediments used in covering the oven. The two burned Early Archaic points were likely present in the sediments during the heating of the rocks. The overall distributional pattern of the formal and informal tools and the small burned rock discard piles in and around Feature 1 indicate that most discards occurred to the southeastern side of the Feature 1. Relatively scant material remains were encountered across the north side of

Feature 1. A relatively high percentage of lithic debitage (about 41 percent) from around the burned rocks exhibit signs of unintentional heat alteration. Their spalled and crazed condition implies they were in close proximity to intense heat.

In Block A, hand-excavations outside the ill-defined and irregular margins of Feature 1 yielded almost no cultural debris, except for burned rock Feature 11 about 2 m north of the Feature 1 near the middle of the northern part of Block A. Only five, or about 18 percent, of the formal tools were recovered outside the defined limits of Feature 1. Roughly 37 percent of the edge-modified flakes were also outside the Feature 1 boundaries. This horizontal distribution reveals that most of the artifacts were within/near the Feature 1 boundaries, implying that various non-cooking activities were carried out within proximity of the cooking feature.

In Block B, roughly 25 m northeast of Feature 1, some 35.5 m² of scattered hand-excavated units penetrated the Late Archaic component immediately below the Toyah component. These excavations revealed four burned rock clusters, Features 7, 15, 28, and 29, and limited quantities of scattered burned rocks that relate to Late Archaic activities. Tiny charcoal flecks (#801-5-4-7-2a) from Feature 15 yielded a $\delta^{13}\text{C}$ corrected (-24.5‰) AMS radiocarbon date of 2140 ± 40 B.P. (Table 9-1: UGA-12725). However, with multiple events projected for this component, it is not clear if the use of one or more of these burned rock features was coeval with the use of Feature 1.

The details concerning the spatial analyses presented below, including the conceptual and methodological framework, are provided in the research design and in the method chapters. Contour maps of density-corrected artifactual data for Block A were generated for selected

variables in this component (Figures 9-12 through 9-18) using Surfer (version 5.01) mapping software. No contour maps were attempted for the cultural materials recovered from Block B since the Late Archaic component was not targeted for excavation in that area and those materials were limited in number. These maps generated for Block A provide a visual reference to aid in the interpretation of the spatial distribution of each artifact category and provide additional depth to interpreting the results of the principal component analyses. The locations of individual recognized features are also plotted on the contour maps as part of the spatial relationship of the activities.

Figure 9-13. Contour Map of Bone Density from Late Archaic in Block A

Figure 9-12. Contour Map of Burned Rock Density from Late Archaic in Block A

Figure 9-14. Contour Map of Lithic Debitage Density from Late Archaic in Block A

Figure 9-15. Contour Map of Biface Density from Late Archaic in Block A

Figure 9-17. Contour Map of Lithic Core Density from Late Archaic in Block A

Figure 9-16. Contour Map of Scraper Density from Late Archaic in Block A

Figure 9-18. Contour Map of Point Density from Late Archaic in Block A

The Late Archaic analytical unit in Block A covers a total area of 45.86 m² and consists of a total volume of 5.69 m³ of sediment. Ceramic sherds, groundstone, awls, drills, gouges, unifaces, and choppers were excluded from this analysis due to the non-occurrence of these artifacts in the Late Archaic component in Block A. The resulting data matrix consists of eight variables (artifact categories) and 86 rows (excavation units), though only seven of the variables figure strongly in the resulting factor solution. The principal components analysis extracted a three-factor solution representing a cumulative total of 66.22 percent of the variability present in the data array. The matrix of correlation coefficients is presented in Table 9-11, and the factor solution is presented in Table 9-12.

Factor 1 is composed of three diagnostic variables—burned rock, faunal bone, and

debitage—collectively composing 25.81 percent of the total variance in the matrix of correlation coefficients (Table 9-12). All three variables exhibit moderately strong to strong positive factor loadings ranging from .649 to .904; none of the diagnostic variables in Factor 1 are negative. This factor may be explained largely in reference to a single high-density peak of all three of these artifact categories in the southwestern quadrant of Block A—centered on the west edge of Unit N101/E50 (Figures 9-12 and 9-14). Lithicdebitage displays two secondary peaks a few meters northeast and southeast of this central peak, whereas neither burned rock nor faunal bone have secondary peaks in this area. Faunal bone displays two minor peaks in the northeastern quadrant and farther south along the eastern edge of the block (Figure 9-13).

Table 9-11. Correlation Matrix for Block A—Late Archaic Component

Category	Category							
	Burned Rocks	Faunal Bone	Cores	Debitage	Bifaces	Edge-Modified Flakes	Projectile Points	Scrapers
Burned Rocks	1.000							
Faunal Bone	.618	1.000						
Cores	.376	.135	1.000					
Debitage	.573	.405	.302	1.000				
Bifaces	.260	-.030	.071	.249	1.000			
Edge-Modified Flakes	.210	.168	.115	.573	.244	1.000		
Projectile Points	.283	.084	.349	.381	.053	.190	1.000	
Scrapers	.112	-.037	.133	.201	.438	.110	-.053	1.000

Table 9-12. Principal Component Matrix for Block A—Late Archaic Component

Variable	Factor ¹		
	1	2	3
Burned Rock	.807	.143	.269
Faunal Bone	.904	-.151	-.074
Cores	.143	.074	.724
Debitage	.649	.340	.434
Bifaces	.084	.823	.029
Edge-Modified Flakes	.374	.392	.265
Projectile Points	.090	-.057	.849
Scrapers	-.022	.807	-.031
% Variance	25.81	20.63	19.78
Cum. % Variance¹	25.81	46.44	66.22

¹ Rotation method—Varimax with Kaiser normalization

² Based on rotation sums of squared loadings

Clearly, the primary determinant of the patterning observable in this factor is the presence of Feature 1, an incipient burned rock midden composed of a central pit feature and a surrounding scatter of burned rocks and associated debris. The location of the central pit feature corresponds to the high-density cluster of materials represented by this factor loading. This factor clearly represents the resource processing activities associated with use of this feature. The inclusion of lithic debitage in this factor is perhaps noteworthy, though it is possible that at least some of this debitage was translocated downwards from a noted high-density peak of debitage and related artifacts from the overlying Toyah component. It is perhaps more interesting to observe that, in contrast to the strong association between debitage and edge-modified flakes observed in Factor 1 in the Toyah component in Block A, edge-modified flakes do not appear to be spatially associated with any other artifact category in the Late Archaic component. In

fact, they do not appear in any of the three factor loadings resulting from the principal components analysis.

Factor 2 is composed of two diagnostic variables—bifaces and scrapers—collectively composing 20.63 percent of the total variance in the matrix of correlation coefficients (Table 9-12). Both variables exhibit strong positive factor loadings of .807 and .823. This factor can be explained largely in reference to a strong pairing between these two artifact categories in two high-density clusters, one in the south-central part of Block A just south of Backhoe Trench 2 and one centered on the intersection of low- to moderate-density peaks in the southwestern corner and just north of BT 2 (Figures 9-15 and 9-16). All of these density peaks are located along the periphery of Feature 1 (contrasting with the concentrations of Factor 1 variables in the center of Feature 1). Scrapers and bifaces may form part of a constellation of tools used to process the resources associated with Feature 1

Factor 3 is composed of two diagnostic variables—cores and projectile points—collectively composing 19.78 percent of the total variance in the matrix of correlation coefficients (Table 9-12). Both variables exhibit moderately strong to strong positive factor loadings of .724 and .849. The spatial patterning represented by this factor is accounted for by a strong correlation between cores and projectile points in one high-density cluster located in the approximate center of BT 2 (Figures 9-17 and 9-18). Whereas cores exhibit only this single peak, points extend in a linear high-density corridor southwards to a primary high-density peak centered on the intersection of the N99 and E52 grid lines. Like Factor 2, it seems likely that the patterning reflected in this factor represents activities conducted along the periphery of Feature 1 more strongly than any special association among these two artifact

types. In the end, the spatial structure of the Late Archaic component appears to be comprised mostly of Feature 1, including the structure of the feature itself and related activities that occurred along its periphery.

It is important to remember that demonstrable spatial associations of different variables, which form the basis of the preceding discussion, do not inherently imply the nature of the relationships among some or all of the variables. The statistics reveal numerical tendencies among variables to co-occur or to co-vary in space. The statistics “force” patterning upon an assemblage of data regardless of whether or not it innately exists in the dimension being examined. However, patterning is always present in archeological data, so it is reasonable to accentuate it where it exists to expedite the task of detection and interpretation. The analyst is responsible for inferring whether such patterning may be indicative of past behavior, such as that reflected *in situ* activity or discard areas; post-depositional processes, such as plowing or erosion; or a combination of both.

Overall, the principal component analyses of this component included in this spatial study have yielded relatively unambiguous patterning among artifact categories. The patterns appear to be constrained and influenced by different factors. The observed associations among artifact categories appear to be regular, patterned, and often exclusive of other categories. If post-depositional factors, such as erosion, or animal burrowing, had resulted in extensive mixing of sediments, one would expect there to be less distinctive patterning among specific classes of variables and more general mixing of classes. Similarly, extensive mixing of deposits would tend to blur the relatively clear spatial clusters of cultural materials observed in components. Thus, it appears that the sediment deposits (the A horizon) that contained the Late Archaic

component were relatively intact, and that the spatial patterning apparent among artifact categories in this Late Archaic component is referable more to the organization of the prehistoric occupation than to post-occupational factors.

9.10.5 Mobility and Land Use Issues

Inferences concerning the social structure during the Late Archaic at the Varga Site are difficult to make, since the tool assemblage and other material aspects are limited in numbers (except for the burned rocks) and biased towards the large cooking feature. The occurrence of the large burned rock oven feature may reflect the presence of female-dominated activity. If stone tool manufacturing and retooling tasks can be related to male activities, then one would assume that this occupation(s) consisted of group(s) composed of males and females. If the cooking feature reflects the cooking of bulk food items, then minimally a small group of people had to be present to collect the foodstuff and spend a few days cooking that resource and retooling their stone tool equipment. These tasks would imply a short-term event focused on plant collecting and cooking a single bulk plant resource.

No direct evidence of trade is identifiable, given that no marine shells or other exotic items of nonlocal origin were identified in the Late Archaic component assemblage. The lithic debitage and stone tools probably represent locally available Edwards chert based on macroscopic observations and INAA. The INAA reveals chemical signatures that, while variable, are similar to Edwards chert from several source areas across the southwestern part of the known Edwards outcrop. Only two or three signatures from different stone tools potentially represent other sources outside the current INAA database. This may indicate mobility within the region or at least contact

with peoples/groups from this region. Therefore, the data relevant to stone procurement for tool production implies a mobile population operating within a relatively limited geographical range.

The 13 radiocarbon dates indicate at least two episodes of occupation during a 600-year period, possibly accounting for the presence of the multiple types of projectile points. However, one or more of the different point types may have been items of trade and/or exchange, or might actually represent curation/reuse of somewhat older points. Alternatively, either a single resident group made/used more than one style of point, or perhaps was comprised of different constituent subgroups, each with its own style of projectile point, residing together on some sort of temporary basis.

Although it is unclear how or why these multiple point types are represented here, such co-occurrence is seen at other Late Archaic sites across Texas. For example, site 41WM815 in the Blackland Prairie to the east yielded three point types-- Marshall, Castroville, and Montell-- in and around a 2 m-diameter burned rock concentration interpreted as oven (Brownlow 2003). Brownlow offers multiple hypotheses to account for the apparent co-occurrence of the different point types.

In the eastern parts of Texas, across much of the Gulf Coastal Plain, and possibly along the eastern edge of the Edwards Plateau, Late Archaic peoples were thought to have been participating in a broader exchange network with peoples and groups further to the east (Hall 1981; Johnson 1982, 1994). The interaction is implied by the recovery of various nonlocal artifacts such as whelk pendants, stone gorgets, atlatl weights (boat stones) of exotic stone, and other exotic goods. No exotic artifacts were recovered from the Late Archaic component at the Varga Site to link the Varga population to

any trade network, or even one of more local interactions. Potentially the rich material expression of this broader exchange network was religious and more restricted to the disposal of the dead, than it was connected to the technoeconomic dimension represented in domestic habitation sites. Since the local Varga group focused on cooking a bulk food product with other limited camping tasks present, expression of this trading or religious belief is not represented in the archeological record.

In the Lower Pecos region, two obsidian flakes from Stratum 9 at Arenosa Shelter that yielded Ensor and Frio Late Archaic points and two radiocarbon dates of 2,070 B.P. (Tx-285) and 2,230 B.P. (Tx-696) indicate a trade network at that location. Both obsidian flakes were traced to Cerro Toledo rhyolite in the Jemez Mountains of north-central New Mexico (Hester et al. 1991). Groups of this time undoubtedly participated in some trading networks, but no evidence of that exists at this Late Archaic component at the Varga Site. Consequently, from the artifact assemblage recovered, it appears that the inhabitants of the Late Archaic component were more focused on local resources with restricted mobility in a relatively restricted home range.

9.10.6 Environmental Conditions

This Late Archaic component documented to ca. 1,700 to 2,300 B.P. yielded limited environmental data. The Late Archaic pollen record here (extracted from three sediment samples in one vertical column and two radiocarbon-dated backhoe trench sediment samples) indicates the presence of at least eight different taxa that include three arboreal and five nonarboreal species. Pollen includes oak (*Quercus*), pecan (*Carya* sp.), pinyon (*Pinus* sp.), relatively abundant cheno-ams, *Asteraceae*, and *Artemisia* (Appendix E).

The identified wood charcoal includes 11 taxa (pecan, walnut, juniper, and mesquite plus buttonbush, condalis, woody legume, lotebush, *agavaceae*, and prickly pear and mesquite seeds; see Appendix I). Juniper wood is the most abundant and comprises nearly 50 percent of the total weight of the charcoal from this component. The different taxa imply a mixed plant community of trees and small shrubs.

The phytolith record reveals 12 recognizable groups with shapes that represent C₃ and C₄ grasses and potentially other classes. This assemblage reveals the dominance of C₃ Pooideae grasses (ranging from 33 to 68 percent) with some C₄ grasses that included Panicoideae and Chloridaceae grasses (ranging from 26 to 64 percent). This is the only component that yielded a possible corn (*Zea mays*) phytolith (Appendix E), although the association with corn is questionable. The middle of the three Late Archaic sample, at 33 to 34 cmbs from the vertical column, reveals a major change from the other two Late Archaic samples 5 cm above and 5 cm below this sample. The C₄ grasses dominate the phytolith record accounting for nearly 63 percent of the record, whereas C₃ grasses comprise about 33 percent of the phytolith record (Appendix E). This specific sample was not directly dated, so its precise age is unknown. This single phytolith record reflects a significant change in the grass composition regardless of how limited or brief a time period it may represent.

The carbon isotope data from these same three Late Archaic column samples reveal values from -28.9 to -29.9‰ and document only organic matter derived from C₃ plants. These values are the most negative of any carbon isotope values obtained from this 6,300-year old sediment column, indicating maximum C₃ input. These very negative carbon isotope values may reflect the occurrence of a mesic period or indicate that the flora in this particular area was dominated by

C₃ plants. This carbon isotope data contrasts with the carbon isotope data from Fort Hood, to the east in Central Texas, that Nordt (1992, 1993) interpreted to indicate a warming period with a mixture of C₃ and C₄ organic input for this general time period. The carbon isotope data also contrasts with the phytolith data from this same sample creating doubt in one or the other set of results.

The Late Archaic Varga Site phytolith assemblage indicates a mixture of C₃ and C₄ contributions, in contrast to the carbon isotope data that indicate a complete dominance of C₃ contribution to the organic matter. The carbon isotope signal is strong and implies a moist and/or cool condition during this period or an area that was dominated by C₃ plants.

In the Lower Pecos, the environmental conditions at around 2,500 B.P. were thought to have been more mesic and probably cooler during a period that Bryant and Holloway (1985) refer to as the Frio Interval. Even though this more mesic period was defined as having a relatively short duration, Bryant believes this provided a grassland environment suitable for supporting bison. The assumption is that the moister conditions provided better grazing, and therefore allowed for the expansion of the bison-grazing range. The massive bison Bone Bed 3 at Bonfire Shelter in the Lower Pecos region that yielded two charcoal and two bone dates between 2,300 and 2,800 B.P. documents the presence of bison in the Lower Pecos region at this time (Dibble and Lorrain 1967). Also in the Lower Pecos, the period following 2,300 B.P. saw a return to aridity, which Bryant (1966) refers to as the Juno Stage. This period is characterized by xeric conditions as evidenced by pollen from Bonfire Shelter and Devil's Mouth Site, the beginning of a general drying trend that continued into historic times. This general drying trend would have been taking

place during the time of Late Archaic occupations at the Varga Site.

At Hall's Cave in adjacent Kerr County, Toomey (1993) saw evidence for moister conditions at about 2,000 B.P. in the presence of the woodland mole (*Microtus pinetorum*). It is not clear if the slight timing differences for the moist conditions are a function of our imprecise dating of events or if more than one moist period is represented.

At Fort Hood in Central Texas, Nordt (1992, 1993) indicates the deposition of the upper West Range alluvium began as early as 2,800 B.P. and ending sometime between 800 and 600 B.P. He documents a mixed assemblage of C₃ and C₄ plant biomass as indicated by carbon isotope values from sediments during a period from about 2,000 to 2,400 B.P., and sees this mixed assemblage as evidence for a slight drying and warming trend.

Johnson and Goode (1994) also see posit change during the Late Archaic period. Before about 2,500 B.P., the eastern Edwards Plateau was thought to have been dryer than present, a period which Johnson and Goode refer to the "Dry Edwards Interval." After 2,500 B.P. and continuing to about 1,000 B.P., the region was slightly moister.

The possible corn phytolith in the Varga assemblage is highly unusual, and the fact that it was isolated in one buried sample at 33 cmbs from Late Archaic context provides some confidence that it does not reflect modern activities. This author believes that this lobate-shaped phytolith is not restricted to corn (see Rovner 2004). Although Turpin's (1991, 1995) discussions of the Blue Hills period in the Lower Pecos are brief, surely she would have mentioned corn if some had been associated with any components of this Late Archaic period. No corn or corn pollen was evidenced in the 43 coprolites analyzed from this period from

Conejo Shelter (Bryant 1974). However, carbon isotope data from four sets of human skeletal remains from this same Conejo Shelter indicate a diet rich in C₄/CAM plants (Huebner 1991a) of which corn is a C₄ plant. The CAM plants, such as prickly pear and *agave lechuguilla*, have been interpreted as major contributors to this more positive carbon isotope signature, based partially on the finding in the coprolites.

Similarly, Collins (1995) does not indicate that corn was part of the subsistence in the Late Archaic period across Central Texas. In fact, corn is extremely limited in Central Texas even in the Late Prehistoric period with only a couple of small cobs ever recovered from archeological context in rockshelters. The scant corn cobs at Kyle Site (Jelks 1962) and Timmeron Rockshelter (Harris 1985) are thought to reflect trade with Caddo groups to the northeast during the late Toyah period, sometime during the last 500 years or so.

Corn has been identified and directly dated in far west Texas, in the El Paso area at around 3,000 B.P. (Upham et al. 1987; Upham and MacNeish 1993; Tagg 1996), similar in age to corn kernels from the Cerro Juanaquena Site in Chihuahua, Mexico that have yielded multiple radiocarbon ages of ca. 3,000 B.P. (Hard and Roney 1998; Hard et al. 1999). These examples indicate that corn is possible during the Late Archaic, but known samples are from considerably west and south of the Varga Site. Exactly what the lobate-shaped phytolith reflects is not clear. The two phytoliths are the only line of evidence for corn. Extensive floating of matrix samples and identifications of the recovered materials revealed no support for the presence of corn in or around Feature 1, in any other Late Archaic context, or even in the later, overlying Toyah component.

9.10.7 Late Archaic Discussion

The absence of Shumla type points at the Varga Site, which dominate the Lower Pecos region at this time, may indicate that the groups that employed the Shumla point type did not venture into northeastern Edwards County. This point type is not well dated, but appears to have occurred in a range from 2,000 to 2,800 B.P. and overlapping with immediately earlier and later periods (Turpin 1991, 1995). Most Lower Pecos sites that are dated and associated with these point types represent occupations a few hundred years earlier than the documented age of Feature 1 at the Varga Site.

In terms of the surviving material-culture record, the Late Archaic groups that occupied the Varga Site area were more similar to the Central Texas region. Supporting this are the Montell, Castroville, and Marcos points from the Varga Site. Although, these point types have also been found in the Lower Pecos region, often in association with bison bones, bison hunting in the area is generally attributed to intrusive hunting populations (Turpin 1991). Although the compressed natural and cultural stratigraphy in the Varga Site Late Archaic deposits prevents any specific clues to address the association between identified point types in Feature 1, the current interpretation is that these different point types were directly associated with this burned rock oven. Assuming the points from the Varga Site to have been associated with Feature 1, these point types can be linked to people who were collecting and processing plant foods, implying that they were not predominantly bison hunters, as various authors have suggested. In support of plant processing, near Rice's Crossing (41WM815) far to the east in the Blackland Prairie of Williamson County, two Montell, two Castroville, and two Lange points were recovered from a 2-m-diameter circular stone-lined pit thought to represent an earthen oven. This feature (Feature 9) was radiocarbon

dated to a 290-year period between 2,240 and 2,530 B.P. (Brownlow 2003). In contrast, at 41TG91 north of here near San Angelo, Marcos points were associated with three radiocarbon ages falling between 2,480 and 2,910 B.P. (Creel 1990). This is just one indication that these Late Archaic groups exploited more than one food resource, and other localities that represent focus on a variety of resources are found across the broader region.

The most frequent point type associated with the Varga Site Late Archaic component is the Frio point, a type found throughout most of Central Texas and in the Lower Pecos region. The radiocarbon dates from the Varga Site correspond well with dated components that contained this same point type elsewhere and the Blue Hills period defined for the Lower Pecos region (Turpin 1991). At Arenosa Shelter the Frio and Marcos point types were in the same Stratum 9, lower part of Cut 3 (Dibble 1967).

In summary, the Late Archaic component was contained primarily in a buried A horizon, immediately below the younger Toyah component. Eleven acceptable radiocarbon dates document a 600-year use period between 1,700 and 2,310 B.P. The Late Archaic component in Block A was comprised mostly of a nearly 6 m-diameter poorly defined burned rock oven with a shallow central basin. A relatively limited cultural assemblage (ca. 6,000 pieces) was recovered, with burned rocks accounting for nearly 67 percent of the material recovered. Four small, amorphous rock clusters/concentrations were identified within the large burned rock oven boundaries. Lithic debitage was not abundant, and formal stone tools are few. Six different point types (Frio, Castroville, Marcos, Montell, Ensor, and Edgewood) were scattered just east of the estimated center of, and apparently associated with, the oven. The Late Archaic tool assemblage supports animal procurement and

processing activities. The high frequency of core reduction flakes, angular debris, early and late stage biface flakes indicate that after chert cobbles were procured, they were reduced to produce tools for plant and animal procurement/processing.

The investigated part of the Late Archaic component functioned primarily as a cooking area. The burned rock oven reflects the preparation of bulk foods that required lengthy cooking. Limited macrobotanical remains in the forms of four burned prickly pear seeds, a burned mesquite seed, burned walnut shell fragments, and seven burned agave leaf fragments provide some hints of what was cooked in this oven. Indirect evidence in the

form the lipid residues extracted from the burned rocks reflect the cooking of high-fat-content plants.

The horizontal distribution of debris indicates that while the oven was in use, general retooling activities were conducted along the eastern margins. No direct evidence of trade/exchange was identified. Macroscopic observations of the lithic debitage and INAA on selected stone tools indicate that locally available Edwards chert was procured for tool production. The current data points to small, mobile group(s) with a relatively limited home range occupying this local for a short period while carrying out limited hunting and conducting plant procurement and cooking activities.

10.0 MIDDLE ARCHAIC COMPONENT

J. Michael Quigg

10.1 INTRODUCTION

The Middle Archaic component was initially identified during the Phase I investigations from deposits on both sides of the Ranch to Market Road by discoveries of a Pedernales point, a Carrizo point, and two Early Triangular points. Sparse cultural materials including scattered burned rocks, lithic debitage, and the occasional stone tool were found in the upper part of Depositional Unit 3, a brown (10YR 5/3) clay loam, between the Late Archaic burned rock Feature 1, and the dense Early Archaic materials at the base of Unit 3. In the initial interim report, these cultural materials were considered too sparse to be considered to represent a distinct zone of occupation, with the result that this zone was not specifically targeted for Phase II investigations (Lintz et al. 2002).

The Phase II investigations yielded a relatively small sample of Middle Archaic materials from Block A, whereas Block B targeted only the Late Prehistoric deposits. The thickest Middle Archaic deposit, between ca. 40 and 80 cmbd, was along the southern edge of Block A. This deposit rapidly thinned to about 20 cm thick, between ca. 10 and 30 cmbs, towards the northern end of Block A. At this compressed northern end, the wedge-shaped Middle Archaic deposit was subjected to more disturbances and mixing with earlier and later materials.

The chronometric age of the Middle Archaic component was established by intensive dating of the cultural components immediately above and below, and through four radiocarbon dates derived from materials extracted from this component. The bracketing ages from the other components provide a time range in which these Middle Archaic events should have occurred. The overlying Late Archaic component is closely dated to less than ca. 2,300 B.P., whereas the lower Early Archaic component is dated to older than ca. 5,200 B.P. These radiocarbon ages provide a ca. 3,000-year temporal interval for the Middle Archaic materials.

Four radiocarbon assays narrow the potential 3,000-year window down to about a 900-year period that better defines the time range of the Middle Archaic component (Table 10-1). Tiny flecks of charcoal from burned rock cluster Feature 37, between 78 to 80 cmbd in Unit N99/E53, yielded an AMS date of $4,260 \pm 40$ B.P. (UGA-12705). Another charcoal chunk from 50 to 60 cmbd, in Unit N104/E56, yielded an AMS date of $4,770 \pm 40$ B.P. (UGA-12717). These two wood charcoal dates provide the best evidence for the chronological placement of the Middle Archaic component at the site. A date on deer bone fragment collagen (#522-7-2-1a), from 50 to 60 cmbd in Unit N106/E53, yielded an age of $3,910 \pm 40$ B.P. (UGA-12719) and accords in a general way with the wood charcoal dates. The dating also provides direct evidence that the bones recovered from this component actually date to this period and were not displaced from other components. The fourth radiocarbon date of $4,820 \pm 40$ B.P. (Beta-175393) was derived from organic sediment at 80 to 85 cmbs in BT 7 on the east side of the road. This latter assay represents a mean resident time and provides further support for the general age of the alluvial fines from which the Middle Archaic materials were recovered.

Table 10-1. Varga Site Radiocarbon Dates from the Middle Archaic Component

Fea. No.	Catalogue #	Blk.	Unit No.	Depth (cm)	Material	Wgt (g)	Lab. No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
na	522-7-2-1a	A	N106/E53	50-60	1/2 deer bone	11.5	UGA-12719	3,850 ± 40	-21.2	3,910 ± 40	Cal 249 to 2230 BC
37	37-5-4-7-1a	A	N99/E53	78-80	16 charcoal	0.1	UGA-12705	4,230 ± 40	-23.4	4,260 ± 40	Cal 3010 to 2690 BC
na	418-7-1a	A	N104/E56	50-60	1 charcoal	0.1	UGA-12717	4,740 ± 40	-23.3	4,770 ± 40	Cal 3650 to 3380 BC
na	1210-4-A	B	BT 7	80-85	Sediment Bk2	200.0	Beta-175393	4,790 ± 70	-23.0	4,820 ± 70	Cal 3710 to 3380 BC

Beta = Beta Analytic, Blk. = Block, Cal. = Calibrated, Con. = Conventional, Fea. = Feature, UGA = University of Georgia, Wgt = Weight

Based on the two wood charcoal dates, these four assays document a probable 900-year period for the Middle Archaic component that is perhaps more restricted to a 600-year period between about 4,200 and 4,800 B.P.

The 83-m² hand-excavations in Block A yielded 6,079 cultural materials attributed to the Middle Archaic that include 4,387 pieces of lithic debitage, 810 pieces of burned rocks, 725 bone fragments, 2.5 g of organic remains, 122 edge-modified flakes, 11 bifaces, 10 projectile points, eight cores, three scrapers, one hammerstone/anvil, and two features. Each category of material is presented and discussed below.

10.2 MIDDLE ARCHAIC FEATURES

10.2.1 Introduction

Only two clusters of burned rocks, Features 11 and 37 were recognized and assigned feature numbers in the field. These were subsequently assigned to this component. Both features were discovered in Block A.

10.2.2 Feature 11

Feature 11 consisted of relatively large limestone burned rocks in a loose cluster near the intersection of four units, N106/E51, N106/E52, N107/E51, and N107/E52, near the middle of the northern half of Block A. Stratigraphically, this cluster was situated in relatively shallow and compressed sediments with vertically scattered materials, making identification and component assignment difficult. These burned rocks were clustered in an area that measured about 80-by-70 cm in diameter with the tops of the rocks at 32 cmbs and the bottoms near 52 cmbs. The burned rocks were located primarily in two clusters with a few rocks scattered in between (Figures 10-1 and 10-2). Since no obvious color change in the matrix was observed or other boundary was

detected, no specific horizontal pattern was distinguished. No basin was detected below the rocks. During excavation, no oxidized sediment, ash or charcoal lenses, and no visible chunks of charcoal were observed around the burned rocks.

Ten liters of matrix (#515-5-4) from around the burned rocks were collected and floated. The floated material yielded a few tiny charcoal pieces, of which five were dated. These five pieces (#515-5-4-7-1) yielded a $\delta^{13}\text{C}$ corrected (-25.7‰) AMS radiocarbon date of $1,990 \pm 40$ B.P. (Table 10-1: UGA-12718). These pieces were too small to identify the type of wood. The dated charcoal falls in the time period documented as the Late Archaic component at the Varga Site. Apparently, these tiny pieces filtered downward from the overlying Late Archaic component and became trapped between the burned rocks. This cluster of burned rock is stratigraphically within the Middle Archaic deposit, and therefore older than the date obtained on the charcoal. Consequently, for identifying the age of this Middle Archaic burned rock feature, the charcoal radiocarbon date is rejected.

The 0.2 liters of light fraction failed to yield any other charred macrobotanical remains (Appendix I). The heavy fraction yielded 45 pieces of chert, three tiny flecks of charcoal, and three tiny bone fragments. One of the burned pieces is a thick nutshell like walnut. The 6.4 mm size fraction yielded three tiny burned rocks, 10 chert pieces, and nine nearly whole snail shells (*Polygyridae* and/or *Helicinidae*).

Four more liters of matrix (#583-5-4 and #507-5-4) were collected from the junction of two units and were also floated. The 6.4 mm size fraction yielded six burned rock fragments that weigh 35.3 g, five pieces of chert, and five nearly whole snail shells (*Polygyridae* and/or *Helicinidae*).

Figure 10-1. Planview of Profile of Feature 11, Middle Archaic

Figure 10-2. Overview of Excavated Feature 11 Showing Burned Rock Associations

Approximately 40 burned rocks were collected from this feature and they represent tabular slabs, rounded cobbles, and amorphous chunks of limestone. Fifty-five percent of the collected burned rocks from Feature 11 were in the 9.1 to 15 cm size class; whereas 18 percent were in the smallest size class between 0 and 4 cm (Table 10-2). The average burned rock weight was nearly 568 g. Seven burned rocks are considered complete with rounded edges implying they were retrieved from the riverbed. Attempts at refitting the broken pieces resulted in piecing together four separate cobbles, two with three pieces each that recreated rounded cobbles, and two refits with two pieces each that were tabular slabs. A few rocks exhibited heat-spalled edges, whereas others exhibited sharp angular or hackled edges. Generally, these two different break types are not thought to reflect the same type of use. Generally, spalled edges are most often thought to be caused by exposure to heat and/or slow cooling. The sharp angular or hackled edges are more often attributed to rapid cooling, as in a stone boiling process.

A sample of five burned rock pieces from five adjacent proveniences was analyzed for lipid

residue. Drs. Malainey and Malisza's detail findings and interpretations are presented in Appendix G, with a summary presented here (Table 10-3). Two samples (#583-5-3-1a, and #276-5-3-2a) yielded high fat content interpreted as representing plant materials. Residues from sample #276-5-3-1a yielded moderate to high fat content. Sample #515-5-3-1a yielded very high fat content, also representing plant matter. Only slight variation is seen in the lipid residue interpretations, and this implies that the rocks were used to cook similar or the same foods, possibly during a single cooking episode.

The same burned rocks analyzed for lipid residues were also analyzed for isotope values. The stable carbon isotope values range from -22.9 to -26.3‰ with a mean of -24.7‰ (Table 10-4). These values indicate that there is mostly C₃ matter in the burned rocks. The nitrogen values range from 6.6 to 8.0‰, with a value of 2.4‰ derived from sample #583-5-3-1b, is questioned because of the extremely low measured weight. Nothing in the nitrogen values indicate the cooking of legumes or nuts.

Table 10-2. Burned Rock Characteristics of Features 11 and 37

Fea. No.	Unit No.	Depth (cm)	Cat. #	Size (cm) and Weight (g)							Material Type ¹				Fracture Type ²			Total Count	Total Wgt. (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	Wgt	LS	SS	Qtz	O	Ang.	Rnd.		
11	N106/E52	40-50	514	0	0	10	2,000	8	6,000	0	0	18			5	4	9	18	8,000
11	N106/E52	50-60	515	3	1,000	1	200	1	1,000	0	0	3			0	0	3	5	2,200
11	N107/E51	30-40	575	0	0	0	0	3	4,500	0	0	3			2	0	1	3	4,500
11	N107/E51	45-53	576	0	0	0	0	4	3,000	0	0	4			1	1	2	4	3,000
11	N107/E52	30-40	582	4	500													4	500
11	N107/E52	40-50	583					6	4,500			6						6	4,500
	Total			7	1,500	11	2,200	22	14,500	0	0	34	0	0	8	5	15	40	22,700
37	N99/E53	70-80	37	5	250	23	7,500	0	0	0	0	7						28	7,750
	Total			5	250	23	7,500	0	0	0	0	7	0	0	0	0	0	28	7,750

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other

2. Ang. = angular, Rnd. = round, Tab. = tabular

Table 10-3. Lipid Residue Results from Burned Rock Samples from the Middle Archaic Component

Lab. No.	Cat. #	Fea. No.	Material	Wgt. (g)	Interpreted Lipid Residue Results
4VG 72	276-5-3-1a	11	Limestone	17	Moderate-high fat content
4VG 76	276-5-3-2a	11	Limestone	61	High fat content – plant
4VG 73	515-5-3-1a	11	Limestone	29	Very high fat content – plant
4VG 74	575-5-3-1a	11	Limestone	20	Borderline medium and moderate-high fat content – plant
4VG 75	583-5-3-1a	11	Limestone	27	High fat content – plant
4VG 77	37-5-3-1a	37	Limestone	25	Moderate-high fat content
4VG 78	37-5-3-2a	37	Limestone	38	High fat content – plant
4VG 79	37-5-3-3a	37	Limestone	32	High fat content – plant
4VG 80	37-5-3-4a	37	Limestone	21	Moderate-high fat content

Table 10-4. Isotope Results from Burned Rocks in Middle Archaic Features

Cat. #	Unit No.	Depth (cmbs)	Fea. No.	Wgt (mg)	N Wgt μg^1	$\delta^{15}\text{N}$ (‰) Value	C Wgt μg	$\delta^{13}\text{C}$ (‰) Value
583-5-3-1b	N107/E52	40-50	11	3.708	9.2	2.36	137.2	-25.54
276-5-3-1b	N102/E50	60-70	11	20.335	107.9	6.59	1865.7	-26.28
276-5-3-2b	N102/E50	60-70	11	20.327	99.5	7.36	1408.5	-24.84
515-5-3-1b	N106/E52	50-60	11	20.101	170.3	6.85	2063.4	-24.05
575-5-3-1b	N107/E51	30-40	11	30.066	146.6	7.98	1747.2	-22.88
37-5-3-4b	N99/E53	70-80	37	22.228	40.9	8.35	655.7	-24.10
37-5-3-1b	N99/E53	70-80	37	30.417	130.6	2.95	1630.9	-24.81
37-5-3-2b	N99/E53	70-80	37	10.522	120.4	-0.24	1470.3	-26.67
37-5-3-3b	N99/E53	70-80	37	17.881	106.2	1.24	1921.3	-25.53

1. Values below 10.0 make the results suspect
2. C = Carbon; N = Nitrogen

The generally high nitrogen values combined with the very negative carbon isotope values indicate cooking C_3 plants or animals that ate C_3 plants. These isotope results combined with the lipid interpretations indicate that C_3 plants comprised the cooked food resources.

Surrounding this cluster of burned rocks were other cultural materials such as lithic debitage ($n=67$), small bone scraps ($n=13$), and tiny charcoal flecks. No formal stone tools were recovered from the four relevant units, but five edge-modified flakes were located in the southwest quadrant, and three edge-modified flakes were located in the northeast quadrant.

This burned rock cluster probably represents a disturbed hearth, as indicated by the few complete burned rocks, the presence of multiple pieces of the same rock, and the large size of the rocks represented. The lack of a definable basin (except for the variation in rock depths), the lack of patterning to the rocks, and other hearth characteristics might occasion some skepticism, however. The radiocarbon date on the obtained charcoal indicates the charcoal is Late Archaic in age and was displaced into this context. As mentioned earlier, this date is not acceptable for the true age of Feature 11, and it is in fact quite similar to the ages obtained from Feature 1 above and slightly to the south. As already noted, the stratigraphic position of the burned rocks was sufficiently deep to be vertically and stratigraphically associated with the Middle Archaic component, with cultural materials immediately below this assigned to the Early Archaic component.

In summary, Feature 11 is interpreted as a disturbed hearth based on the probable presence of a possible basin below the rock combined with the relatively large size of the individual rocks. The burned rocks were used to cook mostly high fat content, C_3 plant foods. It is not

clear whether or not this feature actually represents some type of oven.

10.2.3 Feature 37

Feature 37, a small burned rock cluster, was discovered in Unit N99/E53 at the very southern edge of Block A. At 70 and 80 cmbd, it was sufficiently deep to have escaped any disturbances from modern activities and is vertically correlated with other Middle Archaic materials. The burned rocks were in an irregular east-west linear alignment that measured about 55 cm long by 25 cm wide (Figure 10-3). The dark brown (10YR 4/3) clay loam matrix that surrounded the burned rocks was similar to that in the rest of the level. Other cultural materials such as stone tools, lithic debris, or bones were nearly absent from among the clustered rocks, although a few flakes and scattered burned rocks were located at this same level outside the feature. No basin or vertical-dimension pattern to the burned rocks was observed. The burned rocks were in a single layer with only slightly variable depths.

Figure 10-3. Planview of Feature 37, in Middle Archaic

Feature 37 contained 28 burned limestone pieces with 82 percent in the 4.1 to 9.0 cm size class (Table 10-2). These limestone pieces had an average rock weight of 277 g. Although not specifically recorded in the field, the small sample of collected burned rocks was seen to represent both rounded cobbles and tabular slabs.

A sample of four burned rock pieces was analyzed for lipid residue. The detailed findings and interpretations are presented in Appendix G, and only a summary is presented here. Two samples (#37-5-3-1a and #37-5-3-4a) yielded moderate to high fat content (Table 10-3). Two other samples (#37-5-3-2a and #37-5-3-3a) yielded high fat content implying the chemical residues of plants. These results indicate that the rocks probably contain two slightly different kinds of residue, implying possible use in multiple cooking events.

Stable carbon isotope values from the four rocks range from -24.1 to -26.7‰, with a mean of -25.3‰ (Table 10-4). These values indicate a very strong C₃ signal in the diet of animals, or alternatively, they represent C₃ plants (Appendix H). The nitrogen isotope values range from -0.3 to 8.4‰, a very large range. The combined isotope values suggest a legume plant, but there is no indication of the species. The -0.3‰ value is in the range of plant matter such as buckeye seeds, oak nuts, Mexican plums, and huisache seeds. The highest nitrogen value of 8.4‰ generally reflects something similar to rabbit or deer meat. The other three nitrogen isotope values generally reflect plants. The range in isotope values is supportive of multiple items cooked by these burned rocks, mostly in the form of various plants.

Five liters of floated matrix (#37-5-4-1), collected from around and below the burned rocks at 70 to 80 cmbd, yielded extremely limited charcoal flecks. Not even the light

fraction (less than 0.1 liters) yielded identifiable carbonized plant remains (Appendix I). The heavy fraction yielded 32 tiny pieces of chert, one nearly whole snail shell, three unburned seed-like specimens, and two tiny unburned bone fragments. The 6.4 mm size fraction yielded one chert flake, and 12 nearly whole snail shells.

Sixteen tiny pieces of charcoal (#37-5-4-7-1a) from 78 to 80 cmbd in Feature 37 were sent for radiocarbon dating. This sample yielded a conventional radiocarbon age of 4,260 ± 40 B.P. (UGA-12705). Feature 37 was stratigraphically level with or slightly below elevations that yielded Early Triangular points (#182-13 and #308-11) and other types of cultural debris just a few meters north and northwest of Feature 37. It is assumed that this wood charcoal date is reflective of an occupational event that left behind the Early Triangular points.

In summary, Feature 37 is interpreted as a burned rock dump or discard pile from a separate primary cooking feature. The overall elongated shape of this cluster combined with the lack of a basin or other evidence for *in situ* burning supports this interpretation. The burned rocks were used to cook mostly C₃ plant foods.

10.3 STONE TOOL DESCRIPTIONS AND DISCUSSIONS

The 155 stone tools are presented by classes, with summaries of attributes and metric measurements in tables in Appendix O. The exception is the category of edge-modified pieces, for which only select number of specimens have been recorded in detail. The projectile point class is subdivided into identifiable point types, as well as containing detailed descriptions. Tool classes are generally thought to represent specific activities, but several individual specimens from the different tool classes were arbitrarily selected for use-wear analyses to investigate specific functions.

Individual use-wear findings are presented following each class summary. Beginning with the identifiable types of projectile points each tool type is described below.

10.3.1 Projectile Points

The 10 projectiles from the Middle Archaic component fall into two groups. Four are untypable because they are small fragments that lack diagnostic characteristics, and six are identified as Early Triangular points (Figure 10-4). All specimens were manufactured of fine-grained chert and lack cortex (Appendix O). Three other Early Triangular points were

recovered from non-Middle-Archaic-contexts. Specimen #138-12 was from a mixed or otherwise unclear context, and specimens #278-27 and #729-10 were from the top part of the Early Archaic component. The attributes for these three points are combined with the six Early Triangular points from the Middle Archaic component to provide a more comprehensive summary of this point type. Only one is complete, whereas the remainder were probably broken during use. Two specimens exhibit some edge beveling. One specimen is burned, and one is heat-treated. Most have essentially straight lateral edges, although a few edges are excurve.

Figure 10-4. Selected Middle Archaic Projectile Points

Left to Right: Top Row: #1140-010, #537-017, #308-011, #182-013;
Second Row: #922-010, #278-027, #654-010, #138-012

A few metric attributes from the Early Triangular points are worth summarizing (individual metric and non-metric characteristics are presented in Appendix O). Maximum thickness ranges from 4.9 to 6.5 mm, with a mean of 5.6 mm and a standard deviation of 0.6 mm. The maximum width ranges from 28.3 to 38.3 mm, with a mean of 33.3 mm and a standard deviation of 3.7 mm. Maximum length measurements range from 31.0 to 52.9 mm, with a mean of 38.4 mm and a standard deviation of 12.6 mm. Blade width ranges from 28.3 to 38.3 mm, with a mean of 33.3 mm and a standard deviation of 4.2 mm.

Four Early Triangular points were subjected to use-wear analyses, briefly described below (with more details presented in Appendix C). Complete specimen #182-13 lacks any sign of resharpening and exhibits one straight and one excurvate edge. It reveals hair fragments that are associated with use together with light polish at either end. The inferred use is unknown, and hide was the probable contact material. A proximal specimen (#308-11) that exhibits a use break reveals abraded ridges that show haft wear, and a hard, high-silica polish and edge damage in the form of step fractures. These characteristics indicate use was probably gouging on hard, high-silica material. A second proximal piece (#537-17) with a use break reveals striation in multiple directions from hard, high-silica material. The inferred use was cutting of some hard, high-silica material. Specimen #729-10 is the proximal section of a heat-treated point that apparently broke during use and exhibits parallel flaking with no sign of rejuvenation or resharpening. Hafting wear is present, along with high-silica polish on the proximal end. Use-wear is evident by high-silica polish indicating a whittling motion on a hard, high silica material.

A piece from the proximal end of #537-17 (TRC122) was subjected to INAA to detect the

origin of the chert. That analysis revealed a chemical signature similar to known Edwards chert that was probably locally procured (see Appendix F). One specimen (#654-10) is a dark gray color that has been through intensive heat and exhibits heat spalls. This piece reveals an ultraviolet fluorescence that is a darker (more purple) color than the amber-orange-yellow expected for most Edwards chert (Hofman et al. 1991). This color is potentially associated with cherts that originate from along the Rio Grande River Valley (Quigg and Cordova 2000; Quigg et al. 2000).

At least one untypable fragment (#225-11) reveals a distal blade that is thicker than the other Early Triangular points and probably represents some other point type. The distal part of a Carrizo point (#213-12) was subsequently refitted to a Carrizo base. However, the diagnostic basal portion was recovered from a level assigned to the Early Archaic component. Unknown distal dart point #225-11 was the only heat-treated piece. Specimen #675-10 appears to be a wide barb from a notched point and again represents a type other than an Early Triangular point. Its small size would easily permit vertical displacement from another component.

The six Early Triangular points that dominate the Middle Archaic projectile point assemblage from this component, and presumably the three Early Triangular projectile points from other contexts, correspond well with the radiocarbon dates obtained from this Middle Archaic component (Table 10-1). Two other slightly deeper Early Triangular points (#138-12 and #278-27) were recovered in the southern part of Block A. Specimen #138-12 was recovered from 80 to 90 cmbd in Unit N100/E55 in a level that could not be confidently assigned to the Middle Archaic, but was near the bottom of the Middle or the very top of the Early Archaic component. This depth is comparable to the Middle Archaic zone even though this level

could not be assigned with accuracy. The second specimen (#278-27) was also located at 80 to 90 cmbd in Unit N102/E50 in a level that was assigned to the Early Archaic component. It too was at approximately the same depth, though assigned to the Early Archaic component. This specimen may have been downwardly displaced, or it was in a mixed context that was arbitrarily assigned to the Early Archaic. The eight Early Triangular points are of sufficient number to indicate they represent human presence at the Varga Site during the Middle Archaic, rather than curated items. Also significant is the fact that they are the dominant point type recovered from this Middle Archaic component. Therefore, these eight, possibly nine, Early Triangular points are probably chronologically associated with at least one of the radiocarbon dates that document a 900-year period, between 3,910 B.P. (UGA-12719) and 4,820 B.P. (Beta-175393).

10.3.2 Bifaces

The 11 bifaces were all manufactured from fine-grained chert with only a small spot of cortex on one early stage specimens (Appendix O). Only three specimens are complete and proximal and distal fragments are roughly equally represented (Figure 10-5). Sixty percent represent late stages, 30 percent represent middle stages, and 10 percent represent early stage bifaces. The early and middle stage pieces are complete, whereas the late stage pieces revealed mostly use breaks. One middle stage biface was apparently heat-treated. The three complete specimens average 70 mm long, 51.3 mm wide, and 16.2 mm thick. The late stage bifaces are much thinner, averaging 8.8 mm thick. Most fragments provide at least some metric data.

Two bifaces, one fragmentary late stage specimen and one complete middle stage piece, were sent for use-wear analysis. Specimen #418-28 is a late stage biface fragment with a

use break that lacks any sign of resharpening or rejuvenation. It reveals polish and striation in multiple directions that indicate cutting in various directions on hard material (Appendix C). A complete, middle stage biface (#419-12) that is 14.2 mm thick appears heat-treated and shows no obvious indication of resharpening. It reveals wood fragments that are probably from use, and hard, high silica polish and striations perpendicular and parallel to the long axis. These attributes are interpreted as representing planing of wood (Appendix C).

Five bifaces (#149-10 = TRC110, #417-13 = TRC115, #418-28 = TRC116, #419-12 = TRC117, and #544-12 = TRC123) were sampled for sourcing through INAA. The chemical signatures were similar to known Edwards chert and these specimens probably originated from local sources in the region, but are apparently from different source localities (Appendix F). Two bifaces, a late-stage piece broken during use (#418-28 = TRC116), and a complete middle-stage piece (#419-12 = TRC117) have chemical signatures that are similar to those from natural chert samples collected from Hackberry Creek immediately adjacent to the Varga Site. It is possible the raw material for at least these two bifaces was derived from the local creek gravels.

10.3.3 Scrapers

Only three scrapers were recognized, and two are fragments that appear to have been broken during use (Figure 10-6). All three were manufactured from fine-grained cherts. Metric and non-metric attributes are provided in Appendix O. Specimen #1124-10 is a fragment of a side-scraper that was heat-treated. The working edge is very steep at 82 degrees.

Figure 10-5. Selected Middle Archaic Bifaces

Left to Right: Top Row: #410-010 Joins to #428-010, #213-010, #287-010, #545-010;
Second Row: #727-010, #417-013, #149-010

Figure 10-6. Selected Middle Archaic Scrapers

Left to Right: #100-011, #318-014, and #124-010

Specimen #100-11 is complete and nearly round in outline with a continuous working edge that curves around to the sides, with three working bits. One lateral and the distal end have steeply angled working edges. This piece still retains cortex on over 50 percent of the dorsal surface. It has also been exposed to intensive heating as it exhibits heat spalls and cracks.

Specimen #100-11 was sent for use-wear analysis and reveals a hair on the ventral surface together with striations that are parallel and perpendicular to the working edge. This piece is interpreted as a planing tool used on hide (Appendix C). Part of this burned scraper was sent for INAA. The chemical signature (TRC109) is similar to known Edwards chert, but is beyond the range of the known natural sources from the southwestern region of the outcrop (Appendix F). However, it does exhibit an ultraviolet fluorescence (UV) that is similar to other Edwards chert. Therefore, it is probably Edwards chert, but not from any currently known source areas.

10.3.4 Edge-Modified Flakes

The 122 edge-modified flakes include two rejuvenation flakes (#83-10 and #182-11) and one graver (#56-11). Nine specimens were selected for use-wear analysis to investigate the range of activities that are represented. Each tool is briefly discussed here, with more specific use-wear information provided in Appendix C. The graver (#56-11) reveals wood fragments from use and hard polish, and striations parallel and perpendicular to the working edge. These characteristics indicate whittling of wood. Specimen #274-5-10 is a complete flake, irregular in shape with continuous tiny flake scars along a straight lateral edge that is rounded. The opposite edge is convex with a few tiny scars on the dorsal surface. Hard, high-silica polish is present and indicates cutting of hard, high-silica material. Specimen #387-10 is

a complete irregularly shaped piece with regular continuous scars along one straight lateral edge. It exhibits plant fibers as use residue and hard, high-silica polish and striations parallel and perpendicular to the working edge. It is interpreted as a planing tool used on hard, high-silica material. Specimen #397-13 is a complete irregularly shaped piece with regular continuous flake scars along a recurvate lateral edge. It exhibits polish and striations in multiple directions that indicate scraping of hard high-silica material. Specimen #409-11 is a complete irregular shaped piece with regular continuous flake scars along three edges. It retains plant fragments, and shows striations parallel and perpendicular to the working edges indicating the whittling of plants. Specimen #417-10 is a complete, has a quadrilateral shape, and is made from the only coarse-grained material in the assemblage. It exhibits two straight lateral edges, one with regular continuous flake scars, and one with irregular continuous flake scars. It exhibits polish that indicates whittling of hard, high-silica material. Specimen #484-16 is a complete irregularly shaped piece with continuous flake scars along a straight lateral edge that is slightly rounded. It exhibits wood fragments and striations parallel and perpendicular to the working edges implying planing of wood. Specimen #484-17 is a complete irregularly shaped piece with regular continuous flake scars along a straight lateral/proximal edge that is slightly rounded. It exhibits plant fragments and polish with striations implying slicing of hard, high-silica material. Specimen #662-10 is a complete ovate piece with two worked lateral edges; one is straight with irregular continuous flake scars, whereas the other is incurvate with regular and continuous flake scars. It exhibits soft use-wear indicating scraping on a soft material.

Eight edge-modified flakes were also sent for INAA. All eight pieces revealed chemical

signatures that are in line with known Edwards chert from the southwestern region of the Edwards distribution (Appendix F). One specimen (#649-11 = TRC124) is unlike most Edwards chert in having a matte gray color that did, however, yield a chemical signature similar to Edwards chert. The broken edge fluoresced under UV light, as does Edwards chert.

10.3.5 Hammerstone

One combination hammer-anvil stone (#514-10) was recovered. This is a complete, somewhat rounded cobble that was recovered from Unit N106/E52 between 40 and 50 cmbd. It measures 92.7 mm long, 88.3 mm wide, 59.8 mm thick, and weighs 592.7 g. The entire cobble was naturally pitted with a relatively rough surface creating positive identification of tool-use areas difficult. The more pointed end exhibits more pronounced pitting than adjacent areas. One face exhibits a central, oval pit that measures about 17 by 19 mm and is about 2 mm deep and surrounded by eroded or worked areas. This is a multi-purpose tool that was used as both a hammer and an anvil.

10.3.6 Cores

Eight cores were recovered from this component. Nearly 87 percent are complete, and one of these appears to have been exhausted. Six are multi-directional, and one each are bifacial and unifacial. All are of fine-grained chert with five specimens exhibiting some cortex that is smooth and water rounded. None appear to have been heat-treated. Two exhibit patination on less than 25 percent the surface. The complete cores range in length from 63.2 to 123.2 mm, with an average of 93.2 mm. The widths range from 52.7 to 91.9 mm, with an average of 71.6 mm. The thickness ranges from 36.1 to 68.5 mm, with an average of 45.8 mm.

The eight cores seemingly were distributed non-randomly. Two excavation units on the western

side of BT 1 yielded three cores, whereas three units in a line near the southern boundary each yielded a single core. Two adjacent units 1 m southeast of the end of BT 2 each yielded a single core. This apparent clustering of cores may indicate specific activity areas for core reduction and/or discard.

10.4 DEBITAGE

10.4.1 Unmodified Debitage

A total of 4,387 pieces of lithic debitage, representing 74 percent of all cultural materials recovered from this component, were recovered. Roughly 13 percent of this debitage class from Block A was analyzed to determine which stages of raw material reduction and tool production, manufacturing, and maintenance are represented. The selected sample was derived from nine different units across the southern half of the block where the Middle Archaic context is most confidently defined.

All categories are represented; however, a single specimen represents the blade category. Low frequencies of core flakes (11.6 percent), early stage biface flakes (12.2 percent), and indeterminate pieces (11.1 percent) are represented. Angular debris is moderately represented (18.7 percent). A high frequency is represented in the late stage biface flakes (25 percent) and the tertiary and thinning flakes (21.3 percent). About 80 percent of the sample reveals unintentional heat alteration through spalling and crazing. Intense heat generated in the Late Archaic hot-rock cooking feature immediately above this component may be the cause of this high percentage.

The data of flake types, just summarized, suggests that significant effort was directed towards biface production to the finished stages. Cores were reduced, probably in the process of producing flakes and initial stage of biface shaping. The relatively high frequency of

tertiary and biface-thinning flakes supports the finishing of bifaces and/or the resharpening of other tools.

10.4.2 Middle Archaic Rejuvenation Flakes

This assemblage includes only two pieces (#83-10 and #182-11) that were classified as rejuvenation flakes. Both were recovered from the southern end of Block A and were associated with other lithic tools and debitage. Both were intentionally removed from the tool to facilitate resharpening. Each exhibits a small segment of the original working edge from which it was removed. Specimen #83-10 was removed from a unifacial tool that had a flat ventral surface. A blow directed into the face of the steep working edge removed this rejuvenation flake and about 18.8 mm of tool edge. Specimen #182-11 also represents removal from a uniface, possibly a long side scraper, which removed a considerable length (40.5 mm) of that working edge. The worked edge is not as steep as on the previous piece, but is somewhat dulled and irregular, indicating extensive use. Neither piece was selected for use-wear analysis.

10.5 VERTEBRATE FAUNAL ANALYSIS

10.5.1 Introduction

The 83-m² excavations in of Middle Archaic component in Block A yielded 725 vertebrate specimens weighing 402.2 g. Although more bone fragments were recovered from this component, they are thought to have been displaced from above, based on their color and condition. Pieces from this component with a pinkish gray (5YR 7/2) appearance were assigned to the overlying Toyah component. Pieces with a beige and calcium carbonate-coated are thought to be derived from the Early Archaic component. Brown bone fragments were visually distinct from the fresh pinkish gray pieces and the older beige and calcium

carbonate coated pieces, and are thought to comprise most of the Middle Archaic assemblage. Therefore, similar brown bones from the lower Early Archaic period were also assigned to this Middle Archaic component. The Middle Archaic pieces vary in color from light reddish brown (5YR 6/4) to dark reddish gray (5YR 4/2). Although this approach may seem somewhat arbitrary, it is supported by the radiocarbon dates derived from bones.

If it were not for the partially burning of these fragments (resulting in the brown color), which is interpreted to have hardened these bones, it is probable that they would not have been preserved. Only 2.2 percent of the fragments assigned to this component are greater than 3 cm in length, and those are between 3 and 6 cm long. Their average weight of 0.4 g per fragment reflects the very small size of the individual pieces. Nearly 74 percent were burned, 80 percent were burned to a brown color, 16 percent are burned to a black and brown color, 1.3 percent are burned black, 1.3 percent are white, and less than 1.0 percent are black and white. Most larger size ungulate bones exhibit a black and brown color generally the result of burning at temperatures less than 400 degrees Celsius, whereas the white color signifies burning at temperatures above about 700 degrees Celsius (Nicholson 1993).

Bones were divided into ten major taxa based on the size and type of animal represented. The 10 groups include: Size Class 1, mole and mice size mammals; Size Class 2, rabbit-size mammals; Size Class 3, raccoon-size mammals; Size Class 4, dog/coyote-size; Size Class 5, deer and antelope size; Size Class 6, bison-size; Size Class 7, turtles; Size Class 8, snakes; Size Class 9, birds; and Size Class 10, fish. The assignment of a bone fragment into a specific size class was based primarily on cortical wall thickness and bone structure. If these attributes were not sufficient to place a bone into one of

the 10 classes, then the piece was designated “unknown”. Eighty-eight percent of the pieces ($n=638$, weighing 151.5 g) were assigned to the unknown category. Of the 638 pieces, 224 pieces, or 35 percent, were burned.

Six fragments weighing 7.4 g were assigned to size class 6 and probably represent bison. Two fragments are sizable pieces of tooth enamel. The other four long bone fragments are burned, three a black to brown color and one black. It is possible these six bison-size bones may not be part of the Middle Archaic component, as they potentially were displaced from above Toyah component. If they were actually part of this component, then their presence indicates at least one bison size individual.

Seventy-eight fragments, or 10.8 percent, were assigned to size class 5 and probably represent deer. These 78 pieces weigh a total of 99.1 g for an average of 1.3 g per fragment. Ninety-one percent are less than 3 cm long with the other nine percent being 3 to 6 cm long. Elements with sufficient attributes to allow species identification, such as deer, include: a left astragals, a left acetabulum, a proximal phalanx, a complete right third lower molar, two inner ear pieces, and a first phalanx that is butchered. Thirty-one percent of this size class is burned, with 50 percent burned a brown to black color, another 33 percent a brown color, and 17 percent are black. A complete third molar from a lower left mandible reveals a partially worn and slightly cupped third cusp indicating a relatively old deer.

One-half of a nearly complete, brown deer calcaneum (#522-2-1b), weighing 5.0 g from 50 to 60 cmbs in Unit N106/E53 in what was considered valid Middle Archaic context, was sent to Beta Analytic Inc. for radiocarbon dating. However, following the careful dissolution of the bone mineral component Beta Analytic Inc. indicated they could find very little separable

collagen, and as such, the sample could not be dated (Ronald Hatfield, personal communication, November 15, 2003). The other half of this same brown deer calcaneum (#522-2-1a), weighing about 6.6 g, was submitted to the University of Georgia Laboratory. This half of the deer calcaneum yielded a $\delta^{13}\text{C}$ corrected (-21.2‰) AMS radiocarbon age of $3,910 \pm 40$ B.P. (Table 10-1: UGA-12719).

A brown long bone fragment (#418-2-1), weighing 2.4 g from 50 to 60 cmbs in Unit N104/E56 and Middle Archaic context, was submitted to the University of Georgia Laboratory for dating. The bone collagen yielded a $\delta^{13}\text{C}$ corrected (-21.5‰) AMS radiocarbon date of $2,290 \pm 40$ B.P. (Table 10-1: UGA-12716). This age best reflects chronological position of the overlying Late Archaic component and is therefore, assumed to have been displaced. The stable carbon isotope data derived from the AMS radiocarbon dating of these two bones reflects animals that ate nearly 100 percent C_3 vegetation. The consumption of C_3 vegetation is consistent with deer feeding habits; and therefore, these two elements probably are from deer.

Besides the two size groups discussed above, four specimens were assigned to the size class 2 that includes rabbit sized animals. This included two long bone fragments (#470-2) that weigh 0.6 g and are burned black and brown. They are within the size range for jackrabbit. One other unburned long bone fragment (#513-2) is of a similar size. An unburned distal humerus fragment that weighs 0.5 g is of cottontail size indicating that both jackrabbit and cottontails are represented.

Two fragments were assigned to the size class 4, which includes animals about the size of a dog. Specimens, #397-2 and #418-2 are brown in color and are proximal metapodial fragments

with articular surfaces. These represent at least one nonungulate in the size range of dog/coyote.

A single piece of turtle shell (#43-2), weighing 1.0 g, was recovered from this component. It is a small, unburned segment that lacks root etching or obvious weathering. It is unclear if this turtle shell represents part of the Middle Archaic subsistence resource, or if it was displaced from some other context.

10.5.2 Discussion

Vertebrate remains from Middle Archaic assemblages across Texas are rare. Therefore, this small and limited bone assemblage is a unique discovery. One deer and at least two rabbits are definitely represented in this assemblage. It is not possible to state with certainty that bison was among the resources procured at this particular time, since evidence of mixing, especially for small bone fragments such as these, is present. Mixing may also account for the one turtle and two dog/coyote size specimens. If these bones actually do represent the Middle Archaic period, they imply a broad-base subsistence pattern during the 900-year period represented.

The horizontal distribution of the vertebrate faunal assemblage appears to represent an intact cultural activity area. Nearly 34 percent of the bones were recovered from a single unit, N104/E56, at the eastern edge of BT 2. Two units to the north of that unit also yielded high percentages of bones. The three units combined account for over 58 percent of the vertebrate assemblage assigned to this component. This type of horizontal concentration inferably reflects a discard area of mostly deer-size bones that had been extensively smashed and burned.

10.6 BURNED ROCKS

A few scattered burned rocks and two burned rock features were found in the Middle Archaic

component. In total, 810 burned rocks, weighing 96,733 g, were recovered. The two features contained 68 pieces, weighing 30,450 g, for an average weight of 448 g per burned rock. The scattered burned rocks total 742 pieces weighing 66,283 g, for an average burned rock weight of 89.3 g. The scattered burned rocks are comprised mostly of the smallest size class with 69 percent by count, followed by the next smallest size class at 27.6 percent, then 3.9 percent in the next size class, and less than one percent in the largest size class.

In Feature 11, the average burned rock weight is 576.5 g, and for Feature 37, the average is 276.8 g. A noticeable size difference exists between the two features and the scattered burned rocks. This indicates a probable use/functional difference. The largest pieces were recovered from Feature 11, interpreted as a disturbed hearth. The second largest average was in Feature 27, interpreted as a discard pile. If these interpretations of the features are correct, then the scattered burned rocks are about 1/15 the weight of those recovered from the more or less intact hearth (Feature 11). The scattered pieces reflect the functionally exhausted pieces that had become too fragmentary for efficient heat retention. The size of the burned rocks in Feature 37 may indicate that those burned rocks had been used several times, but not so many, that they were not still functionally viable.

10.7 MACROBOTANICAL REMAINS

This component was largely devoid of charred plant remains with only about 2.5 g recovered (Table 10-5). The near absence of features hindered the potential preservation of such remains. Combined with the probable displacement of macrobotanical specimens from other components, the recovered pieces may come from questionable contexts.

Table 10-5. Macrobotanical Remains from the Middle Archaic Component

Cat. #	Unit No.	Depth (cmbd)	Wgt. (g)	Comments	Identifications
37-005-004-007-1a	N99/E53	70-80	0.1	From light fraction C ¹⁴ dated to 4,260 ± 40 B.P.	
188-007	N101/E51	30-40	0.7		
199-007	N101/E52	40-50	0		
199-007-1a	N101/E52	40-50	0.5	Sent to Dering for ID	Mesquite (n=10)
200-007	N101/E52	50-60	0.9		
365-007	N103/E51	80-90	0.1		
418-007	N104/E56	50-60	0		
418-007-1a	N104/E56	50-60	0.1	C ¹⁴ dated to 4,770 ± 40 B.P.	
418-007-1b	N104/E56	50-60	0.1	Sent to Dering for ID	Indeterminate (n=1)

The two wood charcoal pieces selected for radiocarbon dating both yielded acceptable dates for this period. Tiny pieces of charcoal from Feature 37 yielded one of the radiocarbon dates. The two obtained ages support the contention that a Middle Archaic occupation(s) is represented. Mesquite and oak wood charcoal are positively identified (Appendix I).

10.8 MIDDLE ARCHAIC SUMMARY

This component was identified by the occasional stone tool, dispersed lithic debitage, sparse bone fragments, occasional burned rock, and two burned rock features horizontally scattered throughout the brown (10YR 5/3) clay loam Bk soil horizon that is the upper part of geologic Unit 3 and sandwiched between the Late Archaic burned rock Feature 1 and the dense Early Archaic materials at the base of geologic Unit 3. In Block A, the Middle Archaic deposits had a maximum thickness of about 40 cm and this rapidly thinned to about 20 cm thick towards the north. The thin, northern portion of this wedge-shaped Middle Archaic component was more potentially mixed with materials from

other cultural components. The cultural materials near the base of the Middle Archaic component may be partially mixed with the Early Archaic materials from below. The southern half of Block A provides the best context for the Middle Archaic materials, which included Feature 37, and about 50 percent of the recognizable formal tools including four Early Triangular projectile points.

The 83-m² hand-excavations in Block A yielded 4,387 pieces of lithic debitage, 810 burned rocks, 122 informal edge-modified stone tools, 24 formal chipped stone tools, eight cores, 725 bone fragments, and two burned rock features (Features 11 and 37). Surprisingly, bone (402.2 g) and charcoal (2.5 g) remains were preserved, but in very limited quantities (Table 10-6). These organic remains allowed AMS radiocarbon dating to determine the absolute age of this component. The direct dating also demonstrated that some displacement had occurred vertically in the deposits. Younger bones and charcoal from the overlying components were displaced downward and became mixed with Middle Archaic materials.

Table 10-6. Summary of the Middle Archaic Assemblage from the Varga Site (41ED28) Investigations

Cultural Material Classes	Middle Archaic Component (2,930 to 4,820 B.P.) Counts
Bone Fragments*	402.2 g, 725 pieces
Deer	7 pieces
Rabbits	1 piece
Mussel Shell*	0
Burned Rock	810
Features	2
Disturbed Hearth	1
Burned Rock Dump	1
Dart Points and Fragments	10
Early Triangular	6
Bifaces	11
Scrapers	3
Edge-Modified Flakes	122
Lithic Debitage	4,387
Cores	8
Hammerstones/Anvil	1
Carbonized Plant Remains	2.5 g
Mesquite wood	
Total Materials	6,079
Average Thickness (cm)	25
Spatial Extent Excavated	83
Volume Excavated (m³)	20.9

* Bone, mussel shell, and carbonized remain totals are weights in grams; ** Mussel shell from testing not weighed

This table does not include materials from float samples

This mixing resulted in subjectively reducing the recovered bone to a much smaller sample thought to represent Middle Archaic events.

10.8.1 Chronology Issues

Two assays on wood charcoal and one on a deer bone fragment directly date the Middle Archaic component to ca. 900-radiocarbon year period from 3,910 to 4,820 B.P. (Table 10-1). A humate sample from geologic Unit 3, or the Bk soil horizon, and stratigraphically equivalent to this zone yielded a mean residence time of 4,790 B.P. that generally supports the cultural radiocarbon ages from this component. This relatively narrow time span has not been previously well documented in the archeological record in Central Texas or the Lower Pecos regions. The only diagnostic projectiles from this component include five Early Triangular points and one Carrizo point fragment. Since the cultural materials were somewhat vertically scattered roughly over 20 to 30 cm, it is not certain that the three wood charcoal dates and ten projectile points are directly associated. It is assumed that the cultural materials represent multiple events during this 900-year time span. The Early Triangular points and associated cultural materials and the obtained radiocarbon dates are in stratigraphic agreement with radiocarbon dates and recovered diagnostic tools from above and below this component. The one exception is the charcoal date derived from Middle Archaic Feature 11 that yielded a Late Archaic age of 1,990 B.P. (UGA-12718). This age is similar to charcoal ages obtained from Feature 1. Therefore, the dated charcoal apparently was displaced downward and became lodged in this Middle Archaic cluster of burned rocks—Feature 11. The radiocarbon documented 900-year period probably reflects the general age of the six Early Triangular points that dominate the sample of typable projectile points.

In the Lower Pecos region, Early Triangular points from Unit 3, Level 24 in Skyline Shelter dated slightly earlier, to $5,210 \pm 70$ B.P. (Tx-6878). Those triangular forms were renamed Devils Triangular points (Turpin and Bement 1992). These same levels (23 through 28) also yielded six Bandy/Martindale, four Baker/Uvalde, three Gower, one Early Barbed, two Golondrina, and five unidentified projectile points. Level 28 that lacks Devils Triangular points, was dated to $5,920 \pm 120$ B.P. (Tx-6947), and may predate the appearance of Early Triangular points in the Lower Pecos.

In Central Texas, the Royal Coachman Site (41CM111) in Comal County yielded dispersed occupation debris containing Early Triangular points and radiocarbon dates in associations (Mahoney et al. 2003). The 20 to 40 cm thick component yielded seven Early Triangular, two Bell, and at least three Nolan dart points in a very slowly aggrading alluvial deposit. Five of the six-radiocarbon assays from wood charcoal returned 1-sigma dates ranging from 5,460 to 5,600 B.P. This is referred to as “one of the more securely dated Early Triangular components in the State” (Tomka et al. 2003:89).

The Holt Site (41HY341) in Hays County contained a minimum of one occupation that is relevant including Zone II that yielded four Early Triangular points, two bifaces, and 145 pieces of lithic debitage. Unfortunately no faunal remains were preserved, but two charred, starchy plant fragments (possibly bulb parts) were recovered from Feature 4, a “rather large earth-oven” (Brownlow 2004). A charcoal sample from Feature 4 yielded a conventional age of $4,740 \pm 40$ B.P. (Bets-191422), similar to the radiocarbon ages of charcoal from the Varga Site Middle Archaic component.

At Cibolo Crossing (41BX377) in Bexar County, two Baird bifaces (beveled triangular

points or Early Triangular point) were associated with nine Bell and one Andice points in an isolated component above a Martindale component. Three reliable radiocarbon dates from Feature 19 that contained two Bell points yielded ages of $4,420 \pm 50$ B.P. (Beta-126362), $4,400 \pm 60$ B.P. (Beta-126364), and $4,370 \pm 80$ B.P. (Beta-126367) (Kibler and Scott 2000). Biface production was prevalent as was evidenced by 74 percent biface-thinning flakes and indications were that biface reduction at the site was carried out on fully corticate cobbles. Cooking was inferred from several burned rock features including two basin-shaped hearths and a few flat burned-rock features.

At the Richard Beene Site (41BX831) on the Medina River, Block U excavations (6 m²) in the Upper Median component yielded several hearth features with minimal fire broken rock, a small sample of chipped stone tools, and mussel shell concentrations that dated to $4,430 \pm 55$ B.P. (GX-21746, Thoms et al. 1996). Although no diagnostic artifacts were recovered, this is the same time period as the Middle Archaic component at the Varga Site and the Cibolo Crossing Bell/Andice component. The artifact concentration was about 15 cm below the Medina paleosol.

The distal Carrizo point fragment from Middle Archaic context, at 70 to 80 cmbd in the middle of the southern part of Block A, fits with a proximal fragment from 40 to 50 cmbd ca. 6 m north in the northern part of Block A. It is not clear if either piece was vertically displaced from its original context. Initially, the proximal section was assigned to Early Archaic context and the distal section was assigned to the Middle Archaic component. Two other Carrizo point fragments (#391-10 and #670-5-12) were recovered from Early Archaic contexts at 120 to 130 cmbd in Unit N103/E55 and 49 cmbd in Unit N108/E52. The latter point was associated with Early Archaic burned rock Feature 23. At

the Varga Site, the overall stratigraphic context of the Carrizo points support an association with the Early Archaic period with one likely displaced distal fragment ending up in the Middle Archaic context. Turner and Hester (1993) indicate the Carrizo point is Middle to Late Archaic type that is primarily found in South Texas. The time range for this type has not been previously determined. One of the best contexts for the Carrizo point was at Loma Sandia where three Carrizo points were recovered from a charcoal dated zone to between 2,500 and 2,800 B.P. (ca. 850 to 550 B.C.; Highley et al. 1995). Although the context at Varga Site is not as secure, the three Carrizo points from a dated context help assign this point type to a chronological position that is earlier than previously thought. With this new data from the Varga Site, the Carrizo points potentially represents a broad time range from 2,500 to 2,800 B.P. in South Texas to ca. 5,200 B.P. in Edwards County. It may be that the Carrizo points in the burials at Loma Sandia were older, curated specimens that were included in the cemetery. More radiocarbon dates for the Carrizo point are necessary to clarify its chronological position.

10.8.2 Subsistence Issues

The sample of 725 fragments from the Middle Archaic context at Varga holds limited potential to contribute to our understanding of the resources employed in subsistence. Six fragments, or less than one percent, which include two pieces of tooth enamel and four burned long bone fragments weighing 7.4 g, were assigned to size class 6 and probably represent bison. Seventy-eight fragments, or 10.8 percent, were assigned to size class 5 and probably represent deer. Identifiable deer elements include one left astragals, one left acetabulum, one proximal phalanx, one complete right third lower molar, two inner ear pieces, and a first phalanx that is butchered.

Four long bone fragments are assigned to the size class 2-- rabbit size animals. An unburned distal humerus fragment is cottontail size. The different sizes of rabbit elements represented indicates the presence of jackrabbit and cottontail species. Two long bone fragments were assigned to the size class 4, that of dog/coyote size. A single piece of unburned, lightly weathered turtle shell was recovered from this component.

Deer and rabbits are definitely part of the Middle Archaic assemblage and represent consumed resources. Some uncertainty exists about the presence of bison, since potential mixing with younger materials may have occurred. Turtle and dog/coyote also may be represented, although without direct dating of these bones their context and chronological placement are uncertain.

The generally broad-bladed Early Triangular points are often associated or are considered contemporaneous with the broad bladed Bell/Andice points, indicating use for hunting large game that may have included bison (see Johnson and Goode 1994). The use-wear on three Early Triangular points from the Varga Site, two of which were broken during use, indicate at least cutting and scraping of hide and hard, high silica materials (Appendix C). Haft wear was detected on one specimen with another specimen that exhibits light polish at either end. Although a hair was observed on one specimen, species is unidentified.

As further evidence for the animal contribution to subsistence, the entire stone tool assemblage generally reflects hunting and processing of game. The use-wear studies indicate 12.5 percent of the analyzed tools were directly associated with animal products.

Plant-food products such as nuts and seeds, from pecan species, oak species, and mesquite beans potentially available, but we lack direct

indication of their use. Whereas tools associated with the processing of nuts, seeds, or other plant resources, such as grinding implements, are lacking here. However, plant fibers were observed on three chipped stone tools (18.8 percent) and wood fiber was observed on 12.5 percent of the tools analyzed. Consequently, 31 percent of the analyzed stone tools document use of non-meat resources, though it is not clear whether the plant fibers and wear indicate plant consumption or just use of various plant products for other purposes.

Lipid residues were extracted from nine burned rocks recovered from Features 11 and 37. The findings do not imply that herbivores are represented. High fat content plant foods, which could include seeds and nuts, appear to be most commonly represented. The $\delta^{13}\text{C}$ values obtained from fragments of the same burned rocks range from -22.9 to -26.7‰ and probably represent C_3 plants. The $\delta^{15}\text{N}$ values reveal a much broader range from -0.2 to 8.4‰, probably reflecting diverse foods that could include seeds, nuts, and perhaps legumes. These combined lipid and isotope results from the analyzed burned rocks do not reflect the cooking of deer or bison meat. The procurement and use of deer is represented only by bones. A few carbon isotope values are in the range for rabbit meat if the rabbits consumed mostly C_3 plants, which is quite likely.

No mussel shells were recovered from this component, strongly indicating that this riverine resource was not part of the subsistence base at this location. Nor is there any indication that mussel shells were procured for making items such as scoops or ornaments.

10.8.3 Technology Issues

Technology issues are best addressed through the preserved materials, which presumably represent only a fraction of the original material-culture inventory. Some daily tasks such as

resource procurement, resource processing, and consumption are represented, as discussed presently.

10.8.3.1 Resource Procurement Issues

Recovered stone tools generally provide the primary evidence for plant and animal procurement practices. The presence of ten projectile points and point fragments represents the killing of larger animals. Smaller game (e.g., rabbits and/or turtles) likely were obtained with the use of traps or nets that are not preserved.

No stone tool class is directly associated with plant procurement. This is not unusual, since most plants (i.e. seeds, nuts, berries, and bulbs) would have been easily procured without the use of specialized tools. If specialized tools, such as digging sticks and/or baskets were used to procure certain plants, they would not have survived in the archeological record at the Varga site.

Tools that might have been used in the procurement of lithic resources such as massive hammerstones, or antler prying bars and wedges are not represented in this assemblage. Their absence implies that lithic raw materials collected without specialized tools. Chert and other rocks would have been readily available in creek bottoms and/or in gravel terraces, so that they were easily collected without the use of special tools.

10.8.3.2 Resource Processing and Consumption

Chert was collected as a raw material and brought to the site for reduction into stone tools. The relatively low frequency of core reduction flakes and early stage biface flakes indicates that the early stages in tool production were quite limited, while the relatively high frequency of late stage biface flakes, tertiary thinning flakes,

indicate that late stage knapping and finishing, flake production, or resharpening were more frequent. Finished and worn-out tools were resharpened, as indicated by the presence of rejuvenation flakes.

Various processing activities are documented through the different types of stone tools recovered. The stone tool assemblage is restricted to formal tools that include points ($n=10$), bifaces ($n=11$), scrapers ($n=3$), and informal edge-modified flakes ($n=122$). The latter are represented by different shapes forms that include, but are not limited to: graters, punches, spokeshaves, and other classes. These edge-modified flakes indicate a range of processing tasks that included cutting, scraping, slicing, planing, gouging and whittling. These recognized tasks were conducted on wood, hide, plants, soft material, hard, high-silica plants, and other materials. The use-wear results provide greater insights into the diversity of tasks and products worked than is strictly indicated by the limited range of formal tools.

Use-wear on three Early Triangular points from the Middle Archaic context plus one from Early Archaic context reveals different uses on similar contact materials. The inferred uses include whittling, gouging, and cutting, whereas the inferred contact material includes hide on one specimen, and hard, high-silica plant material for three specimens. Since penetration of a projectile into hide and meat leaves, at best, only limited use-wear evidence, the observed use-wear on these presumed projectiles likely indicate that they served multifunctional uses. Detected haft wear in the form of abraded ridges and hard, high-silica polish was observed on two of the four points.

Analyses and interpretations surrounding the similar triangular Tortugas points from across South Texas indicate these points had apparent adaptive advantage in their wide blades that

allowed for higher numbers of resharpening events as the edges dulled. This resharpening while still in the haft would have extended their use life longer than stemmed points. Tortugas points may have also been more resistant to impact fractures, because they were frequently thickest near the distal end (Mahoney et al. 2002; Mahoney et al. 2003; Tomka 2002). Tortugas points have also been shown to have been multifunctional, and they were not used only as killing instruments (Quigg and Cordova 1999; Church 2000; Hardy 2002).

The 810 burned rocks indicate that the cooking technology focused on the use of hot rocks to prepare foods for consumption. Features 11 and 37 are the only burned rock features identified, and these features apparently represent a disturbed hearth and a discard pile. The lack of formal or recognizable structure to the burned rock features provides little evidence from which to infer function. If we assume that cooking was done based on the presence of these two features, cooking was not an intense or prominent task, and may have supported only a small group(s) for a short-period of on-site residence.

Not far to the east, in Kerr County and along the upper Guadalupe River drainage, points similar to our Early Triangular points were the dominant form recovered from burned rock middens at the Sheep Site and Wounded Eye Site (Luke 1980). Although the stratigraphy in these middens was not clear-cut, it was assumed that this point type reflects the major associated occupations. The middens at those sites reflect a specific type of plant cooking feature. Therefore, groups employing Early Triangular points in this region probably have used different types of plant and animal resources at different sites and may have had task specific camps.

The general scarcity of tool forms, other than projectile points and edge-modified flakes, and

the relatively high frequency of lithic debitage, specifically the late stages of biface manufacturing and thinning, indicate that tool manufacture and retooling probably were primary activities at this locality. It is likely that these tasks were of short duration, which contributed to the lack of tool diversity and the small number of features. The absence of other tool classes may be partially attributed to the multifunctional nature of the hafted triangular points that have been documented as being used in various tasks. After hafting, this killing instrument also served for cutting, gouging, whittling, etc., thereby reducing the need for other tool classes. The absence of other tool classes may reflect to the structure and gender makeup of the group(s) that occupied the Varga Site.

10.8.4 Intra-component Patterning

The 900-years of documented radiocarbon time, the vertically dispersed nature of at least part of the Middle Archaic assemblage, and the lack of a well-defined material lens potentially indicating that multiple activities were carried out during at the site during the Middle Archaic. The inability to distinguish the events in this ca. 30 cm thick component is linked to the difficulty in gleaning information about the internal patterning of the various classes of material. The formal stone tools and the two recognized features were nearly equally divided between the northern and southern half of Block A. Generally, the formal tools appeared in small clusters that potential reflect activity or discard areas.

Feature 11, near the middle of the northern half of Block A, is interpreted as a disturbed hearth. No formal stone tools were recovered within one meter of this feature. This absence may indicate that it served primarily if not exclusively as a cooking locality. Two bifaces, three points—two of which are unidentifiable fragments and at

least five edge-modified flakes were recovered less than 2 m north of Feature 11. No other formal tools were in the immediate vicinity. This distribution pattern may indicate a small activity area on the north side of the cooking feature that focused on the retooling of hafted points.

Burned rock Feature 37, next to the southern boundary of Block A, reflects the dumping of unwanted burned rocks following their use in a cooking activity. Two scrapers were recovered less than 2 m north and were the formal tools found closest to Feature 37. Other formal tools that include points and bifaces were more than 2 m north and east of Feature 37. It is not clear if these tools were discarded at an activity area or were discarded in a discard zone together with the burned rocks.

Contour maps of density-corrected artifactual data for Block A were generated for each variable in this component (Figures 10-7 through 10-13), using Surfer (vers. 5.01) mapping software. These maps provide a visual reference to aid in the interpretation of the spatial distribution of selected artifact categories and to provide additional depth to interpreting the results of the principal components analyses.

The locations of the two recognized features (Features 11 and 37) are also plotted on the contour maps as part of the spatial patterning.

Awls, drills, choppers, gouges, and unifaces were excluded from the analysis due to the non-occurrence of these artifacts in the Middle Archaic component in Block A. The resulting data matrix consists of nine variables (artifact categories) and 86 rows (excavation units), though only eight of the variables figure strongly in the resulting factor loadings. The principal components analysis extracted a three-factor solution representing a cumulative total of 63.92 percent of the variability present in the data array.

Figure 10-7. Contour Map of Bone Density for Middle Archaic in Block A

Figure 10-9. Contour Map of Biface Density for Middle Archaic in Block A

Figure 10-8. Contour Map of Lithic Debitage Density for Middle Archaic in Block A

Figure 10-10. Contour Map of Edge-Modified Density for Middle Archaic in Block A

Figure 10-11. Contour Map of Burned Rock Density for Middle Archaic in Block A

Figure 10-13. Contour Map of Point Density for Middle Archaic in Block A

Figure 10-12. Contour Map of Lithic Core Density for Middle Archaic in Block A

Table 10-7. Correlation Matrix for Block A—Middle Archaic Component

Category	Category								
	Burned Rocks	Faunal Bone	Ground-stone	Cores	Debitage	Bifaces	Edge-Modified Flakes	Projectile Points	Scrapers
Burned Rocks	1.000								
Faunal Bone	.119	1.000							
Groundstone	.783	.008	1.000						
Cores	-.058	-.060	-.026	1.000					
Debitage	.017	.580	-.113	.060	1.000				
Bifaces	.016	.573	-.029	.253	.575	1.000			
Edge-Modified Flakes	.088	.788	-.049	-.003	.536	.382	1.000		
Projectile Points	.004	.099	-.030	-.066	.004	-.016	.054	1.000	
Scrapers	-.029	-.034	-.020	.098	-.039	-.051	-.014	-.051	1.000

The matrix of correlation coefficients is presented in Table 10-7, and the factor solution is presented in Table 10-8.

Factor 1 is composed of four diagnostic variables—faunal bone, lithicdebitage, bifaces, and edge-modified flakes—collectively composing 30.52 percent of the total variance in the matrix of correlation coefficients (Table 10-8). All four variables exhibit moderately strong to strong positive factor loadings ranging from .766 to .892; none of the diagnostic variables in Factor 1 are negative. The spatial patterning reflected in this factor loading is largely accounted for by a high-density peak centered on the intersection of the N105 and E57 grid lines along the eastern edge of Block A that contains most of the assemblage of each of these four artifact types present in the Middle Archaic component (Figures 10-6 and 10-9).

Table 10-8. Principal Component Matrix for Block A—Middle Archaic Component

Variable	Factor ¹		
	1	2	3
Burned Rock	.073	.941	-.041
Faunal Bone	.892	.076	-.187
Groundstone	-.065	.944	.028
Cores	.118	-.056	.777
Debitage	.812	-.071	.030
Bifaces	.766	-.014	.268
Edge-Modified Flakes	.822	.028	-.168
Projectile Points	.058	-.055	-.516
Scrapers	-.050	-.025	.448
% Variance	30.52	19.96	13.44
Cum. % Variance ¹	30.52	50.48	63.92

¹ Rotation method—Varimax with Kaiser normalization

² Based on rotation sums of squared loadings

No cultural feature was recognized in this area (presumably due to the relative non-occurrence of burned rock in this vicinity), but it would appear that an activity area is represented

here. The association of bifaces, debitage, and edge-modified flakes may be best explained based on the assumption that all three artifact categories reflect the task of lithic reduction; specifically, producing lithic flakes (presumably during biface manufacture) and subsequently modifying some of the flakes for use in various cutting and scraping tasks. Whether lithic reduction strategies in this context are oriented toward producing flakes specifically for modification and use, or the flakes simply represent a byproduct of producing other tool forms, such as bifaces, is unclear, though the cores resulting from flint knapping activities would probably be bifacial implements themselves rather than multidirectional cores (assuming that all activities are occurring *in situ*). For spatial studies, no distinction was made between various flake or core types that might clarify this issue. The association of these lithic artifacts with faunal bone suggests that some of the activity performed in this area related to animal resource processing.

Factor 2 is composed of two diagnostic variables—burned rock and groundstone—collectively composing 19.96 percent of the total variance in the matrix of correlation coefficients (Table 10-8). Both variables exhibit strong positive factor loadings of .944 and .941. As only one piece of groundstone was recovered from the Middle Archaic component in Block A, it seems likely that this artifact was subsequently reused as burned rock, and that this factor more or less exclusively represents a concentration of burned rock in the northern half of the block centered on the N107 grid line on the border of Unit N106/E52 and N107/E52 (Figure 10-10). This burned rock concentration was designated as Feature 11, though it appears that no other

artifact categories, with the possible exception of an association with edge-modified flakes, are associated with this feature.

Factor 3 is composed of two diagnostic variables—lithic cores and projectile points—collectively composing 13.44 percent of the total variance in the matrix of correlation coefficients (Table 10-8). Cores exhibit a moderately strong positive factor loading of .777, whereas projectile points demonstrate a moderate negative factor loading of -.516. Mutually exclusive clusters of projectile points and lithic cores represent the spatial patterning reflected in this factor (Figures 10-11 and 10-12). Two relatively high-density clusters of projectile points occur in the northeastern quadrant of Block A (cores are absent from this area), and one relatively high-density cluster of cores is present along the west-central edge of the block (an area from which points are notably absent). Considering the relatively small numbers of points and cores recovered from the Middle Archaic component, it seems inadvisable to infer much from this patterning. It is, however, notable that the concentration of lithic cores along the western edge of Block A is largely exclusive of the distribution of lithic debitage in Block A.

It is important to remember that demonstrable spatial associations of different variables, which form the basis of the preceding discussion, do not innately imply the nature of the relationships among some or all of the variables. The statistics reveal numerical tendencies among variables to co-occur or to co-vary in space. The statistics “force” patterning upon an assemblage of data regardless of whether or not it innately exists in the dimension being examined; the analyst is responsible for inferring whether such patterning may be indicative of past behavior, such as that reflected *in situ* activity or discard areas; post-depositional processes, such as plowing or erosion; or a combination of both.

Overall, the principal components analyses of the Middle Archaic component included in this spatial study have yielded relatively unambiguous patterning among artifact categories. The observed associations among artifact categories probably are regular, patterned, and often exclusive of other categories. If post-depositional factors, such as erosion, or animal burrowing, had resulted in extensive mixing of sediments, we would expect there to be less distinctive patterning among specific classes of variables and more general mixing of classes. Thus, it appears that the sediment deposits containing the Middle Archaic component are relatively intact, and that the spatial patterning apparent among artifact categories is referable more to the spatial organization of the prehistoric activities than to post-occupational natural influences.

10.8.5 Mobility and Land Use Issues

This Middle Archaic component yielded no artifacts that might reflect social structure of the group(s) that occupied the Varga Site, but dominance of a single point type in the assemblage may support the idea that the material remains represent a single group or multiple groups of a common background or origin. The cooking tasks reflected by the scattered burned rocks and the two burned rock features, might be related to the presence of females. Tool manufacture and retooling tasks may best reflect male activities. If these inferred activities are, in fact, gender related, it can be assumed a group(s) composed of males and females is represented.

Marine shell and exotic lithic materials that might indicate trade or any sort of long-distance movement of people or materials are entirely lacking. If contact with other populations in adjacent regions occurred, it is not currently visible in the recovered archeological record for the Middle Archaic at this site.

The generalized nature of the stone tool assemblage reflects a moderate range of activities, lithic tool production, whereas high frequency of informal/expedient tools and discarded broken tools, the generalized nature of the cooking features, the small size of the cooking features, the diverse subsistence resources exploited, all reflect a small residential group that was practicing a generalized foraging adaptation. The amount of cultural material present may be closely aligned with the length of the occupation(s), which probably was short-term based on the lack of obvious evidence for maintenance activities and only the two identified features.

The INAA indicates that the lithic material used for the manufacture of chipped stone tools was from the local southwestern region of the Edwards chert outcrop (Appendix F). The chemical signatures indicate the Edwards cherts used in the manufacture of chipped stone tools were procured from different sources, which in turn implies mobility within this region. Coupled with the evidence indicating short-term residence, it can be inferred that the Middle Archaic foragers who occupied the site were practicing a fairly high degree of residential mobility necessitated by a broad-based resource procurement strategy.

10.8.6 Paleoenvironmental Conditions

The pollen and phytolith record from the Varga Site provides limited clues to indicate what the environment was like at this locality during this ca. 900-radiocarbon year period from 3,910 to 4,820 B.P. It is likely that poor preservation has limited the usefulness and reliability of both kinds of data.

Oak pollen is present in small quantities. A small amount of hackberry is present in one sample, and pecan pollen is found in five of the seven samples. Low spine Asteraceae tends to increase moving up in the sample column,

Cactaceae and *Ephedra* were also present in single samples from Middle Archaic contexts. The evidence implies, albeit weakly, that relatively dry conditions may have prevailed during this period (see Appendix E). Mesquite wood was the only taxon identified in the macrobotanical remains.

The phytolith assemblage reflects a transitional assemblage with Pooideae C₃ grasses dominating the lowest samples and gradually increasing between 4,800 and 3,900 B.P. C₄ grasses appear in the middle part of the Middle Archaic period and reveal a progressive increase toward the top part of the Middle Archaic section (Appendix E). Generally speaking, the environment likely contained trees in the immediate vicinity with extensive grass cover comprised mostly of C₃ grasses with some C₄ grasses.

The Varga Site carbon isotope data derived from a sediment column through the cultural deposits reveal values from -25.84 to -28.41‰, and showing marked and steady increase toward more negative values over the 900 years of documented Middle Archaic times from 3,900 to 4,800 B.P. These data also point to a near absence of C₄ plant contribution and complete dominance of C₃ organic plant matter, roughly in accord with the phytoliths which show a predominance of C₃ grasses during this period. The carbon isotope value derived from one radiocarbon dated humate sample (with an age of 4,820 ± 70 B.P.) yielded a δ¹³C value of -23.0‰, indicating an approximately 87 percent contribution from C₃ plant matter. This latter value is not as negative as those Middle Archaic carbon isotope values derived from the sediment column, but generally supports the broader interpretation.

In the Lower Pecos region, the general period dated to between ca. 3,000 and 5,000 B.P. was interpreted to have been one of aridity that

Bryant (1966) refers to as the Sanderson Stage. The beginning of this arid period is marked by an erosional unconformity, the Ozona Erosional period (Bryant 1966) as evident by the sedimentary break at the Devil's Mouth Site. This is also the general period in which 22 flood events were identified at Arenosa Shelter, 10 of which occurred between 4,500 and 3,200 B.P. (Patton 1977). Carbon isotope values derived from AMS radiocarbon dates on eight burned walnut shells from three burned rock midden sites in the uplands of northeastern Val Verde County reveal a marked change of 6.0‰ from about -19.5‰ to about -25.5‰ between about 4,400 and 3,900 B.P. This indicates a trend from dry to moister conditions during this period (Cliff 2003).

Just north of here at Hall's Cave, the period from about 2,000 to 5,000 B.P. was represented by increased sediment deposition evidenced by a weak brown (10YR 2/2) soil during a time when drying culminated to produce a drier-than-modern environment (Toomey 1993). Toomey interpreted this period's vegetation as open grassland, and speculates that the western and central Edwards Plateau contemporaneously shifted to a short grass or semi-desert shrub grassland.

In Central Texas, the climate is projected to have been somewhat mesic during the Bell-Andice-Calf Creek period or ca. 4,500 B.P., but then changed to more xeric conditions (Collins 1995). Blum and Valastro (1989) documented one climatic shift during the Middle Holocene near 4,500 B.P. in the Pedernales River valley. Before about 4,500 B.P., there was an erosional unconformity in the alluvial deposits that was thought to indicate a dry climate (Blum and Valastro 1989). Johnson and Goode (1994) indicate that a period of erosion occurred between 4,570 and 4,700 B.P., and they interpret this as marking a very dry period of widespread cessation of floodplain aggradation. Following

that was a period of about 1,700 years of surface stability, although some colluvium accumulated slowly (Strata 4 and 5) at the Jonas Terrace Site (Johnson and Goode 1994).

At about 4,500 B.P. on the southern High Plains, eolian sedimentation ceased or slowed and pedogenesis began (Holliday 1995). Pedogenesis was the dominant geomorphic process in the southern High Plains during this period (Holliday 1995). At around 3,200 B.P. there was a decrease in grasslands, based on the reinterpretation of Central Texas bog pollen data (Bousman 1998). At Fort Hood, the stable carbon isotopic data indicates that during the interval from ca. 6,000 to 5,000 B.P., a significant increase in C_4 plants at TR19 was detected. This indicates a relatively warm and dry climate, just earlier than the period documented here. These data contrast with the carbon isotope values from the Varga Site. At Fort Hood, the C_4 grasses continue to dominate through to ca. 3,000 B.P., but reveal a decline from the ca. 6,000 to 5,000 B.P. peak at roughly 85 to 95 percent to about 60 percent around 3,000 B.P. (Nordt 1992, 1993). Nordt also indicates that an erosional episode separates his Fort Hood member from the later West Range member, sometime between about 5,100 and 5,300 B.P. He indicates this event produced a 1,000 to 3,000-year unconformity at this contact. Deposition of the lower member of the Fort Hood alluvium began about 4,300 B.P. and terminated sometime between 2,400 and 2,800 B.P. (Nordt 1992, 1993).

10.8.7 Discussion

The cultural materials recovered reflect one or more short-term camps by populations using the Early Triangular dart point type. Limited cooking activities were performed through the use of burned rocks that targeted mostly C_3 plant products, although deer meat was also procured. Other activities were directed towards

refurbishing of chipped stone tools, retooling implements, and discarding worn-out tools. Documented processing activities include cutting, whittling, scraping, planing on hard and soft wood and other plants, and hide working. The seasonality of the occupation(s) is unknown.

In the Lower Pecos region, the Pandale point type dominates the time period from ca. 5,500 to 4,100 B.P. and possibly slightly later to 3,700 B.P. The occurrence of only one Pandale point (from the Early Archaic context) at the Varga Site implies groups employing this point type did not often camp in this area. Occupations associated with Langtry, Val Verde, and Almagre points are common in the Lower Pecos also were not recovered at the Varga Site, again, implying that the headwaters of the Nueces River area probably was just beyond the operational area of those Lower Pecos groups. However, two Pandale points were recovered a few kilometers west of the Varga Site in the Devil's Sinkhole State Natural Area (Howard et al. 1996) indicating some margin use of the region by people from, or with cultural affinities to, the Lower Pecos River area.

The Varga Site Middle Archaic component that yielded the Early Triangular points is in many ways similar to the Early Triangular component at Royal Coachman (Mahoney et al. 2003) and Cibolo Crossing (Kibler and Scott 2000). However, the Varga Site component is the only one represented by a single point type; the other two components yielded Bell/Andice points. These sites appear as relatively short-term campsites with limited tool assemblages, limited small burned rock cooking and discard features, limited bone and mussel shell remains, and nearly a complete absence of macrobotanical remains, all implying a basic similarity to the short-term occupation and high group mobility suggested here for the Varga site Middle Archaic. The lack of preserved fauna and floral

remains in most sites of this age creates extreme difficulties in identifying subsistence resources. This necessitates the use of chemical analysis such as lipid residues and isotope data to provide clues to the subsistence practices and other related issues. At the Varga Site the chemical

analyses allowed further interpretations of what was cooked by the rocks. Even though meat products were definitely present at the Varga Site, the lipid residues derived from the burned rocks did not reflect meat, but only the cooking of plant products.

11.0 THE EARLY ARCHAIC COMPONENT

J. Michael Quigg

11.1 INTRODUCTION

This rich and dense component was first identified during the Phase I investigations as relatively profuse cultural materials lying directly above, and interspersed within, the gravels and cobble-sized clasts at the bottom of the profile. Cultural materials representing this period were recovered from BTs 1 and 2 and 10 m³ hand-excavated units on both sides of the road. The cultural material was contained in the brown (10YR 5/3) clay loam Bk soil horizon at the lowest part of Depositional Unit 4 and mixed in with Depositional Unit 5, which was pale brown (10YR 6/3) coarse sandy loam 2Bk soil horizon. Depth of material varied considerably from 50 to 120 cmbd, since the bottom gravel deposit varied considerably in elevation below the ground surface along the southern edge of the T1.

The Phase I investigations did not encounter any cultural features, but yielded quantities of lithic debitage, scattered burned limestone rocks, some bone and mussel shell, and many chipped stone tools that included five Bandy points, five Gower points, and six Martindale points from the west side of the road and 16 Martindale, Gower, and Bandy forms from the east side of the road (Lintz et al. 2002). Lithic debitage counts were extremely high in the lower 30 to 40 cmbd on the west side of the road, but were present in low-to-moderate frequencies on the east side (Lintz et al. 2002).

The initial recovery indicated that this substantial Early Archaic component (possibly dating from 8,000 to 6,000 B.P.) should be targeted during the next phase of investigations. The accepted data recovery plan was to target the Early Archaic component through the block excavations only on the west side of the road (Lintz et al. 2002).

The investigations yielded a substantial quantity of Early Archaic materials from Block A that included a total of 83 m² of hand-excavations. The 83 m² of hand-excavations includes 5.25 m² during Phase I and an additional 77.75 m² in Phase II. In Block A, the entire vertical Holocene deposit was sampled through the hand-excavations that captured 83 m² of this component in the lower 30 to 40 cm of the profile. The initial two-backhoe trenches (BTs 1 and 2) excavated during Phase I were located near the middle of Block A and penetrated through this lower component. This mechanical excavation destroyed some 25 to 26 m² of this component in Block A.

The chronometric age of this Early Archaic component is derived primarily through direct radiocarbon dating of 15 samples recovered from the cultural component (Table 11-1). The dated material includes five charcoal samples, one charred prickly pear seed sample, three deer bone samples, five walnut shell samples, one *Rabdotus* snail shell, and two sediment samples. Two samples were spilt to obtain multiple dates from the same sample, bone sample #76-2-11 was split two ways, whereas walnut sample #344-71 was split three ways.

Table 11-1. Radiocarbon Dates from the Early Archaic Component

Fea. No.	Catalogue #	Blk.	Unit No.	Depth (cm)	Material Dated	Wgt (g)	Lab. No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
	76-2-11a	A	N99/E56	110-120	1/4 deer bone collagen	5.0	Beta-175396	5580 ± 40	-17.8	5,700 ± 40	Cal 4660 to 4460 BC
	76-2-11c	A	N99/E56	110-120	1/4 deer bone	7.5	UGA-12706	5180 ± 40	-19.7	5,270 ± 40	Cal 4230 to 3980 BC
40	128-5-4-7-1a	A	N100/E54	100-110	22 charcoal	0.1	UGA-12709	5220 ± 40	-26.2	5,200 ± 40	Cal 4220 to 3940 BC
	154-7-1	A	N100/E56	113	12 charcoal	0.1	Beta-175406	5680 ± 60	-24.4	5,690 ± 60	Cal 4690 to 4370 BC
	255-2-1	A	N101/E56	110-120	5 deer bones	2.2	UGA-12712	5270 ± 40	-21	5,340 ± 40	Cal 4330 to 4040 BC
	344-7-7-1a	A	N102/E56	90-100	1/4 chard walnut	0.1	UGA-12715	5440 ± 40	-26.6	5,410 ± 40	Cal 4350 to 4050 BC
	344-7-1c	A	N102/E56	90-100	1/4 chard walnut	0.1	Beta-183624	5540 ± 50	-26.2	5,520 ± 50	Cal 4460 to 4260 BC
	344-7-1d (1218)	A	N102/E56	90-100	1/4 chard walnut	0.1	UGA-12733	5430 ± 40	-26.7	5,400 ± 40	Cal 4340 to 4040 BC
	531-7-1a	A	N106/E54	90-100	1/2 chard walnut	0.1	UGA-12720	5500 ± 40	-25.2	5,500 ± 40	Cal 4460 to 4250 BC
	570-7-1a	A	N107/E50	50-60	20 charcoal	0.7	UGA-12721	6090 ± 40	-24.7	6,100 ± 40	Cal 5210 to 4850 BC
	599-1 (103-1)	A	N106/E54	90-100	1 <i>Rabdotus</i> shell	1.3	Beta-170402	5600 ± 40	-7.7	5,880 ± 40	Cal 4810 to 4680 BC
	607-7-1a	A	N107/E55	60-70	1/2 chard walnut	0.1	UGA-12722	5580 ± 40	-26.2	5,560 ± 40	Cal 4490 to 4330 BC
26	615-5-7-2a	A	N107/E56	50-60	2 chard seeds	0.1	UGA-12723	5440 ± 40	-11.6	5,660 ± 40	Cal 4600 to 4360 BC
26	616-5-7-1a	A	N107/E56	64	7 charcoal	0.1	UGA-12724	5610 ± 40	-23.2	5,640 ± 40	Cal 5450 to 4360 BC
23	735-5-7	A	N109/E55	40-50	1 charcoal	0.1	Beta-175407	6290 ± 50	-25.6	6,280 ± 50	Cal 5340 to 5080 BC
	1207-4-A	A	BT M-1	100	Sediment 2Bw	200.0	Beta-175394	6220 ± 50	-21.9	6,270 ± 50	Cal 5330 to 5070 BC
	1209-4-A	B	BT 7	115-120	Sediment 2Bk	200.0	Beta-175391	5190 ± 50	-22.6	5,230 ± 50	Cal 4220 to 3960 BC

Beta = Beta Analytic, Blk. = Block, Cal. = Calibrated, Con. = Conventional, Fea. = Feature, UGA = University of Georgia, Wgt = Weight

Sample #76-2-11 was part of a multi-piece fragmented bone awl manufactured from a deer long bone recovered from 110 to 120 cmbd in Unit N99/E56 in Early Archaic context. This deer bone was discovered in multiple pieces that fit together. Individual pieces of this long bone were submitted to two different radiocarbon laboratories for dating. About 5.0 g (#76-2-11a) of unworked shaft section was submitted to Beta Analytic Inc. (Beta) and 7.5 g (#76-2-11c) of the same shaft was submitted to University of Georgia (UGA). The reported conventional age from Beta was 430 radiocarbon years older than the conventional age report by UGA. Using CALIB REV4.4, the two samples were first calibrated and then subjected to a *t*-test. The *t*-test ($t=57.78$; $df=2$) indicates that the samples are statistically different at a 95 percent confidence level. The reported stable carbon isotope result from Beta is -17.8‰ compared to carbon isotope result from UGA of -19.7‰. Although a nearly 2‰ difference in the stable carbon isotope value was determined in processing the samples, this difference was accounted for in the reporting. The stable carbon isotope values are not out of line with those reported for deer bones. Although a 430-radiocarbon year difference exists between the two samples, they are both accepted as representative of this component.

Sample #344-7-1 was a nearly complete, burned walnut shell from 90 to 100 cmbd in Unit N102/E56. The walnut shell was split into three pieces with two pieces sent to UGA (#344-7-1a and #344-7-1d) and one piece to Beta (#344-7-1c). This shell originated from Early Archaic context near the bottom of the excavations. Radiocarbon results were determined on all three parts of the same walnut shell. The two reported conventional ages from UGA were only 10 radiocarbon years different from one another, whereas the reported conventional age from Beta was some 110 radiocarbon years older (Table 11-1). Using

CALIB REV4.4, the three samples were first calibrated and then subjected to a *t*-test. The *t*-test ($t=4.04$, $df=2$) indicates that the samples are statistically the same at the 95 percent confidence level.

The data from the two-radiocarbon laboratories are comparable insofar as the 15 samples generally reflect the same cultural component, and age differences cannot be accounted for based on the use of two different radiocarbon laboratories. All 15 organic samples, encompassing different materials, yielded radiocarbon dates within a period of 1,080-radiocarbon years from 6,280 B.P. (Beta-175407) to 5,200 B.P. (UGA-12709; Table 11-1). Two mean residence dates of $6,270 \pm 50$ B.P. and $5,230 \pm 50$ B.P. on organic sediment from which the cultural material were in direct association occur during this same time period and provide support for the ages obtained on the carbonized plant materials..

The OSL dating of alluvial deposits continued with the analyses of two sediment samples (#1242 and #1243) from Early Archaic context in different locations in Block A. Sample #1242 was collected from a brown (10YR 3/2) silty clay loam in Unit N106/E50 between 80 and 88 cmbs and stratigraphically below the dated younger components and about 10 cm above the gravels. Sample #1243 was collected from Unit N103/E51 between 94 and 102 cmbs and in the earliest part of the fine alluvial sediments.

The detailed methods and results of the OSL technique are presented in Appendix L and only a summary is presented here. The two sediment samples from the Early Archaic context again did not yield many single dateable quartz grains. Only seven percent of the measured grains in sample #1242 or UW1051 and only 24 percent of the measured grains in sample #1243 or UW1052 were dateable (Appendix L). The central age determination from the fine grains

provides an average age for each sample. Sample #1242/UW1051 yielded an age of $6,670 \pm 1,110$ years before A.D. 2004. Sample #1243/UW1052 yielded an age of $5,000 \pm 864$ years before A.D. 2004. Both of these age determinations are compatible with the radiocarbon results.

It appears, then, that the OSL dating technique on the fine-grained sediments from alluvial deposits provides a reasonable strategy for determining relative ages on sediments. The OSL dates determined for the two younger components match reasonably well with the charcoal and other organic materials dated in each of those components, and they are also congruent with their relative stratigraphic positions. Therefore, in situations where early occupations do not yield preserved organic materials for radiocarbon dating, OSL dating of sand-grains within sediment matrices may serve as a reasonably reliable alternative method for obtaining chronological information.

The 83-m² hand-excavation in Block A yielded 56,644 items of cultural origin, including 51,869 pieces of lithic debitage, 3,044 burned rock fragments, 229 faunal bone fragments, 223.5 g of organic remains, 1,038 edge-modified flakes, 170 dart points, 198 bifaces, 27 scrapers, 17 drills, four unifaces, three gouges, two choppers, one hammerstone (#128-5-11), one faceted stone (#739-11), 25 cores, seven mussel shell fragments, and nine features. Each category is described and discussed below.

11.2 EARLY ARCHAIC FEATURES

Nine clusters cultural material were recognized and assigned feature numbers in the field and subsequently assigned to this component. All clusters were comprised mainly of burned rocks and classified into the same basic categories identified in the previously discussed site components, namely, hearths ($n=2$), burned rock dumps ($n=2$), and burned rock clusters ($n=5$).

Hearths were areas of intentional *in situ* burning as evidenced by oxidized earth, ash, charcoal lenses, and systematically placed stones. Hearths may be within basins or pits, or may rest on level planes. Burned rock clusters are concentrations of burned rocks lacking characteristics that would indicate direct, *in situ* heating. A dump was a concentration of burned rocks deposited in one place and sometimes containing more than one class of cultural debris. The nine features were all discovered in excavation Block A. Each feature is described individually below within its assigned category.

11.2.1 Hearths ($n=2$)

11.2.1.1 Feature 40

Feature 40 was a hearth found between 100 and 111 cmbd in Unit N100/E54 in the southern part of Block A. This hearth was a tight cluster of burned rocks with a semi-circular outline that measured 69-by-72 cm (Figure 11-1).

Figure 11-1. Planview of Feature 40, Early Archaic

Although the rocks did not form a complete circle, no obvious signs of disturbance were detected along the eastern side. The burned rocks along the western side appeared more systematically placed with the outer rocks in contact with one another. Near the center, five or six smaller burned rocks were at slightly lower elevations than the larger ones in the immediate vicinity, possibly indicating a slight basin. The matrix outside the burned rocks was a very dark grayish brown (10YR 3/2) with a slightly lighter grayish brown (10YR 5/2) matrix just below the burned rocks.

The 42 burned rocks weighed a total of 17,750 g, for an average rock weight of 423 g (Table 11-2). About 36 percent of the burned rocks were 4.1 to 9.0 cm in diameter, with another 55 percent in the 9.1 to 15 cm size class. Three larger pieces were complete round, water-worn cobbles and six to seven were tabular slabs.

Four burned rocks were selected for lipid and stable carbon and nitrogen isotope analyses. Drs. Malainey and Malisza's detail findings and interpretations are presented in Appendix G, with a summary of the results presented here (see also Table 11-3). Samples #128-5-3-1a and #128-5-3-4a yielded moderate to high fat content, with the former believed to represent plant matter. Samples #128-5-3-2a and #128-5-3-3a yielded high fat content that reflects lipids from plants. The carbon isotope values on these same samples range from -23.9 to -25.1‰, with a mean of -24.6‰ (Table 11-4). These reflect C₃ plants or animals that ate C₃ plants. The nitrogen isotope values range from 5.6 to 8.2‰ and are all relatively positive. The combined results indicate the possibility that these burned rocks were used to cook mainly C₃ plants, none of which are likely to have been legumes. Six liters of matrix (#128-5-4) from around the burned rocks between 100 to 110 cmbd were collected and floated. The less than 0.1 liters

light fraction was sent to Dr. Dering for macrobotanical analysis. No identifiable plant remains were present (Appendix I). The heavy fraction was sorted and yielded 44 tiny chert pieces, 29 tiny charcoal pieces, and 23 tiny bone fragments. The 6.4 mm mesh yielded 24 tiny chert pieces and nine tiny charcoal pieces.

Twenty-two tiny pieces of charcoal (#128-5-4-7-2a) were sent for radiocarbon dating. These yielded a $\delta^{13}\text{C}$ corrected (-26.2‰) AMS radiocarbon date of 5,200 ± 40 B.P. (Table 11-1: Beta-170409). Part of this same dated sample was sent to Dr. Dering, and one piece was identified as oak wood (Appendix I). Outside Feature 40, this unit-level yielded 239 pieces of lithic debitage and four edge-modified tools.

The circular placement of the rocks, combined with the presence of charcoal, indicates this was a place of *in situ* burning (probably a hearth). It is not clear if the tiny bone fragments and lithic debitage were directly associated with the hearth during the occupation or post-depositionally displaced.

11.2.1.2 Feature 41

Feature 41, interpreted as a hearth, lay between 76 and 86 cmbd in Unit N101/E50 in the southern part of Block A and about 120 cm west of Feature 29. This hearth consisted of 41 burned rocks in a tight cluster forming a somewhat circular-to-oval pattern in plan view (Figures 11-2 and 11-3). The cluster measured 58-by-70 cm in diameter and was mostly one rock thick, except for a few burned rocks that lay below the others. Most pieces were lying flat, with the two largest burned rocks along the western margin slanted downward towards the middle of the cluster. The larger pieces rested at the outer margins of the cluster. The clay loam matrix between the burned rocks was indistinguishable from that outside the cluster.

Table 11-2. Burned Rock Characteristics from Features 40, 41, 27, 39, 12, 23, 26, and 31

Fea. No.	Unit No.	Depth (cm)	Cat. #	Size (cm) and Weight (g)							Material Type ¹				Fracture Type ²			Total Count	Total Wgt (g)
				0-4	Wgt	4.1-9	Wgt	9.1-15	Wgt	>15.1	LS	SS	Qtz	O	Ang.	Rnd.	Tab.		
40	N100/E54	100-110	128	4	250	15	1,000	23	16,500	0	15							42	17,750
	Total			4	250	15	1,000	23	16,500	0	15	0	0	0	0	0	0	42	17,750
41	N101/E50	76-86	183	0	0	30	5,750	9	5,000	2	3,500	9			17	5	19	41	14,250
	Total			0	0	30	5,750	9	5,000	2	3,500	9	0	0	17	5	19	41	14,250
27	N109/E56	36-54	740	25	500	30	3,750	16	8,750	11	26,000	82			60	0	22	82	39,000
	Total			25	500	30	3,750	16	8,750	11	26,000	82	0	0	60	0	22	82	39,000
39	N101/E52	85-99	203 & 204	12	1,000	10	3,500	9	6,000	1	2,500	32			13	1	18	32	13,000
39	N102/E52	80 to 100	299 & 300	11	500	3	1,000				14				7		7	14	1,500
	Total			12	1,500	10	4,500	9	6,000	1	2,500	46	0	0	20	1	25	46	14,500
12	N108,109/E51	40-50	644	0	0	4	500	1	750	0	0	5			4	0	1	5	1,250
	Total			0	0	4	500	1	750	0	0	5	0	0	4	0	1	5	1,250
23	N109/E55	30-55	734, 735, & 736	20	250	44	6,250	42	23,500	3	4,850	109						109	34,850
23	N108/E55	40-50	670	4	100	7	1,000	7	4,750	3	6,000	21			15		6	21	11,850
	Total			24	350	51	7,250	49	28,250	6	10,850	130	0	0	15	0	6	130	46,700
26	N107/E56	50-60	615	3	250	4	250	0	0	0	0	7			7	0	0	7	500
26	N107/E56	60-70	616	6	1250	7	3,000	0	0	0	13				8	0	5	13	4,250
	Total			9	1,500	11	3,250	0	0	0	20	0	0	0	15	0	5	20	4,750
31	N110/E56	40-47	756	14	200	5	1,250	7	4,500	3	3,600	6			21	0	8	29	9,550
	Total			14	200	5	1,250	7	4,500	3	3,600	6	0	0	21	0	8	29	9,550

1. LS = limestone, SS = sandstone, Qtz = quartzite, O = other 2. Ang. = angular, Rnd. = round, Tab. = tabular

Table 11-3. Lipid Residue Results from Burned Rock Samples from the Early Archaic Component

Lab. No.	Cat. #	Fea. No.	Material	Wgt (g)	Interpreted Lipid Residue Results
4VG 100	644-5-3-1a	12	Limestone	28	Very high fat content – plant
4VG 101	644-5-3-2a	12	Limestone	48	Moderate-high fat content –plant
4VG 102	644-5-3-3a	12	Limestone	40	High fat content – plant
4VG 96	658-5-3-1a	13	Limestone	134	Borderline high and very high fat content – plant
4VG 97	658-5-3-2a	13	Limestone	30	Very high fat content – plant
4VG 98	658-5-3-3a	13	Limestone	22	Moderate-high fat content – plant
4VG 99	658-5-3-4a	13	Limestone	41	High fat content – plant
4VG 81	616-5-3-1a	26	Limestone	120	Borderline high and very high fat content – plant
4VG 82	616-5-3-2a	26	Limestone	128	Moderate-high fat content
4VG 83	616-5-3-3a	26	Limestone	11	Moderate-high fat content
4VG 84	757-5-3-1a	31	Limestone	36	Very high fat content – plant
4VG 85	757-5-3-2a	31	Limestone	75	Borderline high and very high fat content – plant
4VG 86	757-5-3-3a	31	Limestone	65	Very high fat content – plant
4VG 87	757-5-3-4a	31	Limestone	24	High fat content – plant
4VG 88	203-5-3-1a	39	Limestone	28	Moderate-high fat content – plant
4VG 89	203-5-3-2a	39	Limestone	33	Moderate-high fat content – plant
4VG 90	203-5-3-3a	39	Limestone	22	Moderate-high fat content – plant
4VG 91	203-5-3-4a	39	Limestone	98	Borderline medium and moderate-high fat content – plant
4VG 92	128-5-3-1a	40	Limestone	45	Moderate-high fat content – plant
4VG 93	128-5-3-2a	40	Limestone	36	High fat content – plant
4VG 94	128-5-3-3a	40	Limestone	21	High fat content – plant
4VG 95	128-5-3-4a	40	Limestone	37	Moderate-high fat content

Table 11-4. Isotope Results from Burned Rocks in Early Archaic Context

Cat. #	Unit No.	Depth (cmbs)	Fea. No.	Wgt (mg)	N Wgt (µg) ¹	δ ¹⁵ N (‰)	C Wgt (µg)	δ ¹³ C (‰)
644-5-3-1b	N108/E51	40-50	12	7.149	3.9	-11.67	60.9	-26.63
644-5-3-1b	N108/E51	40-50	12	11.745	52.8	1.35	834.9	-25.61
644-5-3-3b	N108/E51	40-50	12	30.054	77.5	3.75	1820.8	-23.64
658-5-3-1b	N108/E53	40-60	13	19.781	35.2	6.02	1408.3	-30.74
658-5-3-3b	N108/E53	40-60	13	7.308	27.1	2.91	337.4	-25.78
658-5-3-1b	N108/E53	40-60	13	3.415	20.1	1.89	593.4	-25.02
658-5-3-4b	N108/E53	40-60	13	43.887	17.4	6.42	2853.2	-30.26
616-5-3-1b	N107/E56	50-60	26	22.694	92.3	4.65	1385.5	-24.15
616-5-3-2b	N107/E56	50-60	26	39.737	56.7	2.82	905.3	-24.47
616-5-3-3b	N107/E56	50-60	26	30.052	63.2	6.03	938.0	-22.21
757-5-3-1b	N109/E56	36-54	31	9.052	4.7	1.47	111.6	-26.89
757-5-3-4b	N109/E56	36-54	31	7.039	23.1	5.79	439.0	-25.26
756-5-3-2b	N110/E56	40-50	31	1.000	2.0	5.44	147.7	-26.71
756-5-3-3b	N110/E56	40-50	31	30.070	90.4	6.14	987.0	-23.77
203-5-3-4b	N101/E52	85-99	39	16.736	81.4	1.90	1298.6	-25.76
203-5-3-1b	N101/E52	85-99	39	30.703	99.0	6.06	1390.0	-25.48
203-5-3-3b	N101/E52	85-99	39	30.518	137.1	6.49	1420.9	-23.69
128-5-3-4b	N100/E54	100-110	40	12.956	32.7	8.16	569.7	-23.88
128-5-3-1b	N100/E54	100-110	40	15.867	41.4	5.67	597.2	-25.12
128-5-3-3b	N100/E54	100-110	40	30.871	128.4	5.95	1563.0	-24.66
128-5-3-2b	N100/E54	100-110	40	32.291	48.4	6.50	791.0	-24.70

1. Values below 10.0 make the results suspect

2. C = Carbon; N = Nitrogen

Figure 11-2. Planview of Feature 41

Figure 11-3. Oblique Angle of Feature 41

Just below the rocks, the matrix changed to a lighter brown and became slightly siltier and the natural stream gravels became more abundant than the cultural burned rocks. No obvious basin was distinguished, but the variations in rock depths are suggestive of such. No charcoal or ash lenses, or burned matrix were detected such as would indicate *in situ* burning.

The 41 burned rocks weighed a total of 14,250 g, with an average rock weight of 348 g. The burned rocks varied from 4.1 cm to greater than 15 cm in diameter (Table 11-2). Seventy-three percent of the burned rocks fell into the 4.1 to 9 cm diameter size class. The lack of the smallest size category may indicate a bias on the excavator's part to record this size class or could reflect an actual absence of pieces in this size class. The remaining level in this unit yielded 382 pieces of lithic debitage, 27 *Rabdotus* snail shells, one bone fragment, one drill (#183-021), and 11 edge-modified flakes (#128-10 through 20).

The level containing the base of the burned rocks yielded similar types of cultural materials, but in reduced quantities. Some 21 limestone burned rocks weighing 9,750 g were outside Feature 41, but a nearly 20 cm-wide void was observed between the feature rocks and those scattered outside (Figures 11-2 and 11-3).

11.2.2 Dumps ($n=2$)

11.2.2.1 Feature 27

Feature 27 was discovered in the northeastern corner of Block A in Unit N109/E56 between 36 and 55 cmbd. This burned rock feature was on the eastern margin of a sizeable (50 cm-diameter) natural boulder and was directly on a bed of rounded river gravels (Figures 11-4 and 11-5). Feature 27 was located about 60 cm east of Feature 23 and about 200 cm north of Feature 26. All three features were at approximately the same elevation. Tiny rootlets were present throughout this feature, but no visible rodent disturbances were detected in this gray (10YR 5/1) clay loam. This was an amorphous cluster of 82 burned rocks weighing 39 kg, a few chunks of charcoal, a few bone fragments, quantities of scattered lithic debitage, into which were intermixed a few stone tools.

Figure 11-4. Planview of Feature 27, Early Archaic

Figure 11-5. Overview of Excavated Feature 27

A light red stain was visible across the top of the feature and in the feature matrix. This cluster measured about 80-by-100 cm in diameter and was about 15 cm thick. No basin or pit, charcoal or ash lenses, or other signs of *in situ* burning were observed. The burned rocks were in two irregular layers, and only a few burned rocks were vertically orientated or had a detectable dip

in orientation. The 82 burned rocks varied from two to greater than 15 cm in diameter with two thirds less than 9 cm in diameter (Table 11-2). The average burned rock weight was 476 g. No lipid residue or isotope analyses were conducted on any of these burned rocks.

Two liters of matrix (#740-5-4) from around the burned rocks at 40 to 45 cmbd were collected and floated in the laboratory. The light fraction was macroscopically inspected, but no burned plant remains were observed. The heavy fraction yielded 76 tiny chert pieces, seven tiny charcoal pieces, four seed-like objects and seven tiny bone fragments. One tiny bone was calcined. The 6.4 mm mesh yielded two tiny burned rock pieces, 12 tiny chert pieces, 12 nearly complete snail shells and one bone fragment.

11.2.2.2 Feature 39

Feature 39 was a loose cluster of burned rocks in Unit N102/E52 in the southern part of Block A (Figure 11-6). The burned rocks rested between 85 and 99 cmbd in a gray (10YR 5/1) clay loam intermixed with natural gravel. The burned rocks appeared to rest directly on or a few centimeters above the abundant river gravels with a few burned rocks and other cultural debris filtering down between the natural gravels. No obvious rodent or root disturbances were detected.

The burned rocks were in no detectable arrangement or pattern, and the outer boundary was unclear. Depending on where the arbitrary boundary to demarcate this cluster is drawn, the contents and number of items in this feature changes considerably. The burned rocks scattered across the southern section of Feature 39 (N101/E52, between 80 and 100 cmbd) appeared to be associated with other cultural debris.

Figure 11-6. Planview of Feature 39, Early Archaic

The latter included a badly burned medial section of a broad dart point (#204-10) and a Merrell point (#203-13) recovered on the south edge of Unit N101/E52 at 90 cmbd. Five edge-modified rejuvenation flakes, four edge-modified flakes, a biface (#203-15), a core (#203-16), a few chunks of charcoal, and

872 pieces of lithic debitage were recovered. The northern section in Unit N102/E52, between 80 and 100 cm, exhibited the more tightly clustered burned rocks and also yielded 728 pieces of lithic debitage, four bifaces (#299-12, #300-16, #300-17, #300-18), one Merrell point (#299-14), three untypable dart points (#299-13, #300-15 and #300-19), a scraper (#300-10), a core (#300-14), five edge-modified flakes, and a rejuvenation flake (#299-15).

Burned rocks in the larger ovate area included 46 pieces, weighing 14.5 kg or 315 g per rock (Table 11-2). This area measured about 90-by-80 cm in diameter and most of the burned rocks were within a 15-cm vertical range. No charcoal, ash, or oxidation lenses were detected. All three of the smaller size classes under 15 cm are nearly equally represented by number. Distinctly angular fragments were slightly more abundant than were less angular ones.

Four burned rocks were selected for lipid residue analysis. Drs. Malainey and Malisza's detail findings and interpretations are presented in Appendix G. A summary of the results is presented here (Table 11-3). Three samples (#203-5-3-1a, #203-5-3-2a, and #203-5-3-3a) yielded moderate to high fat content interpreted to represent plants. Sample #203-5-3-4a yielded residues that are borderline medium and moderate to high fat content, again interpreted as representing plants. Parts of the same four burned rocks were subjected to stable carbon and nitrogen isotope analyses. The carbon isotope values on these same samples range from -23.7 to -25.8‰ with a mean of -25.0‰ (Table 11-4), representing C₃ plants or animals that ate C₃ plants. The nitrogen values reflect a broad range from 1.9 to 6.5‰ with an average of 4.8‰. The combined results imply that these burned rocks were used to cook mostly C₃ plants or animals that ate C₃ plants.

Twelve liters of matrix (#203-5-4) for flotation were collected from around the tighter cluster of burned rocks between 85 and 99 cmbd in Unit N101/E52. The light fraction yielded 56 tiny charcoal pieces. The heavy fraction yielded 530 tiny pieces of chert debitage, 204 tiny charcoal pieces, six seed-like objects, and 10 tiny bone fragments. The 6.4 mm size fraction yielded 178 pieces of chert debitage, five charcoal pieces, three tiny burned rock fragments and three stone tool fragments (two distal projectile points and one rejuvenation flake).

Only about 0.5 liter of matrix for flotation (#204-5-4) was collected from around the few burned rocks between 90 and 100 cmbd in Unit N101/E52. The light fraction yielded 36 tiny charcoal pieces. The heavy fraction yielded 48 pieces of chert debitage, 109 tiny charcoal pieces, and five tiny bone fragments. The 6.4 mm fraction yielded 10 pieces of chert debitage, 10 charcoal pieces, and one small bone fragment.

Tiny chunks of charcoal were recovered from the southern unit, N101/E52, and seven tiny pieces (0.1 g) (#203-5-4-2-1) were sent for radiocarbon dating. These yielded a $\delta^{13}\text{C}$ corrected (-21.9‰) AMS radiocarbon date of $2,230 \pm 40$ B.P. (Table 11-1: Beta-170408). Four pieces from part of this same dated sample were identified as mesquite wood (Appendix I). This date reflects a Late Archaic age, and therefore, the charcoal is considered intrusive into this earlier feature/occupation, and the age is rejected as it is non-representative of the Early Archaic component.

The diversity of cultural debris amongst these burned rocks would imply this location was probably a discard or dump locality rather than an *in situ* burning or cooking location. This accords with the lack of a formal shape to this

cluster and the absence of any concentrations of charcoal or ash within the feature.

11.2.3 Burned Rock Clusters ($n=5$)

11.2.3.1 Feature 12

Feature 12 was a small cluster of five burned rocks in the very northeastern corner of Unit N108/E51 in Block A (Figure 11-7). These rocks rested between 45 and 50 cmbd directly above or resting immediately upon the natural river gravels. This cluster measured about 40-by-25 cm in diameter. The surrounding matrix was a dark gray (5YR 4/1) clay loam, the same as outside the feature. Minor termite damage was the only disturbance noted. No basin or pit, or other signs of *in situ* heating such as charcoal or ash lenses, or oxidation were detected. No individual chunks or flecks of charcoal were observed during the excavation.

Figure 11-7. Planview of Feature 12, Early Archaic

Four of the five burned rocks were in the 4.1 to 9 cm size class with one greater than 9.1 cm (Table 11-2). The average rock weight is 250 g. Two of the larger pieces were rounded water worn cobbles that were still complete, but had internal discoloration indicating they had been heated. Most pieces appeared to have water worn exterior edges. Two sets of rocks (a total of 4 pieces), could be refit one to another. One was a spall from a larger piece.

Parts of four burned rocks were sent for lipid residue and stable carbon and nitrogen analyses. The detailed findings and interpretations from lipid residue analysis on three rock samples are presented in Appendix G, with the results summarized here (also, see Table 11-3). All three samples (#644-5-3-1a, #644-5-3-2a, and #644-5-3-3a) yielded variations of high fat content interpreted to represent plants. These results suggest that the same kind of food was cooked using these rocks, hinting perhaps at a single cooking event. The carbon isotope values on these same samples range from -23.6 to -26.6‰, with a mean of -25.3‰ (Table 11-4), representing C₃ plants or animals that ate C₃ plants. The nitrogen isotope values range from 1.3 to 3.82‰ and are all relatively low, with a value of -11.7‰ from #644-5-3-1b; these results are questionable due to this very low representation of nitrogen. The combined results at least indicate the possibility these burned rocks were used in the cooking of mostly C₃ plants or animals that ate C₃ plants.

Two liters of matrix from around and below the burned rocks at 35 to 50 cmdbd were collected and floated. The less than 0.1 liters of light fraction (#644-5-4-1) was sent to Dr. Dering, but yielded no identifiable carbonized plant remains (Appendix I). The heavy fraction yielded 33 pieces of chert debitage, and the 6.4 mm mesh yielded four pieces of chert debitage.

11.2.3.2 Feature 13

Feature 13 was small cluster of nine burned rocks in an area of about 50-by-50 cm between 50 and 54 cmbs in the northwestern corner of Unit N108/E53 (Figure 11-8). Natural stream cobbles were also present immediately under the burned rocks. No obvious disturbances were noted; only tiny rootlets were observed. No charcoal or ash lenses were detected, nor was there any oxidation of the matrix or sign of a basin or pit. The nine burned rocks were within a 5-cm of vertical distance of each other, indicating their association.

Data on sizes and weights were not recorded for the rocks in this feature. The sample of rocks collected included one-half of a rounded cobble, one large burned rock that was greater than 15 cm diameter and one complete cobble that was burned but not broken. One collected piece is a complete water worn cobble with a slightly pinkish internal pink.

Figure 11-8. Planview of Feature 13, Early Archaic

Four limestone burned rocks were sent for lipid residue analysis. Drs. Malainey and Malisza's

detailed findings and interpretations are presented in Appendix G, and the results are briefly summarized here (see also Table 11-3). All four samples (#658-5-3-1a, #658-5-3-2a, #658-5-3-3a, and #658-5-3-4a) yielded variations of high fat content interpreted to represent plants. These results imply that the same type of food was cooked, possibly representing as single cooking episode. The carbon isotope values on these same samples range from -25.1 to -30.7‰, with a mean of -27.9‰ (Table 11-4). These reflect C₃ plants or animals that ate C₃ plants. The nitrogen values range from 1.9 to 6.4‰, with an average of 4.3‰. The combined results indicate that it is probable that these burned rocks were used mostly to cook C₃ plants or animals that ate C₃ plants.

One liter of matrix (#658-5-4) from around and below the burned rocks between 50 and 60 cmbd was collected and floated. The light fraction did not yield any macrobotanical remains for analysis. The heavy fraction yielded 13 pieces of chert debitage, two tiny charcoal pieces, and one bone small bone fragment. The 6.4 mm size mesh yielded six pieces of chert debitage that.

The upper part of the feature rocks (40 to 50 cmbd) was associated with 154 pieces of lithic debitage and six edge-modified tools. The lower part of the feature (50 to 60 cmbd) in Unit N108/E53 yielded 229 pieces of lithic debitage, six edge-modified tools, four bone fragments, three projectile points, and one core (#658-20). The three points include one Merrell (#658-16) and two Martindales (#658-17 and 658-18).

The current data indicate that these burned rocks were employed in some kind of cooking activity, but it is unclear if these were intentionally dumped or merely randomly clustered burned rocks. The apparent extensive use of this location has mixed the constituent materials,

thus making specific associations that could clarify the origin of the rock cluster.

11.2.3.3 Feature 23

Feature 23 was a large cluster of burned rocks in the northeastern corner of Block A in Units N108/E55 and N109/E55 (Figures 11-9 and 11-10), that covered an area about 90-by-110 cm in diameter. The burned rocks, concentrated between 38 and 50 cmbd, were intermixed with other cultural debris such as lithic debitage, stone tools, and some bone fragments. No clear boundaries, obvious basin, oxidized matrix, or charcoal/ash lenses were observed. The depths of burned rocks varied slightly, which does implies the presence of at least a very shallow basin. The matrix surrounding the feature was the same color and texture as the matrix between the rocks.

The 130 burned rocks in this feature include pieces in all size classes with the 4.1 to 9 cm and 9.1 to 15 cm classes in nearly equal numbers and accounting for 77 percent of the total (Table 11-2). The average rock weight was about 359 g.

Four liters of matrix from slightly different elevations in the feature were collected and floated. The resulting light fraction (#735-5-4) was macroscopically inspected, but no burned plant material was found. Three levels of heavy fraction yielded similar types of materials. The upper part (#734-5-4) from 30 to 40 cmbd in Unit N109/E55 yielded 10 pieces of chert debitage and only two tiny pieces of charcoal. At 36 to 45 cmbd, another sample (#735-5-4) yielded one tiny burned rock fragment, 26 pieces of chert debitage, one whole snail shell, and one tiny bone fragments. The 6.4 mm mesh yielded four pieces of chert debitage, and four nearly complete snail shells.

Figure 11-9. Planview of Feature 23

Figure 11-10. Oblique Angle of Feature 23

The sample from 45 to 52 cmbd yielded 35 tiny chert debitage, 12 pieces of charcoal, and two tiny bone fragments. The 6.4 mm mesh yielded 13 pieces of chert debitage, eight tiny charcoal pieces, and one tiny projectile point tip.

One tiny chunk of charcoal (#735-5-7) from among the burned rocks in the feature yielded a $\delta^{13}\text{C}$ corrected (-25.6‰) AMS radiocarbon date of $6,280 \pm 50$ B.P. (Table 11-1: Beta-170407). Part of that sample was sent for macrobotanical analysis, but the pieces were too small for identification (Appendix I). This is the oldest charcoal date obtained for the Varga Site and it is substantiated by another charcoal sample (#570-7-1a) from Unit N107/E50 that yielded a date of $6,100 \pm 40$ B.P. (UGA-12721). A humate sample (#1207-4-A) from 100 cmbs in BT M-1 yielded a $\delta^{13}\text{C}$ corrected (-21.9‰) AMS radiocarbon date of $6,270 \pm 50$ B.P. (Table 11-1: Beta-170394), again supporting the relatively early age for the cultural materials.

Abundant lithic debitage, some tiny bone fragments, several stone tools, and a few chunks of charcoal were associated with the burned rocks. These cultural materials rested just a few centimeters above a layer of dense river gravel.

11.2.3.4 Feature 26

Feature 26 was discovered between 56 and 63 cmbd in Unit N107/E56 along the eastern edge of Block A and only 100 cm south of Feature 23 and 150 cm south of Feature 27. The feature was a few centimeters above the river gravels, and the matrix that surrounded the burned rocks was dark brown (10YR 4/3) clay loam. This was an elongated cluster of small burned rocks dispersed over an area that measured 50-by-70 cm (Figures 11-11 and 11-12). This cluster lacked an obvious form in plan view. No basin or pit was revealed in the cross section, nor was there any color or texture change in the matrix, and lenses of charcoal or ash were not present. The basal elevations of the rocks varied about 7 cm.

The 20 burned rocks varied from 2 to 9 cm in diameter with a nearly equal number in each of the two smallest size categories (Table 11-2). These were limestone pieces that exhibited mostly angular forms. One piece had a hackled edge implying a rapid temperature change. One 6 cm diameter rock was still complete. The average rock weight was 238 g.

Three burned rocks from this cluster were selected for lipid residue analysis (see Appendix G for details; see also Table 11-3, this chapter). Two samples (#616-5-3-2a and #616-5-3-3a) yielded moderate to high fat content. The third sample (#616-5-3-1a) yielded borderline high to very high fat content interpreted to represent plants. These results generally imply that the same type of food was cooked, and it is possible that only one cooking episode is represented. The carbon isotope values on these same samples range from -22.2 to -24.5‰, with a mean of -23.6‰ (Table 11-4), representing C₃ plants or animals that ate C₃ plants. The nitrogen values range from 2.8 to 6.0‰, with an average of 4.5‰. The combined results indicate that it is likely that these rocks

Figure 11-11. Planview of Feature 26

Figure 11-12. Overview of Feature 26

were used to cook mostly C₃ plants or animals that ate C₃ plants.

Six liters of matrix (#615-5-4) from between the burned rocks at 56 to 64 cmbd were collected and floated. The less than 0.1 liters of light fraction was sent to Dr. Dering for

macrobotanical analysis. He identified two pieces of juniper wood, and 15 pieces of indeterminate taxa (Appendix I). The heavy yielded three tiny burned rock fragments, 83 chert debitage pieces, eight nearly complete snail shells, one tiny point tip fragment, and nine small faunal bone fragments. The 6.4 mm mesh yielded 303 tiny chert pieces, 66 tiny charcoal pieces, two seed-like pieces and 34 tiny bone fragments. Two of the latter bone fragments were burned, as were three tiny walnut shell fragments.

Seven tiny pieces of charcoal (#616-5-7-1a) recovered from 64 cmbd among the burned rocks yielded a $\delta^{13}\text{C}$ corrected (-23.2‰) AMS radiocarbon date of $5,640 \pm 40$ B.P. (Table 11-1: UGA-12724). A second sample consisted of two burned prickly pear cactus seeds from just above this level (#615-5-7-2a), yielded a $\delta^{13}\text{C}$ corrected (-11.6‰) AMS radiocarbon date of $5,660 \pm 40$ B.P. (UGA-12723).

The level between 50 to 60 cmbd yielded three bifaces (#615-5-16 through 18), two projectile points (1 untypable [#615-5-19], and one Merrell point [#615-5-20]), eight edge-modified flakes (#615-5-10 through 15), 161 pieces of lithic debitage, three tiny bone scraps, and *Rabdotus* land snail shells. The level just below, from 60 to 70 cmbd, yielded two edge-modified flakes (#616-5-10 and 11), 273 pieces of lithic debitage, one bone, and many whole *Rabdotus* snail shells. The lack of patterning of the burned rocks, no sign of *in situ* burning, combined with the presence of other cultural debris in the immediate vicinity indicates these burned rocks were dumped or discarded at this location. This represents general camp maintenance activity and implies a residence of some duration.

11.2.3.5 Feature 31

Feature 31 was a burned rock cluster between 40 and 47 cmbd in Unit N110/E56 in the very northeastern corner of Block A (Figure 11-13).

foods. The carbon isotope values on these same samples range from -23.7 to -26.9‰, with a mean of -25.7‰ (Table 11-4). These values reflect C_3 plants or animals that ate C_3 plants. The nitrogen isotope values range from 5.9 to 6.1‰ with an average of 6.0‰ with two values of 1.5‰ and 5.4‰ that are not acceptable since the measured nitrogen weight is extremely low. The combined results indicate that these burned rocks cooked mostly C_3 plants or animals that ate C_3 plants.

Two samples (#757-5-3-1a and #757-5-3-3a) yielded very high fat content food such as in seeds or animal fats. The third sample (#757-5-3-2a) yielded borderline high to very high fat content interpreted to represent plants. The fourth sample (#757-5-3-4a) also yielded high fat content food. These results generally imply that the same type of food, probably derived from plants, was cooked, possibly in a single cooking episode.

Figure 11-13. Planview of Feature 31

Two liters of matrix from between the burned rocks at 40 to 50 cmbd was collected and floated. The less than 0.1 liters of light fraction (#756-5-4-1) was sent to Dr. Dering, but yielded no identifiable plant remains (Appendix I). The heavy fraction was carefully sorted and yielded 20 tiny burned rock pieces, 42 pieces of chert, four tiny charcoal pieces and one bone small fragment. The 6.4 mm mesh material yielded one tiny burned rock fragment, 13 pieces of chert, four nearly complete snail shells, and one unifacial chert tool fragment.

Twenty-five pieces of lithic debitage were recovered from within the boundaries of the feature. The rest of the containing level, between 40 and 50 cmbd, yielded 131 pieces of lithic debitage, eight bone fragments, three edge-modified flakes (#756-5-10, #756-10, and #756-13), and two bifaces (#756-5-11 and #756-11). This cluster of burned rocks, which lacked any sign of *in situ* burning or discernible shape, and contained apparently associated lithic debitage, is believed to be another discard area. Feature Summary and Discussion

11.2.4 Discussion of the Features

The nine Early Archaic features may represent a number of occupational events, as suggested by age differences in the 17 acceptable radiocarbon dates. The 17 radiocarbon ages are derived from six different materials that include deer bones, prickly pear seeds, a *Rabdotus* shell, sediments, walnuts, and wood charcoal. They all were obtained from three features plus isolated samples of organic material, and indicate a general time range between about 6,280 to 5,200 B.P. (Table 11-1). This 1,100-year interval falls within a chronological period that is currently not very well documented in the archeological record for Texas. More discussions concerning the importance of this age range will be presented later.

All nine features were clusters of burned rocks with similar characteristics indicating a generally similar set of behavioral patterns. The nine burned rock features yielded 395 burned rocks weighing 147,650 g, with an average rock weight of 374 g. The two hearths, Features 40 and 41 are thought to represent *in situ* burning location, whereas the two dumps are interpreted to be related to a cooking activity that utilized the burned rocks in some type of cooking event and then were discarded. The five-burned rock clusters are not as clear, since evidence for one specific interpretation is absent. These clusters lacked clear indications of basins, charcoal, ash, or burned lenses, and definite patterning to the rocks. With the presumed multiple events represented in this component, combined with the impossibility of making any intra-component stratigraphic distinctions, the identification of discrete behavioral patterns that linked together features and various classes of debris is not reasonably possible.

Identifications of charred materials from floated matrix extracted from four features and 20 non-feature samples reveal some 69 pieces of charcoal, and 10 ml of charred material. This limited sample provides minimal evidence with which to reconstruct the Middle Archaic environmental mosaic. Only juniper wood and prickly pear cactus seeds were identified in the floated material from the features. Scattered non-feature botanical samples include mesquite, oak, littleleaf walnut, and juniper. The first three species and indeterminate wood pieces were about equally represented with 0.6 to 0.7 g each. Charred juniper charcoal was nearly five times more frequent than any of the other species, implying that this may have been the dominant arboreal species in the immediate area. This may indicate an environment that is similar to today's conditions with certain species restricted to certain areas. It is not clear if the littleleaf walnut pieces represent food resources,

or they were attached to the wood pieces that were used for fuel.

11.3 STONE TOOL DESCRIPTIONS AND DISCUSSION

The 1,486 stone tools are not described individually, although individual attributes and metric characteristics have been recorded for each piece, with the exception of edge-modified flakes. Classes of tool forms such as scrapers and drills are presented with summaries of attributes and metric measurements provided. Tool classes are generally thought to represent certain types of activities, but several individual tools from various tool classes were arbitrarily selected for use-wear analyses to identify specific functions. Individual findings of the use-wear are presented following the class summaries.

11.3.1 Projectile Points

The 179 projectile points (from all contexts, with 170 points coming from Block A), all dart points, are subdivided into nine identifiable types that combine to account for 116 pieces, or 68 percent of the total point sample, plus 53 untypable point fragments. The typed specimens include 32 Gower, 22 Martindale, 21 Bandy, 15 “Group 1”, 12 Baker, 12 Merrell, seven “Group 2” (corner-notched), three Carrizo, and one Pandale, are presented by groups in order of their frequency.

The Gower point group contains the highest frequency, comprising 25.8 percent of the identifiable points in the Early Archaic component. Twenty-eight specimens were recovered from hand-excavations in Block A, one was recovered from BT 1, and three were collected from the surface (Figure 11-14). A summary of the Gower point data is presented below with individual characteristics presented in Appendix O. All 32 specimens were manufactured from fine-grained chert. Only

three percent of the Gower points retain any cortex. Of those, each specimen has cortex covering roughly 50 percent of the surface. About nine percent of the Gower points exhibit patination, with three percent or one specimen, exhibiting showing patination over 100 percent of their surface. Only 19 percent are complete or nearly complete, with 66 percent representing proximal ends, nine percent medial sections, and six percent distal fragments. Slightly over six percent were broken by intense heat, and the rest were broken during use. Not a single manufacturing break was recognized. About six percent are thought to bear the scars of rejuvenation-flake removal, whereas nine percent exhibit some edge beveling. About 44 percent exhibit slight edge rounding. The observed flaking pattern was indeterminate on 47 percent, or 15 specimens. Of those 17 pieces for which flaking patterns are recorded, 53 percent are subparallel, 35 percent are oblique subparallel, and 12 percent are “chevron”. In the 53 percent of the cases where the edges are sufficiently intact for shape determination, nearly 66 percent are straight, 28 percent are excurvate, and six percent are incurvate. The stem shape is 84 percent curved, nine percent indeterminate and six percent expanding. Gower point generally exhibit one large flake scar at the base, usually on one side and sometimes on both sides (Elton Prewitt, Personal Communication, September 30, 2003). The metric attributes are summarized in Table 11-5.

A complete, lanceolate shaped Gower point (#391-11) with bifacially beveled edges was subjected to high-powered use-wear analysis. Hafting wear is evident through abraded inter-flake ridges on the proximal end, and use residue in the form of plant fiber is along the edges near the distal end. Use-wear is present in the form of high-silica polish along the distal edges, suggesting use in the cutting and/or boring of plant material (Appendix C).

Figure 11-14. Selected Gower Points, Early Archaic

Left to Right: Top Row: #591-018, #632-016, #29-010, #333-022, #11-005-013, #153-028, #86-020
Second Row: #1216-010, #289-021, #228-014, #345-026, #411-016, #215-019, #289-022
Third Row: #50-013, #1206-010, #591-017, #345-027, #255-030, #62-014, #254-014

Table 11-5. Metric Measurements on Gower Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	37.3 - 62.7	46.9	9.5
Maximum width	11.7 - 25.4	19	3.5
Maximum thickness	3.6 - 8.3	6.6	1
Blade length	25.6 - 46.4	34.7	8.6
Blade width	11.7 - 22.3	16.1	2.3
Shoulder width	16.4 - 25.4	20.5	2.6
Left notch depth	1.3 - 5.3	2.5	1
Right notch depth	1.4 - 4.8	2.8	0.9
Left notch width	5.6 - 10.8	8.7	1.4
Right notch width	5.1 - 13.3	8.4	1.9
Left notch angle	42 - 115	68	18.5
Right notch angle	41 - 90	64	13.9
Stem length	9.0 - 19.0	13.8	2.5
Stem width	10.9 - 15.8	13.8	1.3
Proximal stem width	13.9 - 20.7	18.1	1.6
Distal stem width	13.4 - 17.1	15.8	1
Stem thickness	3.5 - 5.9	4.8	0.8
Base depth	3.1 - 8.2	5.5	1.2
Base notch width	6.8 - 11.5	9	1.5
Weight	2.2 - 7.3	4.6	1.7

Measurements in mm

Four Gower specimens (#86-20 = TRC132; #192-11 = TRC139; #215-21 = TRC141 and #1213-10 = TRC190) were sent for INAA. All four probably reflect different sources of Edwards chert that outcrops across the southwestern Edwards Plateau region, but from different specific sources (Appendix F). Presumably, the source areas were widely spaced areas across the region.

Of the twenty-nine Gower points recovered from Block A, 83 percent are from the southern part of the Block. Seven different units, six in the southern and one in the northern part, yielded multiple Gower points, with Units N101/E53 and N102/E51 each yielding three points. These occurrences may indicate retooling locations.

Twenty-one Martindale points were recovered from hand-excavations with one from BT 1 (Figure 11-15). All 22 Martindale points, are summarized below whereas data on individual specimens are presented in Appendix O. Only 36.4 percent are considered complete or nearly complete, with another 59.1 percent represented by proximal fragments and 4.5 percent by medial sections. Only one broken Martindale point, or 4.5 percent, was determined to be from a manufacture break, with all other breaks interpreted as use related. About 9.0 percent exhibit what are believed to be rejuvenation flake scars. Of the nearly 60 percent overall shape is visible, some 85 percent are triangular and 15 percent are lanceolate. These 22 specimens were all manufactured from fine-grained chert and exhibit no sign of cortex. About 18 percent appear to have been heat-treated, with another 13.6 percent having been burned. About 13 percent, or three points, exhibit some patination, one completely so. Nearly 68 percent are complete enough to reveal flake-scar patterning. Of those, 46.7 percent appear to have an oblique pattern, 40 percent have a chevron pattern, and 13 percent have a subparallel pattern. Edge rounding was observed on 54.5 percent. Of the 25 edges that are complete enough to provide an indication of their shape, 48 percent are straight, 40 percent are excurvate, eight percent are incurvate, and four percent are recurvate. Ninety-five percent exhibit expanding stems. A general overview of the size variation of the 22 Martindale points is provided through the summary of metric measurements in Table 11.6.

Two Martindale points (#141-21 and #591-19) were subjected to high-powered use-wear analysis. Specimen #141-21 is a fragment that exhibits a use break, and this piece exhibits light polish confined to the proximal end indicative of hafting. It did not exhibit any use-wear and the inferred use and contact material are unknown (Appendix C).

Figure 11-15. Selected Martindale Points, Early Archaic

Left to Right: Top Row: #19-014, #268-022, #854-010, #268-021, #347-014
Second Row: #658-018, #7-010, #9-014, #1201-010, #39-015
Third Row: #730-013, #40-013, #77-013, #230-013, #346-024

Specimen #591-19 is a complete point that lacks any sign of rejuvenation or resharping. It exhibits plant tissue and striations parallel and perpendicular to the long axis confined to the proximal end that indicates it was hafted. Raphides are randomly distributed on the surface, indicating that plants were part of the contact material (Appendix C). This is the only Early Archaic projectile to have raphides identified on it, and this may indicate this tool was also employed in cutting some type of agave plants.

Parts of five Martindale points were sent for INAA (#39-15 = TRC127; #77-13 = TRC131;

#268-21 = TRC144; #311-13 = TRC146; and #854-10 = TRC188). Four of the five points probably represent Edwards chert from the local region, whereas specimen #268-21 (TRC144), which exhibits a glassy brown color with light spots, and probably was heat-treated, is chemically different from most known Edwards chert (Appendix F). It also fluoresces a darker orangish color than most Edwards chert. It is assumed that this one piece is nonlocal in origin. Its darker fluorescence implies an origin in the river gravels of the Rio Grande valley (Quigg et al. 2000; Quigg and Cordova 2000).

Table 11-6. Metric Measurements on Martindale Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	34.8 - 57.8	48.9	8.2
Maximum width	5.1 - 8.6	7	0.8
Maximum thickness	24.2 - 37.6	30.7	4.2
Blade length			
Blade width	19.2 - 35.9	36.3	4.8
Shoulder width	24.2 - 37.6	30.9	4.3
Left notch depth	3.4 - 9.0	5.9	1.8
Right notch depth	4.1 - 9.5	6.5	1.8
Left notch width	8.0 - 14.1	10.1	1.8
Right notch width	7.1 - 15.9	10.6	2.9
Left notch angle	32 - 57	48	7.3
Right notch angle	23 - 51	36.8	9.9
Stem length	10.3 - 15.8	12.3	1.7
Stem width	15.7 - 23.2	20.1	1.8
Proximal stem width	18.0 - 27.8	23.2	2.4
Distal stem width	13.1 - 18.8	17.4	1.4
Stem thickness	3.3 - 5.8	4.6	0.6
Base depth	1.2 - 3.9	2.6	0.8
Base notch width	3.2 - 14.5	9.9	2.8
Weight	6.0 - 14.3	9.2	2.5

Measurements in mm

The 20 Martindale points were non-randomly scattered across Block A. Eighty percent were in the southern half of the Block. Five units yielding multiple points, and four of those units were in the southern half.

Twenty Bandy points were recovered from the Early Archaic component and one was retrieved from the surface of Block B. These specimens account for 11.8 percent of the 170 points from this component (Figure 11-16). Seven, or 33.3 percent, are complete, 57.1 percent are proximal fragments and 9.5 percent are medial fragments. All 14 broken specimens appear to have been broken during use. There is no

visible evidence of rejuvenation, and only a single specimen (4.8 percent) exhibits evidence of edge beveling. Of the 10 specimens complete enough to indicate the overall shape, all have triangular blades.

All 21 points were manufactured from fine-grained cherts and none retain any cortex. Nineteen percent appear to have been heat-treated and 23.8 percent are burned. Only one specimen is patinated, and is white in color over 100 percent of its surface. Flaking patterns are variable, but 38.1 percent did not sufficiently complete for identification of flaking pattern. Of those specimens on which patterning is discernible, 46.2 percent appear in a chevron pattern, 23.1 percent exhibit parallel flaking, 15.4 percent exhibit oblique flake scars, and 7.7 percent bear essentially a random flaking pattern. Edge rounding was detected on 52.3 percent. The lateral edges are generally straight (38.1 percent), whereas most others (57.1 percent) are indeterminate. Stem shape is 90 percent expanding. Bandy point metric measurements are summarized below, in Table 11-7.

Two Bandy points were sent for high-powered, use-wear analysis. Specimen #344-22 is a complete point that lacks rejuvenation and resharpening. It exhibits hard, high silica polish on the lower proximal end indicating it was hafted. Bone/antler use residue fragments were observed. This specimen was used as a projectile point that came in contact with bone/antler (Appendix C). Specimen #712-14 is complete with no sign of rejuvenation or resharpening. It exhibits hard, high silica polish use-wear restricted to the proximal end, and also bears impact striations. The use-wear indicates a hafted projectile (Appendix C).

Figure 11-16. Selected Bandy Points, Early Archaic

Left to Right: Top Row: #390-010, #400-011, #142-011, #347-013, #563-017
Second Row: #346-022, #689-020, #694-017, #651-011, #116-020
Third Row: #1204-010, #439-010, #531-018, #746-014, #599-015

Parts of four Bandy points (#116-20 = TRC133; #347-13 = TRC154; #400-11 = TRC158; and #719-10 = TRC183) were subjected to INAA. Three of the four exhibit chemical signatures similar to known Edwards chert from the region (Appendix F). Specimen #400-11 (TRC158) has a chemical signature beyond the currently known range of variation. This latter specimen has, however, the same ultraviolet fluorescence as the other Edwards chert specimens and is assumed to be Edwards chert. All four specimens probably represent Edwards chert from regional sources.

The 20 Bandy points were widely distributed across Block A, but only Unit N102/E56 yielded multiple Bandy points, along with two Martindale points. Sixty percent of the Bandy points were from the northern half of the block, in contrast to the distribution of Martindale points, whose distribution only partially overlaps.

Table 11-7. Metric Measurements on Bandy Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	30.8 - 55.8	39.5	3.1
Maximum thickness	3.4 - 6.8	4.7	0.17
Blade length	24.5 - 46.9	31.6	2.8
Blade width	19.4 - 30.8	25.7	1.1
Shoulder width	26.1 - 40.2	34	1.8
Left notch depth	4.2 - 9.1	6.8	0.39
Right notch depth	4.5 - 9.1	7	0.36
Left notch angle	14 - 51	34.3	2.7
Right notch angle	19 - 41	28.3	1.8
Stem length	5.4 - 10.8	8.2	1.1
Stem width	11.5 - 14.6	13.1	1.1
Proximal stem width	13.6 - 19.2	16.1	1.4
Average stem width	12.6 - 16.4	14.6	1.1
Stem thickness	2.4 - 4.8	3.2	0.6
Weight	2.1 - 5.3	3.9	0.52

Measurements in mm

Thirteen points classified here as Group 1 points, or 7.7 percent of the 170 points, were recovered from the Early Archaic component. Two of this group were found in BTs 1 and 2. These points exhibit a cluster of similar characteristics and cannot be assigned to any established type. All 15 points will be summarized below with individual characteristics presented in Appendix O. Only 27 percent are complete or nearly complete, and the others are represented by the proximal fragments (Figure 11-17). Thirteen percent were broken through excessive heating, whereas the rest were broken during use. No specimens exhibit rejuvenation scars, although 20 percent have beveled edges. Among the 13 specimens with a sufficient blade remaining, 82 percent have triangular outlines and 18 percent have lanceolate outlines. All were manufactured from fine grain cherts, and no cortex remains on their

surfaces. One specimen appears to have been heat-treated, and one other was burned. Thirteen percent exhibit some patination. Flaking patterns are observable on ten specimens. Three show a chevron pattern, three have subparallel flaking and two show an oblique flaking pattern. Seventy-three percent of the points exhibit edge rounding. In the 10 specimens that exhibit retain enough edge for identification, 80 percent of the blade edges are straight, 15 percent are excurvate, and five percent are recurvate edges. Table 11-8 summarizes the metric measurements for the individual Group 1 points, and shows the size variation in the recovered specimens.

Table 11-8. Metric Measurements on Group 1 Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	40.2 - 62.1	51.1	11.6
Maximum width	24.1 - 39.4	31.1	4
Maximum thickness	6.2 - 9.3	7.6	0.9
Blade length	27.3 - 45.0	36.6	9.4
Blade width	19.5 - 34.9	26.9	4.8
Shoulder width	25.8 - 39.4	31.8	3.5
Left notch depth	3.2 - 7.8	5.9	1.4
Right notch depth	11.5	2	1.1
Left notch width	8.8 - 14.1	11.5	2
Right notch width	8.6 - 19.0	11.3	2.9
Left notch angle	25 - 68	47	14
Right notch angle	20 - 56	35	10.6
Stem length	10.2 - 17.8	14.3	2
Stem width	14.3 - 21.5	18.1	1.8
Proximal stem width	19.0 - 24.5	22.2	1.8
Stem width	16.7 - 22.6	20.2	1.8
Stem thickness	3.5 - 6.3	4.8	0.9
Base depth	7.2 - 13.4	10.8	2
Base notch width	7.2 - 13.4	10.8	2
Weight	4.2 - 15.2	9.3	3.7
Measurements in mm

Figure 11-17. Selected Group 1 Points, Early Archaic

Left to Right: Top Row: #1203-010, #141-020, #628-012, #671-011, #334-023;

Second Row: #193-018, #599-016, #694-018, #1202-010, #665-016

Two Group 1 points were subjected to use-wear analysis. Specimen #599-17 is a nearly complete point that exhibits abraded flake-scar ridges and an impact fracture on the proximal end, indicating a hafted projectile point (Appendix C). Specimen #670-5-11 is nearly complete with no sign of resharpening or rejuvenation. It exhibits hard, high silica polish on the proximal end and an impact fracture on the distal end. It also appears to have functioned as a projectile point (Appendix C).

Parts of three Group 1 points were sent for INAA (#670-13 = TRC179; #671-11 = TRC180; and #1203-10 = TRC189). All three specimens have chemical signatures similar to that of known Edwards chert from the southwestern area of the Edwards Plateau (Appendix F).

These specimens were manufactured from locally available raw material.

Seventy-seven percent of the 13 Group 1 points were from the northern half of Block A. Only Units N107/E54 and N108/E55 yielded multiple Group 1 points. Some Group 1 points were recovered from the same units as Bandy, Martindale, Merrell, Gower, and Group 2 points. Since multiple events are represented, it is unclear how these different point types were originally associated.

Eleven Baker points are from the Early Archaic component, representing .5 percent of the 170 specimens from that context. An additional two specimens, presumably displaced, came from the Toyah component. These points are summarized as a group here, and individual

characteristics presented in Appendix O. Only 25 percent are complete and 67 percent represented by proximal fragments (Figure 11-18). Seventy-eight percent of the fragmentary specimens exhibit use breaks, with no obvious indication that any had been rejuvenated. All were manufactured from fine grained cherts and all lack any trace of cortex. Only 8.3 percent are interpreted to be manufactured from a flake, whereas the remaining 92 percent probably were produced from bifacial preforms. Only 8.3 percent appear to have been heat treated, and one other is burned. No specimens are patinated.

The overall shapes vary from triangular to lanceolate. The lateral edges vary slightly from basically straight to slightly excurvate. The edges appear slightly rounded in 58 percent of the specimens. Observed flaking patterns are oblique-parallel in 41.7 percent of the specimens and subparallel in 33.3 percent. The stem shape is expanding in 50 percent, curved in 33 percent, and straight in 17 percent. Table 11-9 summarizes the metric measurements from individual Baker points to provide a general overview of size and shape of the recovered specimens.

Figure 11-18. Selected Baker Points, Early Archaic

Left to Right: Top Row: #95-018, #28-013, #28-014, #462-015, #229-019;
Second Row: #569-013, #653-012, #431-010, #346-023, #117-021

Table 11-9. Metric Measurements on Baker Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	35.7 - 57	46.8	8
Maximum width	18.9 - 23.2	21	1.4
Maximum thickness	5.9 - 7.5	6.7	0.6
Blade length	23.1 - 45.2	34	8.3
Blade width	16.1 - 20.2	18.2	1.3
Shoulder width	21 - 23.2	21.7	0.8
Left notch depth	1.9 - 3.5	2.7	0.6
Right notch depth	1.8 - 4.8	3	1.1
Left notch width	7.3 - 11.8	9	1.7
Right notch width	7.1 - 13.2	10	2.1
Left notch angle	36 - 62	49	10
Right notch angle	25 - 63	42	13.5
Stem length	10.9 - 17.3	13.4	
Stem width	14.2 - 17.5	15.7	1.2
Distal stem width	12.9 - 16.2	14.8	1.2
Proximal stem width	14.9 - 18.5	16.6	1.3
Stem thickness	2.6 - 7.0	4.5	1.2
Weight	3.4 - 7.6	5.3	1.4
Measurements in mm			
Maximum length	35.7 - 57	46.8	8
Maximum width	18.9 - 23.2	21	1.4

The proximal section of a single Baker point (#140-24) was subjected to use-wear analysis. It exhibits use-wear in the form of polish and an impact fracture. It functioned as a projectile point, but contact material is unknown.

Parts of three Baker specimens (#117-21 = TRC134; #402-11 = TRC160; and #462-15 = TRC166) were subjected to INAA. The analysis reveals they are chemically similar to southwestern Edwards Plateau chert, but from chemically different source areas (Appendix F). The tools were apparently manufactured from locally available raw materials.

The 12 Baker points were scattered across Block A with only Unit N99/E52 yielding more than one specimen. That same unit also yielded

a Gower point. Bandy, Martindale, and Merrell points were infrequently recovered from the same unit as Baker points. The compressed stratigraphy undoubtedly had an impact on associations, and the seeming co-occurrence of these various types may simply be the result of resultant mixing of points that could well represent distinct episodes of occupation during the Early Archaic.

Eleven Merrell points, 6.5 percent of the 170 points, were recovered directly from Early Archaic component while one other specimen (#157-11) of this type was recovered from the Toyah component. All twelve are summarized here with individual characteristics presented in Appendix O. Seventy-five percent are proximal fragments, and the remaining 25 percent are complete or nearly complete points (Figure 11-19). The forms of breakage imply use-related damage, and no manufacture breaks detected. No points exhibit rejuvenation scars or resharpening through beveling. Of the seven for which blade shape can be detected, 57 percent are lanceolate and 43 percent are triangular. All points were manufactured from fine-grained chert, with no point exhibiting any sign of cortex. Eighteen percent are partially patinated and nine percent are completely patinated. One, or nine percent, appears to have been heat treated and three were burned. Of the eight points for which the flake pattern is revealed three are subparallel, three are oblique, and two are chevron. Eighteen percent exhibit some edge rounding. All blade edges on which configurations are discernible are straight. Seventy-three percent have expanding stems and 27 percent have curved stems. In general, the overriding characteristic of the Merrill point is the angular asymmetry in the base (Elton Prewitt, Personal Communication, September 30, 2003). The general size and shape of the 12 Merrell points is provided through the summaries of the metric measurements in Table 11-10.

Figure 11-19. Selected Merrell Points, Early Archaic

Left to Right: Top Row: #157-011, #584-015, #117-020, #658-016, #345-028
Second Row: #523-022, #479-013, #615-020, #203-014, #523-025 Refits to #463-021

No Merrell points were subject to use-wear analysis. Parts of four Merrell points (#157-11 = TRC137; #299-14 = TRC145; #345-28 = TRC151; #615-20 = TRC174) were sent for INAA. All four have chemical signatures similar to Edwards chert, and all probably were made from local cherts (Appendix F). They also exhibit very similar ultraviolet fluorescence, similar to that known for Edwards chert.

The 12 Merrell points were horizontally distributed across Block A, with 60 percent from the northern half and 40 percent from the southern half. A single unit in the northern half (N106/E56) was the only unit to yield multiple Merrell points. Merrell points were recovered

from units that also yielded Baker (three cases), Gower (one case), Martindale (one case), and Bandy (two cases) points.

Seven Group 2 projectile points were identified, comprising about four percent of the 170 Early Archaic points. Although similar point types have been referred to as Early Corner-Notched in the literature, these are early corner-notched forms that do not fall into any established type. Six were recovered from the Early Archaic context, and one was recovered from the Toyah component in Block A. Information on individual specimens is presented in Appendix O.

Table 11-10. Metric Measurements on Merrell Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	41.1 - 56.6	47.3	8.2
Maximum width	16.7 - 25.2	21	2.4
Maximum thickness	5.7 - 8.1	6.9	0.8
Blade length			
Blade width	14.0 - 18.8	17.2	1.3
Shoulder width	16.7 - 25.2	21	2.4
Left notch depth	2.2 - 5.5	3.6	0.9
Right notch depth	1.6 - 5.4	3.2	1.3
Left notch width	6.7 - 11.5	8.5	1.3
Right notch width	5.6 - 6.2	8.5	1.4
Left notch angle	37 - 109	68	20
Right notch angle	55 - 113	75	16.5
Stem length	11.7 - 17.7	14.2	1.6
Stem width	15.5 - 19.4	17.6	1.3
Distal stem width	11.4 - 15.7	14.4	1.5
Proximal stem width	18.1 - 23.7	20.7	1.6
Stem thickness	3.1 - 5.5	4.4	0.8
Base depth	3.9 - 6.5	5.2	0.9
Base notch width	6.7 - 11.8	8.8	1.6
Weight	4.7 - 9.5	5.8	1.8

Measurements in mm

Twenty percent of these are complete with 80 percent consisting of proximal fragments (Figure 11-20). All were manufactured from fine-grained chert, and the finished products lack any sign of cortex. One has about 25 percent patination. The breaks are from use, and 20 percent exhibiting partial beveling of edges. No sign of rejuvenation is present. One specimen appears to have been heat-treated. Fourteen percent were burned as a consequence of exposure to intense heat. Eighty-three percent have a generally lanceolate shape, and 17 percent are triangular. The lateral edges are nearly all straight and stems are all expanding. The unifacially-beveled point has curved edges. The flaking patterns appear to differ; 29 percent are subparallel, 43 percent are chevron,

14 percent show random flaking, and 14 percent have oblique to subparallel flaking patterns. Edge rounding is present on 29 percent of the specimens. The stems are all expanding, and the notches are all directed inward from the corners.

Given that the sample is comprised of mostly broken specimens, it is difficult to provide meaningful metric summaries for the Group 2 category. Only attributes observable on three or more specimens are summarized in Table 11-11.

Two Group 2 points (#283-14 and #412-10) were subjected to use-wear analysis. One complete specimen (#283-14) has a small use break, unifacial edge beveling, and is burned.

Wood fragments and polish were observed in the haft area. Other wood fragments are scattered over the entire surface and are probably use residue. This tool is interpreted as hafted, but the use is unknown. Complete specimen #412-10 exhibits some unifacial beveling.

Table 11-11. Metric Measurements on Group 2 Points from 41ED28

Characteristic	Range	Mean	Standard Deviation
Maximum length	49.7 - 74.5	61.3	12.4
Maximum width	22.5 - 37.6	27.3	5.6
Maximum thickness	5.5 - 8.5	6.1	1.1
Blade length	39.2 - 63.9	48.4	12.4
Blade width	20.2 - 33.0	25.5	4.3
Shoulder width	22.5 - 37.6	35.4	8.1
Notch angle	35 - 47	38	6
Stem length	9.1 - 12.1	10.6	1.4
Distal stem width	9.5 - 20.2	14.4	3.4
Proximal stem width	20.3 - 29.3	22.7	3.6
Stem width	17.0 - 24.8	19.3	3
Stem thickness	3.9 - 5.8	4.7	0.7
Base depth	1.8 - 4.1	2.9	0.9
Base notch width	10.6 - 19.0	13.5	2.9
Weight	4.4 - 9.0	9.5	4.8

Measurements in mm

Figure 11-20. Selected Group 2—Corner-Notched, Carrizo, and Pandale Points, Early Archaic

Left to Right: Top Row: #412-011, #324-016, #215-018;
Second Row: #523-021, #412-010, #670-010;
Third Row: #670-005-012, #391-010, #213-012 Joins to
#650-016, #411-017

Resin and plant fibers combined with polish were observed on the proximal haft area. Possible blood residue may be related to use. This point was hafted with resin and was the only one of 10 points examined to bear resin (Appendix C).

Parts of two Group 2 points (#324-16 = TRC149 and #412-11 = TRC163) were subjected to INAA. These two specimens reveal chemical signatures similar to known Edwards chert and are probably from local sources (Appendix F).

The seven Group 2 points were concentrated (86 percent) in the southern half of Block A.

Unit N104/E47 yielded two Group 2 points. In three cases, Group 2 points were from units that yielded Gower points, in one case from a unit with a Martindale, and one case from a unit that also contained Bandy points.

Three proximal Carrizo point fragments, less than two percent of the 170 points, were recovered from apparent Early Archaic context, whereas a distal fragment came from a Middle Archaic context. The distal segment #213-12 refits with one proximal segment (#650-16) that was located about 6 m to the south (Figure 11-16). It is assumed that the distal piece was slightly displaced upwards, and that the Carrizo points here are associated with the Early Archaic component. Specimen #670-5-12 was associated with Feature 23, a definite Early Archaic burned rock cluster. It may be that all these pieces were near the interface between the Early and Middle Archaic components.

Individual characteristics are presented in Appendix O, but are summarized here. All were manufactured from fine-grained cherts with one that appeared to have been heat treated. No cortex remains across the general lanceolate segments. The two refit pieces are nearly 100 percent patinated to a white surface color. The size of each specimen varies considerably, with only a few metric measurements that could be summarized (Appendix O). These four fragments were equally distributed between the northern and southern half of Block A.

The distal segment #213-12 (TRC121), specimen #391-10 (TRC156), and specimen #670-5-12 (TRC178) were submitted for INAA. The chemical signatures are similar to known signatures for Edwards chert from the southwestern region (Appendix F). These pieces apparently were manufactured from regionally available Edwards chert.

A single Pandale point (#411-17) was also found in an Early Archaic context at 70 to 80 cmbd in

Unit N104/E47, along the very western margin of Block A. This was at the very base of the Middle Archaic and the top of the Early Archaic component, but was assigned to the latter, since it was in the same level as a Gower point (#411-16). Two Group 2—Early Corner-Notched points (#412-10 and #412-11) were encountered in the level below. The Pandale point was manufactured from a dark gray fine-grained chert that appeared to have been burned (Figure 11-16). No patination or cortex was observed. It is a lanceolate shaped point with generally straight lateral edges, oblique parallel flake scars, and a straight to slightly expanding, unground stem. A distal fragment was sent for INAA. The INAA (TRC161) reveals this material is similar to locally available Edwards chert (Appendix F).

Fifty-four unclassifiable dart points and dart point fragments were recovered from the Early Archaic component with two more or less complete specimens (#628-13 and #730-12) not identifiable as to a specific type. Forty-four percent are distal fragments, 36.5 percent are medial sections, 15.4 percent are proximal pieces, and about four percent are indeterminate fragments. These specimens appear to be from points that were similar to the types described above, and show considerable variation in most attributes. All 54 specimens were manufactured from fine-grained chert. Slightly more than seven percent of the dart points are covered with patination on between two and 100 percent of the surface. Less than two percent exhibit any sign of cortex. A relatively high fraction (31.2 percent) is burned pieces with another relatively high 13 percent that appear to have been heat treated. Various individual metric and non-metric attributes are presented in Appendix O.

One small unidentifiable point fragment (#578-15 = TRC171) was sent for INAA. This piece has a chemical signature similar to known

Edwards chert from the southwestern area of the Edwards Plateau. Apparently, the material was from a regional, perhaps local, source of Edwards chert (Appendix F).

In summary, a total of 179 Early Archaic dart points were recovered from all contexts, with 170 points from Block A. The 179 points include nine identifiable types accounting for 125 pieces, with 54 broken unidentifiable fragments. The nine different recognizable types include 32 Gower, 22 Martindale, 21 Bandy, 15 Group 1 (corner-notched), 12 Baker, 12 Merrell, seven Group 2, three Carrizo, and one Pandale. Although some researches have had difficulty in distinguishing between the Bandy and Martindale point types, the Varga Site assemblage provides a large enough sample of points for generating metric data that imply these are two different and distinct types. The Gower and Merrell point types are very similar, but slight differences in the shape of their bases provide indications that two different types are represented. It is also possible that these two named types are varieties of a single type. The variations are might reflect regional differences, individual manufacturing differences, and/or reworking of the original form. Some points similar to these are misidentified in the current literature, which is understandable since not much has been documented or published about either type, especially Merrell. The Varga Site has yielded the first sizeable sample of Merrell points and provides the first associated radiocarbon ages.

11.3.2 Bifaces

The 193 bifaces from Block A and five from Block B were, with a single exception, manufactured from fine-grained chert. The exception is made of a relatively coarse-grained chert specimen (Figures 11-21 through 11-23). Individual characteristics of the bifaces are presented in Appendix O, and the data

summarized below. Smooth, rounded (water-worn) cortex is present on 4.8 percent of the specimens. About 4.4 percent appear to have been heat treated, and another 19.1 percent were burned. Twenty-two percent exhibit some patination; 3.1 percent exhibit nearly complete patination, 3.2 percent exhibit surfaces that are roughly 75 percent patinated, 4.9 percent have 50 percent patination, and some 11.9 percent show patination on less than 25 percent of the surface. Patination is somewhat unusual, and may be a clue that some 22 percent of this

material may be older, or at least was exposed to more light than the other 78 percent. The specimens are represented by 22.5 percent complete pieces, 25.8 percent proximal, 24.2 percent distal, 17.6 percent medial, and 9.9 percent indeterminate pieces. Of those that exhibit breaks, 35.9 percent are believed to be use breaks, 41.1 percent are of indeterminate origin, 18 percent are thermally broken, and 4.7 percent were broken during manufacturing.

Figure 11-21. Selected Early Archaic Bifaces (Elongated)

Left to Right: Top Row: #117-023, #591-021, #591-024, #165-015, #333-023;
Second Row: #61-016, #203-015, #664-017, #746-015, #116-019

Figure 11-22. Selected Early Archaic Bifaces (Ovate)

Left to Right: Top Row: #465-011, #699-020, #502-017, #765-011;

Second Row: #563-019, #205-010, #734-010, #699-019;

Third Row #312-018, #552-017, #402-017 Joins to #403-012

Figure 11-23. Selected Early Archaic Bifaces (Triangular)

Left to Right: Top Row: #204-017, #472-013, #447-016;
Second Row: #242-015, #755-010, #521-014;
Third Row: #154-024, #49-012, #523-023

Seventy-three percent represent the late stage of manufacture, 30 percent are middle stage, nine percent are early stage, and the remaining 11 percent are indeterminate. Only 2.1 percent exhibit any sign of rejuvenation, although 5.5 percent exhibit some degree of edge beveling. The flaking patterns are in many cases (32.2 percent) indeterminate. Among those specimens that are sufficiently complete to show flaking patterns, nearly 50 percent have random

flaking, 19.4 percent have oblique flake scars, 9.4 percent are in a chevron pattern, 8.9 percent are collateral, 8.9 percent are subparallel, and 3.2 percent are parallel. No specific flaking pattern could be detected that correlates with overall shape.

The more or less complete bifaces have length ranges from 33.9 to 110.2 mm, with an average of 72.3 mm. The width measurements range from 21.3 to 77.5 mm, with an average of 37.3 mm. The thickness is quite variable and ranges from 4.3 to 26 mm, with an average of 10.7 mm.

Ten bifaces of various shapes and stages of manufacture were selected and subjected to high-powered use-wear analysis. Specimen #28-11 is a complete, early-stage biface that appears to have been heat treated. Use-wear analysis revealed no sign of hafting but showed light use polish and flake scars from resharpening. It is not known how or on what material the tool was used. Specimen #49-12 is a complete, late-stage lanceolate biface that exhibits use residues in the form of raphides on the distal end. Use-wear is in the form of striations parallel and perpendicular to the working edge. This biface was used in cutting of plant material (Appendix C). Specimen #61-16 is a complete early-stage lanceolate biface that exhibits light use on the distal end. This biface was used in cutting of an unknown material (Appendix C). Specimen #154-24 is a complete late-stage, triangular biface with plant fibers and light hafting wear confined to the proximal end. Red staining, possibly ochre, and hard, high silica polish were observed on the distal end. It is not clear how this tool functioned (Appendix C). Specimen #205-10 is a distal fragment of a late-stage biface. It reveals use residues in the form of plant tissue, with use-wear in the form of polish and multidirectional striations. This biface was used for cutting on hard high silica material

(Appendix C). Specimen #422-19 is the proximal fragment of a late-stage biface with a use break. It has plant tissue and striations parallel and perpendicular to the long axis along the proximal end. Use residues in the form of raphides are present on the working edge. This biface probably was hafted and used on plant material (Appendix C). Specimen #563-19 is a nearly complete late-stage, tear-dropped shaped biface with plant tissue on the proximal end and raphides over the entire surface. It is not clear how this biface was used, or on what material it was used. Specimen #591-24 is a proximal fragment of a late-stage, lanceolate biface with wood fibers on the proximal end and additional use residue in the form raphides. Light polish from use is present along the working edge. This biface appears to have been hafted and used for cutting on unknown material (Appendix C). Specimen #598-13 is a nearly complete late stage, ovate biface, with a break near the distal end. It has raphides on the proximal end. It is unclear how this tool functioned, and the raphides may be related to the haft (Appendix C). Specimen #699-20 is a proximal section of a late stage, teardrop shaped biface that exhibits a use break. It exhibits hafting wear in the form of striations perpendicular and parallel to the long axis and high areas that exhibit polish. This biface was hafted and was broken during use on unknown material (Appendix C).

Seven bifaces that represent different shapes and sizes were sent for INAA. Six have chemical signatures similar to those of known Edwards chert from the southwestern area of the Edwards Plateau (Appendix F). The other specimen (#205-10 = TRC140) has a chemical signature beyond the current known range for Edwards chert but exhibits an ultraviolet fluorescence of a yellow orange that is similar to other known Edwards chert. This specimen is of Edwards chert from a source that is currently unidentified.

This specimen is a light brown with large and small light spots.

The 193 bifaces were scattered across Block A, but the frequencies were skewed with 62 percent in the southern half, compared to 38 percent in the northern half. About 17 percent of the excavated units did not yield a biface, whereas another 29 percent yielded only one biface. Consequently, nearly 59 percent of the excavated units yielded multiple bifaces with three units yielding seven specimens each. These apparent concentrations indicate potential use or discard areas.

11.3.3 Scrapers

The 27 scrapers include 54 percent side-scrapers, 33 percent end-scrapers, and eight percent combination end-and-side scrapers (Figure 11-24). Individual characteristics are presented in Appendix O, with summary data presented here. All were manufactured from fine-grained cherts with less than four appearing to have been heat treated. Only 11 percent exhibit any patination, which in no instance is present on more than 25 percent of the artifact surface. Thirty percent exhibit limited areas of cortex, which is in all cases rounded and smooth. Nearly 60 percent are complete with distal, proximal, medial, and indeterminate fragments each comprising less than 15 percent of the sample. Less than four percent exhibit a rejuvenation flake scar, indicating that either these tools were seldom subjected to reworking or that rejuvenation flake scar was obliterated by reworking. Scraper shapes are quite variable with rounded specimens dominant at 30 percent. Less than four percent were broken during manufacture.

Fifty-two percent exhibit a single working edge (bit), 37 percent have two working edges, and 11 percent have three working edges. Rounding is evident on 60 percent of the edges. The primary working bit is approximately equally

Figure 11-24. Selected Early Archaic Scrapers

Left to Right: Top Row: #154-023, #75-020, #734-011, #62-011;
Second Row: #746-011, #500-013, #18-21;
Third Row: #141-022, #539-011, #704-010

divided between the lateral (30 percent) and the distal (26 percent) edges, and a combination of distal and lateral edges. Seventy percent of the working edges are excurve, with the remaining specimens having a variety of configurations. Nearly 82 percent of the edges exhibit regular and continuous retouch. . The secondary bit is located in 62 percent of the specimens along one of the lateral edges. The shape of the secondary working edge is straight in 62 percent of the cases, excurve in 31 percent, and incurvate in eight percent. Table 11-12

summarizes the metric measurements from the Early Archaic scrapers.

Five scrapers were submitted for high-magnification microscopic use-wear analysis. A complete side scraper (#29-12) exhibits polish. This scraper was used on a hard, high-silica material (Appendix C). Specimen #312-19 is a complete lanceolate side scraper with use residues in the form of plant fiber. Use-wear is reflected by hard, high silica polish and striations along the working end. This tool was used as a scraper on a high-silica plant

(Appendix C). Specimen #323-20 is a complete ovate end-scraper. Striations parallel and perpendicular to the long axis and polish indicate use-wear. This scraper was used in planing a hard, high-silica material (Appendix C). Specimen #401-36 is a complete ovate end-scraper that exhibits use residues in the form of raphides and plant fibers. Use-wear

Table 11-12. Metric Data, Early Archaic Scrapers from 41ED28

Characteristic	Range	Mean
Maximum length	35.7 - 87.9	59.9
Maximum width	32.0 - 79.1	52.5
Maximum thickness	5.4 - 27.6	14.6
Weight (g)	18.7 - 146.2	58.6
Worked edge 1 - length	7.5 - 128.6	46.1
Worked edge 1 - thickness	1.9 - 12.7	8.5
Worked edge 1 - angle	42 - 90	64.4
Worked edge 2 - length	13.4 - 53.9	27.6
Worked edge 1 - thickness	0.8 - 7.5	3
Worked edge 1 - angle	46 - 70	57.5

Measurements in mm

in the form of polish and edge rounding indicate use in planing hard, high-silica material (Appendix C). Specimen #627-13 is a complete triangular end-scraper with polish on the working end indicating a cutting action on a hard, high-silica material.

Three scrapers (#29-12 = TRC126, #346-25 = TRC153, and #401-36 = TRC159) were also subjected to for INAA. All three specimens reveal chemical signatures similar to Edwards chert that was locally available in the southwestern area of the Edwards Plateau (Appendix F).

Twenty-six scrapers were non-randomly distributed, across Block A, with nearly 70 percent in the southern half of Block A. Three units, N100/E56, N103/E56, and

N110/E50, yielded two scrapers each, whereas the other units yielded only one scraper each.

11.3.4 Drills

The seventeen drills recovered are described according to attributes in Appendix O. A summary of the data is presented here. All were manufactured from fine-grained chert and none appear to have been heat treated. Only 6.2 percent exhibit small areas of smooth, rounded cortex. Ninety-four percent probably were manufactured from flakes (Figure 11-25). Nearly 25 percent exhibit limited areas of patination. The specimens vary in their condition: 18.8 percent are complete, 31.3 percent are distal fragments, 18.8 percent are proximal fragments, and 31.3 percent are medial fragments. Of the broken specimens, 62.5 percent have use breaks, 12.5 percent exhibit thermal fractures, and 6.3 percent have breaks of indeterminate origin. On the specimens with measurable sections, the metric attributes provide a general idea of size and shape. For the three complete specimens, the overall length ranges from 48.1 to 72.9 mm, with an average of 63.3 mm. The thickness of 13 measurable specimens ranges from 5.3 to 21.4 mm, with an average of 8.3 mm. Stem length varies from 20.4 to 48.4 mm, with an average of 35.5 mm.

Four drills were subjected to high-magnification use-wear analysis. Specimen #278-26 is a complete drill that exhibits use residues of raphides and pollen grains on the distal end. Striated use polish indicates this tool was used to bore into an unknown material (Appendix C). Specimen #343-13 is the distal section broken during use with use-wear in the form of abraded flake-scar ridges, and multidirectional directions. This tool was used in boring/drilling of a hard material (Appendix C). Specimen #455-16 is a complete drill with use-residues in the form of raphides, and use-wear in the form

Figure 11-25. Selected Early Archaic Drills

Left to Right: Top Row: #278-013, #455-016, #670-005-015, #278-026, #63-016;
Second Row: #40-012, #277-014, #289-020, #578-018, #183-021

of multidirectional striations, indicating use on plant material (Appendix C). Specimen #670-5-15 is a complete drill from Feature 23 that exhibits abraded flake-scar ridges on the proximal end indicative of hafting. Use residues are in the forms of wood fragments and raphides on the working edge, with use polish and striations confined to the tip. This tool was used in boring/drilling of wood (Appendix C).

Four specimens (#40-12 = TRC128, #63-16 = TRC130, #183-21 = TRC138, and #735-12 = TRC187) were subjected to INAA. These have chemical signatures similar to known Edwards chert from the southwestern area of the Edwards Plateau, probably indicating use of locally available chert. (Appendix F).

11.3.5 Unifaces

Four tools have one face that is completely or nearly completely worked, and are placed in a category distinct from scrapers because they lack the steep working edge characteristic of scrapers. These specimens include one complete specimen, two proximal fragments, and one fragment from an indeterminate section of the original tool (Figure 11-26; Appendix O). All are of fine-grained chert lacking any trace of patination. The one complete piece is teardrop in shape. The edge flaking is quite variable as is the location of the working edge(s). One has three working edges, and two specimens have rounded edges. The one complete piece measures 88.4 mm long, by 51.1 mm wide,

Figure 11-26. Selected Early Archaic Unifaces and Gouges

Left to Right: Top Row: Unifaces #153-030, #546-014, #84-010;
Second Row: Gouges #346-011, #724-013, #64-014

16.6 mm thick, and weighs 67.4 g. The three fragments are smaller in size.

One complete, teardrop shaped uniface (#546-14) was sent for high-magnification use-wear analysis. Use residue is present in the form of wood fragments, and there is polish along the working edge. This tool was used for whittling of wood (Appendix C). A fragment of this same specimen (TRC169) was sent for INAA. It reveals a chemical signature that is similar to other known Edwards chert from the surrounding region (Appendix F), and was probably locally available chert.

11.3.6 Gouges

Three gouges were identified and all three are complete and manufactured from fine-grained cherts that were not heat-treated. They lack patination, and one specimen retains cortex on approximately 50 percent of its surface (Figure 11-26). All exhibit regular and continuous flaking along the primary bit, or distal end. Individual metric measurements are provided in Appendix O.

Two gouges were subjected to high-magnification microscopic use-wear analysis. The triangular shaped gouge (#346-11) with lateral and distal flaking has use residue in the form of plant or bone fragments. Use-wear in the form of silica polish was observed,

interpreted to represent planing/scraping on bone or wood (Appendix C). A second gouge (#724-13) has regular and continuous bit-end flaking with use residues in the form of hair and use-wear in the form of soft polish indicating use-contact on animal hide (Appendix C).

These same two gouges (#346-11 = TRC152 and #724-13 = TRC184) were subjected to INAA. Their chemical signatures are similar to known Edwards chert from the southwestern part of the Edwards Plateau (Appendix F), presumably indicating locally available chert.

11.3.7 Edge-Modified Flakes ($n=1,038$)

Twenty-seven edge-modified tools were selected and subjected to high-powered use-wear analysis. The analyzed tools include nine rejuvenation flakes, 14 edge-modified flakes, three graters, and a spokeshave. Each tool is briefly described, and the use-wear results are summarized in Table 11-13.

Twelve edge-modified flakes, including one graver (#400-10 = TRC157) and five rejuvenation flakes were sent for INAA. These reveal chemical signatures that are similar to the known Edwards chert from the southwestern region (Appendix F). It is assumed that all 12 pieces are from raw materials derived from the region, but from a variety of source localities.

The 1,038 edge-modified flakes were thought to represent a variety of tasks that targeted a variety of materials. This assumption was generally verified through the use-wear analysis and residue identification on roughly 2.5 percent of the broader assemblage, which included 14 edge-modified flakes, nine rejuvenation flakes, three graters, and a spokeshave. The analyzed sample reflects uses such as scraping, cutting, planing, whittling, and slicing. These tasks were directed towards plants, hard, high

silica material, wood, soft materials, bone/antler, and some unknown materials.

11.3.8 Other Artifacts

Two specimens are identified as choppers. Specimen #477-14 is a massive chert flake (113.1 by 74.1 mm by 40.6 mm thick) with roughly 12 percent cortex remaining on the end opposite from the one worked edge. The 60.3 mm-long worked edge is at the distal end and exhibits use-flake scars that extend no farther than 11.8 mm onto one face and 6.2 mm on the reverse face. Specimen #698-13 is a chunk of chert nodule with nearly 50 percent cortex mostly on the end opposite the worked edge. This chopper measures 85 mm long, 64.5 mm wide, 41.2 mm thick. The one worked edge exhibits use scars on both faces, but again these appear more frequent and larger on one face. The edge of the flaked/worked end is rounded. Hard contact material is suggested by the fact that the working edge both pieces is rounded.

One complete combination hammer/anvil stone (#128-5-11) was recovered from between 100 and 110 cmbd in Unit N100/E54 and directly associated with Feature 40. This ovate limestone, which measures 123.9 by 102.5 by 48.9 mm, specimen exhibits pitting on one end, both faces, and two sides (where pitting is concentrated near the center of the stone). The central pit on one face is roughly round in shape, about 20 mm wide and 1.6 mm deep. The central pit on the reverse face is oval in shape, nearly 22-by-16 mm in diameter, and 2.8 mm deep. Tiny linear striations are present across this face together with other small pits and divots. The more pointed end reveals two and possibly three impact scars and pitting/crushing.

Table 11-13. Data on Residues and Use-Wear, Early Archaic Modified Debitage

Item	Lot No.	Residue	Use-Wear	Inferred Function
Rejuvenation flake	50-11	raphides	polish, multi-dir. striations	cutting hard, high-silica materials
Edge-mod. flake	128-14	plant tissue, starch grains	high-silica polish	working starchy plant
Rejuvenation flake	153-31	plant fibers	high-silica polish, striations	planing hard material
Rejuvenation flake	255-11	plant fibers	high-silica polish, striations	scraping hard material
Edge-mod. flake	288-10		high-silica polish, edge rounding, striations	whittling (wood?)
Rejuvenation flake	345-23		light polish	planing, material unident.
Flake graver	345-12		light polish on distal end	planing, material unident.
Edge-mod. flake	366-13	bone/antler frags.	light polish	scraping bone/antler
Flake graver	412-13	hair, raphides, starch grains	polish	scraping plant, hide
Rejuvenation flake	421-11		soft polish	scraping soft material
Edge-mod. flake	431-11	plant fibers	hard-silica polish	planing hard material
Edge-mod. flake	466-11	charcoal frags.	polish, oblique striations	whittling hard material
Edge-mod. flake	449-10	wood fragments	polish	planing wood
Edge-mod. flake	465-10	hair, raphides	polish	working plant material
Edge-mod. flake	477-10	plant tissue	polish	cutting plants
Rejuvenation flake	539-12	plant tissue	polish	planing of plants
Edge-mod. Flake	577-11	plant tissue, raphides	striations	working of plant material
Edge-mod. Flake	590-10		light polish	slicing, unident. material
Flake spokeshave	590-10		light polish	planing unident. Material
Edge-mod. Flake	592-11		light polish	unidentified
Edge-mod. Flake	616-10	wood tissue, raphides	polish	planing wood
Rejuvenation flake	628-11		polish, striations	unidentified
Flake graver	671-10		light polish	unidentified
Rejuvenation flake	677-11	raphides, starch	polish	slicing starchy plant
Rejuvenation flake	718-15	hafting plant fibers	polish, striations	cutting soft material
Edge-mod. flake	724-12	plant tissue	striations	slicing plant material
Edge-mod. flake	725-14		soft polish	scraping soft material

A complete groundstone object (#739-11) was recovered from Unit N109/E56 between 30 and 40 cmbd. This is a fine-grained, ovate sandstone pebble 53.9 mm long, 37.7 mm wide, by 31.1 mm thick that exhibits a single ground facet along one slightly angular edge. The facet measures about 24.6 mm long and 9.7 mm wide.

A bone awl was recovered from Unit N99/E56 between 110 and 120 cmbs. It is a deer long bone shaft worked to a fine point at one end, and was broken into three conjoinable sections (#76-2-11 and #76-2-12) (see Figure 11-27). This awl, measuring 139.7 mm long by 18 mm in maximum width, exhibits a rough weathered and root-etched surface, longitudinal drying cracks, with calcium carbonate adhering to the surface in places.

Figure 11-27. Selected Early Archaic Bone Awl (#76-2-11) and Crinoid Section (#637-16)

The constituent fragments vary in color from light reddish brown (5YR 6/4) to dark reddish gray (5YR 4/2). The proximal end exhibits very minimal modification. The distal, pointed end is polished from use.

The proximal end section was submitted for radiocarbon dating and yielded a $\delta^{13}\text{C}$ corrected (-17.8‰) AMS radiocarbon date on collagen of $5,700 \pm 40$ B.P. (Beta-175393). A second piece (76-2-11c) that appears to be from just past the

proximal end yielded a $\delta^{13}\text{C}$ corrected (-19.7‰) AMS radiocarbon date on collagen of $5,270 \pm 40$ B.P. (UGA-12706). The stable carbon isotope values from the two radiocarbon laboratories indicate an average value of 18.75‰, which is in line with animals such as deer consuming roughly 70 percent C_3 vegetation.

This bone tool probably functioned as to pierce soft materials such as hide and/or plant products. It is remarkable that it survived. Its survival was potentially facilitated by its use as a tool, which through use hardened the exterior.

One unique item, a possible bead, was recovered from the Early Archaic context in Unit N108/E50 at 30 to 40 cmbd along the northern end of Block A. It is a thin section of a crinoid fossil shell with a natural hole. It measures 13.2 mm in diameter, 4.0 mm thick, and weighs 0.7 g. The two faces are not flat as one might expect, but are slightly irregular (Figure 11-27). The outer edge was not ground or shaped, although it is partially broken. The central hole is 3.0 mm in diameter. One edge is broken. Crinoid fossils date to the Pennsylvanian in age and are not known to occur in Cretaceous limestone, which implies a non-local origin for this item.

11.3.9 Cores

Twenty-four cores were recovered from Block A and a single specimen from Block B. These 25 pieces are summarized here, with individual characteristics presented in Appendix O. Twenty-one specimens (84%) are complete, two (8%) are fragmentary, and two others (8%) appear to have been exhausted. All are of fine-grained cherts, and 15 specimens retain portions of smooth, water-worn cobble cortex, while two exhibit remnants of a rough, tabular cortex. Twenty percent are partially patinated. None appear to have been heat-treated, and none are burned. Forty-eight percent are bifacial,

44 percent are multidirectional, and eight percent are unifacial.

The 21 complete cores range from 55.9 to 135 mm long, with an average of 85.1 mm. Widths range from 38.1 to 131.4 mm, and average 71 mm. The thickness ranges from 15.1 to 60.4 mm, with an average of 39.6 mm.

11.4 LITHIC DEBITAGE

11.4.1 Unmodified Debitage

Nearly 52,000 pieces of lithic debitage were recovered from Block A. A sample of 6,314 of these has been analyzed to determine the represented stages of raw material reduction and tool production, manufacturing, and maintenance.

Just over 28 percent of the analyzed debitage exhibits unintentional heat alteration through spalling and/or crazing. Relatively high frequencies of tertiary and retouch flakes (36 percent) and late stage biface thinning flake (25 percent) categories are represented. Low frequencies are represented in the core reduction flake category (7.5 percent), early stage biface flakes (10.3 percent), angular debris (12.2 percent), and indeterminate flakes (8.7 percent). Prismatic blades are represented by less than one percent of the sample. This analysis indicates that finishing of bifaces and other tools, and probably resharpening of tools, was commonly carried out at the site.

11.4.2 Rejuvenation Flakes

The Early Archaic assemblage included 82 pieces that were classified as tool-edge rejuvenation flakes (Figure 11-28). Nine rejuvenation flakes were selected for use-wear analyses (Appendix C). Minimally three specimens #50-11, #677-11, and #718-15 reveal hard, high silica polish, with plant fibers (raphides) still adhering to the tool edge, and were interpreted as cutting actions on plants.

Three other pieces including #153-31, #345-23, and #539-12 exhibit polish wear that reflects planing of hard, high silica material. Plant tissues were observed on #539-12. Specimen #255-11 exhibits plant fibers together with hard, high silica polish interpreted to have been used in scraping plants. Specimen #628-11 exhibits light polish and striations with unknown use actions. Specimen #94-10 exhibits hard, high silica polish interpreted to have been used in scraping materials with high silica content. A high percentage of these tool edges exhibit use-wear from actions on plants.

The distribution of the 82 rejuvenation flakes extended across 37 units of the 83 m² of Block A and exhibits apparent horizontal patterning. Nearly 85 percent were south of BT 2, but not directly within the two features (Features 39 and 40), although many were in the immediate area that surrounded these two burned rock clusters. The high frequency of rejuvenation flakes in the vicinity of these two features may indicate resharpening or discard areas around hearths.

11.5 VERTEBRATE FAUNAL ANALYSIS

The 83 m² excavations of Early Archaic component in Block A yielded a relatively high frequency of small bone fragments for a deposit of this age. The assemblage included 731 pieces weighing 280.5 g. However, upon close inspection of the individual bones and carefully scrutinizing the Middle Archaic bone assemblage, it became clear that not all of these pieces actually pertain to Early Archaic period. Based on the bone colors and conditions, the 731-piece assemblage was sorted a second time. The light reddish brown (5YR 6/4) to dark reddish gray (5YR 4/2) bone fragments were assigned to the overlying Middle Archaic component, whereas the pinkish gray (5YR 7/2) colored pieces were assigned to the Toyah component.

Figure 11-28. Selected Early Archaic Rejuvenation Flakes

Left to Right: Top Row: #255-013, #278-022, #229-017, #277-011, #229-018, #392-013, #357-011;
Second Row: #204-012, #228-010, #255-027, #204-013, #63-013, #254-012, #391-014;
Third Row: #75-012, #299-015, #515-019, #515-018, #345-020, #356-013;
Fourth Row: #76-010

It is assumed that the brownish colored pieces were displaced downward into the Early Archaic deposits, rather than representative of the older Early Archaic cultural events. Brownish bone fragments in the Middle Archaic assemblage were visually distinct from the pinkish gray (5YR 7/2) to a light gray (5YR 7/1 and reddish yellow (5YR 6/6), calcium carbonate-coated pieces apparently pertaining to the Early Archaic. The cultural deposits at the north end of Block A are quite shallow, with the identified components compressed into a roughly 60 cm thick vertical range. Therefore, brownish bones, resembling Middle Archaic specimens, have been assigned to the Middle Archaic component.

In a similar manner, the fresher appearances of the pinkish bones are ascribed to the Toyah component. Following reassignment of the recovered assemblage, only 229 pieces weighing 109.7 g were ultimately assigned to the Early Archaic component.

It is quite surprising that any bone was preserved and derived from this early component. Ninety-seven percent of the fragments assigned to this component are less than 3 cm in length, whereas the remaining pieces are between 3 and 6 cm long. Their average weight of 0.5 g reflects their very small size. Nearly 18 percent were burned. Of the burned pieces, 60 percent are brown and

black in color, 20 percent are white or calcined, 12 percent are black, and nine percent are black and white. It is not clear if the burned pieces are truly part of the Early Archaic component, since these lack the diagnostic color and the calcium carbonate that is believed to characterize the Early Archaic faunal-bone assemblage.

Bones were divided into 10 major taxon size groups based on the size. The 10 groups are: Size Class 1, mole- and mouse-size mammals, Size Class 2, rabbit-size mammals, Size Class 3, raccoon-size animals, Size Class 4, dog/coyote-size animals, Size Class 5, deer and antelope-size animals, and Size Class 6, bison-size, Size Class 7, turtles, Size Class 8, snakes, Size Class 9, birds, and Size Class 10, fish. The assignment of a bone fragment into a specific size class was based primarily on cortical wall thickness, bone shape and structure, and other observed morphological attributes. If these factors were not sufficient to confidently assign a specimen into one of the 10 size classes, then the fragment was assigned to the “unknown” category.

All but four fragments were assigned to the unknown taxon category, which consisted of small long bone fragments lacking the requisite. Two fragments, or about one percent of the assemblage, were positively identifiable as deer elements. These include the very distal tip of an antler tine (#719-2) and a distal end of a first phalanx (#402-2). The distal end of the deer phalange displays a green bone fracture, indicating it was broken for marrow extraction.

Two small and thin long bone fragments were assigned to size class 2 group that are similar in size to rabbit long bones. No bone fragments are in the bison size class.

11.5.1 Discussion

The vertebrate faunal remains are extremely rare here and in other contexts of similar age (Collins

et al. 1990; Decker et al. 2000). The limited sample of 229 bone fragments do, however, indicate that deer and rabbit were among the faunal taxa exploited by the Early Archaic occupants of the Varga Site.

The 1980 excavations at the Royal Coachman Site (41CM111) in Comal County yielded one identifiable whitetail deer element that was potentially associated with this, or perhaps a slightly younger, period (Mahoney et al. 2003). The Early Archaic zones at 41UV88 yielded a few mussel shells but produced no vertebrate faunal remains (Decker et al. 2000).

The stable carbon isotope results from the radiocarbon dating of the different sections of the same long bone awl range from -17.8 to -21.0‰, with an average of -19.5‰ (Table 11-1). These values reflect ca. 85 to 100 percent intake of C₃ food, which is generally thought of as the dietary intake of a deer. The dated element probably represents a deer and supports the identification of deer as part of the subsistence resources at the Varga Site.

11.6 MUSSEL SHELL REMAINS

This Early Archaic component yielded only seven pieces of mussel shell weighing 21.3 g. These small fragments include one umbo and one tooth section. The umbo and tooth sections are similar to *Lampsilis* sp. This species is natural to the region and exists in a variety of aquatic habitats (Howells et al. 1996). It is possible that these small fragments were naturally deposited within the site’s alluvial matrix. If, however, they represent human gathering of mussels, their scarcity implies only a very minimal role in overall subsistence strategy.

11.7 BURNED ROCKS

A moderate number of scattered burned rocks and nine burned rock features were encountered.

A total of 3,044 burned rocks were recovered and included the burned rocks from features. The average density of burned rock was about 37 pieces per m².

The scattered burned rocks outside the identified features included 2,649 pieces that weighed 423,851 g, for an average burned rock weight of about 160 g. The scattered burned rocks were comprised mostly of the smallest size class with 63.3 percent by count, followed by the next smallest size class at 29 percent, then 6.5 percent in the next size class, and less than one percent in the largest size class.

The burned rock features yielded a total of 395 pieces that weighed 147,650 g and yielded an average rock weight of 374 g. This is over twice the average size of the scattered burned rock and indicates that the larger pieces were in the features and the smallest pieces were scattered about the occupation.

11.8 MACROBOTANICAL REMAINS

Carbonized plant remains were quite sparse in this component. Sediment samples from with most burned rock features and possible hearth features were collected from their interiors and floated, though most features lacked significant chunks of charcoal, charcoal lenses, or even burned matrix, indicating that charcoal recovered in or around features may not be directly associated with this early component. Four light fractions totaling 0.4 liters of organic matter were obtained from floating 16 liters of sediment from four Features 12, 26, 31, and 40. These light fractions were submitted to Dr. Dering for inspection and identification of wood species. Very few carbonized pieces were present and only five were identified (Appendix I). Light fractions from other Early Archaic features here did not yield any potential for burned plant remains and were not submitted to Dr. Dering.

Although 223.5 g of carbonized plant remains were recovered, seemingly a sizeable quantity, two samples of over 50+ g each, account for nearly 50 percent of the total. These were collected the gravels at the base of the component rather than from discrete features and thus it is unclear if that charcoal was deposited at the same time as the gravel or during subsequent events.

In many instances, individual pieces of charcoal exhibit a thin calcium carbonate film coating on the exterior surface that implies that piece had been in place for considerable time. These few calcium-coated pieces were given preference for radiocarbon dating. Most often, the piece that was sent for radiocarbon dating was split into two parts and one piece sent to Dr. Dering for species identification (Table 11-14). Dr. Dering's identifications indicate that minimally four species of wood- oak, mesquite, juniper, and littleleaf walnut, all presumably close at hand-- were selected for burning.

11.9 EARLY ARCHAIC SUMMARY

The Early Archaic component contained large quantities of cultural material with no detectable separation representative of separate occupational episodes. Including burned rock fragments, a high density of 676 pieces of cultural materials were found per one-meter-square of excavated area, and it is likely that more than a single occupational event is represented (Table 11-15).

The presence of bone fragments and macrobotanical materials permitted radiocarbon dating of the component. It was considered extremely important to determine which, if any, of the different organic material classes such as charcoal, bone, nutshells, or snail shells had filtered down from overlying younger components.

Table 11-14. Early Archaic Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
29-007	N99/E52	90-100		4		
29-007-1a	N99/E52	90-100		0.1	Sent to Dering for ID	Oak sp. (n=3)
38-007	N99/E53	80-90		0		
38-007-1a	N99/E53	80-90		0.1	Sent to Dering for ID	Mesquite (n=1)
64-007	N99/E55	120-130		0		
64-007-1a	N99/E55	120-130		0.1	Sent to Dering for ID	Oak sp. (n=1)
75-007	N99/E56	100-110		3		
75-007-1a	N99/E56	100-110		3	Sent to Dering for ID	None
76-007	N99/E56	110-120		0		
76-007-1a	N99/E56	110-120		0.1	Sent to Dering for ID	Indeterminate (n=1)
106-007	N100/E52	90-100		1		
128-005-004-007-1a	N100/E54	100-110	40	0.1	C ¹⁴ dated to 5,200 ± 40 B.P.	Oak sp. (n=1)
128-005-004-007-1b	N100/E54	100-110	40	0.1	Sent to Dering for ID; from light fraction	Oak sp. (n=1)
154-007	N100/E56	110-120				
154-007-1a	N100/E56	110-120		0.1	C ¹⁴ dated to 5,690 ± 60 B.P.	Oak sp. (n=1)
154-007-1b	N100/E56	110-120		1	Sent to Dering for ID	Oak sp. (n=5)
202-007-1	N101/E52	70-80	39	0		
202-007-1a	N101/E52	70-80	39	0.1	Sent to Dering for ID	Mesquite (n=1)
202-007-2	N101/E52	70-80	39	0		
202-007-2a	N101/E52	70-80	39	0.2	Sent to Dering for ID	Mesquite (n=3)
203-7-1b	N101/E52	80-90		1.2	Sent to Dering for ID	Mesquite (n=12)
204-007	N101/E52	90-100		0.1		Walnut shell (n=1/2)
204-007-1a	N101/E52	90-100		0.9	Sent to Dering for ID	Oak sp. (n=6)
216-007	N101/E53	100-110		41		
216-007-1a	N101/E53	100-110		0.5	Sent to Dering for ID	Oak sp. (n=2) + Mesquite (n=4)
323-007	N102/E54	130-140		1		
323-007-1a	N102/E54	130-140		1	Sent to Dering for ID	Indeterminate (n=1)
344-007	N102/E56	90-100		0.4		
344-007-1a	N102/E56	90-100		0.1	Walnut, C ¹⁴ dated to 5,410 ± 40 B.P.	Walnut shell (n=1/3)
344-007-1b	N102/E56	90-100		0.1	Sent to Dering for ID	Walnut shell (n=1/3)
344-007-1c	N102/E56	90-100		0.1	Walnut, C14 dated to 5,520 ± 40 B.P.	Walnut shell (n=1/3)
345-007	N102/E56	100-110		8.7		
345-007-1a	N102/E56	100-110		0.1	Sent to Dering for ID	Juniper (n=4)
346-007	N102/E56	110-120		0.2		
346-007-1a	N102/E56	110-120		0.1	Sent to Dering for ID	Juniper (n=7)
347-007	N102/E56	120-130		19		

Table 11-14. Early Archaic Macrobotanical Remains

Cat. #	Unit No.	Depth (cmbd)	Fea. No.	Wgt (g)	Comments	Identifications
347-007-1a	N102/E56	120-130		17	Sent to Dering for ID	Walnut shell (n=1)
375-007	N103/E51	82		1		
375-007-1a	N103/E51	80-90		1	Sent to Dering for ID	Juniper (n=1)
402-007	N103/E56	90-100		57		
402-007-1a	N103/E56	90-100		53	Sent to Dering for ID	Walnut shell (n=2) + Indeterminate (n=3)
432-007	N105/E47	80-90		1.5		
432-007-1a	N105/E47	80-90		3	Sent to Dering for ID	Juniper (10 ml)
465-007	N105/E53	70-80		0		
465-007-1a	N105/E53	70-80		0.1	Sent to Dering for ID	Indeterminate (n=1)
531-007	N106/E54	90-100		0		
531-007-1a	N106/E54	90-100		0.1	Walnut, C14 dated to 5,500 ± 40 B.P.	Walnut shell (n=1/2)
531-007-1b	N106/E54	90-100		0.1	Sent to Dering for ID	Walnut shell (n=1/2)
546-007	N106/E56	40-50		0		
546-007-1a	N106/E56	40-50		0.1	Sent to Dering for ID	Walnut shell (n=1)
570-007	N107/E50	50-60		1.1		
570-007-1a	N107/E50	50-60		0.1	C14 dated to 6,100 ± 40 B.P.	Indeterminate (n=1)
570-007-1b	N107/E50	50-60		0.1	Sent to Dering for ID	Indeterminate
607-007	N107/E55	50-60		0		
607-007-1a	N107/E55	50-60		0.1	Walnut, C14 dated to 5,560 ± 40 B.P.	Walnut shell (n=1/2)
607-007-1b	N107/E55	60-70		0.1	Sent to Dering for ID	Walnut shell (n=1/2)
615-5-4-1	N107/E56	50-60	26		Sent to Dering for ID	Prickly Pear seeds (n=3), Juniper (n=2), Indeterminate (n=15)
616-005-007	N107/E56	64		0.1	Not enough for ID; <0.1g	
616-005-007-1a	N107/E56	64		0.1	Prickly pear seeds C14 dated to 5,640 ± 40 B.P.	
644-5-4-1	N108/E51	40-50	12	0	Sent to Dering for ID	None
683-7	N109/E47	40-50		0.1		Walnut shell (n=1/2)
735-005-004-007-1a	N109/E55	40-50	23	0.1	Sent to Dering for ID	Indeterminate (n=1)
735-005-007	N109/E55	40-50	23	0		
735-005-007-1a	N109/E55	40-50	23	0.1	C14 dated to 6,200 ± 50 B.P.	
735-005-007-1b	N109/E55	40-50	23	0.1	Sent to Dering for ID	Indeterminate flecks
756-5-4-1	N110/E56	40-50	31	0	Sent to Dering for ID	None

Table 11-15. Summary of Early Archaic Assemblage from the Varga Site (41ED28) Investigations

Cultural Material Classes	Early Archaic Component (5,200 to 6,280 B.P.) Counts
Bone Fragments*	109.7 g, 229 pieces
Deer	2 pieces
Mussel Shell*	21.3 g, 7 pieces
Burned Rock	571,501 g, 3,044
Features	9
Hearths	2
Burned Rock Dumps	2
Burned Rock Clusters	5
Dart Points	170
Gower	32
Martindale	22
Bandy	21
Group 1	15
Baker	12
Merrill	12
Group 2 (corner-notched)	7
Carrizo	3
Pandale	1
Bifaces	198
Scrapers	27
Drills	17
Edge-Modified Flakes	1,038
Lithic Debitage	51,869
Cores	25
Choppers	2
Ground Stone	1
Unifaces	4
Gouges	3
Hammerstones/Anvil	1
Bone Tool - awl	1
Carbonized Plant Remains	223.5 g
Juniper wood	
Littleleaf walnut shells	
Mesquite wood	
Oak wood	
Prickly pear seeds	4
Total Materials	56,644
Average Thickness (cm)	30
Spatial Extent Excavated	83
Volume Excavated (m³)	25.9

* Bone, mussel shell, and carbonized remain totals are weights in grams; ** Mussel shell from testing not weighed

This table does not include materials from float samples

This was achieved through direct dating of the different materials, which in fact demonstrated that displacement of younger bones had occurred. Although this made it clear that many of the faunal bone fragments had been downwardly displaced, most of the dated organic remains were much older than the overlying components and are therefore interpreted to best reflect the age of the deposits from which they were recovered.

11.9.1 Chronology Issues

This Early Archaic component was directly dated with 15 radiocarbon assays from diverse materials to about a 1,100-radiocarbon year period between 6,280 and 5,200 B.P. The dated material includes five charcoal samples, five walnut shell samples, three deer bone samples, one charred prickly pear seed sample, and one *Rabdotus* snail shell. Two other mean residence dates were obtained from organic sediment, with which the cultural materials were in direct association. The results fall within this same time period and support the direct ages obtained from the cultural materials.

This is a relatively narrow time span that has previously been poorly documented in the archeological record in Central Texas and the Lower Pecos regions. Minimally seven named projectile point types (Baker, Bandy, Carrizo, Gower, Martindale, Merrell, and Pandale) and two unnamed groups (Group 1, and Group 2) were recovered from this component (Table 11-15). At one level, their occurrence here documents that these multiple point types were potentially all in use during the relevant 1,100-year time span. However, it does not provide a complete time range for these different point types, nor does it directly date any single type. Potentially, the absolute dates obtained reflect the age of some of the point

types, but it is possible that older organic materials that might be associated with older

point types may not have been preserved. Presently, however, we interpret these 15 assays to represent some part of the age range of each of the nine-point types. Only further radiocarbon dating from intact context with single point types will help determine the full age range of each of the point types.

Ninety-six percent of the 124 identifiable projectile points associated with this Early Archaic component are considered part of what Johnson and Goode (1994) refer to as the “Early Barbed” and “Early Spilt-stem” traditions for the Central Texas region. We have opted to be splitters, assigning the 124 points to named types where possible. The “Early Barbed” tradition contains 42 percent of the points and includes the 22 Martindale, 21 Bandy, and seven Group 2 points. The “Early Spilt-stem tradition” contains 58 percent and includes the 32 Gower, 15 Group 1, 12 Baker, and 12 Merrell points. According to Collins (1995), these two major traditions are temporally separable, with the Early Split-stem group dating from 8,000 to 7,000 B.P., followed by the Martindale and Uvalde group between 7,000 and 6,000 B.P. Collins terminates the Early Archaic at about 6,000 B.P. The Varga Site projectile points and radiocarbon dates do not fit well into Collins’s (1995) chronological sequence. Based on his framework, the point types recovered at the Varga Site should represent minimally a 2,000-year period at a somewhat earlier time interval than the ca. 6,300 to 5,200 B.P. range indicated by the radiocarbon ages. Part of the problem stems from the lack of a well-dated context for the Early Split-stem group in Central Texas (i.e., Landslide and Youngsport sites). It may be that the organic material associated with the earliest Early Split-stem point types in this Varga Site component was not preserved, thereby distorting the absolute radiocarbon time range documented for these nine different projectile point types.

In the Lower Pecos region, the Early Barbed, Early Stemmed, Early Corner-Notched, and a few Early Triangular forms are all present at about this same period (Turpin 1991). Currently, the small sample size of identifiable projectile points from any one particular dated provenience does not allow for a clear understanding of associations between the different point types and the obtained dates. With so few identifiable points from any one provenience, it is not clear if one point type is more prominent than another, if one specimen represents a curated piece, or if one point was otherwise intrusive to the dated context. The Early Archaic component at the Varga Site dates within the currently established Viejo period, specifically the last 1,000 years of that 3,400 year long period. At Skyline Shelter, Unit 3, Level 28 yielded two Bandy, one Baker, and one Gower point in association with a charcoal date of $5,920 \pm 120$ B.P. (Tx-6947). The Skyline Shelter data supports the associations of these three point types with the radiocarbon dates from the Varga Site. The Varga dates push Turpin's (1991, 1995) ending date for the Viejo period closer ca. 5,000 B.P.

The Varga Site has yielded the first substantial assemblage of Merrell points, and the first time that this rare point type has been associated with radiocarbon dates. Johnson and Goode (1994) were not sure where to place this point type in their general chronological sequence. Collins (1995) does not even mention this type by name, but lists a generic "Early Split-stem" group for a period dated between roughly 8,000 and 7,000 B.P. It is not clear if Collins (1995) includes this poorly known and infrequently mentioned type in that group or not. The 12 Merrell specimens identified by Prewitt from the Varga Site provide general metric and non-metric variability in their attributes and establish the type's general characteristics. For now, the obtained dates from this component provide a

general age range of about 1,100 years, from 6,300 B.P. to 5,200 B.P. for the type.

The Lower Pecos region has previously yielded a few projectile points that resemble the Merrell or Gower types. A point from the lowest level (Level 17) of the Bench area at Devil's Mouth (Sorrow 1968), listed as Miscellaneous 6 (Figure 18:r), resembles a Merrell point, which is in the same level as a Plainview point. Although that level was not radiocarbon dated, this point was stratigraphically below a Martindale point. Another possible Merrell point was recovered from the lowest levels in Zones Ie and III mixed, in Devils Rockshelter (Prewitt 1966: Figure 4:A). At least one illustrated point from Baker Cave resembles a Gower or Merrell point that is apparently earlier than Baker I type (Word and Douglas 1970: Fig. 10:E).

In the Lower Pecos region, Pandale points are distinctive of the Eagle Nest period of the Middle Archaic that dates from 4,100 to 5,500 B.P. Pandale points have been recovered from mixed strata attributed to ages that range from 5,500 to 6,100 B.P. at Eagle and Hinds caves (Turpin 1991:28). Consequently, the occurrence of a single Pandale point at the Varga Site together with many different Early Archaic point types is not unheard of and fits relatively well with what is known about their ages from the Lower Pecos region. This single Pandale specimen and associated ages from the Varga Site are slightly older than the 22 accepted core dates for the Eagle Nest period (Turpin 1991:29). The lack of a substantial number of Pandale points at the Varga Site indicates that the population(s) that produced the type did not generally occupy this particular locality.

The Carrizo point type is generally thought of as a Middle Archaic type primarily from South Texas (Turner and Hester 1993; Hester 1995).

However, it has rarely been dated from secure contexts. The best-dated context is at Loma Sandia in South Texas where three Carrizo points were recovered from a mortuary context dated to between 2,800 and 2,500 B.P. (ca. 850 to 550 B.C.; Highley et al. 1995). Based on their principle association with multiple Early Archaic point types at the Varga Site, these few Carrizo points were not in their original contexts. It is possible that the three Carrizo points from Loma Sandia were curated items rather than actually manufactured during that radiocarbon-dated period. If these two sets of dates are anywhere close to representing the time frame for this point type, then the Carrizo points were potentially in use during a very lengthy 2,700-year time span. Better context and more dates will eventually determine the overall time range for this point type. Turner and Hester (1993) indicate this was primarily a South Texas point type and Prewitt's (1995) distribution map supports this notion, with some scattered specimens in Central Texas counties. Their occurrence in Edwards County may reflect the western extent of the type's distribution.

This well-dated component at the Varga Site slightly extends the ending date for the Early Archaic in the Lower Pecos region as revised by Turpin (1991) from her 5,500 B.P. to the 5,300 B.P. here. This may hint at population movements away from the Lower Pecos region towards Central Texas near the end of that period. Comparisons with Central Texas chronology, the Varga Site dates push the end of the Early Archaic a few thousand years younger than is currently projected (Johnson and Goode 1994; Collins 1995) and raises some questions concerning the current time ranges for the Early Split-stem group. The later dates from the Varga Site may indicate movements from the Central Texas region towards the Lower Pecos region.

11.9.2 Subsistence Issues

As discussed above, faunal bone specimens from the Early Archaic component have been identified as deer and rabbit. Considering its far larger size and greater meat weight, it can be concluded that deer was the primary source of dietary meat for the Varga Site occupants during this period. None of the bone fragments from this period were within the size class representing bison, and it is therefore apparent that this species was not present or exploited. The isotope data from the burned rocks indicate no C₄ products present that presumably would indicate bison residues and consequently the presence of bison.

In further support of mammalian species as parts of the subsistence base, microscopic residues including hair and bone/antler were observed during the use-wear analysis on least eight percent of the 63 Early Archaic analyzed tools. This indicates tools that had direct contact with animal products. Possible blood residue was observed on a single Group 1—Early Corner-Notched projectile point. Nearly the entire chipped stone tool assemblage is characteristic of and supportive of animal hunting and processing.

Only seven freshwater mussel shell fragments weighing 21.3 g were recovered, including an umbo fragment similar to *Lampsillis* sp., a species indigenous to the region. The paucity of mussel remains indicates that if the site's occupants were gathering mussels for food, it was not in sufficient quantities to serve as a significant part of the subsistence regimen. Possibly the shells were used in another capacity, perhaps for tools and/or ornaments.

Only minimal evidence is available for the use of plant resources as food. Burned walnut shells ($n=8$) and burned prickly pear seeds ($n=3$) are identified for, and radiocarbon dated to, this component. It is not clear whether these items

were used as or accidentally burned in during food preparation. The littleleaf walnuts contain little meat, though the oil could have been a significant product. Indirect but compelling evidence for the use of non-meat products comes from the use-wear analysis that indicates plant processing on minimally 46 percent of the analyzed tools through the identification of various plant tissues, such as raphides, starch grains, and plant fibers. Although specific plants are not identified, the presences of plant residues indicate the use and processing, though not necessarily for consumption as food.

The lipid residue analysis provides the best indirect evidence for nonmeat products as part of the broader subsistence package. All 22 burned rock samples analyzed yielded lipid residues interpreted to represent plants. The detected residues were about 95 percent high in fat content with no low or medium fat content residues apparent. Seeds and nuts comprised a good portion of the plant taxa that could account for the high fat content. The $\delta^{13}\text{C}$ values from these same burned rock samples range from -22.2 to -30.7‰, with an average of -24.3‰. These $\delta^{13}\text{C}$ values document that all the plants were of the C_3 pathway. No indication is present in the obtained residues for any C_4 or CAM plants with C_4 signatures, such as lechuguilla bulbs or seeds, prickly pear cactus pads or fruit, or warm season grasses. Consequently, such C_4 products were not cooked by the hot rock cooking technology.

11.9.3 Technology Issues

The artifacts recovered are presumed to reflect the strategies used to exploit resources and perform general maintenance activities. Technology issues are concerned with a wide range of artifacts and daily tasks they represent, including resource procurement and resource processing.

11.9.3.1 Resource Procurement Issues

Procurement of food resources, both plant and animal is generally interpreted from the recovered artifacts. The 124 identified projectile points plus 54 other point fragments document the presence of killing instruments used in the procurement of larger animals. Nine Early Archaic projectile points were subjected to high-power use-wear analysis, which indicates that these tools most often functioned as projectile points, but the presence of organic residues indicates that they served in other tasks, as well. A Gower point (#391-11) reveals plant fiber and hard, high silica polish that indicates it was used for cutting plants (Appendix C). A Martindale point (#591-19) also reveals plant fiber residues that suggest direct contact with plants. A Group 2—Early Corner-Notched point (#912-10) reveals possible blood residue implying use as a killing instrument. A Bandy point (#334-22) reveals bone/antler residue that indicates it was in contact with an animal, likely a deer.

Lacking the remarkable preservation found in the dry rockshelters in the Lower Pecos region, the other equipment potentially used in the procurement of game resources, such as fiber nets, stick and twine traps, clubs, throwing sticks, etc., are not represented. Given their presence in that nearby area, however, it is fair to assume that similar technologies were in use at the Varga Site, and open campsite without conditions for such exceptional preservation of organic materials.

No stone tool class is directly associated with plant procurement. This is not unusual, since most plants were easily collected without the use of specialized tools. If specialized tools were employed to procure certain plants, these probably were perishable items such as digging sticks or baskets.

Bone, antler, or stone tools that might have been used in the procurement of lithic resources are not readily identifiable in the recovered assemblage. This may be a reflection of poor preservation, but it might be that the raw tool stone and cooking stone were procured/collected without specialized tools such as large hammerstones, or antler prying bars and wedges. Chert and other lithic materials used by the occupants were readily available in the adjacent creek bottom and/or in gravel terraces so that material was easily collected by hand.

11.9.3.2 Resource Processing and Consumption

The relatively low frequency of core reduction flakes, early stage biface flakes, and angular debris implies the restricted nature of early-stage lithic reduction at this site. The relatively high frequencies of the tertiary thinning flakes and late stage biface manufacturing flakes, on the other hand, reflects a focus on finishing and resharpening chipped stone tools. The relatively high frequency of rejuvenation flakes testifies to the resharpening of worn or dulled tools.

The stone tool assemblage is relatively restricted to points ($n=170$), bifaces ($n=198$), scrapers ($n=27$) that includes three items identified as gouges, drills ($n=17$), unifaces ($n=4$), choppers ($n=2$), ground/pecked stones ($n=2$), and edge-modified flakes ($n=1,038$). The latter class includes a wide variety of shapes and types that include, but are not limited to, graters, punches, spokeshaves, cutting and scraping tools, and other recognized functional forms. By their presence, these differently shaped edge-modified flakes indicate that many and diverse processing tasks were carried out through the use of expedient tools made from flakes of minimally worked stone.

Various activities are indicated by the use-wear analysis conducted on 63 chipped stone tools, which includes both formal tools and a fair

number of expedient tools in the form of the edge-modified flakes. The tasks identified include boring/drilling, cutting, scraping, slicing, planing, puncturing, and whittling. Based on the fact that 46 percent of the tools analyzed for use-wear reveal plant residues, close to half the analyzed assemblage was employed for both plant and animal processing. A gouge (#724-13), a tool form often thought to have served in woodworking, revealed animal hair and soft polish connecting it to planing animal hides (Appendix C). A drill (#670-11) exhibits haft wear and a wood fragment indicating that it was used to bore/drill wood (Appendix C). A graver (#412-13) revealed evidence that it was probably used on both plant and animal parts.

The use-wear on five of 10 analyzed bifaces indicates use on or contact with plants. Two bifaces (#49-12 and #205-10) were used to cut plants, as indicated by raphides and/or other plant tissues. Specimen #49-12 was used to cut hard, high silica plants (Appendix C). All five bifaces with plant residues are late-stage bifaces.

Of the 1,493 formal (points, bifaces, scrapers, etc.) and informal tools (edge-modified flakes), the informal tools are two and half times as abundant as the formal ones. Among the formal tools, nearly 10 percent exhibit rejuvenation scars (2.8 percent) or have been rejuvenated through edge beveling (7.0 percent). Eighty-two pieces, or 5.5 percent of all tools, were identified as rejuvenation flakes. The relatively low incidence of rejuvenation may reflect an abundance of raw tool stone that was easily obtained. When formal tool was worn out, it was more cost-effective to replace it with a new one than to extend its use life through rejuvenation of the working edge.

Fifty percent of the bifaces analyzed for use-wear reveal evidence of hafting. Four exhibit haft residues in the form of plant tissues and wood fibers, whereas a single biface exhibits

haft wear in the form of proximal-end polish (Appendix C). Five percent, or two other tools analyzed for use-wear, an edge-modified flake (#446-11) and a drill (#670-11), reveal haft wear in the form of abraded flake scar ridges.

Three tools from the Early Archaic component are classified as gouges. This is a very low number since many authors see the “Clear Fork” tool/gouge or adze as a regular or even a diagnostic indicator of Early Archaic tool assemblages across Southern and Central Texas (Dial 1998; Turner and Hester 1999). Most often gouges are thought to have been used in woodworking and plant processing (Hudler 1997). Specimen #724-13, reveals an animal hair and soft polish linking it to planing animal hides (Appendix C). A second gouge, #346-11 reveals plant or bone residues with hard, high silica polish that is interpreted as reflecting planing/scraping on bone or wood (Appendix C).

The different types of formal tools present indicate that animal processing was a significant activity. However, the use-wear findings show that a high percentage of the tools also served in the processing of plant products. In the final analyses, the recovered assemblage reflects very diverse tasks including boring/drilling, cutting, scraping, slicing, planing, puncturing, and whittling directed toward processing both plants and animals.

The 3,044 burned rocks, weighing 571,501 g, indicate that cooking technology commonly involved the use of hot rocks. Although nine burned rock features were identified, the features are not sufficiently distinct or well preserved for a precise identification of the specific type of cooking technology that was employed. Features 40 and 41 apparently functioned as hearths, neither of which was associated with an earth oven. The average weights of individual burned rock in these features were 423 g and

348 g, respectively. The other seven features were piles and/or clusters of burned rocks that most likely represent discarded rocks no longer required in the cooking process. The discarded burned rocks in these clusters yielded a total of 395 pieces that weighed 147,650 g revealing an average rock weight of 374 g.

The scattered burned rocks recovered from outside identified features included 2,649 pieces that weighed 423,851 g, for an average burned rock weight of about 160 g. This is less than half the size of the average burned rock in the clusters and nearly a third the size of those in Features 40 and 41. This difference in size probably indicates a recycling of the burned rocks, until they were too fragmented for adequate heat retention. The current available information does not clarify whether or not these rocks were used to heat/boil water for cooking.

Drs. Malainey and Malisza interpreted the lipid residues extracted from 22 burned rocks to reflect predominantly the cooking of plants (Appendix G). Although meats were clearly important subsistence items, the burned rocks were used mainly if not exclusively to cook plant foods. Meat was apparently prepared without the use of hot rock cooking, presumably by drying, smoking, and/or roasting. The relatively small, overall size of the recognized burned rock features indicates they were used to process relatively small quantities of plant food at any one time.

11.9.4 Intra-component Patterning

Assuming that the 1,100-years of radiocarbon-documented time and multiple point types indicate multiple cultural events, the remains of which are all compressed into a rather thin (30 cm) vertical zone, it is probably that the component is essentially a palimpsest in which the physical imprints of discrete occupations/activities have been intermixed beyond recognition. Some horizontal patterning

may be detected, as is the case with the six burned rock features clustered in the northeastern part of Block A, but the overall horizontal patterning is difficult to identify. Nonetheless an attempt has been made to define horizontal patterning, as was done for the more recent components, discussed in previous chapters.

Contour maps of density-corrected artifactual data for Block A were generated for selected variables within this component (Figures 11-29 through 11-37), using Surfer (vers. 5.01) mapping software. These maps were used to provide a visual reference to aid in the interpretation of the spatial distribution of the selected artifact categories and to provide additional depth to interpreting the results of the principal components analyses. The locations of individual recognized features are also plotted on the contour maps, potentially as part of the spatial relationship of the activities. Block A revealed eight cultural features, Features 12, 13, 23, 26, 27, 31, 39, and 40, which may have some internal functional relationship with the different artifact classes.

The data matrix consists of 14 variables (artifact categories) and 86 rows (excavation units), though only 10 of the variables figure strongly in the resulting factor loadings. The principal components analysis extracted a six-factor solution representing a cumulative total of 60.61 percent of the variability present in the data array. The matrix of correlation coefficients is presented in Table 11-16, and the factor solution is presented in Table 11-17.

Factor 1 is composed of three diagnostic variables—lithic debitage, edge-modified flakes, and projectile points—collectively composing 15.63 percent of the total variance in the matrix of correlation coefficients (Table 11-17). All three variables exhibit moderately strong to strong positive factor loadings ranging from .647

to .815; none of the diagnostic variables in Factor 1 are negative. The association of projectile points, debitage, and edge-modified flakes may be best explained by the assumption that all three artifact categories reflect the task of lithic reduction; specifically, producing lithic flakes during projectile point manufacture, and subsequently modifying some of the flakes for use in various cutting and scraping tasks. Whether lithic reduction strategies in this context are oriented toward producing flakes specifically for modification and use, or the flakes simply represent a byproduct of producing other tool forms, such as projectile points, is unclear, though it appears likely that projectile points were being produced in some quantity at the Varga Site based on the sizable assemblage of points recovered.

Figure 11-29. Contour Map of Lithic Debitage Density in Early Archaic

Figure 11-30. Contour Map of Edge-Modified Density in Early Archaic

Figure 11-32. Contour Map of Core Density in Early Archaic

Figure 11-31. Contour Map of Point Density in Early Archaic

Figure 11-33. Contour Map of Drill Density in Early Archaic

Figure 11-34. Contour Map of Burned Rock Density in Early Archaic

Figure 11-36. Contour Map of Bone Density in Early Archaic

Figure 11-35. Contour Map of Scraper Density in Early Archaic

Figure 11-37. Contour Map of Uniface Density in Early Archaic

Table 11-16. Correlation Matrix for Block A—Early Archaic Component

Category	Category													
	Burned Rocks	Faunal Bone	Groundstone	Cores	Debitage	Awls	Bifaces	Choppers	Drills	Edge-Modified Flakes	Gouge	Projectile Points	Scrapers	Unifaces
Burned Rocks	1.000													
Faunal Bone	.053	1.000												
Groundstone	.265	-.034	1.000											
Cores	.049	.079	.014	1.000										
Debitage	-.054	.059	-.118	-.036	1.000									
Awls	.009	.182	-.017	-.051	.067	1.000								
Bifaces	-.149	-.052	-.116	-.065	.381	.002	1.000							
Choppers	.000	-.014	-.023	.011	-.182	-.017	-.081	1.000						
Drills	.084	-.033	-.057	.321	.187	-.041	.071	-.057	1.000					
Edge-Modified Flakes	-.020	.222	-.101	-.079	.533	.004	.284	-.079	.069	1.000				
Gouge	.030	-.069	-.029	-.012	.107	-.020	-.014	-.029	.064	.048	1.000			
Projectile Points	-.071	.109	-.134	-.112	.503	.019	.283	-.114	-.012	.325	.123	1.000		
Scrapers	.013	-.009	.016	-.047	.235	.104	.185	-.090	-.048	.075	.046	.241	1.000	
Unifaces	-.030	-.038	-.032	-.049	.161	-.023	.098	-.032	-.079	.088	-.040	-.020	.058	1.000

Table 11-17. Principal Component Matrix for Block A—Early Archaic Component

Variable	Factor ¹					
	1	2	3	4	5	6
Burned Rock	.013	.099	.795	-.013	.063	.078
Faunal Bone	.264	.045	.103	-.247	.761	-.051
Ground stone	-.162	-.076	.741	.131	-.063	-.073
Cores	-.129	.789	.019	-.017	.085	-.042
Debitage	.795	.107	-.060	.287	-.015	-.021
Awls	-.115	-.073	-.090	.383	.685	.035
Bifaces	.480	.028	-.278	.321	-.170	-.191
Choppers	-.124	-.128	-.095	-.474	.028	.052
Drills	.138	.807	.005	.045	-.104	.113
Edge-Modified Flakes	.815	-.004	.033	-.122	.133	-.077
Gouges	.178	-.034	.067	.041	-.249	.712
Projectile Points	.647	-.142	-.124	.239	.064	.258
Scrapers	.123	-.120	.017	.743	.060	.045
Unifaces	.194	-.116	.043	.078	-.230	-.667
% Variance	15.63	9.82	9.37	9.07	8.89	7.83
Cum. % Variance¹	15.63	25.45	34.82	43.89	52.78	60.61

¹ Rotation method—Varimax with Kaiser normalization

² Based on rotation sums of squared loadings

For spatial studies, no differentiation was made among various flake or point types that might clarify this issue. Examination of density maps for these artifact categories suggests that, whereas the spatial associations are not perfect among them, these artifact types do exhibit a marked tendency to cluster in relatively small, discrete areas more or less right next to similar clusters of other artifact types constituent of Factor 1 (Figures 11-25 through 11-27). Whereas the high proportion of relatively complete points recovered remains something of a mystery, it seems clear that multiple, small-scale activity areas (or dumps associated with activity areas) are scattered across Block A at relatively evenly spaced intervals of 2 to 5 m.

Factor 2 is composed of two diagnostic variables—lithic cores and drills—collectively composing 9.82 percent of the total variance in the matrix of correlation coefficients (Table 11-17). Both variables exhibit moderately strong to strong positive factor loadings of .789 and .807. These two artifact types both occur in a single high-density cluster in the northwest corner of Block A centered on a large, buried boulder that appears to represent an activity area in which tool production and generalized maintenance tasks were performed (Figures 11-28 and 11-29). Other artifact types, including lithicdebitage, bifaces, and projectile points, have moderate-density peaks in this area, though they do not

cluster in the same exact locations as drills and lithic cores.

Factor 3 is composed of only one diagnostic variable—burned rock—representing 9.37 percent of the total variance in the matrix of correlation coefficients (Table 11-17). Burned rock exhibits a moderately strong positive factor loading of .795. Burned rock occurs in six marked concentrations across Block A and represents the loci of *in situ* burned rock features or dumps of burned rocks from features (Figure 11-30). The covariance of burned rock with all other artifact types in the Early Archaic assemblage strongly suggests that the burned rock concentrations represent *in situ* features, such as hearths, around which the activities represented by the other artifact types occurred (though not necessarily simultaneously).

Factor 4 is also composed of only a single diagnostic variable—scrapers—representing 9.07 percent of the total variance in the matrix of correlation coefficients (Table 11-17). Scrapers exhibit a moderately strong positive factor loading of .743. Like other tool types in this component, scrapers form several small-scale, relatively high-density clusters, including two primary ones centered on 0.25-by-0.25-m Unit N103/E55 and the northeastern corner of Unit N110/E50 as well two secondary peaks in the southeastern and south-central parts of Block A (Figure 11-31). The cluster of scrapers located near the east end of BT 2 coincides with clusters of projectile points and edge-modified flakes, and to a lesser extent bifaces, located in the same general vicinity. Scrapers appear to reflect the locations of activity loci involved with fabricating and/or processing tasks.

Factor 5 is composed of two diagnostic variables—faunal bone and bone awls—collectively composing 8.89 percent of the total variance in the matrix of correlation coefficients (Table 11-17). Both variables exhibit

moderately strong positive factor loadings of .685 and .761. All three awls were recovered from Unit N99/E56, an area that also generally coincides with clusters of scrapers, uniface, edge-modified flakes, projectile points and, to a lesser extent, burned rock. Based on the co-occurrence of so many classes of fabricating and processing tools, it seems reasonable to propose that an activity area associated with generalized fabricating and processing tasks (not necessarily associated with subsistence resource processing) is represented in this area. An alternate possibility is that tools associated with this component have eroded down into a small swale that is observable in the southern and eastern wall profiles. Whether or not this swale was present during the Early Archaic occupation or represents an erosional feature that cut through part of it at a later date is unknown. Whereas the latter hypothesis is possible, it seems likely that a broader, non-selective range of artifact categories would be represented in an erosional feature, so the activity area hypothesis is favored. As only three bone awls were recovered from this component, it seems reasonable to assume that they were crafted from bones extracted from the small assemblage of animal bone associated with this component (Figure 11-32).

Factor 6 is composed of two diagnostic variables—unifaces and gouges—representing 7.83 percent of the total variance in the matrix of correlation coefficients (Table 11-17). Gouges exhibit a moderately strong positive factor loading of .712, whereas unifaces demonstrate a moderate negative factor loading of -.667. As only four unifaces and three gouges were recovered from this component, it seems inadvisable to rely greatly on the apparent covariation among these two artifact classes. Unifaces occur in three separate parts of Block A (Figure 11-33), and two of the three gouges are located along the periphery of one of these clusters in the southeast corner of Block A,

where an activity area containing the remains of multiple classes of fabricating and processing implements appears to exist. Thus, the apparent covariation between these two artifact types is probably somewhat spurious, given the small sample sizes.

It is important to remember that the statistics “force” patterning upon an assemblage of data regardless of whether or not it innately exists in the dimension being examined. However, the principal components analyses in this spatial study have yielded some relatively unambiguous patterning among artifact categories. The patterns appear to be constrained and influenced by different factors. The observed associations among artifact categories appear to be regular, patterned, and often exclusive of other categories. Thus, it appears that the sediment deposits that contained the cultural materials are relatively intact, and that the spatial patterning apparent among artifact categories is referable more to the organization of the prehistoric occupations than to post-occupational natural influences.

11.9.5 Mobility and Land Use

Patterns of mobility and land use issues during this time period are difficult to address as only a few hints of possibilities are expressed by recovered materials. Macroscopic observations of the lithic material types indicate that only Edwards chert was employed throughout the Early Archaic occupations. The more precise INAA demonstrates that nearly all chipped stone tools were derived from Edwards Formation sources in the southwestern plateau region rather than imported from distant regions (Appendix F). Even with multiple point types possibly representing different groups, the local procurement of tool stone appears to have been a constant during the Early Archaic. The different populations that camped at the Varga Site apparently had restricted home ranges limited to

this general southwestern part of the Edwards Plateau.

The absence of marine shell also implies a lack of contact/interaction with coastal groups. The groups camped at the Varga Site were operating and interacting only within the relatively limited region just mentioned. The Crinoid fossil fragment was not local and probably was brought here by humans. These fossils are Pennsylvanian in age and generally outcrop further north in the Central Texas mineral belt and beyond the Cretaceous period limestone rocks of the Edwards Plateau. This one item may represent very limited movement, contact, and/or trade with populations to the north.

Data clearly indicative of the seasonality of site occupation are lacking. Whereas the presences of walnut shells and prickly pear seeds in this component do imply late summer-fall occupation, this is less than certain since both products can be stored for a period of time.

11.9.6 Paleoenvironment

The pollen and phytolith record recovered from the vertical sediment column through deposits near the middle of Block A provide only sketchy information concerning the environment between 6,300 and 5,200 B.P. in radiocarbon age (Appendix F). The pollen record suffered significant deterioration with only the most resistant species represented. The arboreal taxa include pine (*Pinus* sp.), oak (*Quercus*), pecan (*Carya*), *Apiaceae* (carrot), and *Poaceae* (grass). *Pooideae* grass phytoliths, which yield a C₃ carbon isotopic signal, comprise most of the grass assemblage.

At least five taxa are represented in the macrobotanical assemblage from across the Early Archaic component, including walnuts, prickly pear seeds, mesquite wood, juniper wood, and oak wood (Appendix I). Only the oak species is duplicated in the pollen record.

The stable carbon and nitrogen isotope analyses from the same matrix as the pollen and phytolith record reveals interesting isotopic trends. Eight Early Archaic samples yielded carbon isotope values that differ about 2.1‰ and range from -24.97 to -27.09‰. The most negative value was from the lowest sample with the more positive values about 30 cm higher and later in time. These carbon isotope values indicate nearly complete C₃ contribution to the organic matter. Carbon isotope values of -21.9 and -22.6‰, derived from two Varga Site humate dates of 6,270 and 5,230 B.P., respectively, from two different backhoe trenches outside Block A, indicate about an 85 percent contribution by the C₃ vegetation. It is not clear what caused the nearly 2.0‰ difference between the column samples and the two dated samples. One possible explanation is the values obtained from the AMS dating technique on the sediments are not as precise as those derived from the isotope laboratory. A second possible explanation is that the two dated samples were outside the main cultural activity areas, and thus, may reflect more of the natural environment. Regardless of what caused the nearly 2.0‰ difference in these Varga Site values, the carbon isotope values significantly contrast with the carbon isotope results from Fort Hood values, where 65 to 70 percent C₄ input from carbon isotope values that range between -16.3 and -16.5‰ date to around 5,200 to 5,800 B.P. If the Varga Site carbon isotope results are accepted as reflecting the local environment, then a warm and dry period in eastern Edwards County was definitely not present during this period in contrast to the Fort Hood region. The Edwards County region potentially provided relatively cooler and moister conditions than the eastern end of the Edwards Plateau and potentially greater resource opportunities and better living conditions. This might account for the more intense Early Archaic occupation

revealed at the Varga Site than elsewhere in the greater Central Texas region.

For this general period, the climate in the Lower Pecos region has been characterized as a drying and warming trend with a gradual decrease in mesic plant pollen and an increase in xeric plant pollen between ca. 10,000 and 5,000 B.P., the period termed the Stockton Stage by Bryant (1966). From Hinds Cave macrobotanical data, Dering (1979) interpreted a decrease in the juniper and oak stands with grasslands increasing between 7,000 and 4,000 B.P. He suggests that semi-succulent plants probably were widely scattered throughout these grasslands by this time. The wooded areas would have been more restricted to the breaks. At about 6,100 B.P., bulk processing of lechuguilla was observed at Hinds Cave in the form of a burned rock midden (Dering 2002). Around 5,000 B.P., Dering (1979) sees an absence of juniper wood charcoal from Hinds Cave, which may indicate a climatic shift.

From analysis of coprolites from Lens 13 at Hinds Cave that date to a range of about 5,719 to 5,590 B.P., William-Dean (1978) indicates the human diet was based on consumption of rodents, rabbits, birds, and two or three species of cacti. Prickly pear plants formed the major seed, epidermis, and fiber components in the coprolites (William-Dean 1978:234). It must be pointed out that only the smaller bones from the smaller animals would have been consumed and thus be present in coprolites, whereas the larger bones from larger animals would not have been present. Other plant parts observed in the coprolites include lechuguilla in 51 percent, onion bulbs in 40 percent, walnut shells in 23 percent, and sotol in seven percent. This reveals a much greater diversity than normally observed in a preserved assemblage from an open-air campsite such as the Varga site, but may provide a more complete picture of the kinds of resources that might have been

available to hunter-gatherers in the general region.

Vertebrate remains from Hinds Cave during the period from between 6,800 and 6,000 B.P. showed an apparent shift from human reliance on deer and rabbits to the procurement of small rodents (Lord 1984). Combining the plant macrofossil record (Dering 1979), the pollen record (Johnson 1963; Bryant 1977a), the coprolite record (Williams-Dean 1978), and the faunal record (Lord 1983), a convincing argument can be made that around 6,000 B.P. the local inhabitants were forced to adjust to vegetation and climatic conditions that were becoming increasingly xeric (Bryant and Holloway 1985:57).

To the east, at Hall's Cave in Kerr County, the vegetation community is not easily reconstructed, but reveals that grasslands, probably a mixed grass assemblage, dominated between ca. 8,000 and 5,000 B.P. (Tome 1993). A change in vegetation was detected by about 5,000 B.P., at which time the area was likely either short-grass grassland or a desert grassland/steppe (Toomey 1993).

Still further east and north, the Fort Hood alluvium initiated by 8,600 B.P. was deposited throughout a period from about 8,600 to 4,800 B.P. (Nordt 1992, 1993). Nordt characterizes the deposition as fine-grained meandering and abraiding on intermediate and small streams. The abraided depositional environment resulted from high magnitude flood events. Of importance is the lack of paleosols in the Fort Hood region documenting moderately rapid deposition through common flood events. The carbon isotope data derived primarily from alluvium indicates the C₄ contributions (grasses) increased during the period between about 8,000 and 6,000 B.P., with a general average of between 65 to 70 percent warm season C₄ grasses. The carbon isotope values of -

16.3‰ and -16.5‰ during the period from about 6,000 to 5,000 B.P. indicates a dry period along Cowhouse Creek (Nordt 1992, 1993). By about 4,170 B.P., a carbon isotope value of -18.2‰ indicates a return to moister conditions.

Still further east of eastern edge of the Edward Plateau, Bousman (1998) reinterpreted Central Texas bog data and determined that by about 6,000 B.P. there was a short period of more mesic conditions, as revealed through a peak in arboreal pollen between two periods of maximum grass cover (>90%). The two peaks in grassland expansion reflect the dryer conditions potentially signaling the Altithermal climatic event further north. Grass pollen reaches nearly 60 percent at roughly 8,600 B.P. and at least 50 percent at about 5,100 B.P. at Hershop Bog (Bousman 1998). Bousman calculates values about 30 percent higher than indicated by modern surface pollen. Johnson and Goode (1994) also view this general period as one of low moisture. Dillehay (1974) indicates that bison were absent in most of Texas during this period. In literature beyond Texas, the period from about 7,000 to 4,500 B.P. is often referred to as the Altithermal (Antevs 1955), considered to have been the maximum Post-Pleistocene warm/dry period.

In the southern High Plains region at Lubbock Lake, the period from 6,500 to 4,500 B.P. is thought to have seen intense deflation and wind erosion (Holliday 1995:89), interpreted as the result of reduced plant cover and declining water tables. The lower water table is also evident through the nearly 60 prehistoric hand-excavated water wells at Mustang Springs that date to between 6,800 and 6,600 B.P. (Meltzer 1991).

At the Varga Site the environmental data from the 1,100-year period between 5,200 and 6,300 B.P. does not reflect a significant warm period as indicated by different lines of data in the adjacent regions. If this period was

significantly warmer, it is not reflected in the nearly complete dominance of C_3 grasses indicated in the phytolith record or the stable carbon isotope values. The current data indicates that the Varga Site locality, and probably the surrounding region, was more mesic than the surrounding regions, thus providing more favorable resource conditions during this period. One may conclude that the drier conditions in the surrounding regions contributed to intensification of prehistoric use of the Balcones Canyonlands as reflected by the Early Archaic component detected at the Varga Site.

11.9.7 Concluding Discussion

The stratigraphic position of this Early Archaic component was at the very base of the alluvial fines. In fact, some of the smaller cultural items along with some fine sediment were recovered from between the alluvial gravels. It is concluded that people were actually living on a stony surface similar to a gravel bar. In fact, for the cultural materials to be so interbedded with the gravels there must have been relatively little sediment accumulation between the rocks at the time of the prehistoric encampments. Apparently the first occupants must have been present soon after the gravels were deposited and prior to any significant sedimentation.

This setting for the Early Archaic at the Varga Site is in a similar topographic and environmental setting to that of the Woodrow Herd Site just to the southeast in Uvalde County. The Woodrow Herd Site yielded very limited cultural materials (one isolated burned rock feature) in the early Holocene Unit I that dated >8,000 B.P. This material was in matrix-support gravel that contained charcoal that ranged in age from 8,380 to 8,010 B.P. Unit IIa immediately above this contained charcoal that ranged in age from 6,430 to 6,060 B.P. The initial cultural component dated to between ca. 6,500 and

4,400 B.P. yielded Martindale, Uvalde, Early Triangular, and Early Corner-Notched points mixed together (Decker et al. 2000).

Further east in Central Texas, the Wilson-Leonard Site (Collins 1998) in Williamson County also yielded Early Archaic projectile points in similar context to the Varga Site assemblage. A region-wide erosional event that included the Lower Pecos region must have occurred before about 6,500 B.P.

In summary, the cultural materials recovered from this Early Archaic component reflect repeated short-term encampments by groups employing a variety of “Split Stem” and “Early Barbed” point types over minimally a 1,100-year period between 6,300 and 5,200 B.P. This location served as a base camp for general foraging groups. The extensive and diverse chipped stone tool assemblage reflects activities directed at the procurement and processing of tool stone, and plant and animal products. Hot rocks in small clusters served as small-scale features for cooking mostly C_3 plant products. Although deer and rabbit meat were procured and undoubtedly consumed, the meat was not cooked by the hot rock technology. Knapping tasks were directed towards biface finishing, refurbishing chipped stone tools, retooling implements, and discarding worn-out tools. Documented processing activities include cutting, whittling, scraping, planing on hard and soft wood and other plants, and hide working. The seasonality of the occupation(s) is not well represented, but at least one event was during the late summer-fall. The site occupants had limited contact with other groups from outside the region, judging by the reliance on locally available cherts and a lack of obvious trade items.

The pollen, phytolith, stable carbon isotope, and macrobotanical data from the Early Archaic deposits reflect a nearly complete C_3 vegetation

community consisting of a mixture of arboreal and grassland communities. This data does not reflect the same warm/dry conditions indicated by data from adjacent regions. The documented environment was potentially more favorable, wetter, and somewhat cooler in comparison to

the surrounding regions, and therefore, provided a greater abundance of plant and animal resources for daily needs. This in turn was potentially the stimulus for a greater use of the Varga Site and the immediate region by Early Archaic peoples.

12.0 MISCELLANEOUS MATERIALS

J. Michael Quigg

12.1 INTRODUCTION

Various materials were found in different levels/proveniences that could not be confidently assigned to one of the identified components. A few pieces are from the surface; several come from backhoe trenches; and other pieces were recovered from isolated test units during Phase I with poor stratigraphy or unclear associations, whereas the majority are from hand-excavated levels that either were not well-defined and/or were at the upper or lower boundary of one of the identified components. As a result, about 1,499 pieces of cultural material cannot be assigned to a particular cultural component. No specific age can be defined for these materials, which are briefly summarized below.

12.2 CHIPPED STONE TOOLS

Fifty-two chipped stone tools including 36 edge-modified flakes, nine projectile points, six cores (#1-11, #556-11, #761-10, #855-11, #1273-10, and #1273-11), three bifaces (#427-11, #762-11, #791-10), two scrapers (#88-12 and #562-13), one drill (#1212-10), and one uniface (#924-11) are not assignable to a specific component. The nine points included two untypable arrow point fragments (#1-15 and #1200-10), two untypable dart points (#53-11 and #923-10), two Bonham (#360-5-10 and #562-10) arrow point, one Frio point (#562-12), one Early Triangular point (#138-12), and one Martindale point (#854-10). The metric and non-metric data from the

projectile points has been included with the other point data summarized in the components under the specific point type with individual attributes presented in Appendix O. The 52 tools represent about 1.5 percent of the total tools identified. Three tools, one drill, an unknown arrow point, and an edge-modified flake were collected from the surface, which has suffered considerable alterations from different mechanisms.

12.3 VERTEBRATE FAUNAL REMAINS

Only five pieces of bone weighing 4.5 g from two proveniences were not assigned to identified components. Most bones recovered are quite fragmentary and are assigned to one of the four components based on color, weathering patterns, and observations on the nature of their burned conditions.

12.4 BURNED ROCKS

A total of 325 burned rocks weighing 24,971 g from 28 difference proveniences were unassigned. This is 1.3 percent of the total burned rocks recovered.

12.5 MACROBOTANICAL REMAINS

Two charcoal samples weighing 0.9 g were unassigned.

12.6 LITHIC DEBITAGE

A total of 1,103 pieces of lithic debitage from 56 proveniences were not assigned to a specific component. This is about 1.3 percent of the total debitage recovered.

12.7 DISCUSSION

These unassigned materials represent about 1.1 percent of the total cultural materials recovered from the Varga Site investigations. Since these materials could not be confidently assigned to one of the four components, limited

time was spent with analyses of the individual specimens, with the exception of the projectile points. The point data was combined with the major point type categories to contribute data towards overall form and variability.

13.0 PALEOENVIRONMENT INFERENCES

J. Michael Quigg

13.1 INTRODUCTION

Insights into past environments are derived from a variety of data sets. Paleoenvironmental information was sought from the roughly 6,300-year-old deposits at the Varga site, through site-specific geomorphic investigations in the existing right-of-way, a single pollen and phytolith column in which stable carbon and nitrogen isotopes were also measured from the same vertical section of fines (the exact same samples), and through cultural materials extracted from the cultural deposits in Block A. The carbonized macrobotanical remains identified, combined with the identified faunal assemblages recovered from each cultural component, augment the other data sets. The detailed paleoenvironmental data and inferences concerning all four major components are presented in the summary section of each component and will not be repeated here. Below we provide a broad summary or overview of the findings together with discussions.

13.2 GEOMORPHIC INFERENCES

The context of the recovered cultural material is partially established from a geomorphic perspective. In T1, the investigated backhoe trenches and block profiles revealed five depositional packages. Below, these five packages are summarized from the bottom of the profile to the top. A dense and thick river gravel lens designated as Depositional Unit 5 was at the

base of the fine matrix. This gravel lens indicates a high-energy flood that moved clasts as much as 30 cm in diameter and potentially stripped or removed early fines. The gravel deposit spans the investigated site area and had highly variable depths below the existing surface, a factor of its undulating or hummocky surface onto which fines were subsequently deposited. This gravel lens was not directly dated, and the base of it was not reached. The radiocarbon dates derived from the cultural deposit directly above the gravels indicate this gravel was deposited before ca. 6,300 B.P. and probably much earlier, during the late Pleistocene or very early Holocene. If the gravels were that old, then deposits representing some 4,000-years, from 10,500 to 6,300 B.P., are missing in the overlying alluvium.

Depositional Unit 4 represents fine overbank flood deposits that top the gravel lens. Unit 4 was a clay loam classified as Bk horizon with Stage I carbonate accumulation, typical of soils that are Middle to Late Holocene in age. These fines vary from 20 to 55 cm thick and indicate the very slow accumulation of alluvial deposits or a combination of erosion and deposition allowing for limited aggradation. This deposit contained mixed Early Archaic cultural materials (a minimum of nine different point types are represented) that date between 6,300 and 5,200 B.P. Early populations may have camped on the gravels and extracted natural chert nodules contained in the gravel deposit. This same stratigraphic scenario with Early Archaic cultural materials resting directly on a basal unit was also observed at the Barton Site (Abbott 1994). Cultural materials in the upper part of this deposit tend to be randomly distributed.

Depositional Unit 3 was a clay loam matrix that also contained a “pea to marble size gravel” (<3 cm diameter) lens. The thin, gravelly lens reflects a relatively high-energy flood event that

resulted in deposition of relatively coarse sediments beyond the confines of the stream channel. Depositional Unit 3 had a clear boundary with the underlying sediments. This pea-gravel lens was classified as a Bk1 horizon that contained Middle Archaic cultural materials dating to between 4,800 and 3,900 B.P. The boundary between Depositional Unit 3 and the overlying Depositional Unit 2 was gradual and smooth, indicating it developed over a period of time.

A black clay loam to silty clay loam that exhibited a very weak, fine granular structure was a developed A horizon designated Depositional Unit 2. This A horizon, roughly 20 to 30 cm thick in places, represents a stable land surface that extended across the entire investigated area. Depositional Unit 2 was probably deposited by multiple overbank flood events, and subsequently underwent pedogenesis just before 2,300 B.P. This organic-rich deposit was subsequently buried by additional fine-grained overbank deposits. Depositional Unit 2 contained quantities of Late Archaic cultural materials that date to between 2,300 and 1,700 B.P., possibly the developmental period for this A horizon. Bryant and Holloway (1985) refer to this period as the Frio Interval, which they believe ushered more mesic and probably cooler climatic conditions at around 2,500 B.P. Hall's Cave also yielded evidence for moister conditions at about 2,000 B.P. through the presence of bones of the Woodland vole (Toomey 1993). The Varga Site buried A horizon, combined with other evidence, reflects similar climatic conditions generally at about the same time in this region.

The boundary contact with the overlying Depositional Unit 1 was abrupt and smooth, indicating a depositional hiatus between Depositional Units 1 and 2, and possibly a partially stripped or eroded surface. Depositional Unit 1 represents clay loam to loam

overbank deposits that have been heavily impacted by modern disturbances and the addition of modern road gravel compressed into the loam over parts of the excavated area. Some areas appear mechanically compressed, whereas other areas were stripped. The deposits near the eastern and western right-of-way margins along the fence lines revealed the greatest thicknesses of this deposit. Accumulation of sediments is most certainly due to multiple flood events over the last 1,700-years with no visible internal stratification. This is a very weak or incipient A horizon with an abrupt and smooth lower boundary.

The oldest radiocarbon dates from this Depositional Unit 1 are about 920 B.P. and a date of 1,390 B.P. was obtained from the underlying Depositional Unit 2. The youngest couple of radiocarbon ages are modern at about 80 and 170 B.P. Thus, Depositional Unit 1 represents about 1,300 to 1,400-years. Depositional Unit 1 contained Late Prehistoric materials, primarily Toyah phase materials with a few projectile points that may reflect slightly earlier occupations radiocarbon dated to between ca. 940 and 300 B.P. The proposed hiatus between Depositional Unit 1 and Unit 2 appears to represent some 300 to 400 radiocarbon years.

It is possible that the buried A horizon documented in Depositional Unit 2 and the lower Bk horizons represent a single soil development with only limited and brief erosional periods. If this were the case, then this is a very unusual alluvial setting. Other river and creek valleys documented in the broader region often contain at least a buried soil dated to roughly around 5,000 B.P. (i.e., Medina Pedocomplex, Mandel et al. 2007) However, the upper reaches of the Pedernales River to the north also lack the 5,000 B.P. buried soil and even the ca. 1,700 to 2,300 B.P. A horizon. (Blum 1987).

Bryant (1966) suggests a return to aridity in the Lower Pecos region after ca. 2,300 B.P., and refers to this as the Juno Stage. This period is characterized by xeric conditions as evidenced by pollen from Bonfire Shelter and Devil's Mouth Site, and this general trend of drying continued into historic times.

13.3 THE MICROFLORAL EVIDENCE

Twenty-five sediment samples were submitted for paired pollen and phytolith analysis. Twenty of these pairs were recovered from a single vertical column through the middle part of Block A and five others were recovered from radiocarbon dated sediment samples from two backhoe trenches. Very generally, the pollen record reveals no abrupt or obvious changes in the vegetation communities. The pollen assemblages were believed to be poorly preserved, since the number of pollen taxa from individual samples is low (5 to 12 taxa, with a mean of 7.75) with the numbers of identified taxa decreasing with increasing age of the samples. Several Early Archaic samples were not counted as they yielded very few pollen grains. Minor variations in the pollen concentrations, such as the decreased amounts of cheno-ams and Asteraceae in the Early Archaic period, are thought to reflect the poor preservation of those samples. Often pollen preservation is so poor in most open-air sites that researchers such as Dr. John Jones and Dr. Vaughn Bryant do not often recommend analysis of such data. The better-preserved pollen localities are generally bogs.

Arboreal pollen of oak and pecan/hickory are present throughout the column. Walnut is quite rare. The presence of these taxa indicates that similar tree species were present from the Early Archaic (6,300 B.P.) through the Toyah period (300 B.P.). Pecan/hickory and walnut generally require a more dependable water source and are often indicators of riparian environments. The

upper part of the matrix column is characterized by high concentrations of cheno-ams, Asteraceae, and Poaceae (grasses) that indicate a mosaic of grassland components interspersed with arboreal components. Members of the Apiaceae Family are generally found in more moist conditions and are expected for this streamside terrace.

The pollen from the Toyah component is consistent with the modern vegetation of the area. The Late Archaic pollen (1,700 to 2,300 B.P.) reflects the same taxa as present during the Toyah component. In the Middle Archaic (3,900 to 4,800 B.P.), low spine Asteraceae tends to increase in concentration values, whereas all other taxa show decreases. This combined with the very low occurrences of non-*Opuntia* Cactaceae and *Ephedra* hint at drier conditions during this period. In the Early Archaic component (6,300 to 5,200 B.P.), the low arboreal pollen concentration values might indicate a relatively dry climate, with decrease in the arboreal cover and a concomitant expansion of meadow-like communities.

Currently, phytolith assemblages are playing an increased role in reconstruction of paleoenvironments. The results from the phytolith analysis at the Wilson-Leonard Site led Fredlund (1998) to state, "that future investments in phytolith analysis for the Texas region are warranted." The Varga Site phytolith assemblage reflects more of the grass component than the boreal or other plant components and represents grass communities that are not reflected in the pollen assemblage.

The Varga Site phytolith results reveal a dominance of Pooideae grasses (C₃ cool season) during the Early and Middle Archaic periods, with an average of less than 15 percent C₄ (warm season) type grasses. C₄ grass phytoliths reveal a gradual increase up to a maximum of 22 percent during the Middle Archaic (4,800 to

3,900 B.P.) period. They continue to gradually increase during the Late Archaic and throughout the Toyah periods. The percentages vary from about 17 to 38 percent C₄ grasses. The highest percentage of C₄ grasses is about 38 percent, which occurred near the end of the Toyah period or in the last few hundred years. During these last few hundred years, the C₄ grasses were comprised mostly of the Chlorideae taxa. These taxa usually dominate assemblages of grama-buffalo grasses (*Bouteloua-Buchloe* sp.) in environments similar to that presently around Lubbock, Texas (Fredlund and Tieszen 1994).

The phytolith data coupled with the pollen data indicate the region saw only minor changes in the mosaic of grasslands and arboreal species throughout the 6,300-years represented by the cultural occupations. In contrast, the phytolith analysis at the Wilson-Leonard Site documents regional and local changes in vegetation over the last 10,000-years (Fredlund 1998). At the latter site, the data indicate that the grassland composition reached the range observed in the modern soil samples from the region between 8,700 and 6,000 B.P. Fredlund (1998) interprets the data to indicate the woodlands became more open by 4,000 B.P. and shrank over the last 2,000-years. If the Central Texas grasses reached their modern balance by 6,000 B.P., then it is possible that the Varga Site data also reflects similar relatively stable grass communities over the last ca. 6,300-years.

Phytolith analyses have not been conducted on sediments from the Lower Pecos region. The few other analyses that have occurred, such as that at Morgan Playa in the Rolling Plains of Texas (Fredlund et al. 1998), are in settings difficult to directly compare to the Varga Site assemblage. The phytolith record at Onion Creek, near Buda, documents no large changes in the vegetation communities over the last ca. 3,000-years (Cummings 1994). The identified charcoal from the Varga Site cultural

components is similar to species represented in the modern environment and generally supports the lack of major change during this lengthy time period.

13.4 STABLE ISOTOPE INFERENCES

Stable carbon isotope values were derived from the same sediment samples as the pollen and phytolith samples extracted from the central area of Block A and indicate the general history of the change in the amount of C₃ vegetation at that specific locality. No obvious zonation in the isotope values is present that reflect stratigraphic or geomorphic boundaries, but two or three general trends are recognizable (Figure 13-1). Overall the carbon isotope values for the Varga Site are quite negative (strongly reflecting C₃ matter), with an average $\delta^{13}\text{C}$ value of -27.3‰. Beginning at roughly 6,300 B.P. and continuing over the next ca. 1,500 to ca. 4,800 B.P., the carbon isotope values varied between -27.0‰ to -24.9‰, with an average of about -25.8‰. This is a clear indication that during this period almost no C₄ grasses or CAM plants with C₄ signatures (such as agave or prickly pear [Eickmeier and Bender 1976]) contributed carbon to the local sediments. From ca. 4,800 B.P. forward until about 2,300 B.P., the carbon isotope values continued to become more negative, from about -25.5‰ to nearly -30.0‰, documenting continued increase in the contribution of C₃ matter to the sediments (Figure 13-1). From about 2,300 B.P. to modern times, the C₃ plant community apparently stabilized or became just slightly less negative. During the period from ca. 300 to 600 B.P., the carbon isotope values average about -28.7‰. The average difference in carbon isotope values for the 1,500-year period between 6,300 and 4,800 B.P. and the 300-year period between 300 and 600 B.P. is about 3.0‰. This documents a general increase in the amount of C₃ vegetation over this period.

Figure 13-1. Stable Carbon and Nitrogen Isotope Results from a Matrix Column Near Middle of Block A

A period of dominance by C_4 or CAM plants with C_4 signatures is not visible in the stable carbon isotope record in this alluvial terrace along Hackberry Creek.

Towards the eastern margin of the Edwards Plateau at the Wilson-Leonard Site just north of Austin, the stable carbon isotope analysis revealed a similar lack of prominent C_4 zones in the 10,000-year long profile. There, the carbon isotope values center on -23‰ with a very slight trend towards more positive values over the last 7,000-years (Fredlund and Tieszen 1998).

At the Varga Site, the nitrogen isotope values from the same organic matter in the same sediment samples as the carbon isotopes and pollen and phytolith samples are relatively consistent over the ca. 6,300-years. Only a slight decrease was detected from about 9.2‰ during the initial 1,500-years to ca. 8.3‰ for the ca. 300-year period between 300 and 600 B.P. This roughly -1‰ change in the nitrogen isotope values supports a general consistency in the overall vegetation record. Again this data reveals no significant change in the vegetation community during the last 6,300-years.

13.5 MACROBOTANICAL INFERENCES

The macrobotanical remains consist of at least 18 different identified taxa, including 12 wood species (Table 13-1). The non-wood species represented at the Varga Site include seeds and nuts that potentially were transported into the site by humans, but are considered to have come from the immediate surroundings. The wood taxa identified definitely represent arboreal flora in the immediate surroundings and are representative of the local vegetation community. Preservation was generally good for an open-air site and especially good considering the absence of well-defined cultural pit features that often contribute to the preservation of organic remains. The most recent cultural interval, as represented in the

Toyah component, yielded 18 taxa, followed by 11 taxa in the Late Archaic, three taxa in the Middle Archaic, and five taxa in the Early Archaic (Table 13-1).

The Early Archaic component is represented by walnut, juniper, mesquite, oak, and prickly pear. These same five taxa were still present during the Late Archaic period, in the more recent Toyah assemblages, and part of the local vegetation community to this day. This implies a significant degree of long-term continuity in broad vegetation communities from ca. 6,300 B.P. up to the present. The densities of the species cannot be determined from the current data sets, and it is likely that their frequencies only changed to some extent over time. Riparian taxa dominate the assemblages as expected for a low alluvial terrace adjacent to a creek. Those species identified that might be considered most representative of upland or rocky slopes, such as the agave and prickly pear, are considered probable food resources that were brought onto the site from the immediately surrounding catchment area.

The wood identifications do not often support the pollen data. Only in eight instances are the same species from each of these groups represented for the same time period. Oak pollen and identified oak wood account for half the instances, perhaps reflecting the dominance of this species during all four major time periods recognized. The lack of correspondence between the pollen results and macrobotanical remains indicates how the two different data sets reflect different taxa, although each data set contributes to our understanding of the past vegetation communities. The two data sets provide a much clearer representation of the vegetation communities and should be considered in combination with each other.

Table 13-1. Wood and Pollen Taxa Identified by Cultural Period

Wood Taxa Identified (x = present)	Toyah	Late Archaic	Middle Archaic	Early Archaic	Pollen Species Identified (o = present)
Agavaceae (sotol/yucca)	x (heart)	x (leaf)			Agavaceae (yucca/sotol)
<i>Berberis</i> (agarita)	x				
<i>Carya</i> sp. (pecan)	x (nut) o	x (nut) o	o	o	<i>Carya</i>
<i>Cephalanthus</i> (buttonbush)	x	x			
Cheno-am seed	x o	o			Cheno-am
<i>Condalis</i> sp. (condalis)	x	x			
Fabaceae (woody legume)	x	x			
<i>Juglans</i> (walnut)	x (nut) o	x (nut)		x (nut)	<i>Juglans</i> sp.
<i>Juniperus</i> sp. (juniper)	x	x	x	x	<i>Juniperus</i> sp.
					<i>Atriplex</i> conescens (saltbush)
<i>Opuntia</i> sp. (prickly pear)	x (seed) o	x (seed)		x (seed)	<i>Opuntia</i> sp.
<i>Pinus</i> sp. (pinyon)	x	o		o	<i>Pinus</i> sp.
<i>Platanus occidentalis</i> (sycamore)	x				
<i>Prosopis</i> (mesquite)	x (seed)	x (seed)	x	x	
<i>Quercus</i> (oak)	x o	x o	x o	x o	Fagaceae
Salicaceae (cottonwood/willow)	x				
	o		o		<i>Celtis</i> sp. (hackberry)
<i>Ulmus</i> sp. (elm)	x				<i>Ulmus</i>
<i>Ungnadia</i> sp. (buckeye)	x				
<i>Ziziphus</i> (lotebush)	x	x			
	o	o		o	Poaceae (grass)
	o	o			<i>Artemisia</i> (sagebrush)
	o	o	o		Asteraceae (composite)
	o			o	Apiaceae (carrot)
Total wood taxa	x = 18 taxa	x = 11 taxa	x = 3 taxa	x = 5 taxa	
Total pollen taxa	o = 10 taxa	o = 7 taxa	o = 4 taxa	o = 5 taxa	

13.6 FAUNA

The apparent repeated hunting of rabbits and deer during the four major time periods represented at the Varga Site reflects the adaptive flexibility of these species. The minor changes in climate and flora indicated by the micro- and macro-botanical data did not sufficiently alter the local environment to markedly affect the habitats of deer or rabbits. On the other hand, bison and antelope were hunted only during the last 600-years of occupation, which may indicate that the region became more open with grassland expansion, and thus better suited to sustaining bison and antelope, during this latest period.

13.7 DISCUSSION

The Varga Site revealed less than 150 cm of fine alluvial deposits atop a thick gravel deposit that is greater than 6,300-years old. Cultural components identified in the fines potentially represent multiple events, but the recognized components represent relatively short, well-defined radiocarbon dated time periods.

Hackberry Creek is a bedrock-constrained channel with a relatively high stream gradient that raises concerns about direct correlation to other regional terrace chronologies that do not share these properties. Examination of terrace chronologies along other small streams in the region show only very limited consistency in the timing of sediment deposition and soil formation. In broad regional terms, and looking eastward where more studies have been conducted, similarities in key ages center around 5,000 B.P. and 2,000 B.P. The most general trend is an episode of valley filling before ca. 5,000 B.P. After ca. 5,000 B.P. overbank deposition dominates, but few paleosols have been identified. At around 5,000 B.P., noticeable changes occurred, but causal factors are not clear. Soils were either truncated or a

noticeable drop in the deposition rate occurred ca. 2,000 B.P. This may indicate a period of widespread downcutting of streams.

In our attempt to reconstruct paleoenvironmental conditions, the employment of multiple lines of inquiry/analysis concerning past environmental conditions has contributed to a broader understanding and identification of a more complete range of plants in pertinent floral communities. The current data from the Varga Site indicates that the local vegetation community did not significantly change over the last 6,300-years. That is not to say that the density of various plant species remained constant over this period, but the data is not robust enough to see those changes, or from another perspective, the changes were not great enough to be represented in our limited data bases. The plant communities were, over the long-term, dominated by C_3 vegetation that consisted of a mixture or a composite of grasses and arboreal species.

It should be kept in mind, as this discussion proceeds, that our data are all from a generally well-watered streamside alluvial terrace, and the apparent near-consistency in the environment may not apply to upland areas away from the stream valley, where even relatively small changes in climate may have had a more profound affect upon plant communities and, by extension, on general biotic productivity. This may partially explain why the general interpretation of the paleoenvironment based on our empirical data is not in keeping with the broader interpretations from across Texas in that a gradual warming and drying trend occurred during the Holocene until about 3,000 B.P., when a wetter phase began. Specific data sets in selected geographical settings reveal paleoenvironmental variations and limited indications of a pronounced change, but a general trend is documented. The timing of these detected changes is not always in direct

correlation with other areas, and it is not clear if the actual events occurred at slightly different times across broad regions, or that variability in our dating techniques or extrapolations of these ages and/or events exists. In most locations, the vegetation communities appear relatively stable, but a warm and dry period has been documented in a few of the surrounding regions.

A study of the upper Pedernales River near Fredericksburg (Blum and Valastro 1989) documents changes in the environment based on geomorphic history of alluvial terraces. The evidence indicates two climate shifts, one around 4,500 B.P. and another around 1,000 B.P. An erosional unconformity indicates a dry climate before ca. 4,500 B.P. From ca. 4,500 to ca. 1,000 B.P., Blum and Valastro (1989) interpret the data to indicate increased precipitation through heavy rains. After about 1,000 B.P., they see a generally modern climate and episodic flash floods.

Just north of Edwards County, at the Buckhollow Site in Kimble County, Late Archaic cultural materials were contained in a paleosol (Johnson 1994), which was much thicker than the Varga Site paleosol that contained a Late Archaic component. Johnson sees this paleosol as requiring a relatively moderate and stable climate and associates this development with relatively mesic conditions. The Buckhollow paleosol is undated, whereas the Varga Site paleosol was radiocarbon dated to 1,900 B.P. and contains cultural materials that date from 1,700 to 2,300 B.P. The carbon isotope value of -22.8‰ from that dated matrix also supports a moist C₃ vegetation community.

Johnson and Goode's (1994) dry Edwards Interval, dated at ca. 5,000 to 2,500 B.P. in the eastern Edwards Plateau is generally supported by the faunal record from Hall's Cave (Toomey et al. 1993), but is not evident at the Varga Site. The stable carbon isotope analysis on the

sediments and other pertinent data from the Varga Site does not reveal any recognizable shift or change in the organic composition that might signal this dry period. Bousman (1998) sees a two-phased, mid-Holocene dry interval, with extremes recorded at 6,500 B.P. and 5,000 B.P. from requantified pollen results from Boriack and Weakly bogs located just east of the Edwards Plateau. In calculating the relationship of the arboreal canopy cover with pollen percentage, Bousman (1998) sees the arboreal canopy at its most restricted extent at about 5,000 B.P.

River valleys across much of Texas reveal a pattern of Middle Holocene channel trenching roughly between 7,000 and 5,000 B.P. due to severe drying conditions. This is generally followed by a postulated wetter period from ca. 4,500 to 1,000 B.P. as evidenced by alluviation, with a return to channel trenching by 1,000 B.P. (Hall 1990).

In the Lower Pecos region, phytolith and stable isotope studies have not been attempted, and pollen records are spotty, mixed, or incomplete. However, rockshelter deposits have yielded great quantities of plant remains (Dering 1977, 1979) and human coprolites (Bryant 1974; Williams-Dean 1978) that have provided data from which past environmental conditions can be extrapolated. It is not clear what specific paleoclimatic conditions existed between 7,000 and 4,000 B.P. This was a period of erosion and severe flooding along the Rio Grande, as evidenced at Devil's Mouth Site (Johnson 1964) and Arenosa Shelter (Dibble 1967), which may indicate increased runoff from slopes with a generally reduced vegetation cover. Before about 6,700 B.P., oak, juniper, walnut, mesquite, hackberry, coyotillo, onion, lechuguilla, yucca, sotol, grasses, and prickly pear were all present in the Lower Pecos region and were exploited by the human population (Dering 1979). By about 6,100 B.P., acacia, yucca, chenopodium, buffalo

gourd, sumac, and Texas mountain laurel were also exploited. Dering sees a major vegetation change in the Lower Pecos region between 5,000 and 4,400 B.P., primarily on the basis of macrobotanical data. Dering (1979) goes on to argue that the general environment of the Lower Pecos region has not changed as drastically as had been previously thought by Bryant (1977a). Currently, it is difficult to state that the Varga Site data are similar to the Lower Pecos region because of the incompleteness of the two records and the different types of data currently available for each region.

Huebner (1991b) used a broad range of environmental data from across Texas to address the presence of bison in Texas over the last 750 years. He saw diverse environmental data indicating that the climate of the southern Plains became more xeric, with an increase in grasses, about 1,000 B.P. He suggested that the bison population grew in response to these conditions and hypothesized that bison herds were permanent additions to the biota, although thinly spread rather than present in all areas at all times. He also stated that local conditions of grass cover, topography, and access to water would be constraining factors in human-ecological decision making. Stable carbon isotope analyses on bison bones from the last 750 years across Texas (Huebner 1991b; Huebner and Boutton 1990) document that bison grazed across a broad range of environments throughout the state and were consuming about 87 percent C_4 grasses, with a resultant mean $\delta^{13}C$ values in their bones near $-9.5 \pm 1.7\text{‰}$. C_4 grasses are established on most of the Southern Plains and probably are the dominant grasses in the modern prairie, oak-juniper, oak-woodlands, and oak-savanna in Texas, judging by analysis of phytoliths from sediments in these regions (Fredlund 1998).

A small bone fragment (#525-5-2-1a) from Feature 2 in the Toyah component in Block A

yielded a stable carbon isotope value on collagen of -8.6‰ , a nitrogen isotope value of 5.1‰ , and a stable isotope value on bioapatite of -4.0‰ . These isotope values indicate the bone was that of a bison, which had consumed about 90 percent C_4 plants (grasses) over its lifetime. These isotope values are similar to those derived on bison bones from a Toyah component at the Rush Site (Quigg and Peck 1995) near San Angelo, some 200 km north of the Varga Site, and bison bones from the Sanders and Broken Jaw sites in the northern Texas Panhandle (Quigg 1993, 1997a). The similarities in the carbon isotope values from the Varga Site bison and the other Toyah bison samples indicate similarities in the bison feeding patterns over the last 600 to 700-years in a vast area across Texas, including eastern Edwards County.

The carbon isotope result on a single bison bone from the Varga Site indicates a very high consumption of C_4 grasses, which is also very similar to other bison isotope results from this same period across Texas (Huebner 1991b). In contrast, the carbon isotope values extracted from the soil organic matter dating to this same period at the Varga Site do not support the presence of C_4 grasses on site. The four sediment samples analyzed from the Toyah component document an average carbon isotope value of -28.72‰ and a nitrogen isotope value of 8.32‰ . These values indicate a nearly complete C_3 community comprised of arboreal species and grasses. If C_4 grasses were not in the immediate site area, then the bison must have generally had a feeding range beyond the Varga Site locality that focused on C_4 grasses. C_4 grasses potentially were part of the upland vegetation community on the short-grass prairies to the north. The bison documented at the Varga Site may have arrived in this vicinity as a result of seasonal herd-migration patterns. The documented animal would have consumed mostly C_4 grasses elsewhere, and then moved into this region on a part time/seasonal basis

when C_4 grasses elsewhere were in their lowest production. One may speculate that the time of the latter low production would have been late winter or spring when C_3 grasses in the region would have been more plentiful and more nutritious than the C_4 grasses elsewhere. Such short-term seasonal movements from the more dominant C_4 grass communities elsewhere would account for the small percentages of C_3 component in the detected isotopic values of the bison bone.

The Toyah component at the Varga Site yielded a phytolith assemblage that contained saddle and simple lobate shaped phytoliths that constitute roughly 20 to 32 percent short-shell phytoliths. These types indicate a relatively low percentage of C_4 type grasses or CAM plants with C_4 signatures that would reflect a short grass prairie. These frequencies are less than half the frequencies identified by Fredlund (1998) for prairies in Bell County of Central Texas, and for an oak savanna region in Kerr County just to the east of Varga. However, the presence of 20 percent C_4 grasses or CAM plants with C_4 signatures are not supported by the stable carbon isotope data that indicate a less than five percent C_4 contribution. The C_4 grasses are the preferred vegetation for consumption by bison as documented by bison bone isotope data. But bison are generalized consumers and will consume a variety of plants (Martin et al. 1951; Pedon et al. 1974; Pedon 1976).

Fredlund and Tieszen (1998) also indicate a discrepancy between the isotope data from soil and the phytolith record at the Wilson-Leonard Site in Williamson County. They suggest this discrepancy is related to spatial scale with the phytolith record indicative of regional vegetation with eolian processes introducing additional phytoliths, whereas the soil organic matter is more reflective of the local environment.

In summary, the Varga Site paleoenvironmental record does not reflect a significant warm and/or dry period during the ca. 6,300-year period represented based on the pollen, phytolith, and carbon isotope data recovered from this streamside site. The local vegetation community did not significantly change over this same 6,300-year period. The vegetation communities were comprised chiefly of C_3 vegetation that consisted of a mixture or a composite of grasses and arboreal species. However, at around 5,000 B.P., a noticeable change occurred in the deposits, but it is not clear exactly what those changes are or related to. Soils were either truncated or a reduction in the deposition rate occurred ca. 2,000 B.P. This may indicate a period of down cutting. These changes may relate to regional fluctuations in wet and dry periods, but the broader climatic conditions appear to have been relatively stable, and apparently were cooler/wetter than conditions in the surrounding regions.

14.0 SUBSISTENCE PATTERNS

J. Michael Quigg

14.1 INTRODUCTION

General subsistence patterns are usually considered to represent the food resources that each prehistoric group consumed over a period of time. These broad patterns are generally established from excavations at many sites in order to accurately document spatial variability in subsistence practices as correlated with the heterogeneity in environmental mosaics. A single site excavation such as this only documents a single point in space, and thus, cannot fully reflect the full range of exploited resources within the relevant human ecosystem.

The subsistence resources for the four major time periods documented at the Varga site (Early Archaic from 6,300 to 5,200 B.P., Middle Archaic period from 4,820 to 3,900 B.P., Late Archaic period from 2,300 to 1,700 B.P., and the Toyah phase into the Protohistoric from 620 to 290 B.P.) were individually mentioned in the preceding chapters dealing with each of the individual cultural components. In this chapter, we summarize the site-specific subsistence patterns each of these four general time periods.

The subsistence resource information for these four time periods was sought from diverse samples of material collected during the excavations and analyzed in an attempt to determine as closely as possible the full range of food resources exploited by prehistoric occupants of the site. Some direct data are

available in the form of about 21,500 faunal bone fragments, about 30 mussel shell fragments, and roughly 460 grams of macrobotanical remains; whereas other data sets comprise proxy evidence in the forms of the 99 lipid residue analyses, the 98 stable carbon and nitrogen isotope results, and the use-wear analysis supplemented by organic residue identifications on 79 of the 156 stone tools analyzed. Offered below are brief summaries of classes of data, comparisons of the records between the different components, and discussions of the findings.

14.2 VERTEBRATE FAUNA

The bones recovered generally represent the hunted or captured animal resources of their respective time periods. Bone is best preserved and most frequent in the Toyah component (20,438 pieces), compared to the three earlier components that yielded a combined total of only ca. 1,000 pieces. Table 14-1 reveals 10 different species that were identified in the Toyah component. The three older components yielded very infrequent and scattered bones, which represent anywhere from three to five species. Although the frequency of individual pieces and species identified is much less in the three older components, there is reason to believe that this lower frequency is not entirely the result of poor preservation. Because some bones were still present in the Early Archaic ($n=200$), one would expect most bones of different hunted species to still be represented. The cortical walls of bison long bones are much thicker than most other species. Therefore, if bison long bones were present in any of the early components, then bison bones would undoubtedly have been preserved, especially since bones of deer and possibly rabbit were present in the Early Archaic assemblage.

Table 14-1. Subsistence Resource Results

Categories Investigated	Toyah 300 to 660 B.P.	Late Archaic 1,700 to 2,300 B.P.	Middle Archaic 3,900 to 4,820 B.P.	Early Archaic 5,200 to 6,300 B.P.
Vertebrates:				
Bison	2	1, ?	1, ?	
Deer	2		2	1
Antelope	1			
Deer/Antelope		1		
Rabbit	2, ?		2	1, ?
Coyote/dog	1, ?		1, ?	
Turtle	2, ?		1, ?	
Fish	2, ?			
Snake	2, ?			
Large Bird	1, ?			
Mussel Shells	x, ?	x, ?		x, ?
Macrobotanical Food Resources:				
Agave heart and leaves	x	x		
Cheno-ams	x, ?			
Walnut shells	x, ?	x, ?	x, ?	x, ?
Mesquite beans	x	x		
Prickly pear seeds	x	x		x, ?
Pecan shells	x, ?	x, ?		
Total weight of samples	70.3 g	23.7 g	0.8 g	6.3 g
Lipid Residues from Burned Rocks:				
Plants residues	76%	97%	100%	100%
Large herbivore residues	24%	3%	0%	0%
Number of samples	29	33	9	22
Carbon Isotopes from Burned Rocks:				
C ₃ values represented	94%	100%	100%	100%
Number of samples	29	33	9	21
Use Interpretations from Stone Tools:				
Plants (wood, hard silica, raphids)	72%	61%	75%	55%
Animals (hair, hide, bone, soft, meat)	14%	22%	25%	12%
Number of tools analyzed	59	17	17	63

2 = minimum number of individuals; x = present; ? = unknown if cultural in origin

With so few bone fragments recovered from the three lower components, it is possible that a few individual bones were displaced downward and mixed with the earlier materials. The procedures followed during analysis to sort *in situ* bones from vertically displaced specimens have been discussed in previous pages and will not be repeated here. Suffice it to say that, while we are cognizant of the influence of taphonomic factors on the bone samples from various components, the faunal data discussed here, and presented in Table 14-1, are believed to be a reasonably reliable basis for interpretation.

Many bison bones ($n=1,481$ pieces) were recovered from the Toyah component, representing a minimum of two adult individuals. Dillehay (1974) documented the presence of bison during this period in Texas, and their presence has been further substantiated over the years at most Toyah sites (e.g., Buckhollow, 41TG91, Rush, Mustang Branch [41HY209], Rainey Sinkhole, Hinojosa). Although bison bones have commonly been identified in Toyah components, the minimum number of animals identified per any single site/event is generally fairly low, usually less than four individuals. Thus, it generally seems that, while bison were consistently a major source of meat during the Toyah phase, they were not procured with a hunting strategy that involved massive kills of large numbers of animals at any one time. Toyah peoples were apparently diversified hunters who killed deer in larger numbers than bison. They also killed and presumably consumed antelope and many types of smaller game animals as well. A subsistence strategy in which bison were taken in limited numbers may represent an adaptation to an environment that contained only relatively limited numbers of these large ungulates. Huebner (1991b:354) discusses the movement of bison into central and southern Texas:

The occupation of the western Edwards Plateau by *Bison* spp. may be limited to the Paleoindian and Late Archaic periods. During the Late Prehistoric the limited evidence of bison remains south of the upper Colorado River does not suggest the movement of large herds. Further, a model showing movement of bison across the Plateau onto the coastal prairies would have to account for canyon lands along the Balcones escarpment. This area of deeply entrenched streams and tight canyons would have been a severe impediment to southward movement.

This author agrees that few large bison kills have been documented in central or southern Texas (Bonfire Shelter, at which large jump kills were carried out, being the one major exception). However, I am unconvinced that the Balcones escarpment was a “severe impediment” to bison movement. The bison at the Varga Site, which lies just below the very southern edge of the Balcones escarpment in the dissected canyonlands, indicates their presence in this rugged topography, if only in limited numbers. The volumes of historic accounts of bison behavior (i.e., Haines 1970; McHugh 1958, 1972; Roe 1972) and modern handling of bison (Frison 1978) reveal that this rugged terrain would not have impeded their movements. The minimum number of bison identified at the Varga Site accords with other findings at Toyah sites, and may indicate that only small herds were present across vast regions of Texas. The eastern route of bison movement into central and southern Texas postulated by Huebner (1991b) was based mostly on the absence of data and/or investigated sites in the western Edwards Plateau dating to this period. The absence of data is a direct result of the lack of investigations rather than a limitation on the movements of bison through that region. Investigated Toyah sites in the western Edwards Plateau region such as Varga, Buckhollow, and Rainey Sinkhole all

have yielded some bison bones, reflecting recent growth in our regional database. These investigated sites document unequivocally that bison were in the western part of the Edwards Plateau and in the rugged canyonlands during the Toyah period. Bison presence in the region continued into the Protohistoric period, as indicated by recorded sightings of these animals in the Val Verde County area (Turpin 1987; Kenmotsu 1994, 2001; Wade 1998).

In contrast to the Toyah component, the Late Archaic component at the Varga Site yielded little in the way of bison remains. Just a few small tooth enamel fragments are identified, and it is probable they were displaced downward from the immediately overlying Toyah component. The evidence for bison presence in the Late Archaic at the Varga Site is questionable at best. The interpretations of the lipid residues from 34 Late Archaic burned rocks indicate no residues definitely attributable to large herbivores, further supporting the absence of bison in the subsistence repertoire at this site during the Late Archaic.

However, the Late Archaic period is one of Dillehay's (1974) identified periods of bison presence with some sites from across the broad region yielding bison bones. In the Lower Pecos region, bison bones have been recovered during the Late Archaic at Skyline Shelter (Turpin and Bement 1992) and Bonfire Shelter (Dibble and Lorrain 1968). The radiocarbon age for the bison Bone Bed 3 at Bonfire is ca. 2,300 to 2,900 B.P. and is associated with Castroville-like and Montell points. Turpin and Bement (1992) believe the presence of bison reflects a winter occupation, but no direct evidence is yet available for a specific seasonal usage. So, bison were in the Lower Pecos during the Late Archaic period, but possibly only on seasonal bases. Therefore, only in some seasons, and some Late Archaic sites occupied during those

seasons, were bison potentially available to the human population.

In the Middle Archaic component at the Varga Site bison bone comprises less than one percent of the faunal-bone sample. More than likely the few, very small pieces were not recovered from their original context, but originated from occupations above. Therefore, it is not likely that bison were present or were part of the Middle Archaic subsistence strategy. Lipid residue analysis on nine Middle Archaic burned rocks from Features 11 and 37 were interpreted as having cooked no large herbivore meat, also indicating an absence of bison in this component. In the Lower Pecos region, where preservation is often better in the large rockshelters compared to open-air campsites, Middle Archaic components at sites such as Skyline Shelter have yielded diverse faunal assemblages including fish, deer, turtle, and mussel shells, but produced no evidence of bison. The absence of bison in the Middle Archaic is probably a more or less localized phenomenon. However, this is the general time frame that Bell/Andice projectiles appear in Central Texas at sites like Landslide, Occupation Phase 3 (Sorrow et al. 1967). These point types are thought to be in association with bison remains (Sorrow et al. 1967; Johnson and Goode 1994), but the radiocarbon dating of bison bones is very limited in support of this assumed association.

No bison bones were identified in the Early Archaic component at the Varga Site, one of Dillehay's (1974) proposed periods of bison absence. In addition to the lack of direct evidence of bison bones, the lipid residue analysis on 22 burned rock pieces from the Early Archaic component also lacks lipid residues interpreted as representing large herbivores. Apparently bison were not procured or present between 6,300 and 5,200 B.P. at the Varga Site.

Identified faunal remains indicate a diverse range of exploited habitats. Exploitation of the riverine environments is implied by the presences of fish and possibly turtle, if these few elements represent human procurement. The presence of deer indicates a forested or wooded environment. Bison, antelope, and potentially jackrabbits indicate upland and/or open-range environments. The lack of additional species that reflect wooded habitats such as skunks, raccoons, bobcats, and squirrels is interesting, but little can be drawn from the absence of species, which may be more reflective of the small, fragmented condition of the bone fragments that precluded large numbers of positive identification of taxa.

14.3 EVIDENCE FOR THE USE OF PLANTS

The exploitation of plant resources is best identified through a combination of data sets, including macrobotanical remains, the proxy lipid residue data supported by stable isotope values, and the combination of organic residue identifications and use-wear on stone tools.

The macrobotanical analysis on remains from 404.5 liters of floated sediments and 75 individual samples resulted in the identification of 20 plant taxa (Table 14-2), six of which are edible plant parts consisting of Agavaceae (sotol, yucca, and agave) leaf and caudex fragments, prickly pear seeds, mesquite seeds, cheno-am seeds (goosefoot and pigweed), littleleaf walnut shells, and thin nutshells that probably represent pecans. Edible plant parts are most abundant for the Toyah component with the Late Archaic also yielding a relatively high number of species (Table 14-2).

The carbohydrate-rich agave heart is ethnographically known to have been cooked and consumed (Castetter and Opler 1936; Bell and Castetter 1941; Castetter et al. 1938). Fiber from different succulents such as yucca, agave, and sotol have been recovered in many of the

rockshelters of the Lower Pecos region (Williams-Dean 1978; Stock 1983; Sobolik 1991a; Brown 1991; Dering 1999). Dr. Dering (Appendix I; 1999) provides data on how these agave hearts were cooked in ovens. Therefore, its presence in the Toyah and Late Archaic components probably reflects use as a food resource.

Pecan nuts, identified in the two youngest components, do offer sufficient meat that could provide an excellent source of nutrition. Pecan wood was not identified in the macrobotanical assemblage, thereby strengthening the assumption that this nut was used as food source. In support of the use of nuts during the Late Archaic period is a single, small nutting or pitted stone (#1251-010), assumed to have been used in the processing of nuts and/or seeds.

Burned mesquite seeds (rich in carbohydrates), identified in the two youngest components, have been well documented in the ethnographic literature as a food resource, and were probably a targeted food. In Appendix I, Dr. Dering provides information on how the mesquite pod was processed. The mesquite seed in the Toyah context was recovered from Feature 30 that also yielded mesquite wood. This specific feature context indicates that the seed may have been attached to the mesquite wood as part of the fuel, rather than targeted as a food resource.

Prickly pear seeds were identified in three of the four components, indicating that this fruit was available and undoubtedly consumed. Further support for peoples in this region consuming prickly pear fruit is indicated by an adult female burial recovered from below the floor of the church at Mission San Lorenzo de la Santa Cruz that contained a concentration of several hundred small prickly pear seeds in her abdomen area (Tunnell 1969).

Table 14-2. Botanical Comparisons by Component

Organic Remains	Toyah 80 to 660 B.P.	Late Archaic 1,700 to 2,300 B.P.	Middle Archaic 3,900 to 4,820 B.P.	Early Archaic 5,200 to 6,300 B.P.
Agarita	36/6.6 g			
Buttonbush	8 + 5 ml/1.4 g	2/0.2 g		
Cheno-am	2/0.2			
<i>Condalia</i> or buckthorn	3/0.2 g	5/0.3 g		
Cottonwood/willow	24/1 g			
Elm	19 + 4 ml/1.1 g			
Hickory	12/0.4 g			
Indeterminate	166 + 23ml/12.1 g	128 + 5 ml/1.6 g	1/0.1 g	25/0.7 g
Juniper	61 + 28 ml/8 g	34 + 14 ml/2.7 g		14 + 10 ml/3.6 g
Littleleaf walnut	5/0.4 g	1/0.1 g		6/0.7 g
Lotebush	41 + 10 ml/5 g	7/0.2 g		
Mesquite	97/7.1 g	37 + 34 ml/16 g	10/0.5 g	9/0.7 g
Mexican buckeye	9 ml/1.7			
Oak	330 + 27 ml/14.8 g	19/1.8 g	1/0.1 g	12/0.6 g
Pecan	5/0.2 g			
Pinyon	1/0.1 g			
Prickly pear	2/0.1 g	3/0.1 g		3/0.3
Sycamore	13/0.6 g			
Sotol/yucca/Agave	20/3.2 g	9/0.3 g		
Woody legume	51 + 21 ml/6 g	4/0.4 g		
Total Count	806 + 126 ml	248 + 53 ml	12	69 + 10 ml
Total Weight (g)	70.4	23.6	0.7	6.3

Sobolik (1991a) also indicates that prickly pear cactus was the most commonly utilized plant at Baker Cave in the Lower Pecos at about 1,000 B.P. Prickly pear seeds were recovered from many human coprolites, documenting their consumption. The recovered seeds were fragmented, indicating that the fruit was

processed before consumption (Sobolik 1991a:108).

Littleleaf walnut shells were identified in all four components. The small size of the walnut meat would make meat extraction time consuming and labor intensive. In support of the consumption of walnuts, Sobolik (1991a)

recovered walnut fragments in human coprolites from Baker Cave. Dr. Dering (Appendix I) provides several ethnographic examples that document the use of walnuts. It is also possible that the walnuts were used as fuel; however, walnut wood was not identified in the burned wood assemblage, indicating the nuts were probably not attached to wood used as part of a fuel source.

Testing at multiple Late Archaic burned rock middens of similar age in northeastern Val Verde County yielded littleleaf walnut shells at 41VV1892 and littleleaf walnut, prickly pear, and sotol/yucca fibers at 41VV1897 (Cliff 2003). Walnut shells account for 53.5 percent of the edible plant parts, prickly pear seeds account for 2.3 percent, and sotol/yucca parts account for nearly 21 percent from the tested middens in northeastern Val Verde County (Dering 2003b). The similarity in macrobotanical remains from these burned rock middens supports the idea that similar foods were processed in these features during the Late Archaic period. In contrast, a Late Archaic burned rock midden in the Blackland Prairie in Williamson County in Central Texas yielded some small burned and unburned bones of deer, turtle, snake, bird, carnivore, and rodents, plus many *canis* sp. bulb fragments (Brownlow 2003; Dering 2003c). In Brown County, a complex of tested burned rock middens from 16 sites yielded quantities (400 bulbs and bulb fragments) of five different geophytes—Eastern Camas, wild onion, false garlic, dog's-tooth violet, and rain lily (Dering 2003a; Mauldin et al. 2003). Obviously, hot rocks were employed to cook different food products, including geophytes. At Hinds Cave in the Lower Pecos region, the coprolite studies indicate that cacti—prickly pear and other succulents—remained important in the diet during all cultural time periods (Stock 1983). Throughout the Lower Pecos and across a wide time period, prickly

pear was probably a dietary staple together with sotol, agave, and yucca (Sobolik 1991a).

The Middle Archaic component yielded little in the way of macrobotanical remains. Only one float sample from Feature 11 yielded a single fragment of a littleleaf walnut shell. However, charcoal from this same feature was radiocarbon dated to the Late Archaic component. Consequently, the walnut shell from this specific feature context is questionable in terms of its cultural/temporal context. If the walnut shell was directly associated with this component, it would reflect the persistent use of this resource throughout the entire 6,300-year time span of Varga Site occupation. Wood charcoal from juniper, oak, and mesquite trees was present. Acorns, mesquite seeds, and juniper berries were thus, potential food resources, though they were not recovered from this Middle Archaic context.

The Early Archaic component yielded radiocarbon-dated prickly pear seeds and littleleaf walnut shells (see Table 11-1). Both plant parts are available in late summer into fall, and therefore, may indicate one of the seasons of occupation. Burned wood identified includes walnut, juniper, mesquite, and oak, and trees of all these species produced edible parts.

Rainfall has significant influence on when most fruits, nuts, and seeds ripen in this region. The best time of year for exploiting sotol, or agave as food is in the spring before the flower stalks develop. Mesquite beans and cheno-am seeds generally ripen in mid-summer. Nuts ripen in late summer to mid-fall. Most occupations at the Varga Site contained macrobotanical remains that indicate two or more seasons of occupation. This may reflect either multi-seasonal use of the site by a single group or, alternatively, it may represent multiple, short-term occupations for each component.

At the Varga Site, plant collecting and cooking is also interpreted by indirect or proxy evidence

from the lipid residues extracted from 94 burned rocks, presumably used in cooking. Since the burned rocks move much less than smaller cultural objects, these larger objects are more confidently believed to represent the stratigraphic component in which they were found. The lipid residues from the burned rocks provide evidence that plants were cooked, and therefore consumed, as opposed to plants collected and used for other purposes (Table 14-3).

A sample of 29 burned rocks from the Toyah context yielded results that indicate nearly 76 percent of the lipid residues represent plant products. About 24 percent yielded residues of the meat of large herbivores (i.e., bison, deer, pronghorn), though for about one-half of the samples, it is unclear if other kinds of meat residues are present. In the Late Archaic period, the large herbivore meat is only reflected by about three percent of the 33 burned rock samples analyzed (i.e., in one sample). The two oldest components did not reveal any lipid residues that reflect cooking of large herbivore meat.

One possible explanation would be that the deer meat was not prepared through cooking by hot rocks (i.e., boiling, broiling, or baking) indicating that deer meat may have been roasted over a flame, dried, or even consumed raw. The lipid residues detected in the burned rocks reflect high concentrations of fatty plant substances (i.e., nuts and seeds) throughout time. Extensive cooking of plants is implied from the lipid residues, providing a sharp contrast to the direct evidence reflected in the faunal-bone assemblages. In combination, the two different data sets reflect a more comprehensive and broader range of resources exploited by the groups rather than does either taken alone.

The lipid residue data is supported by 92 stable carbon and nitrogen isotope results derived from

the exact same burned rocks, with the Varga Site background data provided through stable isotope analyses of the dated sediment samples from the soil column (Table 14-3 and Figure 14-1). These results indicate extensive use of C₃ plants and/or animals that ate C₃ plants, in support of the lipid residue results. A few isotope results in the projected terrestrial animal range may represent animals such as rabbits and buffalo that consumed C₃ plants, as reflected in the sample of modern plants and animals analyzed (Figure 14-2).

Plant and animal diversity is also documented in the stone tool assemblages from each of the four components. The use-wear analyses and organic residue identifications support the manipulation of multiple food resources. Multiple tool forms including points, bifaces, scrapers, and edge-modified tools were present in all four components and imply diverse functions on multiple materials. The use-wear evidence does not associate a specific tool class to a specific functional task or material, but does reveal a broad range of activities directed toward plants and animals. The use-wear interpretations and organic residues identified on the tools from all four components reveal extensive use on, and residues from, plants and animals.

The observed residues on Toyah component tools reveal the use of starchy plants (possibly roots or tubers), mammals, birds, and other types of plants. Feathers on one Toyah biface (Appendix C) substantiate the use of birds. The use-wear interpretations on the Toyah tools indicate that only about 14 percent were associated with animal use or residues, whereas 72 percent of the interpretations of the use-wear support use of tools on plants. The latter figure is nearly equal to the identified plant lipid residues identified from the burned rocks.

Table 14-3. Summary of Interpretations of Foods Cooked by Burned Rocks Analyzed from Selected Features

Fea. No.	C ¹⁴ Age B.P.	Cat. #	Wgt (mg)	δ ¹³ C (‰) Value	δ ¹⁵ N (‰) Value	Lab. No.	Lipid Residue, Results and Interpretations
Toyah							
8	570-620	865-5-3-1a	40.381	-26.11	-4.21	4VG 9	Moderate-high fat content
8		865-5-3-2a	7.623	-21.84	5.61	4VG 10	Borderline medium and moderate-high fat content
8		865-5-3-3a	12.374	-23.93	4.99	4VG 11	High fat content
8		843-5-3-1a	5.316	-18.43	5.75	4VG 12	Large herbivore – somewhat fatty
8		843-5-3-2a				4VG 13	High fat content – plant
8		843-5-3-3a				4VG 14	Large herbivore – fat meat
9	660	830-5-3-1a				4VG 15	Borderline medium and moderate-high fat content – plant
9		830-5-3-2a	41.813	-23.57	3.83	4VG 16	Large herbivore – fat meat, possibly plant
9		830-5-3-3a	4.438	-25.75	6.44	4VG 17	Large herbivore + plant or bone marrow
9		830-5-3-4a	12.351	-20.97	6.67	4VG 18	Borderline medium and moderate-high fat content – plant
25		1051-5-3-1a	12.351	-20.97	6.67	4VG 19	High fat content – plant
25		1051-5-3-2a	23.835	-18.45	4.85	4VG 20	Borderline medium and moderate-high fat content – plant
25		1051-5-3-3a	17.353	-20.45	6.41	4VG 21	Large herbivore – somewhat fatty, possibly plant
25		1051-5-3-4a	42.672	-25.70	2.02	4VG 22	Moderate-high fat content – plant
38		1030-5-3-1a	30.632	-18.58	5.25	4VG 23	Large herbivore – somewhat fatty, possibly plant
38		1030-5-3-2a	13.640	-22.07	4.21	4VG 24	Large herbivore – somewhat fatty, possibly plant
38		1030-5-3-3a	2.983	-23.23	11.36	4VG 25	Moderate-high fat content – plant
38		1030-5-3-4a	30.794	-20.32	-2.19	4VG 26	High fat content – plant
36		158-5-3-1a	15.883	-24.31	6.08	4VG 27	Borderline moderate-high and high fat content – plant
36		158-5-3-2a	42.373	-24.78	3.40	4VG 28	Borderline moderate-high and high fat content – plant
36		158-5-3-3a	39.406	-24.80	5.94	4VG 29	Moderate-high fat content – plant
21	300-380	79-5-3-1a	7.805	-24.80	3.59	4VG 30	Moderate-high fat content – plant
21		79-5-3-2a	5.808	-21.16	2.80	4VG 31	Medium fat content – plant
21		79-5-3-3a	42.012	-24.87	3.56	4VG 32	Moderate-high fat content – plant
18		534-5-3-1a	26.876	-27.99	1.89	4VG 33	Moderate-high fat content – plant
18		534-5-3-2a	15.539	-25.29	7.92	4VG 34	Moderate-high fat content – plant
NA		1005-3-1a	4.901	-21.45	4.80	4VG 35	Borderline moderate-high and high fat content – plant
NA		79-3-1a				4VG 36	Borderline medium and moderate-high fat content – plant
NA		79-3-2a				4VG 37	High fat content – plant

Table 14-3. Summary of Interpretations of Foods Cooked by Burned Rocks Analyzed from Selected Features

Fea. No.	C ¹⁴ Age B.P.	Cat. #	Wgt (mg)	δ ¹³ C (‰) Value	δ ¹⁵ N (‰) Value	Lab. No.	Lipid Residue, Results and Interpretations
Late Archaic							
1b	2310	273-5-3-1a	6.751	-25.66	1.08	4VG 38	Borderline moderate-high and high fat content – plant
1b		273-5-3-2a	19.183	-25.09	5.93	4VG 39	High fat content
1b		273-5-3-3a	30.054	-22.55	6.81	4VG 40	Borderline high and very high fat content – plant
1c	1700-2300	293-5-3-1a	3.645	-24.18	5.78	4VG 41	High fat content – plant
1c		293-5-3-2a	22.800	-24.89	3.94	4VG 42	Very high fat content – plant
1c		293-5-3-3a	5.439	-24.54	6.72	4VG 43	Borderline moderate-high and high fat content – plant
1a	1700	89-5-3-1a	40.574	-23.24	7.83	4VG 44	Very high fat content – plant
1a		89-5-3-2a	30.178	-24.97	3.41	4VG 45	Very high fat content – plant
1a		89-5-3-3a	47.687	-25.90	3.17	4VG 46	Borderline high and very high fat content – plant
29	1700-2300	966-5-3-1a	1.346	-26.71	5.68	4VG 47	Very high fat content – plant
29		962-5-3-1a	12.626	-28.39	-5.96	4VG 48	Very high fat content – plant
1d	1700-2300	11-5-3-1a	40.574	-23.24	7.83	4VG 49	High fat content – plant
1d		11-5-3-2a	30.178	-24.97	3.41	4VG 50	High fat content – plant
1d		11-5-3-3a	47.687	-25.90	3.17	4VG 51	Very high fat content – plant
28	1700-2300	941-5-3-1a	7.756	-24.69	2.38	4VG 52	Insufficient lipid for analysis
28		941-5-3-2a	30.576	-22.05	8.66	4VG 53	Very high fat content – plant
15	2140	801-5-3-1a	32.874	-23.21	7.92	4VG 54	High fat content – plant
15		801-5-3-2a	40.271	-24.48	5.53	4VG 55	Moderate-high fat content – plant
15		801-5-3-3a	3.360	-25.34	6.62	4VG 56	Borderline moderate-high and high fat content – plant
1	1700-2300	263-5-3-1a	7.058	-24.13	8.23	4VG 57	Borderline medium and moderate-high fat content – plant
1b		274-5-3-2a	24.516	-23.30	7.05	4VG 58	Borderline moderate-high and high fat content – plant
1		187-5-3-2a	40.472	-23.45	4.63	4VG 59	Very high fat content – plant
1		80-5-3-1a	7.606	-23.88	4.78	4VG 60	Very high fat content – plant
1		187-5-3-1a	42.543	-25.47	3.91	4VG 61	Medium fat content – plant
1		179-5-3-2a	17.820	-24.65	6.12	4VG 62	Low fat plant
1		98-5-3-1a	16.006	-24.19	7.65	4VG 63	Borderline medium fat content and large herbivore + plant
1		179-5-3-1a	8.294	-24.67	4.55	4VG 64	High fat content – plant
1b		274-5-3-1a				4VG 65	High fat content – plant
1		178-5-3-1a	30.115	-21.78	5.22	4VG 66	Borderline medium and moderate-high fat content – plant
1		370-5-3-1a	30.608	-23.19	7.09	4VG 67	Borderline moderate-high and high fat content
1		161-5-3-1a	26.233	-30.62	6.08	4VG 68	Borderline high and very high fat content – plant
1		352-5-3-1a	40.293	-26.33	2.00	4VG 69	Borderline high and very high fat content – plant
1		352-5-3-2a	1.650	-24.63	4.64	4VG 70	High fat content – plant
1		81-5-3-1a	2.161	-26.02	-3.15	4VG 71	High fat content – plant

Table 14-3. Summary of Interpretations of Foods Cooked by Burned Rocks Analyzed from Selected Features

Fea. No.	C ¹⁴ Age B.P.	Cat. #	Wgt (mg)	δ ¹³ C (‰) Value	δ ¹⁵ N (‰) Value	Lab. No.	Lipid Residue, Results and Interpretations
Middle Archaic							
11	3900-4820	276-5-3-1a	3.708	-25.54	2.36	4VG 72	Moderate-high fat content
11		515-5-3-1a	20.335	-26.28	6.59	4VG 73	Very high fat content – plant
11		575-5-3-1a	20.327	-24.84	7.36	4VG 74	Borderline medium and moderate-high fat content – plant
11		583-5-3-1a	20.101	-24.05	6.85	4VG 75	High fat content – plant
11		276-5-3-2a	30.066	-22.88	7.98	4VG 76	High fat content – plant
37	4620	37-5-3-1a	22.228	-24.10	8.35	4VG 77	Moderate-high fat content
37		37-5-3-2a	30.417	-24.81	2.95	4VG 78	High fat content – plant
37		37-5-3-3a	10.522	-26.67	-0.24	4VG 79	High fat content – plant
37		37-5-3-4a	17.881	-25.53	1.24	4VG 80	Moderate-high fat content
Early Archaic							
26	5640-5660	616-5-3-1a	22.694	-24.15	4.65	4VG 81	Borderline high and very high fat content – plant
26		616-5-3-2a	39.737	-24.47	2.82	4VG 82	Moderate-high fat content
26		616-5-3-3a	30.052	-22.21	6.03	4VG 83	Moderate-high fat content
31	5200-6300	757-5-3-1a	9.052	-26.89	1.47	4VG 84	Very high fat content – plant
31		757-5-3-2a	7.039	-25.26	5.79	4VG 85	Borderline high and very high fat content – plant
31		757-5-3-3a	1.000	-26.71	5.44	4VG 86	Very high fat content – plant
31		757-5-3-4a	30.070	-23.77	6.14	4VG 87	High fat content – plant
39	5200-6300	203-5-3-1a		-25.76	1.90	4VG 88	Moderate-high fat content – plant
39		203-5-3-2a		-25.48	6.06	4VG 89	Moderate-high fat content – plant
39		203-5-3-3a		-23.69	6.49	4VG 90	Moderate-high fat content – plant
39		203-5-3-4a				4VG 91	Borderline medium and moderate-high fat content – plant
40	5200-6300	128-5-3-1a	12.956	-23.88	8.16	4VG 92	Moderate-high fat content – plant
40		128-5-3-2a	15.867	-25.12	5.67	4VG 93	High fat content – plant
40		128-5-3-3a	30.871	-24.66	5.95	4VG 94	High fat content – plant
40		128-5-3-4a	32.291	-24.70	6.50	4VG 95	Moderate-high fat content
13	5200-6300	658-5-3-1a	19.781	-30.74	6.02	4VG 96	Borderline high and very high fat content – plant
13		658-5-3-2a	7.308	-25.78	2.91	4VG 97	Very high fat content – plant
13		658-5-3-3a	3.415	-25.02	1.89	4VG 98	Moderate-high fat content – plant
13		658-5-3-4a	43.887	-30.26	6.42	4VG 99	High fat content – plant
12	5200-6300	644-5-3-1a	7.149	-26.63	-11.67	4VG 100	Very high fat content – plant
12		644-5-3-2a	11.745	-25.61	1.35	4VG 101	Moderate-high fat content – plant
12		644-5-3-3a	30.054	-23.64	3.75	4VG 102	High fat content – plant

Bold indicates an isotope value that is questionable because of the measured weight

Figure 14-1. Stable Carbon and Nitrogen Isotope Results from Burned Rocks and Natural Sediments

Figure 14-2. Stable Carbon and Nitrogen Isotope Results on Modern Plants and Animals for Comparison

Although plant resources are nearly invisible in the archeological record, however, indicate that plants played a much greater role than the direct macrobotanical or tool evidence indicate. This should caution against facile assumptions that, because the Toyah folk are known to have relied rather heavily on hunting, that a major part of their subsistence was based on plant use.

The use-wear observed on Late Archaic tools indicates that about 22 percent were used on animals with nearly 61 percent used on plants. The plants involved were comprised mostly of hard, high silica species, which are also prevalent in all other time periods, and this would include wood, various cacti, and grasses. The Middle Archaic tools reveal a similar ratio of use on animals and plants with 25 and 69 percent, respectively.

Use-wear on Early Archaic tools indicate that around 10 percent of the tools were used on animals, versus 46 percent on plant matter, including wood, starchy plants, and soft plants. About 27 percent of the tools submitted for analysis revealed plant residues in the form of raphide crystals, which are primarily found in plants of the Agavaceae family, such as sotol, yucca, agave, and lechuguilla. The raphides were observed on diverse tool classes that include a point, a graver, three drills, five bifaces, and seven edge-modified flakes. Other than Early Archaic period tools, raphide crystals were only observed on one other tool and that was a Late Archaic edge-modified flake (#543-12). Interestingly, no meat and only one example of hide use-wear (on a gouge, #724-13) was evidenced on Early Archaic tools. However, two tools, a graver (#456-10) and the gouge (#724-13), revealed hair fragments, which indicate their use on hides.

14.4 CONCLUSIONS

Although minor frequency changes are apparent in the plant versus animal usage over the ca.

6,300-years represented here, the dominance of activities related to plant processing is generally consistent (Tables 14-1 and 14-3). The faunal remains combined with the perceived general functions of the stone tool classes should not bias our conclusions concerning the proportional importance of hunting-related activities during any given time period. Through the use of chemical analyses and the observed microscopic residues adhering to the stone tools, the high significance of plant resources has been documented.

The general absence of grinding implements (i.e., manos, pestles, abraders, and metates) indicates that seed and/or nut grinding, if conducted, was not performed with such implements, or alternatively, that grinding tasks were not a significant activity, or perhaps that such tasks were carried out with tools made of perishable materials. Wooden mortars made of pinyon logs have been recovered from sites in the Lower Pecos (Collins and Hester 1968; Prewitt 1981b), so their use at the Varga site is not an unreasonable postulation.

Hunting deer and rabbits was, unsurprisingly, a relative constant throughout the represented occupational sequence (Table 14-1), although the evidence indicates that bison and antelope were hunted only during the Late Prehistoric Toyah interval. Birds are represented by a single third phalange and a potentially displaced long bone recovered in Early Archaic context, as well as by a Toyah biface bearing traces of feathers (Appendix C). The limited number of turtle elements identified in the Middle Archaic and the Toyah components reveal an additional source of meat resources during those periods. Although present in three of the four components, mussel shell fragments are so infrequent that they probably do not represent more than a very minor, opportunistic food resource.

The broad subsistence picture divulged by all the components at the Varga Site followed a generalized subsistence pattern that included the use of multiple types of plants and animals. The available information indicates that Toyah occupants of the site did have a generalized subsistence pattern despite some reliance on large game animals, as the Toyah component exhibits the most diverse plant and animal resource data base of any at the site. However, this may be largely a factor of better preservation of the most recent materials. Because bison was definitely available and procured by Toyah groups, it is likely that meat was not in short supply. Therefore, if the taxa of questionable cultural origin in the Toyah component, such as the bird, snake, coyote, fish, and turtle were actually procured and consumed, then these species may best be viewed as supplemental, rather than starvation or stress, foods. The presence of birds, snakes, coyote,

fish and turtles further documents the diversity in the Toyah subsistence base. This same diversity in the vertebrate remains can be observed at other Toyah components such as Rainey Site (Henderson 2001) and Buckhollow (Johnson 1994).

The incipient burned rock midden (Feature 1) that dominates the Late Archaic component may represent the cooking of bulk foods such as bulbs, tubers, agave hearts, or other plant products. This focused cooking activity is partially substantiated by the fact that 97 percent of the burned rocks analyzed from this component yielded lipids interpreted as plant residues (Table 14-3; Appendix G). This is supported by the identification of agave heart and leaf parts, and prickly pear seeds in this component (Table 14-1; Appendix I), a suite of plants also documented in burned rock middens in the Lower Pecos (Dering 1977; Shafer 1981; Cliff 2003).

15.0 TECHNOLOGICAL SYSTEMS AND ORGANIZATION

J. Michael Quigg

15.1 INTRODUCTION

Technology is an integrated system of knowledge and techniques through which humans solve problems and/or respond to changes in their natural and social environments. In Chapters 8.0—*Toyah Component*, 9.0—*Late Archaic Component*, 10.0—*Middle Archaic Component*, and 11.0—*Early Archaic Component*, we addressed technology within the four individual time distinctive components and addressed issues related to resource procurement, processing, and consumption. Here, these findings are consolidated in an overview that takes in the entire long-term cultural sequence at the Varga site.

Very few differences exist between the stone tool assemblages from the four components, with very similar formal and informal tool types recovered from all components, indicating that technological solutions to the challenges of resource procurement and processing were relatively consistent through time. Cooking technology also appears relatively stable throughout time with the exception of the addition of ceramic vessel technology to compliment the existing hot rock technology during the Toyah Phase. Technological strategies for resource procurement, tool-manufacturing, processing, and tool and camp maintenance are discussed below.

15.2 RESOURCE PROCUREMENT STRATEGIES

15.2.1 Tool Stone Procurement and Exploitation

Nearly all artifacts collected from the Varga Site are made of stone. These stone objects are of two broad categories: tool stone (chert) and cooking stone (limestone). Chert was used for the manufacture of nearly all recovered tools, and limestone was used to transfer heat from an open fire to various foods for consumption.

As with many other natural resources, the specific procurement process of obtaining tool stone is not readily visible in the recovered tool assemblage. Most natural chert was probably collected by hand from easily accessible localities such as gravel bars that contained water-worn cobbles. For those chipped stone tools that exhibit some cortex, over 99 percent of the cortex appeared to have rounded and smooth surfaces that resemble cortex from such cobbles. If some natural chert nodules were extracted directly from bedrock sources, then the tool types necessary and used in the extraction process, including bone and/or wooden prying instruments and digging tools, were not preserved or were removed during site abandonment. Extraction tools were potentially left at the procurement locale rather than returned to the campsite. Three recovered small hammerstones with an average weight of 520 g, one each from the Toyah, Middle Archaic, and Early Archaic components, potentially served in part for this extraction process together with other functions. The relatively small size of each of these hammers may not have possessed sufficient mass to have functioned as major stone-extraction tools. All three hammerstones were of limestone that would have been locally and readily available.

Macroscopic observations on the chipped stone tools and the lithic debitage from the four

components revealed that high-quality chert was used exclusively in the manufacture of formal and informal tools. To investigate the general source areas from which this high quality tool stone originated, INAA was conducted on a total of 261 chert samples. This included 154 cultural artifacts from the four identified components. Selected chert artifacts include tool classes such as points, bifaces, scrapers, drills, and edge-modified flakes, with a focus on edge-modified flakes from each cultural component. The submitted artifacts included 48 samples from the Toyah component, 23 samples from the Late Archaic component, 17 samples from the Middle Archaic component, and 66 samples from the Early Archaic component.

In conjunction with the cultural artifacts analyzed from the Varga Site, 107 natural chert samples from both local and regional sources were submitted to identify potential cultural artifact source areas. Sampling the natural chert helped to establish the chemical variability in the “Edwards chert” category from across the Edwards Plateau. About 36 of the Edwards chert samples were collected by Charles Frederick in 1993 and include nine of his 26 localities (sample numbers CF-6, 7, 9, 10, 11, 12, 16, 17, and 19). They are listed in Frederick and Ringstaff (1994; Table 6.4) and described in Trierweiler (1994; Appendix C, Part 2). These natural chert samples were collected from specific locations in six counties (Edwards, Kerr, Pecos, Real, Sutton, and Val Verde) across the central southern reaches of the Edwards Plateau. This writer collected or had in his possession the remaining 71 samples. These include, one Burro Mesa chert sample from Brewster County, 47 samples from Edwards County including 21 samples from the Hackberry Creek gravels and 20 upland sources, 20 samples from the Nueces River gravels near Camp Wood in Real County, and three Georgetown chert samples from Williamson County along the Plateau’s eastern margin.

Following the INAA, Glascock and Speakman (Appendix F) concluded that:

the results show that the source (i.e., non-Varga Site) samples from the current study have extremely low probabilities of membership in the Fort Hood groups, relatively low probabilities of membership in the Howard County Segovia Formation group, and high probabilities of membership in Frederick’s mixed collection.

This in fact builds upon and reinforces the previous findings that Edwards cherts from different parts of the Edwards Plateau region are chemically distinct and reflect different source areas (e.g., Hudler 2003a; Glascock 2003). A prominent factor contributing to the broader chemical signatures in the TRC natural samples is that some 41 samples represent two different gravel sources from local streams and may not reflect one specific localized bedrock source, but an areally broader signature.

In general, the Varga Site artifacts show a close chemical relationship to both Fredrick’s and Quigg’s natural chert collections of Edwards Formation source specimens, “Edwards chert,” from across the broad central and southern plateau regions. They do not show a close chemical relationship with the analyzed Fort Hood cherts (Appendix F). This indicates that most tool stone recovered from the Varga Site did not originate from known source areas a great distance from this site, such as from the Fort Hood region or non-Edwards sources outside the plateau. Chemical signatures from one outcrop of natural chert in western Edwards County (MQ-1), two in Val Verde County (CF-11 and CF-12) along Highway 163, and another in Pecos County (CF-16) are mostly distinct from the chemical signatures derived from the chert gravels collected from the Hackberry Creek streambed adjacent to the Varga Site, and natural chert pieces extracted from buried deposits near the bottom of the Varga Site.

Comparing the chemical signatures of the natural cherts to those of the Varga Site artifacts indicates that the human populations that camped at the site did not often exploit the western chert source areas analyzed here. The majority of tool stone chemical signatures compare favorably with chert from the Edwards Plateau region in relatively close proximity to the Varga Site, estimated within a 100 to 150 km radius.

Examination of the INAA data derived from individual chipped-stone artifacts that represent each individual component sampled at the Varga Site indicates the tool stone was derived from multiple source areas. A prominent chemical overlap occurs with cherts from the surrounding region that includes the Camp Wood samples from the Nueces River and the Hackberry Creek chert gravels.

At the Varga Site, most Early Archaic chemical signatures (83 percent) overlap with the signatures from local sources, but reveal that diverse of sources were exploited (see Appendix F, Figure F-7). Eleven specimens, or 17 percent of the analyzed tools, have chemical signatures that are different than the chemical signatures of the analyzed local samples. These include one Martindale point (#268-21 = TRC144), two Bandy points (#142-11 = TRC135 and #400-11 = TRC158), three Gower points (#86-20 = TRC132, #333-22 = TRC150, and #1213-10 = TRC190), two Merrill points (#157-11 = TRC137 and #299-14 = TRC145), a scraper (#627-13 = TRC176), one biface (#205-10 = TRC140), and one edge-modified flake (#366-13 = TRC155). At least one Gower (#86-20 = TRC132) and one Bandy (#400-11 = TRC158) point exhibit chemical signatures similar to cherts from further west in Val Verde and/or Pecos counties. A minimum of one edge-modified flake (#621-10 = TRC175) and potentially many other tools have chemical signatures that are quite similar to the chert from

Hackberry Creek. It is apparent that the Early Archaic populations at the Varga Site used multiple chert source areas from the southern and central Edwards Plateau including some sources from Val Verde or Pecos counties, as well as the locally available chert gravels and/or outcrops.

The chemical composition of Middle Archaic artifacts recovered from the Varga Site indicates that most tools analyzed (as high as 83 percent), originated from local plateau sources. Many signatures appear chemically similar to the Early Archaic source areas and just as diverse as the Early Archaic source areas (see Appendix F, Figure F-6). The chemical signatures for at least three tools, or a minimum of 17 percent, and potentially as many as seven tools, or 41 percent, reflect non-local source areas. Three tools, a scraper (#100-11 = TRC109), a biface (#417-13 = TRC115), and at least one edge-modified flake (#397-10 = TRC113) exhibit apparent non-local chemical signatures, indicating these tools were brought to the Varga Site. One biface (#417-13 = TRC115) exhibits a signature similar to some natural cherts from Val Verde or Pecos counties to the west. One edge-modified flake exhibits a signature similar to cherts from Kerr County. The scraper has a signature that is not within the currently identified range for Edwards Chert; however, it exhibits a UV florescence that is a yellowish orange similar to other Edwards pieces. Inspection of the parent scraper indicates that the submitted sample may have had some cortex remnant, plus the specimen was also burned. It is not clear if either of these observations contributed to the chemical signature. Four other pieces, three edge-modified flakes (#417-10 = TRC114, #484-16 = TRC118, and #484-17 = TRC119), and one biface (#484-16 = TRC118) are probably non-local and exhibit signatures similar to cherts from Kerr County. In contrast, a minimum of two bifaces (#418-28 = TRC 116 and #419-12 = TRC117), one Early

Triangular point (#537-17 = TC122), and one edge-modified flake (#197-11 = TRC111) apparently were manufactured from local cherts, since their chemical signatures are similar to the chert cobbles analyzed from Hackberry Creek. Only the one artifact has a signature that is similar to the analyzed source materials from Pecos, Val Verde, or western Edwards counties. Consequently, the Middle Archaic populations apparently had a lithic procurement area that centered on Edwards and Kerr counties or counties slightly further north.

In the Late Archaic period at the Varga Site, the tool stone again exhibits chemical signatures that are mostly (74 percent) similar to chemical signatures for Edwards chert from the central core region of the Edwards Plateau (see Appendix F, Figure F-8). For the roughly 26 percent that are likely non-local, these include at least one Marcos point (#187-10 = TRC200), one Frio (#89-10 = TRC198), two bifaces (#2-12 = TRC193 and #263-10 = TRC205), and two edge-modified flakes (#2-11 = TRC192 and #42-10 = TRC197) that exhibit chemical signatures sufficiently distinctive to indicate that these six tools were transported to the site from some distance away. The two edge-modified flakes exhibit chemical signatures similar to cherts from Pecos or Val Verde counties to the west. One biface (#263-10 = TRC205) has a chemical signature that is similar to some natural chert from Kerr County to the east. Two other tools, a biface and a Frio point, have chemical signatures similar to natural cherts from Taylor and Nolan counties to the north. The Marcos point reflects a chemical signature that currently is not yet identified and is not similar to any other tools sampled here. However, the Marcos point was likely manufactured from Edwards chert as it exhibits a UV florescence that is a yellowish orange and similar to other Edwards pieces. The apparently different source areas within the Edwards Plateau indicate that the lithic sources were

geographically diverse, but the breadth of the area remains unknown.

From the Varga Site Toyah component, the tool stone exhibits roughly 85 percent chemical signatures that are similar to the local cherts (see Appendix F, Figure F-9). A minimum of seven exceptions, or 15 percent of the signatures, appear beyond the current variability in the local materials and are potentially of non-local in origin. These tools, which may have been transported from some distance to the Varga Site, include two bifaces (#159-5-28 = TRC 215 and 220-15 = TRC218), a scraper (#888-14 = TRC239), a graver (#836-10 = TRC234), a Clifton point (#967-24 = TRC248), and a Perdiz point (#1031-13 = TRC251). The scraper (#888-14 = TRC239) exhibits a chemical signature similar to natural cherts from farther west in Val Verde or Pecos counties. Six of the specimens appear to be Edwards chert from counties further north such as Mills, Taylor, and Nolan. Three or four other Toyah tools have signatures that might be linked to western sources. The Cuney point (#349-13 = TRC223) exhibits a chemical signature that is quite similar to materials from a local source area near 41ED58. This would support an interpretation that this point was manufactured from locally derived chert rather than brought in from the northeast or eastern part of Texas, where this point type is more prevalent (see Prewitt's 1995 distribution map). The apparent diverse source areas, from which tool stone was procured, indicate a fairly broad north to south lithic resource exploitation region, and may indicate directions of group movement or, possibly, trading patterns.

In summary, the INAA on the Varga Site chert tools contributed significantly towards understanding what areas were exploited as tool-stone sources by human populations that camped at the Varga Site. This chemical analysis establishes that some local resource areas can be

distinguished from distant source areas, thus allowing for the identification of local versus non-local materials and provides insight into contact, exchange, or population movements. The local Hackberry Creek gravels reveal a range of chemical signatures that indicates the origins of the river cobbles are as diverse as one might expect. Although not immediately local, the Camp Wood gravel sample, collected from the Nueces River some 35 km south of the Varga Site, also exhibits a broad chemical signature that overlaps with the Hackberry Creek signatures. The overlap in chemical signatures was expected with water moving bedloads downstream from source areas near the river headwaters. One possible source area lies a few kilometers upstream along Hackberry Creek in the vicinity of Devils Sinkhole at sites like 41ED58 (Howard et al. 1996). This is a Segovia Formation bedrock source. Bedrock materials also reveal a wide range of chemical signatures that overlap with the Hackberry Creek and Nueces River gravels, as expected.

Although individual procurement source areas cannot currently be specified and are not all identified, some general trends and overall observations concerning the known chemical signatures allow for some preliminary observations and interpretations. In general, the chemical signatures derived from the cultural artifacts analyzed reflect known chemical variations in Edwards chert and show the Varga Site occupants used almost exclusively Edwards chert. Only a few signatures fall outside of the currently identified range for Edwards chert samples, but at this time, there is not enough definitive evidence to determine the actual source of these materials, or to say definitively that they are not Edwards chert.

15.2.2 Clay Procurement

In the Toyah component at the Varga Site, another natural resource, clay, was procured

primarily for the manufacture of ceramic vessels. Based on the petrographic analysis, at least Vessel Group 2 and possibly Vessel Groups 3 and 4 were manufactured with clay similar to the local clay at the Varga Site. This implies that at least some Varga Site vessels were manufactured locally using local alluvial clay. The INAA indicates that clays from the Varga Site vessels represent at least four different sources. Based on the current limited INAA data on clay source areas in Texas, it appears these clay source areas were not those currently recognized from the Central Texas region on the eastern end of the Edwards Plateau as indicated by the Toyah sherds previously analyzed from Central Texas and representing reference groups 1 and 2 (Appendix N, Figures N-1 and N-2). It is clear that the unknown clay figurine-like object was not made from local clays, since it does not compare favorably with the local clays. This item was brought into the site as a finished artifact. Its clay source currently remains unknown.

15.2.3 Food Procurement

Food procurement, both plant and animal resources, is most often interpreted from the recovered artifacts, since preservation of these organic remains plays a substantial role in what organic remains are recovered. Stone tools, the best preserved, bias how we interpret the food procurement process. Projectile points, the tip of the killing instrument, are numerically well represented in two of the four components—the Early Archaic and the Toyah. The groups represented by these two components appear to have focused heavily on the procurement of larger animal resource, based on high frequencies of projectile points. The recovered points from the Late and Middle Archaic components also indicate those groups pursued similar animal resources, but maybe not as intensively at this particular location. Although points are not dominant in the Middle Archaic

assemblage, no other tool category represented in the Middle Archaic assemblage indicates that other food resources were targeted. In contrast, a large cooking feature, an incipient burned rock midden in the Late Archaic component reflects a focus on plant resources. The number of camping events that are represented in each component possibly accounts for differences in the number of projectile points between components. The specific number of events in each component is unknown at this time.

In general, the broad technology of procuring large game animals through killing them with sharp tipped instruments remained a constant through time. However, within the last 1,000-years a significant technological change occurred in how that tip was propelled at the animal. This technological change is represented by the introduction of the bow and arrow as reflected by the much smaller projectile points employed during the Toyah and slightly earlier. No direct evidence for the weaponry system is preserved other than the projectile point. Here, the gross size difference provides the most visible evidence to this system change. In addition to the differences in projectile points, the overall classes of stone tools are remarkably similar in all four components. Although the bow and arrow marked a new delivery system from the proceeding atlatl and dart use, its appearance and employment did not significantly affect the overall subsistence practices or the apparent nature of the hunter-gatherer lifeway. The presence of other classes of chipped stone tools—bifaces, scrapers, and edge-modified flakes—in each assemblage is generally linked to various processing activities, but also supports large game procurement activity.

Not visible in the archeological record at the Varga Site is the technology associated with the procurement of small game and plant resources. Judging from findings in dry caves in the Lower Pecos area, this lack of visibility is the result of

poor preservation of fiber, nets, bags, traps, bone, and wooden implements. Detected residues such as plant fiber and feathers on some stone tools, such as scrapers, bifaces, and edge-modified tools, might indicate these tools served in the plant procurement process, although the evidence from these tools may only reflect subsequent processing activities.

15.2.4 Bone Procurement

It is suspected that bone used in the production of bone tools and ornaments was not procured specifically for that purpose, but rather was obtained as a by-product from the animals procured for subsistence. The few bone tools and the bone bead blank appear minimally altered. The bone bead blank from the Toyah component, a rabbit long bone, was minimally altered and discarded with four potential beads still attached along the shaft.

15.2.5 Cooking Rock Procurement

Limestone dominated the stone used to transfer heat in various cooking activities for each component. The immediate site environs and the region surrounding the site contain quantities of limestone both in the form of bedrock outcrops and alluvial gravels. The limestone was undoubtedly procured locally from both sources. This procurement pattern does not appear to have changed over time and probably was restricted to local stream gravels, immediate valley slopes, and adjacent bedrock outcrops.

No formal or informal tools (large stone hammers, bone wedges, etc.) were recovered to reflect clear indications that procurement of limestone was conducted from bedrock sources. In contrast, the rounded edges of many pieces of fractured limestone indicate that this material was collected by hand from streambed sources.

15.2.6 Wood Procurement

Wood for fires was undoubtedly available in the immediate area during all occupational periods. No specific formal or informal tools were recognized as possibly used for cutting or chopping down large trees. The wood that undoubtedly was used for fires, handles, traps, etc. most likely would have come from bushes, saplings, or dried wood rather than from large, growing trees. Consequently, specialized stone tools for wood procurement activities were probably not likely to have been necessary. The three gouges recovered from the Early Archaic component are of a form often thought of as woodworking tools, but they do not possess sufficient mass or formal characteristics to have functioned for cutting down trees. Use-wear on one gouge (#346-11) indicates hard, high-silica polish plus use residue in the form of plant or bone fragments. A second gouge (#724-13) exhibits use residues in the form of hair, combined with soft polish indicating planing animal hide. The use-wear evidence from these two gouges does not support their use in the procurement or processing of wood.

15.3 RESOURCE PROCESSING, CONSUMPTION, AND STORAGE

15.3.1 Generalized Lithic Technology

Lithic debitage samples were analyzed from each component at the Varga Site as a broad indication of the types of knapping activities that were carried out during these four represented time periods. The raw counts of lithic debitage vary considerably between the four components. The Early Archaic component yielded the most lithic debitage, over two times the amount recovered from the Late Archaic component, which yielded the least amount. The substantial differences in the lithic counts may reflect the amount of time spent at that specific spot or number of events represented by each component rather than the proportion of time

spent on lithic processing activities. The analyzed debitage indicates an overall similarity of general knapping processes between all four components. The general process includes, but is not limited to, core reduction, early and late stage biface manufacturing and general biface thinning, and manufacture of unifacial tools. This addition of the bow and arrow does not appear to have significantly changed the general knapping processes for the production of arrow points. In very general terms, the Toyah component reveals greater lithic debris that relates to late stage biface preparation. This is supported by that fact that only five percent of the bifaces recovered were in their early stage of production, and nearly 70 percent were in their late stage or finished forms. Bifaces themselves account for 23 percent of the formal Toyah tools. Less than one percent of the analyzed debitage can be classified as blades. Therefore, the arrow points that might have been produced at this site were undoubtedly manufactured from generalized flakes removed from multidirectional cores rather than formal blade cores. At least 41 percent of the cores were classified as multidirectional with other types consisting of unifacial and bifacial, suitable for general flake production.

The Late Archaic assemblage reveals that knapping tasks were diversified. Pieces classified as shatter were the most extensive, followed by thinning and/or resharpening activities. The lack of rejuvenation flakes, and near absence of manufacture breaks on the formal tools, indicates that extensive tool production was not attempted at this locality during this period. Apparently flake production and tool finishing and/or reworking of chipped stone tools were more significant.

The Middle Archaic assemblage was dominated by late stage biface reduction pieces, followed by thinning flakes, which together probably reflect emphases on biface production and

resharpening activities. The latter activity is also indicated by the presence of at least two rejuvenation pieces from unifaces. Late stage bifaces account for over 50 percent of the bifaces and nearly 21 percent of the formal tools. Only one early stage biface was recovered. Core reduction flakes were the least frequent in the analyzed debitage, contrasting with the relatively high frequency of cores that represent nearly 28 percent of the formal tools recovered.

The Early Archaic assemblage reflects relatively high frequency of thinning flakes, followed by moderate to high frequencies of late stage biface flakes. This focus is supported by the fact that nearly 47 percent of the formal tools are bifaces, of which the majority, 79 percent, were in the late stage of production compared to only about 15 percent in the early stage. This high frequency of bifaces, together with the limited counts of points and bifaces that exhibit beveling, supports the refurbishing of tools and finishing the production of formal tools. Although cores were frequent by count ($n=25$), cores only account for less than seven percent of the formal lithic artifacts recovered.

Although the four lithic debitage assemblages reflect a broad range of knapping activities, this knapping process led to the production of similar chipped stone tools for specific procurement and processing tasks in each component. The recognized classes of formal and informal chipped stone tools were quite similar from each component. With a few minor exceptions, all four components yielded chipped tools classified as points, bifaces, end- and side-scrapers, and edge-modified flakes. Drills were only recovered from the Toyah and Early Archaic components, and may reflect specific activities not represented by the other two components. Gouges, similar to scrapers, were only recovered from the Early Archaic. Use-wear on two gouges indicates these tools functioned in a manner similar to formal scrapers and a few

informal edge-modified flakes, and their inferred use was scraping and planing on hides and hard, high silica material. Therefore, these gouges apparently served a similar function or processing task as other stone tools, rather than some specific task not represented in the other components. Although some general size and shape differences are apparent in the tool classes between the four components, the range of activities and processing tasks represented by these tools apparently changed very little over time (Table 15-1). The general lithic debitage assemblage combined with the formal tool assemblage reflects similar processing activities within each component.

15.3.2 Hafting Technologies

The most obvious difference in the chipped stone tools assemblage was observed in the different styles of projectile points represented in and between the four components. The Early Archaic dart points can be divided into two broad style groups based on their proximal configurations. The two broad groups reflect at least 50 specimens from three different type categories (Bandy, Martindale, and Groups 2 corner notched forms) that are considered barbed points with expanding stems. In contrast, some 70 specimens representing at least four identifiable types (Baker, Group 1, Gower, and Merrill) are considered part of the generalized split stem group. It is not clear if these two broad groups of different hafting techniques reflect two distinct subperiods, two different but essentially contemporaneous cultural groups, or differences in hafting techniques. Measurements on the distal stem width (i.e., neck width) for all the Early Archaic points varies about 5.0 mm from an average of 13.1 mm on the Bandy points to about 18.1 mm in the Group 1 points. The overall average stem width for these nine Early Archaic types is about 15.6 mm.

Table 15-1. Tool Function by Use-Wear

	Inferred Use										Contact Material										
Artifacts By Ages	Unknown	Scraping	Cutting	Planing	Boring/Drilling	Whittling	Hafted	Slicing	Projectile	Gouging	Plant	Meat	Bone/Antler	Mineral	Hard, High Silica	Wood	Animal Hair	Soft	Hard	Hide	Unknown
Toyah Tools																					
Points	1		1				5		1						1	1					6
Bifaces		1	3			2	1				2		1		2	4	1				1
Scrapers		4		4							3				4	1		1		1	
Drills	1		1				1				1										1
Edge-Modified Flakes		18	2	4	1	5	2	3			2				20	7	2	3		1	
Late Archaic Tools																					
Points			1						1							1					1
Bifaces		1	2				1				1				1	1				1	1
Scrapers		2		1											2	2					
Edge-Modified Flakes		3	2		1	2		1			2				4			1		2	1
Middle Archaic Tools																					
Points	1		1			1	1			1					3				1		
Bifaces		1	1												1				1		
Scrapers		1			1													1	1		
Edge-Modified Flakes		2	1	2		3		1			3				4	2		1		1	
Early Archaic Tools																					
Points			1				8		1		1		1			1	1				6
Bifaces	5		4				2				4			1							5
Scrapers		2	1	2		1					1				5	1					
Drills			1		3						1				1	1					1
Edge-Modified Flakes	2	5	4	13		2	1	4			10		1		8	2		3			7
Gouges		1		2											1					1	

The stem thickness varies slightly as well with a low of 3.2 mm for the Bandy type to a thickness of 4.8 mm for the Group 1 points. These relatively narrow ranges for stems indicate these dart points were attached to shafts that had relatively limited size ranges. If the shafts were a relatively constant size, then the variability in the proximal ends reflects differences that were more stylistic than technological.

The points in the Middle Archaic assemblage are triangular in outline and lack any form of stem or notching modifications to the base, to facilitate hafting the stone dart to the shaft, indicating a change in the hafting technology from the Early Archaic patterns. The proximal ends of the triangular points were distinctly thinned to permit insertion into a narrow slit in the haft. Use-wear on four triangular points indicates no haft wear on two points, but the haft area on two others showed abraded flake scar ridges on one and hard, high silica polish on another, clearly indicating that they were hafted. At least three triangular points exhibit some edge beveling, interpreted as resharpening that occurred before the tool broke during subsequent use.

During the Late Archaic period, the hafting technology again reveals changes. Projectiles once again exhibit various forms of notching to facilitate hafting. The few specimens recovered from the Late Archaic assemblage reveal slight variations to the proximal ends to facilitate hafting, but the limited number of specimens does not allow averaging of metric data for individual types or good comparisons with the Early Archaic dart points.

A dramatic change in hafting technology is present in the much later Toyah point assemblage. The overall size and weight of the hafted stone tips is greatly reduced from its predecessors and the stem area is dramatically narrower. The distal stem widths in the Perdiz

points are quite narrow (average 6.9 mm with standard deviation of 1.6 mm) compared to the Early Archaic points with an average stem width of 15.6 mm. This signals a dramatic change in the shaft size to which these Perdiz points were attached. This narrow stem width marks a switch in the technology systems used to propel the point—the use of the bow and arrow. Although the Perdiz and Cliffton points reveal narrow, tapering stems to facilitate insertion into a narrow arrow shaft, other stem modifications including corner and side notching were also in use to facilitate hafting stone points to the narrow arrow shafts. It is assumed that culturally informed preferences influenced the particular style of hafting technology used with the arrow points and the attachment to the smaller arrow shafts.

15.3.3 Cliffton Point Type Discussion

The Perdiz points have been considered one of the diagnostic artifact types for the Toyah manifestation for quite some time. Cliffton points are associated with most Toyah components, but are not as frequent as the dominant Perdiz points from those same components. Cliffton points are similar to Perdiz points in that they exhibit stems that tend to narrow towards the proximal ends, but most stems are much shorter and wider than Perdiz forms, and overall the stems and blades are not as well executed. Therefore, they have been given separate names and have been recognized as a separate form. These points are not considered intrusive to the Perdiz components.

The Cliffton point type was initially used by Kelley (1947a, 1947b) and defined by Suhm and Jelks (1962:269) as a:

Roughly triangular blade, crudely chipped, often modified on only one face, or on one face more than the other. Shoulders may project at right-angle but often are difficult to distinguish from the short, pointed stem.

Blade edges may be fairly straight but are often convex, concave, or asymmetrical.

No comment was made to their function and they were not referred to as Perdiz preforms.

Turner and Hester (1985:169) indicate studies have shown that the Clifton point is an unfinished Perdiz point with little validity as a point type. They characterize the Clifton point as roughly triangular, and a crudely chipped form. The three illustrated Clifton points in Turner and Hester (1985:169) show three broad bladed forms with straight to irregular lateral edges and triangular in overall shape, but the short, wide contracting stem with shoulders that extend outward are unlike the Perdiz barbs that extend downward. Similar specimens have been recovered from various Toyah components such as Blum Rockshelter (Jelks 1953), Smith Rockshelter (Suhm 1957), Kyle Rockshelter (Jelks 1962), 41TG91 (Creel 1990), Buckhollow (Johnston 1994), Rush Site (Quigg and Peck 1995), and others. Following the analyses of the Hinojosa Site, Black (1986) reported that the Clifton type had little validity, and he considered them to be unfinished Perdiz points. At Hinojosa, points with attributes similar to the Clifton point type were placed in with the Perdiz arrow points.

Creel (1990) suggests that Clifton points are clearly and readily distinguished from Perdiz points. He stated, "One of the interesting characteristics of these specimens is that most are lacking the distal portions of the blades." At least one of the broken distal ends at 41TG91 was accounted for by manufacture failure, but Creel does not interpret the broken ends as caused by use.

At the Barton Site (41HY202-A) a relatively large collection of chert debitage ($n=33,006$), 168 Perdiz points and fragments of points, plus 76 fragmentary bifaces in various stages of manufacture indicate a Toyah tool

manufacturing locale (Ricklis 1994b). In that point assemblage are several specimens ($n=10$) that are similar in characteristics to Clifton types, but were classified as Perdiz point preforms. Only one of the Clifton specimens is complete. Nine transverse snap breaks on the blade sections indicated to Ricklis that the breakage was due to transfer of excessive force to the blade during stem flaking (Ricklis 1994b).

The large block excavation of a single well-defined occupation area at Mustang Branch Site (41HY209-T) yielded some 23 Perdiz arrow points, mostly around a hearth feature (Ricklis 1994b). Two small, complete arrow points in the form of Clifton points were present. Ricklis (1994b:243) states that in view of the contextual associations "it is possible that these are finished but poorly formed arrow points." A third specimen also similar to the Clifton type and nearly twice as large as the two previous Clifton like specimens has finely pressured flaked blade edges. Ricklis considers this specimen to be a finished point.

The question then arises as to whether or not the interpretation of the Clifton as a preform can be substantiated. At the Varga Site, 12 specimens were classified as Clifton points, with 11 directly associated with at least 44 Perdiz points. Only two of the Clifton points are complete, with 83 percent represented by proximal ends. The breaks appeared to be associated with use. The presence of use breaks indicates that this type was used rather than being only an arrow point preform. It was anticipated that use-wear analyses would help to clarify the matter. If no use-wear were detected, then one might presume the Clifton point was a preform. The presence of use-wear would support it as a functional, finished tool.

Use-wear analysis on four Clifton points from the Toyah component at the Varga Site indicates these four Clifton points were actual hafted

tools with possible multiple functions. All four analyzed specimens reveal evidence of haft wear. Specimen #22-14 reveals abraded ridges in the haft area. Specimen #914-11 reveals hard, high silica polish in the haft area, plus wood fragments and striation indicating cutting actions on wood. Specimen #943-1b shows plant fragments, plus striations in the haft area. Specimen #1154-10 reveals striations in the haft area. The contact material is unknown on three specimens (Appendix C). The use-wear results support the interpretation that Cliffton points were functional tools rather than preforms for Perdiz points.

How might have this Cliffton tool been used? Use-wear analyses indicate haft wear on the short stems of each of the four Cliffton points. Therefore, it seems reasonable that Cliffton points were hafted. Since the Cliffton points are often associated with other projectiles, and the Cliffton form is in the form of a projectile, then one would suspect that it served in a similar fashion. This author suggests that the Cliffton type may be an expedient form of projectile, which was quickly manufactured and hafted into a foreshaft for immediate use. Time was not spent to carefully craft the delicate and lengthy stem and well-formed barbs, but just enough of a stem was created to facilitate placement into a hollow haft. The often broken nature of the blade would support its use as a projectile that snapped during use, but also indicate how fragile these thin bladed, minimally worked forms really were. At Mustang Branch Site, the context of the three Cliffton-like points together with numerous Perdiz points around a hearth may also support their use was similar to the Perdiz points. Indirectly, the assemblage of 180 Perdiz points recovered from the Las Haciendas cairn burial (Mallouf 1987) supports the new interpretation presented here, that the Cliffton point form was an expedient point. Not a single specimen of the 195 arrow points recovered was in the form of a Cliffton point,

even though a large variation of Perdiz forms was present. In Mallouf's reconstruction of the method of manufacture of Perdiz points, the Cliffton form is not represented. This may also indicate that Mallouf sees the Cliffton form as a separate tool, rather than a preform for the Perdiz. The general occurrence of Cliffton forms in many Toyah assemblages supports the interpretation that these tools were an integrated part of that culture. Their limited numbers may testify to the occasional need for a more expedient form of projectile point.

In summary, the use-wear analysis on four Cliffton points from the Varga Site provides direct evidence that the Cliffton point was a functional, hafted tool, rather than a preform. The Cliffton and the Perdiz arrow points are two different forms of stone tips hafted on narrow arrow shafts that facilitated the killing process. Here, the Cliffton point is considered an expediently manufactured point, compared to the more formally manufactured and finished form of the Perdiz points.

15.3.4 Plant Processing

Specific plant processing tools are nearly non-existent at the Varga Site, with only a very few nonspecialized tools such as hammerstones ($n=3$) and anvils ($n=2$) recovered. These tools might have been used for plant processing tasks. Assuming at least some plants were processed before consumption, beyond just cooking, the processing task might have been conducted primarily through the use of perishable tools (i.e., wooded mortars and pestles) or with generalized chipped stone tool forms such as the bifaces and scrapers.

Use-wear studies on samples of chipped tools from the four components provide a broad and general understanding of the range of processing tasks (inferred uses) directed toward plants in general and other products. Table 15-2 reveals the types of tools from each component that

Table 15-2. Use-wear Summary on Artifacts from Varga Site Components

Use-wear Interpretations	Toyah Component	Late Archaic Component	Middle Archaic Component	Early Archaic Component	Total Count	Total Percentage
Inferred Use						
Unknown	5	1	1	10	17	10.5
Scraping	22	7	4	6	39	24.0
Cutting	8	5	3	11	27	16.7
Planing	7	1	3	17	28	17.3
Boring/Drilling	1	1		3	5	3.1
Whittling	7	2	3	4	16	9.9
Hafted	3			10	13	8.0
Slicing	2	1	1	3	7	4.3
Projectile	3	1		5	9	5.6
Gouging			1		1	0.6
Contact Material						
Plant	2		3	18	23	15.2
Meat					0	0.0
Bone/Antler				3	3	2.0
Mineral				1	1	0.6
Hard, High Silica	27	7	6	9	49	32.5
Wood	12	3	2	5	22	14.6
Animal Hair	2			2	4	2.6
Soft	4	1	2	3	10	6.6
Unknown	8	3		18	29	19.2
Hard			1	2	3	2.0
Hide	2	3	2		7	4.6

were used in the processing of plants. In general, the use-wear analysis documents that plants constitute a high percentage of the contact material.

Preservation is assumed to have played a significant role in the amount and possibly the type of organic remains recovered in the older components. These factors have directly influenced the amount and type of botanical remains recovered from the recent Toyah component, which indicates a broad suite of plant and wood resources were utilized during

that time (Table 14-2). This is a drastic change from the Early and Middle Archaic components that appeared to have had, or used, more restricted botanical resources. For the most part, the same few species represented in the Early Archaic component were also represented in each of the other younger components. The diversity detected in the Early Archaic expanded to even greater diversity in the two most recent components.

15.3.5 Burned Rock Cooking Technology

Often in central and western Texas burned rocks are the dominant material class at open-air hunter-gatherer sites. Although the raw material (i.e., limestone, sandstone, and quartzite) may vary across different regions, the function of the burned rocks as thermal storage devices either scattered or in discrete features, was primarily a part of cooking technology. Therefore, the characteristics and distribution of the burned rocks in a component reflects, at least in part, the cooking technologies, types of cooking features, and related cooking activities such as cleanup and discard of no longer useable cooking rocks.

Regardless of the type of local raw material available and employed, the use of natural rocks centered on heating them in a fire, and then using the stored heat in the rocks to cook foods for consumption. Foods that required cooking were placed with the hot rocks, and the stored heat then cooked the foods. This transfer of heat could have included cooking foods by boiling, grilling, baking, and steaming (see Ellis 1997 for more detailed discussions). In addition to cooking, other uses of hot rocks are acknowledged, such as production of steam in sweat lodges, but such uses are assumed to have played a limited role in most sites.

The heating, use, and discard of rocks are the focus of this discussion. Judging by the frequency of burned rocks in each of the four components, the amount of cooking through the use of burned rocks varied significantly over time at this locality. In the Toyah component, the burned rocks represent 25 percent of the total assemblage. In the Late Archaic component, these represent nearly 69 percent. In the Middle Archaic component, burned rocks represent only 13.5 percent. In the Early Archaic component, this class represents 5.4 percent. The majority of burned rocks in each component were scattered rather than part of recognized cultural

features. The exception was Feature 1 that dominated the Late Archaic component. The clustering of burned rocks in recognized features will be addressed first.

Different archeological contents, forms, and contexts provide clues to the different functions and cooking technologies represented by the burned rock clusters. The approach employed in the field was to label each burned rock cluster as a feature, then record metric and non-metric attributes and make other observations concerning that cluster. Directed field documentation combined with subsequent laboratory analyses of different aspects of that cluster (size, shape, and type of rock, plus chemical analyses of the rocks, etc.) and associated materials (type and frequency of debitage, bone, and charred plant remains) provides further data for interpreting the formation processes and function of that cluster/feature.

The Varga Site excavations yielded 27 features comprised mostly of burned rocks. These were assigned to the four temporally restricted cultural components. Detailed information concerning each feature is presented above, by individual components. Table 15-3 summarizes pertinent information for each feature by component.

Feature size is one attribute that provides a first order of sorting (Figure 15-1). Two very general size classes for the burned rock features were identified. One large and 26 small burned rock features were identified. Nearly 97 percent of the burned rock features were less than 200 cm in diameter (Figure 15-1). It is assumed that these two size classes represent different cooking technologies and/or strategies.

Table 15-3. Summary of Burned Rock Features at the Varga Site

Fea. No.	Diameter (cm)	Depth (cm)	BR Count	BR Wgt (g)	Avg. BR Wgt (g)	Lipid Types	Deb. Count	Tool Count	Ceramic Count	Mussel Shells	Bone Count	Charcoal in Float (g)	Radiocarbon Date (B.P.)	Basin /Pit	Fea. Type
Toyah															
8	150 x 200	22	289	18,775	65	Multiple	294	14	4	2	135	Lots, 10.6	570, 620, 600	None	Refuse Dump
9	44 x 56	22	28	10,500	375	Multiple						Lots, 5.6	660	None	Hearth
18	60 x 150	23	30	3,750	125	Plants	166	28			374	Yes, 3.8		None	Refuse Dump
21	62 x 62	17	78	15,950	204	Plants						Lots, 24.5	380, 380, 300	Basin	Hearth
25	160 x 190	33	542	25,100	46	Multiple	1046	56	8	2	1,328	Lots, 61.0	170, 320	None	Refuse Dump
30	87 x 110		45	14,600	324	NA	14	1			4	Yes, 3.2		Basin	Hearth
38	30 x 100	20	75	14,700	196	Multiple	7	3	4		104	Lots, 12.7	390	Basin	Hearth
Late Archaic															
1	600	40	3,196	469,150	146	Plants	3,597	71		3	41	Yes, 23.0	1,700 to 2,300	Basin	Oven
1a	42 x 47	26	23	4,500	196	Plants	1				1	Yes	1,710, 890	None	BR Dump
1b	Unknown	35	53	10,650	201	Plants	42				8	Yes, 1.0	2,310	None	BR Dump
1c	100 x 200	25	323	3,750	108	Plants	6					No	860	None	BR Dump
1d	75 x 50	23	30	6,250	208	Plants	6					No	1,390	None	BR Dump
7	55 x 45	30	11	3,250	297	NA						NA		None	BR Dump
15	25 x 35	28	31	3,900	126	Plants	3					Yes, 0.1	2,140	None	BR Dump
28	90 x 50	36	13	5,100	392	Plants						NA		None	BR Dump
29	90 x 100	38	78	4,300	551	Plants						NA		None	BR Dump

Table 15-3. Summary of Burned Rock Features at the Varga Site (Continued)

Fea. No.	Diameter (cm)	Depth (cm)	BR Count	BR Wgt (g)	Avg. BR Wgt (g)	Lipid Types	Deb. Count	Tool Count	Ceramic Count	Mussel Shells	Bone Count	Charcoal in Float (g)	Radiocarbon Date (B.P.)	Basin /Pit	Fea. Type
Middle Archaic															
11	70 x 80	52	40	22,700	568	Plants	15					Yes, 0.1	1,919	None	Disturbed Hearth
37	25 x 55	80	28	7,750	277	Plants	1					Yes	4,260	None	BR Dump
Early Archaic															
12	25 x 40	50	5	1,250	250	Plants	4					No		None	BR Cluster
13	50 x 50	54	9			Plants	6					Yes, 0.1		None	BR Cluster
23	90 x 110	50	130	46,700	359	Plants	17					Yes, 3.3	6,280	Basin?	BR Cluster
26	50 x 70	63	20	4,750	238	Plants	303				34	Yes, 0.5	5,640, 5,660	None	BR Cluster
27	80 x 100	55	82	39,000	476	NA	12				1	Yes		None	BR Dump
31	40 x 60	47	29	9,550	329	Plants	13	1				Yes, 0.1		None	BR Cluster
39	80 x 90	99	46	14,500	315	Plants	188	3			1	Yes, 0.9	2,230	None	BR Dump
40	69 x 72	111	42	17,750	423	Plants	24					Yes, 5.2	5,200	Basin?	Hearth
41	58 x 70	86	41	14,250	348	Plants						No		Basin?	Hearth

Fea. = Feature; BR = Burned Rock; Deb. = Debitage

Figure 15-1. Average Diameter of Each Cultural Feature

Feature 1, the one large burned rock feature that dominated the Late Archaic component, was nearly 6 m in diameter. It was interpreted as a burned rock oven that exhibited a poorly defined central basin and irregular and ill-defined outer boundaries, with different densities of burned rocks across this 6 m area. The poorly defined, broad, shallow basin consisted of dense accumulations of fractured limestone rocks in about three layers filling the shallow basin. The basin was not rock lined or well defined and exhibited no obvious sediment color change, and

no charcoal lens or oxidation rim. A dense accumulation of relatively large burned rock pieces lay along the southeastern edge of the poorly defined basin. Moving away from the apparent central basin the burned rocks became scattered, were in different densities, with four small burned rock clusters (Features 1a, 1b, 1c, and 1d) within the broader scatter of burned rocks. These smaller burned rock clusters were interpreted to represent individual dumping events. It is speculated that the rocks that comprised the four small clusters were removed

from the basin area, possibly as cleaning episodes, or removed from the top part of the oven.

Twenty-seven burned rocks from across Feature 1 were subjected to lipid residue analysis. Chemical analysis on 15 scattered burned rocks yielded lipid residues with medium to very high fat content interpreted to be associated with cooking plants. Another 12 burned rocks, all from the four small burned rock clusters within the boundaries of Feature 1 (1a, 1b, 1c, and 1d), also yielded lipid residues that were similar to those scattered about Feature 1. The similarity in the chemical results indicates all these rocks were used to cook similar food. Macrobotanical remains from across Feature 1 documented two potential food products, specifically Agavaceae and possibly prickly pear fruit. These products were probably the food resources cooked in this rock oven.

The combined archeological record from Feature 1 resembles a commonly encountered cooking apparatus in central and western Texas. Exactly how this apparatus functioned is not quite clear from the current archeological data and context at the Varga Site but, as mentioned above, the preserved attributes resemble a rock oven. Large cooking ovens, comprised mostly of broken rocks, are just one type of cooking apparatus that have been reported in ethnohistoric and ethnographic documents, and documented in the archeological literature (see recent reviews and discussions by Black et al. 1997; Mauldin et al. 2003). Ellis (1997) provides various versions of how pit ovens were possibly constructed and used. Although Feature 1 has similarities to a pit oven, there are still unanswered questions concerning the basin. If the food was cooked inside the shallow basin, then why was the basin still filled with layers of fractured rocks? Why were charcoal, ash, and burned sediments not observed in the basin? If this oven had food resources in or near the

bottom of the basin, then in order to remove the food products, one had to first remove the top part of the oven. The top possibly included burned rocks and dirt, which would have been set or tossed aside. The smaller clusters of fractured rock within the broader scatter may represent part of the material removed to get to the food. Potentially, the burned rock clusters represented cleaning episodes that removed no longer desired rocks from previous cooking events. It is also possible that the four small clusters represent the minimum number of use episodes at this particular location. Regardless, exactly how this perceived oven was constructed and used the large quantities of burned rocks with demonstrated plant residues in them, testifies to a large cooking apparatus in use during a radiocarbon dated period from ca. 1,700 to 2,300 B.P. Its presence documents intensive, probably bulk food processing.

Similar types of burned rock features and much larger burned rock middens are well known across much of Central Texas, the Lower Pecos, and far Western Texas. Burned rock middens with and without well-defined central basins are known for this Late Archaic period. Therefore, this specific cooking technology, the use of rock ovens to cook plants, is neither unusual nor new to this time period.

The 26 smaller burned rock features often yielded limited archeological evidence making interpretations concerning their function much more difficult. The more attributes recorded, and/or cultural materials directly associated with these small burned rock features, the greater possibility that a specific feature can be assigned to a specific functional category. In addition to the feature size, other attributes documented include feature shape, the quantity and size of burned rocks present, evidence of a basin, presence of charcoal, matrix staining, matrix oxidation, and presence of other classes of material directly in the feature.

Based on the combination of documented and observed attributes and the results from the different technical analyses, the 26 smaller burned rock features were interpreted to represent *in situ* hearths, or some type of discard pile or dump activity (Table 15-4). Six, and possibly seven, features (about 27 percent) were classified as hearths, 13 features, or 50 percent, were classified as dumps, and five features, or about 19 percent, were classified as clusters with insufficient evidence to assign a function.

At least three (about 12 percent of the total) small features revealed indication of a basin (Table 15-3). Features with a basin have been interpreted as hearths and presumably represent *in situ* heating. Four features without basins were also classified as hearths and presumably represent *in situ* heating elements as well. The

lipid residue evidence from burned rock analysis reveals the rocks from all these suspected hearths came in contact with foods. The chemical evidence alone implies some type of cooking feature as oppose to a warming fire. If these hearths or heating elements were used to cook foods, it is not clear precisely how they functioned and how the burned rocks accumulated the food residues. It is possible that many of these basin hearths that contained burned rocks were small rock ovens.

The 13 features classified as dumps lack evidence of a basin, and other attributes that suggest *in situ* heating. A combination of other attributes, most of which provide negative evidence, plays a greater role in their interpretations. No single attribute can define the function for most small features.

Table 15-4. Cultural Feature Types by Component at the Varga Site

Feature Types	Toyah 300 to 660 B.P.	Late Archaic 1,700 to 2,300 B.P.	Middle Archaic 3,900 to 4,820 B.P.	Early Archaic 5,200 to 6,300 B.P.
Bone Cluster	2			
Burned Rock Clusters				12, 13, 23, 26, 31
Burned Rock Dumps	8, 18, 25	1a, 1b, 1c, 1d, 7, 15, 28, 29	37	27, 39
Burned Rock Hearths				
Small Tight Cluster with Charcoal	9			
Medium Tight Cluster with Charcoal	21			
Large Cluster with Shallow Basin	30, 38			40, 41
Disturbed			11	
Incipient Burned Rock Midden		1		
Occupation Zones	22, 35, 36			

The combined attributes lead to interpreting 13 small features as discard piles or dumps of used-up rocks. Some times the burned rocks were dumped or discarded by themselves as indicated by Features 1a, 1b, 1c, and 1d. In some instances the fractured burned rocks were dump/discarded with other diverse cultural materials into general refuse piles such as in Features 8, 18, and 25 in the Toyah component.

The average weight of an individual burned rock from each feature was calculated using the total count and weight of the rocks recovered (Figure 15-2). It is assumed that the average burned rock size, as indicated by the average rock weight, provides an indication of its stage in its use life and contributes to classifying and/or identifying the feature function. It has been demonstrated through heating and cooling experiments using limestone that rock fracturing was so extensive that after two boiling episodes, two heating and cooling episodes, most limestone rocks were too fragmentary for reuse (Duncan and Doleman 1991). Leach et al. (1998, 2001) demonstrated that after two heating episodes with Central Texas limestone rocks that the initial 26 rocks fractured into 217 pieces, or that a 3,500 gram rock fractured into eight pieces weighing an average 430 g. These findings document that the original rocks used for thermal storage were reduced in size relatively quickly and soon became too small to retain sufficient heat. Therefore, the heating and cooling process reduced the rock size, and at some point rendered the rock non-viable for heat transfer, after which it was discarded. In this light, given the many small burned rock fragments in some features, often weighing less than 250 g per rock, it is reasonable to assume that many of burned rock features represent dumps or discard piles of undesirable rocks.

The five burned rock features that were classified as clusters lacked sufficient attributes to clearly assign them to a particular function.

These clusters were all in the Early Archaic component and the lack of good preservation of the feature combined a palimpsest effect resulting from intense use of this area, were contributing factors that did not allow further interpretations of function.

The use of rocks to transfer heat is evidenced in all four components, indicating the long-term use of hot-rock technology. Even the addition of ceramic cooking vessels in the Toyah component did not render the use of hot rock cooking obsolete. Compared to the earlier components, the frequency of burned rocks in the Toyah component decreased from the Late Archaic component. Compared to the Middle and Early Archaic components, the Toyah component yielded considerably higher percentage of burned rocks, in spite of the ceramic cooking technology added to the Toyah assemblage.

The overall average size of the individual burned rocks decreased over time (Figure 15-2). The average size of burned rocks in the Early Archaic was about 187 g. The average size decreased to about 119 g during the Middle Archaic, increased slightly to about 146 g during the Late Archaic events, and then significantly decreased to about 68 g in the Toyah component. The larger burned rocks were mostly documented in the recognized features, whereas those scattered about the broader occupations were significantly smaller (Figure 15-2). During the Early Archaic period, the burned rocks in the identified features averaged about 374 g, whereas those scattered across the broader occupations were about 168 g. The size difference in the Middle Archaic component is even more pronounced with the average size of the scattered burned rock equaling about 96 g compared to those in the two features that yielded average rock sizes of about 448 g. The Late Archaic oven feature does not provide a good comparison to the other

Figure 15-2. Average Burned Rock Weight of Cultural Features (Grams)

smaller features in the other three components. For the Toyah component, the average size of the scattered burned rocks was about 66 g, but the burned rocks in features averaged only about 89 g. The average size difference between the two settings is undoubtedly a reflection of the number of times the rock was heated and cooled until it was finally discarded. If so, the Toyah population apparently used the rocks more intensively than the Early Archaic population, possibly reflecting greater length of occupation, or different thermal requirements according to the specific foods being prepared.

Specific cooking technologies may be associated with specific food resources and may account

for some variations detected in the burned rock features. Obviously, the large burned rock oven feature in the Late Archaic was used to cook one or possibly a few specific foods that required lengthy cooking times to enable consumption. Wandsnider (1997) lists many plants and animals that were pit-roasted. She also indicates that fatty meats and insulin-bearing plant foods were often pit-roasted. Dering (1999), using data from rockshelters in the Lower Pecos region, documented diverse food resources in earth ovens, but indicates that lechuguilla and sotol are most abundant and definitely require oven processing. The large oven feature in the Late Archaic component was not encountered in any of the other three components at the Varga

Site, but that does not mean that similar cooking features may not have been part of the broader cooking technology known to each of those groups.

The lipid residue interpretations indicate that cooking with burned rocks focused on cooking plant resources rather than animal resources. Even though the stone tool assemblages in each of the four components strongly reflects the procurement and processing of animal products, which is also supported by the presence of vertebrate faunal remains in at least two of the components, only the Toyah component reveals a significant percentage (24 percent) of the lipid residues interpreted as reflecting large herbivores. Both the Early and Middle Archaic components reveal no evidence that large herbivore products were cooked using burned rocks. This finding is significant, since large herbivores were definitely procured in each of the four major periods of site use. Wandsnider (1997) points out that fatty meat, those that generally have high lipid-to-protein ratio, such as bear, muskrat, opossum, ground squirrels, otter, and beaver, are generally pit-roasted. Meat that is boiled is primarily from species with low lipid to protein ratios, such as elk and moose.

The lack of large herbivore residues might reflect the fact that meat was not cooked through the use of burned rocks. If this was the case, then how was the meat prepared for consumption? It is possible that the meat was roasted over an open flame or in coals, dried, or even consumed raw. Even the Toyah component, which yielded considerable large herbivore products based on the vertebrate faunal remains recovered, indicates that only about 24 percent of the burned rocks contained animal residues. Only about 25 percent of the ceramic sherds analyzed from the Toyah component also yielded signs of large herbivore residues. However, some residue signatures

were not sufficiently distinct to enable positive identifications to assign plant or animal use, and it may be that animal residues are actually more prevalent than is apparent with the present data interpretations.

The common cooking technology of boiling was not recognizable at the Varga Site. Boiling is usually conducted with hot rocks and it is reasonable to assume that it was carried out. Dried and lean meats are often boiled to restore moisture. Meats with low fat contents such as antelope, bison, deer, and rabbit are often boiled. Fatty meat tissue may be boiled to further lipid hydrolysis and to melt and express tissue lipids (Wandsnider 1997). Plant foods rich in starches are primarily boiled before consumption. The explanation for why no boiling features were recognized probably reflects the difficulty in the recognition of the technique rather than the true absence of this cooking technology. Although attempts to identify rocks used in boiling have been tried (Jackson 1998), the specific processes for identification have not often been implemented in burned rock analyses. Identification is further hindered by the lack of understanding of how limestone responds to the boiling process, and if it is visibly different from other heating and cooling processes.

Part of the cooking process during Toyah times involved, of course, the use of ceramic vessels. The employment of pottery was a new technology not represented in the preceding components, but was added to the hot rock technology. The Toyah ceramic assemblage was quite limited, with only about 115 sherds that represent between five and eight vessels. Vessel reconstruction was not possible; therefore, vessel size and shape are unknown. Lipid residue analysis on six sherds, two each from Vessel Groups 1, 2, and 3, yielded very similar results. The detected residue signatures were interpreted as ranging from borderline moderate to high, with high fat content, implying that fatty

plant parts were cooked in these vessels. The stable carbon and nitrogen isotope values, derived from these exact same samples, also suggest plant cooking, specifically C₃ plants. Even though a significant quantity of vertebrate faunal remains was recovered from the Toyah component, it does not appear that the procured animal products were cooked in the ceramic vessels. Apparently at the Varga Site, the ceramic cooking technology was used primarily to cook plant foods, as was the hot rock technology.

15.3.6 Pottery Manufacturing Technology

Two analytical techniques contributed to a greater understanding of the technology pottery, which was restricted to the Toyah component. Variability in the finished products was detected through petrographic analyses and INAA.

General observations and metric attributes indicate very limited stylistic variability within the Toyah ceramics. The kinds of aplastics added to clay are similar throughout the Varga Site sample, which is in turn similar to those from across the surrounding region. There are, however, some intra-regional variations in the type of additives that might be attributed to cultural differences. The Infierno phase ceramic assemblage postulated for the Lower Pecos region, which has been previously studied by petrographic means, share the same fundamental technological similarities in the nature of the clay matrix, commitment to bone tempering, firing techniques, and therefore, are quite similar to the known Toyah ceramic industry (Robinson 1999). Currently, it appears that the same technology was employed across a broad east to west region of the Edwards Plateau during Toyah times.

The inclusion and analyses of two different samples of native manufactured sherds from the Protohistoric period representing two different

aboriginal populations who settled two different Spanish Missions indicate that the manufacturing technology used during the Toyah period was carried forward into Protohistoric times in at least one of the missions. This is evident at Mission San Juan in San Antonio and elsewhere across Southern Texas, but not at the Lipan Apache Mission of San Lorenzo de la Santa Cruz at Camp Wood. This is not a new idea, as Clark (1978) observed bone-tempered ceramics at many of the Spanish missions sites in Southern Texas, and Black (1982) argued for a single ceramic tradition extending from the prehistoric Toyah times into the mission period, based on the bone tempering.

Although the petrographic analysis indicates some Varga Site vessels were manufactured locally, the INAA documents multiple sources of clay for most Varga Site Toyah pottery. Those sources were not the same as used for most of the Toyah ceramics composing the Central Texas-1 and Central Texas-2 reference groups (Appendix N). At least three different clay source localities provided clays for the construction of the Varga Toyah vessels assemblage. Since the INAA detected chemically different source areas for the Varga Site vessels, compared to those from the Central Texas sherds, it does not appear that the clay used in the construction of the Varga Site vessels originated in Central Texas. Apparently, Varga Site Toyah population exploited and processed raw clay resources from local and non-local sources in the manufacture of their vessels. Until we gain a greater understanding of where the potential clay source localities are located across Texas, it is not clear how far and in which directions these source areas might have been from this site.

The presence of ceramic vessels in the Toyah component indicates the addition of a new technology to the hunter-gatherer economy during Toyah times. The pottery manufacturing

technology represented is rather sophisticated and does not appear in a developmental stage. Therefore, this new technology was apparently adopted from elsewhere.

15.3.7 Maintenance Strategies

Tool maintenance strategies were detected in all four components through observations made on chipped stone tools and the identification of rejuvenation flakes in the lithic debitage assemblage. Rejuvenation flakes were identified in three of the four components, the exception being the Late Archaic. Possible explanations for their absence in the Late Archaic include the relatively limited lithic debitage assemblage ($n=1,801$), the limited chipped stone tools recovered ($n=98$), limited use of tools, and/or the dominance of the large burned rock cooking feature. Only two rejuvenation flakes were identified in the Middle Archaic assemblage, and both were removed from unifacial tools. The Middle Archaic component yielded only three unifaces/scrapers, and these three tools were not the same pieces from which the rejuvenation flakes were removed. Apparently, the two rejuvenation flakes were removed from tools that were not discarded in the investigated area. The Early Archaic component yielded 82 rejuvenation flakes, whereas the Toyah component yielded 28 rejuvenation flakes. As tools became dulled during use, the dulled edge was intentionally removed to initiate the rejuvenation of that edge. Three of the five Toyah rejuvenation flakes were subjected to use-wear analysis. That analysis demonstrated edge rounding along the worked edges, which occurred primarily from scraping hard materials. The Early Archaic rejuvenation flakes reveal extensive use primarily through planing and/or scraping plants with high silica content, before the edge was removed. The presence of rejuvenation flakes is a sign that processing activities/tasks were conducted on site and that

as tools became dulled, edges were rejuvenated in order to extend the use life of the tool.

Rejuvenation flake scars were observed on formal and informal tools in all four components. Again the Late Archaic component yielded the fewest number of recognized rejuvenation scars on tools ($n=1$), followed by the Middle Archaic with two, the Toyah with five, and the Early Archaic with 12 observations. The only tool in the Late Archaic assemblage with a rejuvenation scar was an edge-modified piece. The two tools from the Middle Archaic component consist of a late stage biface that exhibits edge rounding and an edge-modified tool. The five specimens in the Toyah component include four scrapers and one edge-modified tool. The twelve tools in the Early Archaic assemblage include five projectiles, four bifaces, and two edge-modified pieces. This maintenance strategy apparently was a common practice and not restricted in time.

Beveling along the lateral edges of projectile points and bifaces is another form of tool maintenance in that it allowed a worn or nicked edge to be refurbished on the spot or during use, without the need to dismantle or rehaft with a new tool. Beveling was identified in tools from all four components. The Early Archaic yielded at least 30 tools with signs of beveling, including 17 points and 13 bifaces. The Toyah component yielded the second highest frequency with 13 points and eight bifaces. Four points from the Late Archaic and three points from the Middle Archaic exhibit beveling. The beveling process was probably a short-term solution to quickly resharpen a dulled edge and continue with the task at hand. Once the group camped in one spot for a period of time and new tool stone was collected, the collection of raw material and the production of new tools, allowed the dulled, reworked, and beveled tools to then be discarded and replaced with new ones. The choice was made to resharpen chipped stone tools through

edge removal and/or beveling techniques occurred even though raw tool stone was generally available and abundant.

Chipped stone tool maintenance activities, the burned rock cooking features, and other activity areas were also subjected to maintenance. Burned rock features were discussed above and include 14 small features classified as discard piles or dumps (Table 15-4). Four of the 14 discard piles or dumps were in the Late Archaic component and were associated with the large burned rock-cooking feature. These four small features comprised mostly of small fragmented burned rock may not reflect true maintenance activities, but possibly resulted from removing the top part of the rock oven to extract the food products. A second alternative hypothesis would be that they represent the cleaning of the central cooking basin to ready the location for the next cooking event. Three features in the Toyah component are classified as dumps. All three contained multiple classes of cultural debris that included lithic debitage, chipped stone tools, fragmented animal bones, and burned rocks, with at least two also yielding small ceramic sherds. The combination of the different classes of artifacts recovered from these dumps may indicate a longer-term occupation occurred to create this diversity in a single location. The Middle Archaic component revealed a single feature classified as a dump, but the feature lacked the multiple classes of artifacts that generally support this interpretation. The near absence of dump features may reflect a short-term camp during the Middle Archaic. At least two features in the Early Archaic component were classified as dumps. However, with the extremely dense lithic debitage and discarded chipped stone tools throughout this component, it was difficult to clearly understand how or what some of these burned rock clusters represented and the true association of different materials. The clustering of different classes of materials in a single

location, most likely reflects intentional cleaning of various activity areas and the subsequent dumping of unwanted materials in a common location. This relates directly to general camp maintenance activities. It also demonstrates that a particular area had been selected or designated for dumping unwanted materials, and directly relates to human behaviors and camp structure.

A cut pottery sherd (#159-8-2) from the Toyah component also indicates that rejuvenation/maintenance was practiced on the ceramic vessels or sherds. Since only a single small piece that exhibits a cut line was recovered, it is not clear what part of the vessel was rejuvenated or how that individual piece was used. The rounded nature of the cut edge implies it was used after it was cut. This may reflect an attempt to continue to use a broken vessel or use a sherd from the broken vessel as a tool to perform another task.

15.3.8 Storage Technologies

Storage technologies are not evident in any of the four components at the Varga Site, which is not unusual for hunter-gatherer contexts. No features were classified as storage facilities and skin and/or fiber bags for storage containers were not preserved. Drying meat is one possible means of storing excess, but this again is not visible in the archeological record. The same can be said for the storage of many plant foods (i.e., fruits, nuts, berries, bulbs, flour cakes, etc.) that might have been kept for a period of time. The ceramic vessels in the Toyah component potentially served for temporary storage, but lipid residues identified in the sampled vessel walls suggest that most vessels functioned primarily as cooking vessels. As with most hunter-gatherer groups, the stored food and the containers likely were employed for storage were not preserved.

The very small fragmented size of the animal bones recovered from the Toyah component

may be indicative of the processing of bones to obtain bone grease and/or marrow. The bone grease is a key ingredient in the manufacture of pemmican, a means of storing/retaining meat that was not immediately consumed. Dried animal meat is the other principal ingredient and mixed together, these two products form a means of storing meat products (see Quigg 1997b). Again, this storage technology has limited visibility in the archeological record. The highly fragmented animal bones, combined with the limited large herbivore lipid residues in the analyzed burned rocks, are clues that this type of storage technology was employed by the Toyah population.

15.3.9 Other Technologies

Ornamental objects are quite rare at the Varga Site. The Early Archaic component yielded a single small stone (fossil) with a natural hole in the middle. This is a thin piece of a fossil crinoid shell, and therefore, not intentionally manufactured. This fossil was probably not collected from the immediate site area, but was rather brought to the site, probably as personal ornament worn on clothing. The Early, Middle, and Late Archaic components did not yield any indications of manufacturing or using ornamental artifacts. However, the chipped stone tools, specifically the drills, in the Early Archaic component could have been employed in the manufacturing of such objects.

The Toyah component yielded six items that are classified into this category and include two pieces of the same unique clay object, a bone bead blank, and three altered shell pieces. The three shell pieces are worked and were probably personal ornaments worn on clothing or the body as was intended for the bone beads. Grinding and drilling were used in their production, and the chipped stone drills potentially were used in this process. Evidence for drilling shells was not detected on the drills

selected for use-wear, but drilling and/or boring were performed on site; so, these sociotechnic objects were potentially manufactured on site. Two pieces are marine shells and were transported into this site, probably as finished items. One piece of mussel shell was potentially procured locally, and then altered into a decorative item. Bone bead production, using the midsection of a small rabbit size long bone, was performed on site through a simple groove-and-snap technology. At least one bead was removed from the bone blank that still contains four roughly equal sections that have been well defined by deep grooves cut perpendicular to the long axis. These sections would then have been snapped off and strung as ornaments. The grooving process would have easily been conducted through the use of a sharp flake or edge-modified flake. At least seven edge-modified flakes analyzed during use-wear analysis reveal use in cutting wood, or perhaps bone. This bone bead preform also appears polished and exhibits excessive numbers of thin scratch lines or incisions, possibly to decorate the beads. The proximal section of a Toyah bone awl also reveals a few, intentional, thin incised lines perpendicular to the long axis that might have served as decorations or potentially were functional in nature. The manufactured, unique clay figurine-like object is of unknown use, but may have served for some non-mundane purpose other than resource procurement, processing, or consumption. This clay object was brought into the site as a finished object as indicated by the INAA. This object probably had a special meaning/purpose that cannot be identified.

15.4 SUMMARY: BASIC, LONG-TERM CONTINUITIES IN TECHNOECONOMIC BEHAVIOR

Whereas the usual stylistic shifts in projectile point types that are well known to characterize the culture history of Central Texas are in

evidence at the Varga Site, the closer scrutiny of the record that is afforded by the various technical analyses employed in this project serve to highlight an underlying pattern of long-term continuity in fundamental aspects of hunter-gatherer adaptive behavior. Overall, and with few exceptions, strategies for survival and the technological systems that supported them, were in place by Early Archaic times, and these did not change in any dramatic (or perhaps even significant) ways, during the subsequent millennia of local/regional prehistory.

The peoples represented in all four components used local Edwards chert for the production of their chipped stone tools. The Late Archaic populations revealed the broadest range of use of non-local chert sources, whereas the other three use periods revealed very similar reliance on local cherts. The technological procurement of large game resources appears similar in the general employment of projectiles that targeted game resources. However, the hafting technology for these projectiles did change, not only through time, but also within specific time periods. This change must be related to human choices concerning style and not technologically driven. One specific tool investigated, the Clifton point, was demonstrated to have been used, as evident by haft wear, most likely as a projectile, and not just a stage or preform in the manufacturing of the Perdiz point.

Although not readily visible in the macrobotanical remains from most components, plant remains were procured and processed in the burned rock features throughout these components. If a particular technology was used to procure and or process these plants it is not visible in the material remains.

The actual food cooking technologies also appear very similar as revealed in the occurrence of burned rock features through time. It appears that the use of hot rocks for cooking foods was mostly directed towards cooking plant foods. The variations in the size and shape of some burned rock features may be related to site function and/or seasonal differences in the occupations.

Two new technologies appeared in the Toyah component, within the last 700 years, and they include the use of a new weaponry system, the bow and arrow, and the ceramic technology in the form of manufactured ceramic vessels and possible figurines. Although the ceramic technology was demonstrated as part of the cooking technology, the previous cooking technology represented by the use of burned rocks, was not totally replaced by this new technology. This new cooking technology may reflect an adaptation that was used for specific types of food processing versus total replacement for all foods to be cooked.

16.0 CULTURAL- HISTORICAL CONSIDERATIONS: THE VARGA SITE ARTIFACT TYPES IN DIACHRONIC PERSPECTIVE

J. Michael Quigg

16.1 INTRODUCTION

The cultural history research domain represents a historical perspective on the observed patterning in the archeological record. Some questions asked pertain directly to specific time periods, whereas other questions pertain to more general or broader issues that cross specific time periods. We begin discussions with specific questions relating to the Toyah phase, followed by the Late Archaic, Middle Archaic, Early Archaic, and then move on to broader issues, not restricted to specific time periods.

16.2 TOYAH PHASE

Many research questions center around the projectile point types recovered from the Toyah component. Some 229 projectile points, which include 216 arrow points and 13 dart points, were recovered from the Toyah component. The arrow points include nine identifiable types (53 Perdiz, 10 Clifton, five Bonham, two Scallorn, two Guerrero, one Edwards, one Cuney, one Harrell, and one Padre), accounting for 35 percent of the arrow point specimens (with 65 percent or 140 unidentifiable arrow

point fragments). The 13 dart points, or slightly over five percent of the total points from this component, include four Late Archaic Frio points, one Early Archaic Group 2 point, one Merrell, one Baker, and six unidentifiable dart point fragments.

Which point types are intrusive to the Toyah occupation? Thirteen dart points are definitely older than the Toyah component and do not represent this time period. Probably, the dart points recovered from this component were displaced from their original contexts lower in the profile through one or more kinds of bioturbation, since all the dart point types are represented in lower components at the Varga Site. It is also possible that one or more of these dart points was collected and curated by the population using the Perdiz point before their occupation of this site. The curation of older point types is not an unusual occurrence in Central Texas sites. As an example, six dart points were recovered from a well-defined and stratigraphically sealed Toyah occupation at Mustang Branch (41HY209-T; Ricklis 1994). It also is possible that the visual stratigraphy, the compressed and disturbed nature of the two youngest components at the Varga Site, and the excavation in 10 cm arbitrary levels may have lead to the misassignment of the four Late Archaic Frio dart points to the Toyah component.

In the case of the multiple arrow point types, the current chronological assignment of individual types represented is not precise enough to place most recognizable point types into narrow time frames, especially across the vast regions of Texas. The one Edwards and two Scallorn points are considered slightly older than the Perdiz, Clifton, and other arrow points recovered from the Toyah component. The Rainey Site, just to the east in Bandera County, provides absolute radiocarbon dates and good stratigraphic context to document that Scallorn

and Edwards points are slightly older than the Perdiz points (Henderson 2001). At that site, the Scallorn and Edwards point types are associated with absolute radiocarbon dates that range from about 800 to 1,400 B.P. The one Edwards and two Scallorn points recovered from the Varga Site may indicate a limited use period just before the Toyah occupations. A total of eight radiocarbon dates (two charcoal radiocarbon dates of 920 and 940 B.P. [Beta-175399 and Beta-175398] from the lowest part of the Toyah component, three radiocarbon dates from the presumed Late Archaic component, two bone radiocarbon dates of 860 and 890 B.P. [UGA-12713 and UGA-12708], and one charcoal radiocarbon date from Feature 1d of 1,390 B.P. [UGA-12704]) are considered too recent for the Late Archaic component and too old for the Toyah component. These eight absolute dates from the Varga Site may well represent a blurred and an obscured use period by a group(s) using the Scallorn and/or Edwards points. These absolute dates fit well with the time period previously documented and associated with these two point types at the Rainey Creek Site. If these two point types represent an event(s) before the Toyah component, then that event(s) became so mixed with the Toyah materials or Late Archaic materials that it was not recognized in the thin sediments above the Late Archaic component. Similar point types have been recovered from the region, and it would not be surprising that these two point types would be in these deposits.

Cliffton points are a recurrent presence, although never in high frequencies, in most Toyah components and are considered part of the Toyah assemblage. As discussed above, Cliffton points were not preforms for the Perdiz points as many have indicated. Use-wear analysis on four Cliffton points completed here indicates that Cliffton points were actual hafted tools with multiple functions. At least two show evidence of hafting wear, another reveals wood

fragments and striation indicating cutting actions, and another reveals plant fragments in the haft area, plus striations across the margins.

Bonham points are sometimes found with the Perdiz points at many Toyah components. They are very similar in overall form and outline to Perdiz points, but have a straighter stem and straight base. Prewitt (1995) indicates Bonham points have been recovered from most areas across Texas, including the area of and around Edwards County. However, Bonham points are considered intrusive to the site and region, as they are generally considered prominent in northeastern Texas (Turner and Hester 1995). They may reflect limited interactions between the Perdiz using populations and other groups of people towards northeastern Texas.

One Harrell and one Padre point were recovered from the Varga Site. These same two distinctive point types have been recovered in limited numbers from a few other Toyah components across Central Texas. As an example, two Harrell points were associated with the main Toyah occupation at the Rush Site near San Angelo (Quigg and Peck 1995). The Harrell points and associated cultural material have a relative broad distribution across northwestern Texas and are concentrated north and west of Edwards County (Prewitt 1995). This point type is associated with the Garza complex in the southern High Plains region (see Boyd 1997 for recent overview). Harrell points are thought to represent a separate plains group and are considered intrusive to the site and region. The occurrence of a Harrell point at the Varga Site is near the southern known extent of its distribution (Prewitt 1995:109). This point may have arrived through trading or by direct interaction with the peoples employing this point type. One assumes some type of contact with peoples employing this point type, although it is possible that this was a collected and curated item from a chance discovery.

The Padre point is a considerable distance from its normal distribution since Prewitt's (1995:124) map shows it to be localized in six counties along the Southern Texas coast. If the coastal region was the home range for this point type, then either travel or exchange would have brought this Padre point into Edwards County some 350 km to the northwest. Although no direct association can be made, one may speculate that if the people associated with the Padre point came from the Texas coast, then possibly the few marine shell pieces recovered from this component also came with them. The Padre point and the marine shell indicate interaction with peoples along the Southern Texas Gulf coast.

The Cuney point type is generally most often recovered in northeastern Texas (Turner and Hester 1993). The single specimen recovered here is west of its primary distribution (Prewitt 1995). Its arrival here was either through trade or direct contact with peoples from Northeastern Texas. Cuney and Perdiz points are recovered from Mission sites as well, such as Espiritu Santo (Walter 1997), which may indicate they are very late in time, and groups were interacting with each other.

Two Guerrero points were recovered from this component, and these point types are most often associated with the Spanish Colonial era (A.D. 1700s; Turner and Hester 1998). Guerrero points have been documented in several counties across Southern Texas and in Val Verde County (Prewitt 1995). They are most often found in Mission contexts such as Mission San Lorenzo de la Santa Cruz (Tunnell and Newcomb 1969) and the various locations of Espiritu Santo Mission (Walter 1997; Ricklis 2000, 2007). Their presence may indicate at least one very late occupation and a definite change in hafting techniques from the stemmed Perdiz points. A single piece of worked glass was the only other artifact that might be

assigned to a very late period. These few items may be related to the very late radiocarbon dates from the Toyah component (see discussion below).

During the Late Prehistoric period, ceramic technology was introduced as another means of cooking foods. This new technology did not totally replace the existing cooking technology based on the use of hot rocks. At the Varga Site, the ceramic technology supplemented hot rock cooking and may have been used more often for cooking plant products rather than meat.

Another question concerns how this component relates to, or transitions into, the Protohistoric period. The 13 acceptable radiocarbon dates, or 65 percent of the Toyah samples, reveal a time range from 290 to 660 B.P. (Table 16-1, Figure 16-1). Acceptable assays were all derived from wood charcoal. Forty-six percent of the acceptable radiocarbon dates document a period between 400 and 660 B.P. with no obvious temporal clustering. Fifty-four percent, or seven acceptable wood charcoal dates from the Toyah component, are younger than 400 B.P., post-dating the arrival of the first Europeans in Southern Texas. These seven radiocarbon dates reveal that the Native American populations probably continued to use the Varga Site into the Protohistoric period. Two Guerrero points that are often associated with Spanish mission settlements may correlate with this. Similar small triangular arrow points and one Perdiz point were recovered from the ca. 180-year old Mission San Lorenzo, 40 km south of the Varga Site (Tunnell and Newcomb 1969) and from excavated mission contexts in the San Antonio area and Espiritu Santo Mission (Walter 1997). Further support for a Protohistoric event may come from a single edge-modified flake made on clear glass and a single igneous-rock-tempered sherd (recovered from the disturbed surface) that probably originated in West Texas.

Table 16-1. Summary of Varga Site Radiocarbon Data and Results

Catalogue #	Blk.	Unit No.	Depth (cm)	Fea. No.	Material Dated	Mat. Wgt (g)	Lab. No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
11-5-4-7-1a	A	N99/E51	7-20	1d	6 charcoal	0.1	UGA-12704	1380 ± 40	-24.3	1390 ± 40	Cal AD 560 to 770
37-5-4-7-1a	A	N99/E53	78-80	37	16 charcoal	0.1	UGA-12705	4230 ± 40	-23.4	4260 ± 40	Cal 3010 to 2690 BC
76-2-11a	A	N99/E56	110-120	na	1 deer bone	5.0	Beta-175396	5580 ± 40	-17.8	5700 ± 40	Cal 4660 to 4460 BC
76-2-11c	A	N99/E56	110-120	na	1 deer bone	7.5	UGA-12706	5180 ± 40	-19.7	5270 ± 40	Cal 4230 to 3980 BC
78-5-7-1b	A	N100/E50	+5 to 10	21	1 charcoal	0.1	Beta-183623	360 ± 30	-24	380 ± 30	Cal AD 1440 to 1630
78-5-7-1a	A	N100/E50	+5 to 10	21	1 charcoal	0.1	UGA-12707	380 ± 40	-24.9	380 ± 40	Cal AD 1440 to 1640
78-5-7-1c (1219)	A	N100/E50	+5 to 10	21	1 charcoal	0.1	UGA-12734	300 ± 40	-24.7	300 ± 40	Cal AD 1480 to 1670
89-007-1	A	N100/E51	20-30	1a	1 charcoal	0.1	Beta-175412	1710 ± 40	-25.5	1700 ± 40	Cal AD 240 to 420
89-5-2-1	A	N100/E51	20-30	1a	1 bone	6.2	UGA-12708	1000 ± 40	-31.6	890 ± 40	Cal AD1020 to 1240
100-007-1	A	N100/E52	30-40	1	1 charcoal	0.1	Beta-175411	1770 ± 40	-26.7	1740 ± 40	Cal AD 220 to 400
128-5-4-7-1a	A	N100/E54	100-110	40	22 charcoal	0.1	UGA-12709	5220 ± 40	-26.2	5200 ± 40	Cal 4220 to 3940 BC
154-007-1	A	N100/E56	113	na	12 charcoal	0.1	Beta-175406	5680 ± 60	-24.4	5690 ± 60	Cal 4690 to 4370 BC
158-5-7-1A	A	N101/E47	20-30	36	1 charcoal	0.1	Beta-175397	420 ± 40	-26.5	400 ± 40	Cal AD 1430 to 1530
159-5-8-1a	A	N101/E47	30-40	36	1 Toyah sherd	3.2	UGA-12710	2930 ± 40	-15.5	3080 ± 40	Cal 1440 to 1210 BC
159-5-7-1A	A	N101/E47	30-40	36	1 charcoal	0.1	Beta-175398	950 ± 40	-25.5	940 ± 40	Cal AD 1010 to 1190
160-005-7-1A	A	N101/E47	40-50	36	1 charcoal	0.1	Beta-175399	930 ± 40	-25.6	920 ± 40	Cal AD 1020 to 1210
171-007-1A	A	N101/E50	50-60	1, central	1 charcoal	0.1	Beta-175402	2120 ± 40	-23.7	2140 ± 40	Cal 360 to 50 BC
179-5-4-7-1a	A	N101/E50	30-40	1	9 charcoal	0.1	UGA-12711	2240 ± 40	-21.7	2290 ± 40	Cal 410 to 200 BC
203-005-4-2-1	A	N101/E52	80-90	39	7 charcoal	0.1	Bea-175408	2180 ± 40	-21.9	2230 ± 40	Cal 390 to 190 BC
255-2-1	A	N101/E56	110-120	na	5 bones	2.2	UGA-12712	5270 ± 40	-21	5340 ± 40	Cal 4330 to 4040 BC
273-004-2-1	A	N102/E50	26-46	1b	1 charcoal	0.1	Beta-175403	2300 ± 40	-24.5	2310 ± 40	Cal 410 to 240 BC
293-2-1	A	N102/E52	20-30	na	1 bone	6.8	UGA-12713	610 ± 40	-9.8	860 ± 40	Cal AD 1030 to 1270

Table 16-1. Summary of Varga Site Radiocarbon Data and Results (continued)

Catalogue #	Blk.	Unit No.	Depth (cm)	Fea. No.	Material Dated	Mat. Wgt (g)	Lab. No.	Measured Age	$^{13}\text{C}/^{12}\text{C}$ Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
293-5-7-1a	A	N102/E52	20-30	1c	17 charcoal	0.8	UGA-12714	560 ± 40	-25.3	550 ± 40	Cal AD 1300 to 1440
344-7-7-1a	A	N102/E56	90-100	na	1/4 charred walnut	0.1	UGA-12715	5440 ± 40	-26.6	5410 ± 40	Cal 4350 to 4050 BC
344-7-1c	A	N102/E56	90-100	na	1/4 charred walnut	0.1	Beta-183624	5540 ± 50	-26.2	5520 ± 50	Cal 4460 to 4260 BC
344-7-1d (1218)	A	N102/E56	90-100	na	1/4 charred walnut	0.1	UGA-12733	5430 ± 40	-26.7	5400 ± 40	Cal 4340 to 4040 BC
362-5-7-1a (100-1a)	A	N103/E51	40-50	1, base	Charcoal	0.1	Beta-170400	2170 ± 40	-22.3	2170 ± 40	Cal 370 to 100 BC
418-2-1	A	N104/E56	50-60	na	1 bone	2.4	UGA-12716	2230 ± 40	-21.5	2290 ± 40	Cal 410 to 200 BC
418-7-1a	A	N104/E56	50-60	na	1 charcoal	0.1	UGA-12717	4740 ± 40	-23.3	4770 ± 40	Cal 3650 to 3380 BC
515-5-4-7-1	A	N106/E52	50-60	11	5 charcoal	0.1	UGA-12718	2000 ± 40	-25.7	1990 ± 40	Cal 60 BC to AD 130
522-7-2-1a	A	N106/E53	50-60	na	1/2 deer bone	11.5	UGA-12719	3850 ± 40	-21.2	3910 ± 40	Cal 249 to 2230 BC
522-7-1b	A	N106/E53	50-60	na	1/2 deer bone	5.0	Beta-183625	Not enough			
525-5-7-1a (102-1b)	A	N106/E54	35-40	2	Charcoal	0.1	Beta-170401	290 ± 40	-25.2	290 ± 40	Cal AD 1490 to 1660
531-7-1a	A	N106/E54	90-100		1/2 charred walnut	0.1	UGA-12720	5500 ± 40	-25.2	5500 ± 40	Cal 4460 to 4250 BC
570-7-1a	A	N107/E50	50-60	na	20 charcoal	0.7	UGA-12721	6090 ± 40	-24.7	6100 ± 40	Cal 5210 to 4850 BC
599-1 (103-1)	A	N106/E54	90-100	na	1 Rabdotus shell	1.3	Beta-170402	5600 ± 40	-7.7	5880 ± 40	Cal 4810 to 4680 BC
607-7-1a	A	N107/E55	60-70	na	1/2 charred walnut	0.1	UGA-12722	5580 ± 40	-26.2	5560 ± 40	Cal 4490 to 4330 BC
615-5-7-2a	A	N107/E56	50-60	26	2 charred seeds	0.1	UGA-12723	5440 ± 40	-11.6	5660 ± 40	Cal 4600 to 4360 BC
616-5-7-1a	A	N107/E56	64	26	7 charcoal	0.1	UGA-12724	5610 ± 40	-23.2	5640 ± 40	Cal 5450 to 4360 BC
735-005-7	A	N109/E55	40-50	23	1 charcoal	0.1	Beta-175407	6290 ± 50	-25.6	6280 ± 50	Cal 5340 to 5080 BC
739-005-7	A	N109/E56	30-40	27	1 charcoal	0.1	Beta-175409	550 ± 40	-25.1	550 ± 40	Cal AD 1310 to 1430
801-5-4-7-2a	B	N115/E73	20-27	15w	15 charcoal	0.1	UGA-12725	2130 ± 40	-24.5	2140 ± 40	Cal 360 to 40 BC
830-005-4-1	B	N117/E71	14-22	9	3 charcoal	0.1	Beta-175404	660 ± 40	-25.0	660 ± 40	Cal AD 1280 to 1400
843-005-7-1A	B	N118/E70	10-20	8	1 charcoal	0.1	Beta-175405	40 ± 30	-22.5	80 ± 30	Cal AD 1680 to 1950

Table 16-1. Summary of Varga Site Radiocarbon Data and Results (continued)

Catalogue #	Blk.	Unit No.	Depth (cm)	Fea. No.	Material Dated	Mat. Wgt (g)	Lab. No.	Measured Age	¹³ C/ ¹² C Ratio (‰)	Con. Age (B.P.)	2 Sigma Calibration Range
865-5-4-7-1a	B	N119/E70	10-20	8	1 charcoal	0.2	UGA-12726	640 ± 40	-26.7	620 ± 40	Cal AD 1290 to 1410
865-5-7-1e	B	N119/E70	10-20	8	2 charcoal	0.2	Beta-183626	570 ± 40	-26.2	570 ± 40	Cal AD 1300 to 1430
865-5-4-7-1d (1217)	B	N119/E70	10-20	8	1 charcoal	0.2	UGA-12732	630 ± 40	-26.6	600 ± 40	Cal AD 1290 to 1420
987-8-1a	B	N125/E73	10-20	na	1 sherd	3.1	UGA-12727	26,510 ± 40	2	26,960 ±	Cal 25100 to 24920 BC
1025-5-7-1a	B	N126/E75	20-30	25	4 charcoal	0.2	UGA-12728	320 ± 40	-24.8	320 ± 40	Cal AD 1470 to 1660
1030-5-3-2c	B	N126/E76	30-40	38	1 burned rock	10.3	UGA-12729	11,690 ± 40	-7.1	11,980 ±	Cal 13300 to 12700 BC
1030-005-7-1A	B	N126/E76	35-50	38	7 charcoal	6.0	Beta-175400	390 ± 60	-25.3	390 ± 60	Cal AD 1420 to 1650
1055-005-7-1A	B	N127/E75	25-35	25	7 charcoal	6.0	Beta-175401	170 ± 60	25.4	170 ± 60	Cal AD 1640 to 1950
1089-8-1a	B	N129/E71	30-35	na	1 Toyah sherd	2.7	UGA-12730	190 ± 40	-17.8	310 ± 40	Cal AD 1480 to 1660
1118-8-1a	B	N120/E71	0-30	na	1 Toyah sherd	0.8	UGA-12731	21 ± 40	-22.8	60 ± 40	Cal AD 1680 to 1930
1207-4-A	A	BT M-1	100	na	Sediment 2Bw	200	Beta-175394	6220 ± 50	-21.9	6270 ± 50	Cal 5330 to 5070 BC
1208-4-A	A	BT M-1	90	na	Sediment 2Ab	300	Beta-175392	1840 ± 70	-23.3	1870 ± 70	Cal 10 BC to AD 330
1209-4-A	B	BT 7	115-120	na	Sediment 2Bk	200	Beta-175391	5190 ± 50	-22.6	5230 ± 50	Cal 4220 to 3960 BC
1210-4-A	B	BT 7	80-85	na	Sediment Bk2	200	Beta-175393	4790 ± 70	-23.0	4820 ± 70	Cal 3710 to 3380 BC
1211-4-A	B	BT 7	15-20	na	Sediment Ab	300	Beta-175390	1860 ± 60	-22.8	1900 ± 60	Cal 30 BC to AD 240
BX5-13002c		21	1	Room 31	1 Mission sherd	5	UGA-12735	1760 ± 40	-16.4	1900 ± 40	Cal AD 20 to 240
BX5-13011-a				Room 31	1 Mission sherd	10	UGA-12736	360 ± 40	-17.1	490 ± 40	Cal AD 1320 to 1480
KM16-25				Lot 25, V7	1 Toyah sherd	3.7	UGA-12737	810 ± 40	-22.5	850 ± 40	Cal AD 1040 to 1280
KM16-385				Lot 385, V2	1 Toyah sherd	5.2	UGA-12738	980 ± 40	-22.2	1030 ± 40	Cal AD 890 to 1160
KM16-481				Lot 481, V6	1 Toyah sherd	5.3	UGA-12739	1140 ± 40	-21.5	1200 ± 40	Cal AD 690 to 750
RE1-1872-6a				Structure 7	1 Mission sherd	3.9	UGA-12740	2420 ± 40	-19.9	2500 ± 40	Cal 800 to 410 BC
RE1-1872-48a				Structure 7	1 Mission sherd	5.5	UGA-12741	1100 ± 40	-18.9	1200 ± 40	Cal AD 690 to 960

Blk. = Block; Con. = Conventional; Fea. = Feature; Mat. Wgt = Material Weight

Figure 16-1. Summary of Varga Site Radiocarbon Dates Plotted through Time

The glass specimen certainly documents an event that can be assigned to the post-contact period. All of this accords with the idea that some of the peoples producing Perdiz points became part of the mission Indian population in Southern Texas.

Further west, in the Big Bend region of Texas and south into northern Mexico, chronometric assays from assemblages that contained Perdiz points also reveal radiocarbon dates that fall within the Protohistoric to Colonial periods. Specifically, three dates on wood charcoal from three hearth features at 41BS706 yielded uncorrected ages of 170 ± 45 B.P.,

210 ± 45 B.P., and 240 ± 45 B.P. (Mallouf 1987). Perdiz points are also associated with the Cielo complex that might have persisted into the A.D. 1700s (Mallouf 1987).

The limited Varga Site ceramic assemblage (ca. 115 pieces), with the exception of a sherd (two pieces that refit) from the surface, conforms to the “Classic Toyah” ceramic technology as discussed by Johnson (1994). Based on the ceramic technology documented at the Varga Site, the same general Perdiz-using cultural pattern identified elsewhere in Central and Southern Texas, is also represented at the Varga Site. The petrographic data from this

Toyah component supports the same clay source areas for the pastes used in the production of vessels from other excavated Toyah sites. However, the INAA indicates that the source areas were quite different from other INAA on Toyah sherds, mostly from the Central Texas region (see Creel 2002, 2003; Appendix N). The INAA data implies that if clay source areas can be identified, that archeologists can begin to address the movements of these vessels across the landscape. The attempt here to directly radiocarbon date ceramic sherds from the Varga Site, Buckhollow Site, and two specific mission sites did not provide results to demonstrate continuity of the Toyah ceramic technology into the Protohistoric period. Based on the petrographic analysis, however, the ceramic technology detected in the prehistoric Toyah ceramic assemblage was carried forward into the mission period. This supports Black's (1982) interpretation of the evidence from 16 Choke Canyon sites and review of earlier analyses from Toyah and Mission sites.

The stone tool assemblage recovered from the Varga Site Toyah component reveals several tool types and classes that are common to other Toyah assemblages. These include the Perdiz points, small well-made flake drills, various biface forms including the four-beveled knife, the Cliffton points, end-scrapers, and many expedient flake tools. The Perdiz points generally conform to the classic Perdiz points recognized by Johnson (1994) with most manufactured from small, thin flakes, many of which are only unifacially worked. However, the majority of arrow points are broken, leaving some questions as to the precise manufacturing attributes. No specific regional manufacturing distinction was detected in this arrow point assemblage. One interesting observation concerns the procedure that was apparently used in the resharpening of unifacial tools, specifically scrapers. A blow directed toward the steep face of the scraping removed a section

of the worked edge, presumably to facilitate reworking and extension of the use life of the tool. Since this rejuvenation procedure has not been discussed for other Toyah assemblages, it is not clear how wide-spread or common the technique might have been.

In short, the Varga Site Toyah assemblage closely resembles the classic Central Texas Toyah assemblages as discussed by Johnson (1994) and nothing was recovered, or observed, that might reflect a local variation or represent influence from the contemporaneous Infierno phase of the Lower Pecos region.

16.3 LATE ARCHAIC PERIOD

The roughly 600-year time period documented by 11 radiocarbon dates (Table 16-1, Figure 16-1), combined with the seven Late Archaic projectiles representing a minimum of four different types (three Frio, one Marcos, one Ensor, and one Montell) and one untyped dart point, indicate that multiple events are likely represented in this component. Four other Frio points were recovered from the Toyah component and may be considered displaced from this Late Archaic component. The lack of vertical separation of the different point types may indicate that these four types were either in a thin, compressed sediment zone that represents different time periods, or that the point types were contemporaneous. If contemporaneous, it is not clear that the different point types represent different groups coming together at one time in pursuit of a joint task (bulk food processing), or if these different point types represent a diversity of forms in a single tool kit. Still, the chronology of point types for Central Texas (Prewitt 1981, 1985) indicates non-contemporaneity of some of the types (e.g., Montell, Ensor), which would seem to support the idea that more than a single occupational episode is represented in the Late Archaic component. The different styles reflect different

hafting techniques, but represent the same piercing function. The Frio point type is most prevalent here and fits well with the 11 radiocarbon dates obtained from this component between 1,700 and 2,300 B.P.

In the Lower Pecos, Turpin (1991, 1995) has separated the Late Archaic into three distinct periods based on different projectile point types and associated radiocarbon dates. The earliest (3,150 to 2,300 B.P.) is the Cibola period marked by the Castroville, Marcos, Marshall, and Montell points associated with bison bones. Subsequently, the Flanders period, poorly dated to ca. 2,800 to 2,000 B.P., is marked by the Shumla point. This is followed by the Blue Hills period (2,300 to 1,300 B.P.), marked by the Ensor and Frio points.

The Shumla point type, known primarily from the Lower Pecos region, was not identified at the Varga Site, therefore, people who made/used this type apparently did not occupy the site. The Varga Site Late Archaic component is closely associated with the Central Texas Late Archaic and related groups that also have ventured into the Lower Pecos region as well during the Blue Hills Period and potentially during the Cibola period (Turpin 1991, 1995). The recovery of Castroville and Frio points, in what appears as the same component, is not a new association given the current radiocarbon dates for the two identified periods in the Lower Pecos overlap at roughly this time.

The limited number of formal tools ($n=28$) from this thin cultural component makes it difficult to address specific questions concerning the presence of other tool forms that might be diagnostic of this period. We demonstrated that a few diagnostic Toyah materials and Toyah age charcoal pieces had been displaced and filtered downward into this lower component. It is not clear if any of the non-diagnostic artifacts may be intrusive into this limited Late Archaic

assemblage. In addition to the Late Archaic point types recovered, no other time-diagnostic stone tools of the Late Archaic were identified from this component.

16.4 MIDDLE ARCHAIC PERIOD

This period is represented by a roughly 40-cm-thick zone along the southern edge of Block A that rapidly thinned to about 20 cm thick towards the northern end of the block. This component contained the occasional chipped stone tool, dispersed lithic debitage, sparse bone fragments, occasional burned rock, and two burned rock features horizontally scattered. This cultural material was vertically dispersed between the Late Archaic burned rock Feature 1 above and the dense Early Archaic materials below.

The only diagnostic projectiles from this component include: five Early Triangular points and one Carrizo point tip fragment. Little is known about the age range of the Carrizo point type. The best context comes from the Loma Sandia cemetery site in South Texas that is dated to roughly 2,500 to 2,800 B.P. (Taylor and Highley 1995). Apparently, the distal Carrizo fragment from the Middle Archaic component at the Varga Site was displaced from the lower Early Archaic component that yielded multiple Carrizo base fragments (see further discussions below). No other Late Archaic dart points were identified from this component.

The five Early Triangular points are associated with radiocarbon dates that are later in time compared to the radiocarbon dates associated with Early Archaic component below. Two radiocarbon assays on wood charcoal and one on deer bone directly date the Early Triangular points to ca. 900-radiocarbon year period from 3,910 to 4,820 B.P. (Table 16-1, Figure 16-1). These triangular points are definitely younger than Bandy, Martindale, Merrell, Gower, and

other notched point types in the Early Archaic deposit at the Varga Site.

Although not recovered from this component, a Pandale point, which is considered a Middle Archaic point type in the Lower Pecos by Turpin (1991, 1995), was obtained from 70 to 80 cmbd in a level that also contained a Gower point and was assigned to the Early Archaic period. Turpin provides an age range of between ca. 3,700 and 5,500 B.P. for the Pandale type, but only about 27 percent of Turpin's primary dates are older than 4,700 B.P. (Turpin 1991). Therefore, it is possible that this Pandale point was displaced downward from its original context in the Middle Archaic zone, mis-assigned, or this point type was made over a long time span.

The remaining formal stone tool assemblage is limited to 15 specimens and includes tool forms commonly found at hunter-gatherer occupation sites. However, the informal tools—the edge-modified flakes—are quite frequent ($n=122$), but show no particular differences as compared to edge-modified flakes from other assemblages.

16.5 EARLY ARCHAIC PERIOD

At least seven named (Baker [$n=12$], Bandy [$n=21$], Carrizo [$n=4$], Gower [$n=32$], Martindale [$n=22$], Merrell [$n=11$], and Pandale [$n=1$]) and two unnamed (Group 1 [$n=15$] and Group 2 [$n=7$]) projectile point types were recovered. This Early Archaic component was directly dated by 15 assays from diverse materials to a 1,100-radiocarbon year period from 5,200 B.P. to 6,300 B.P. (Table 16-1, Figure 16-1). Thus, this group of projectile points represents at least 1,100-years of prehistory, and more specific subperiods cannot be assigned to individual types at the Varga Site. These point types are probably not all contemporaneous with one another, but have become commingled in this component over time. It is possible that this radiocarbon-

documented time period does not represent the entire time range represented by projectile points, since it is possible that the older organic materials from earlier events were not preserved.

Although some researchers have had difficulty in distinguishing between the Bandy and Martindale point types, the Varga Site assemblage provides large enough samples of each type for metric data to confirm that two distinct types are represented. Better context and more precise dating will eventually reveal any temporal distinctions for these types, if such actually exist.

The Gower and Merrell point types are also very similar, but slight differences in the shape of their bases provide indications that two different types are represented in this assemblage. Potentially, these two taxa are actually varieties of one type. Some similar points are misidentified in the current literature, which is understandable, since not much has been said or documented about either type, especially the Merrell type.

The Varga Site has yielded the first substantial collection of Merrell points ($n=11$) and the first association of the type with radiocarbon dates. Johnson and Goode (1994) were not sure where to place this point type in their general chronological sequence. Collins (1995) does not mention this type by name, but lists a generic “Early Split-Stem” group for a period dated between roughly 8,000 to 7,000 B.P. The Merrell point is definitely an “Early Split-Stem” type, although it is not clear whether or not Collins (1995) includes this poorly known and infrequently referred to type in that broad group. Elton Prewitt identified 11 specimens from the Varga Site that provide metric and non-metric variability that establishes a general characterization for this type. For now, this component's chronometric data provide a general age range of ca. 6,300 B.P. to

5,200 B.P. (ca. 7,200 to 6,000 B.P., calibrated), for the Merrell point.

It is not clear if any of the nine types/groups of points is intrusive to this area. Most Early Archaic point types in the literature are in limited numbers, came from poor context, lack associated radiocarbon dates, etc., which limits understanding of their distribution, precise ages, and associations with other point types and tool forms. The better-known and more frequent types such as Bandy, Gower, and Martindale have been recovered from the Lower Pecos region and across much of Central Texas (Prewitt 1995).

Compared with the Central Texas chronology, the Varga Site ages push the end of the Early Archaic a few thousand years younger than is currently projected in the literature (Johnson and Goode 1994; Collins 1995) and raises questions concerning the current time ranges for the Early Split-Stem group in this region. The later dates from the Varga Site may indicate movements from the Central Texas region towards the Lower Pecos region.

16.6 BROADER CULTURAL HISTORY ISSUES

In addition to the diagnostic projectile points, are there other tool forms present that might be restricted to specific time periods? Two- or four-beveled knives typical of the Toyah phase/interval were not recovered in the Late, Middle, or Early Archaic components. These resharpened knives were not abundant in the Toyah phase/interval, with only one specimen present. Johnson (1974) indicates that this type of knives has a greater range than just in the Toyah components in Texas, mostly further north in the buffalo habitat of the Great Plains. He goes on to state that the final form often has four beveled edges, but specimens from the coastal plain region of South Texas usually have only two beveled edges. This particular form is

currently restricted to the Late Prehistoric period, but it is not restricted to only the Toyah phase. Different groups in the Texas panhandle also employed similar beveled knives. Specimen #159-5-28 is a typical four-beveled knife that is often referred to as a characteristic bison-processing tool of the Toyah phase. The use-wear analysis revealed wood residue in the haft area and striations parallel and perpendicular to the long axis on the proximal end. Use-residue in the form of hair fragments and starch grains plus hard, high silica polish were also present. The presence of these materials and use-wear indicate that this particular piece was used for multiple tasks that included cutting and possibly piercing on hard, high silica plants and possibly animals.

The gouge, or specific types of gouges such as the Clear Fork tool, is often thought to be diagnostic of the Middle and possibly the Late Archaic time periods (Hall et al. 1986). This tool type was identified in the Early Archaic component in limited numbers ($n=3$). High-powered use-wear on two gouges indicates scraping and/or planing on bone or wood and animal hides. Although these actions and materials are not restricted to just this tool type, gouges were not represented in later components at the Varga Site. Gouges were not restricted in time, since they have been recovered from contexts in South Texas associated with events and components younger than 5,000 B.P. (i.e., Scott 1982; Hall et al. 1982; Highley et al. 1995; Quigg et al. 2002). However, they have not been identified in the Late Prehistoric period. In Central Texas, Clear Fork tools were present at the Wilson-Leonard Site in Williamson County, from Paleoindian to Late Archaic times. Unifacial gouges were present only during the Archaic period, from 4,000 to 6,500 B.P. (Dial 1998). The Brushy Creek bifaces were mainly in early contexts representing Late Paleoindian occupations from ca. 8,700 to 9,500 B.P. (Dial 1998). A detailed use-wear analysis on these

types of tools currently reveals a diversity of tasks similar to that of a scraper. This tool type was not, apparently, manufactured to conduct one specific activity or task. It is not surprising that this tool shows up at different time periods across wide regions of Texas. Dial (1998) points out that much of the metric and non-metric variation in distally beveled tools may be derived from resharpening and rejuvenation of the distal bit end.

Chipped stone drills in general are not restricted to a specific time period, although they were absent in the Late and Middle Archaic components at the Varga Site. The size and particular configuration of the drills recovered from the Early Archaic may be distinctive. Although perforators at the Wilson-Leonard Site were not numerous in any of the occupations, they had higher frequencies in the Early Archaic period (Dial et al. 1998). Dial et al. (1998) discovered that the form of the basal portion appeared to have limited importance. At present, few sites/components of this age have yielded radiocarbon dates and/or good contexts; therefore, it is not possible to state with any degree of certainty that this elongated form reflected in the Early Archaic component at the Varga Site is restricted to this period. It is worth further investigation, and use-wear would be important to determine if the contact material co-varies with changes in tool form.

Rejuvenation flakes were identified in three of the four components (not in Late Archaic). The rejuvenation strategy/technology appears to have been implemented at least by 6,300 B.P. and carried forward through time. Collins (1974) identified similar types of sharpening flakes and refurbished edges in most of the strata at Arenosa Shelter in the Lower Pecos. The knowledge of how to rejuvenate a chipped stone tool edge does not appear limited in time across most of Texas, but the current terminology used in the literature centering on such a strategy has

hindered a more thorough understanding of the distribution of this technology. Rejuvenation is evidence on two- and four-beveled (Harahey) knives in the Toyah Component. Rejuvenation derives from the need to continue to use a particular tool so replacement is unnecessary as ongoing use-wears the tool edge. Beveling/rejuvenation is also observed in the Early Triangular points from the Varga Site and elsewhere, as some points exhibit one or two edges that have been beveled. In fact, the primary difference between the original Taylor and Baird triangular points (Kelly 1947a) was the beveled edge (or lack thereof).

The quantities of burned rocks and numerous burned rock features provide clues to various cooking tasks, presumable food processing. It is possible that a few of the identified burned rock features were used for specific types of cooking that might be restricted in time. However, many of the potential food resources in the area and region have been present for long periods of time, it is unlikely that one type of burned rock feature/structure would be limited to a specific type of cooking at one point in time. The small, amorphous looking and ill-defined burned rock features in the Varga Site Early Archaic component are not well enough preserved to detect a particular shape or configuration that might be considered distinctive of this period. It is apparent that burned rocks were used to cook foods, specifically plant foods as indicated by the lipid residue results. This trend in cooking technology that employed the use of hot rocks to cook foods was undoubtedly initiated before 6,300 B.P., and its use appears to have continued through to the very latest period as represented in the Toyah component. Even the addition of pottery to the cooking technology in the Toyah component did not obviate the need for hot-rock cooking. The Late Archaic component, with its incipient burned rock midden, reflects a totally different type of cooking apparatus, but this probably just reflects a specific type of food

being cooked, or a specific cooking technique that is not visible in the rest of the three components at the Varga Site. Although not represented in the other three components at the Varga Site, large burned rock ovens are known from many other time periods and across broad regions of central and western Texas. These cooking apparatuses were in use for a minimum of 6,000-years and probably more. The employment of the boiling strategy is not apparent at the Varga Site, perhaps only because it is hard to identify in the case of limestone rocks, which do not necessarily break apart in the same way as do harder quartzite's when used to transfer heat to liquids. If boiling was used at the Varga Site, it is not visible in the limestone or feature record.

The broad subsistence pattern and/or utilization during the four identified components indicates broad based hunter-gatherers occupied the Varga Site periodically over a period of about 6,300-years. The subsistence was directed toward seasonally available plants and multiple animal resources, with mussels and other aquatic resources playing, at most, a very minor role. Seasonality may have played a role in the patterns detected, but identifying the season in which these components were utilized is difficult and recovered data sets conflict with one another. The presence of littleleaf walnuts and pecan shells in three of the four components implies late summer to fall occupations. However, this may conflict with the presence of agave hearts and leaves, best procured in early spring, identified in the Toyah and Late Archaic components. The conflicts may stem from multiple events being represented in the components. The general pattern of subsistence indicates diversity was the norm with the Toyah populations exhibiting the most varied plant and

animal resource base compared to earlier groups. However, preservation of these data sets may be playing a significant role in this apparent trend, since the quantity of organic materials is greatest in the Toyah and significantly less in the Early Archaic component. If the plant and animal resources were generally available and being more or less consistently procured from the Varga Site, then one may assume that the general environment was relatively constant or at least stable over the millennia represented in the archaeological record.

The mobility patterns detected in the four components at the Varga Site reflect broadly similarity, which is expectable in light of the apparent consistency in basic patterns of resource use. The encampment residues at the Varga Site reflect relatively short-term occupations. The group's movements appear to have been restricted to relatively small territories or home ranges that were the operational area of technoeconomic activities. The procurement of tool stone, which was generally available throughout the region as a whole, reveals that most of the territories were relatively restricted the Edwards Plateau around the site, rather than broad ranging across vast areas, or even the entire Plateau. The INAA from each of the four components indicates that multiple tool stone sources were involved, which also implies mobility and movement of the various groups. The lack of obvious and preserved trade goods in the four assemblages indicates support for the relatively restricted territory and possibly the limited contact/interactions with outside groups. Though still very limited, there may have been an increase in long-distance interactions during the Toyah period, as indicates by marine-shell objects and the apparently exotic ceramic figurine-like object.

17.0 FUNDAMENTAL PATTERNS OF ARCHAIC AND LATE PREHISTORIC LAND USE AND MOBILITY AT THE VARGA SITE AND ITS ENVIRONS

J. Michael Quigg

17.1 INTRODUCTION

Hypotheses about hunter-gatherer mobility, settlement, and land use patterns are based on the limited perspective of completed empirical analyses of data from the four Varga Site components, plus a limited and selected body of relevant data from other sites in the region. While inferential, they serve as working hypotheses for the Edwards Plateau and can be augmented, modified and/or refined as more precise data becomes available.

The upland survey conducted at the Devil's Sinkhole State Natural Area, just a short distance to the northwest of the Varga Site, provides a systematic survey that reveals general site density for the uplands immediately in the vicinity of the Varga Site. That survey yielded one prehistoric site per 35 ha (or one per 87 ac; Howard et al. 1996). Some 43 burned rock middens were encountered in the 21 sites identified, indicating a high frequency (one midden per 17 ha [or one midden per 42 ac]) of that feature type in the uplands. Nearly 38 percent of the sites yielded natural chert outcrops that potentially were considered

resource procurement areas. Based on surface collections of diagnostic projectile points about 50 percent of these sites yielded indications as to their ages, information that indicates this upland area was used most intensively during the Late Archaic and Late Prehistoric periods, between 4,400 and 200 B.P. (2,400 B.C. and the seventeenth century). Although the survey does not provide a complete picture for the region, or even for one particular time period, the data do provide a partial view of general land-use strategies in the uplands for this region. Seemingly, hot-rock cooking was a common activity in this region, although the specific resources that were processed are largely unidentified. The high number of lithic procurement sites in the region indicates there was no shortage of locally available chert for the manufacturing of stone tools.

17.2 TOYAH

The Varga Site Toyah encampment and its recovered cultural assemblage are similar to other excavated Toyah sites across Texas. Johnson (1994) has reviewed a number of the excavated and better-documented sites. A compilation of selected data, primarily pertinent to subsistence, from nine Toyah sites provides a foundation to address general patterns of land use and attendant mobility (Table 17-1). The distribution map that Johnson provides (Figure 105, 1994:243) indicates the very broad region of the Toyah Culture, which includes all of the Edwards Plateau, much of inland South Texas, the Blackland Prairie, and northward into the southern Plains region. The vegetation and plant food resources across this broad Texas area are diverse and often available on seasonal bases. The animal resources are quite similar across the region, with more diversity in the Edwards Plateau than in South Texas. Densities of animal populations potentially were more variable from region to region.

Table 17-1. Selected Toyah Sites Indicating Subsistence and Settlement Data

Characteristics	41ED28 Varga	41TG91 East Levee	41KM16 Buckhollow	41HI1 Kyle	41TU42 Smith	41BN33 Rainey Zone III	41LK201	41JW8 Hinojosa	41HY209T Mustang Branch
Vertebrate Faunal	Present	Present	Present	Present	Present	Present	Present	Present	Present
Bison	Present	Present	Present	?	Present	Present	Present	Present	Present
Deer	Present	Present	Present	Present	Present	Present	Present	Present	Present
Antelope	Present	Present		No			Present	Present	Present
Rabbit	Present	Present	Present	Present	Present	Present	Present	Present	Present
Turtle	Present		Present	Present		Present	Present	Present	Present
Fish	Possible	Present	Present	Present		Present	Present	Present	Present
Bird	Possible	Present	Present	Present			Present	Present	Present
Other Game	Present	Present	Present	Present	Present	Present	Present	Present	Present
Fragmented Bone	Present	Present	Present	?					Present
Grease Extraction	Possible	Possible	Possible	?					Present
Plant Foods									
Corn	No	No	No	Yes = 1	No	No	No	No	No
Onion	No	No	No	Present	No	No	No	No	No
Acorns	No	No	No	Present	No	No	No	No	No
Pecans	Present	No	No	Present	No	No	No	No	No
Walnuts	Present	No	No	No	No	No	No	No	No
Mussel Shells		Present		Present	Present	Present	Present	Present	No
Burned Rock Oven	No	No	No	No	No	No	No	No	No
Landform	Terrace	Terrace	Terrace	Shelter	Shelter	Sinkhole	Terrace	Terrace	Terrace
Seasonality	Spring	Fall or Winter	Unknown	? Fall		? Fall	Spring	Winter? Summer	Spring
Multiple Point Types	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Exotic Goods	Yes	Yes	Possible	Yes	No	No	Yes	Yes	Yes

Bison reappeared in Central Texas around 750 B.P. and remained until roughly 150 B.P., and therefore, were available throughout the Toyah period (Dillehay 1974).

The climate across much of Texas throughout this period is postulated to be much the same as in historic times, though temperatures may have been somewhat lower during the period of the Little Ice Age, ca. 500 to 100 B.P.

The different localities or landforms occupied by Toyah populations such as rockshelters (i.e., Kyle and Smith), terrace sites (i.e., Buckhollow, Varga, Hinojosa), and sinkholes (i.e., Rainey) may reflect different seasons of occupation and/or variable weather conditions at the time of occupations. Although Johnson (1994) postulates that the Rainey Site was occupied in the late fall to winter, no direct substantiating evidence is available. Rockshelters were probably used during rainy seasons, whereas viable open campsites could have been easily established during most of the year. The size of shelters, including the Rainey Site, which was only about 40 m², would be a significant limiting factor on the sizes of residential groups, since restricted space would have only allowed for a few individuals-- possibly a family unit-- to have been in residence at any one time. The Kyle Rockshelter, roughly 335 m², could have provided shelter for a larger group.

Most excavated Toyah sites have been located in terrace settings along watercourses, which provided immediate access to necessary resources such as wood and water, and diversity of plant and animal resources. Special food-extraction sites or sites focused on one or two food resources are nearly absent from the list of Toyah sites. For example, the vertebrate fauna from Mustang Branch Site (41HY209T), a terrace setting, yielded an extensive population of deer (a minimum number of 19), at least eight antelope, two bison, plus turtles, rabbits,

dog/coyote, and other small mammals (Mason and Holderby 1994). Nearly all excavated Toyah sites have yielded bones from a range of animals, with an apparent focus on large game such as deer, antelope, and bison, being supplemented by smaller faunal resources such as turtles, rabbits, and probably birds and fish. In a number of instances, only selected parts of the larger animals have been identified at camp sites, indicating that the animals were procured and subjected to initial butchering some distance away. Plant resources such as nuts, yuccas, seeds, and geophytes have been recovered from a number of sites. The materials from the few excavated sites reveal procurement of diverse animals and plants from at least two or three broad habitats that surrounded the terrace campsites, including streams, valley floors (open meadows and wooded thickets), colluvial slopes, and open grassy uplands. This indicates that the terrace camps were base camps from which resources were sought and procured, processed, and either consumed or stored. Since most Toyah sites lack any direct evidence of food storage, most foods were probably immediately consumed. Extended processing of animal bones by breakage for marrow extraction and smashing for grease rendering is evident at some sites (Quigg 1997b; Mason and Holderby 1994), indicating that meat was prepared for storage in the form of pemmican for subsequent use.

Other, non-food, resources that were undoubtedly procured from this and other terrace settings included clays for the manufacture of ceramic vessels and stone (chert and limestone). Clays and natural rock were often readily available and exposed along creeks and rivers and alluvial cutbanks often exposed or contained quantities of clay that was potentially used in the manufacture of ceramic vessels. The eroding valley walls exposed outcrops of limestone that were used in cooking processes. Although not many of the samples from excavated sites have been subjected to source

analyses concerning these two natural resources, the Varga Site data provides a glimpse at the possible distribution of chert procurement localities. The Varga Site INAA results indicate that nearly all chipped stone tools were manufactured from Edwards cherts, with some chemical signatures on the cherts similar to those obtained from natural tool stone various locales along the southern Edwards Plateau.

INAA and the petrographic analysis on several ceramic sherds and one sediment sample from the Varga Site reveal that the four identified Varga Site Toyah vessels were not manufactured from Central Texas clays from identified source locales. The Varga Site vessels were manufactured from clays from at least two and probably three separate sources. In short, a few vessels were manufactured from local clays and a few vessels were from non-local clays, implying movement of peoples and vessels across the landscape.

Social interactions with adjacent non-Toyah groups appear to have been quite limited, based on the low frequencies of exotic goods in the recovered Toyah assemblages. The excavated Toyah campsites along the northwestern margin of the Edwards Plateau such as East Levee (41TG91), Rush (41TG346), Buckhollow (41KM16), and Varga (41ED28), lack southwestern ceramic vessels such as the El Paso brownwares, Chupadero Black-on-white, and various painted or corrugated wares from the Jornada region or southwestern ceramics from northern New Mexico. The surface context of the one El Paso originate sherd makes its association with the Toyah component questionable. None of the 47 Varga Toyah chipped tools subjected to INAA revealed chemical signatures that indicate the procurement of raw materials was in western Edwards County or further west in Val Verde County. However, the same cannot be said about the area to the northwest, which had more

dense populations known to have conducted extensive trading and interactions with groups further north. A few Harrell points in with the dominant Perdiz points at East Levee, Rush, and Varga sites indicate at least some contact/interactions with Plains groups to the north. If the one El Paso sherd from the surface is truly associated with the Toyah component, then there is a hint at interactions to the west, the north and the Lower Texas coast to the southeast. Thus, widespread interactions may have occurred in almost all directions.

Toyah sites along the eastern margins of the Edwards Plateau such as Kyle (41HI1), Smith Shelter (41TV42), and Mustang Branch (41HY209T) have yielded sherds of pots (brushed and engraved vessels) that appear to represent interaction with non-Toyah Caddoan groups to the northeast. The corncob at Kyle may also reflect interaction with the horticultural Caddoan peoples. Marine shells and a Padre point recovered at Varga indicate trading and/or contact with coastal groups some 410 km to the southeast. Therefore, Toyah sites along the margins of the Edwards Plateau have yielded minor quantities of non-local goods from the adjacent regions indicating some limited interactions or contact with other populations. The majority of interactions appear relatively limited rather than focused on obtaining goods of technoeconomic necessity, indicating that Toyah hunter-gatherers in this area did not rely on exchange of subsistence resources or technological items required to meet subsistence needs.

The small Toyah group(s) that occupied the Varga Site were general foragers that moved across the Edwards Plateau and took advantage of relatively evenly distributed and stable resources that included tool stone (i.e., Edwards chert), clays (i.e., alluvial deposits in stream valleys), plants (i.e., acorns, berries, sotol), animals (i.e., rabbits, deer, antelope, and bison),

and other foods (i.e., mussels, turtles, fish, etc.) necessary in their daily existence. It is postulated that small groups followed a general cyclic pattern (Figure 17.1) that coincided with the ripening of various plant foods. During fall, they collected nuts, berries, and seeds, and hunted various game animals, with a focus on deer. In winter, they mostly hunted large and small game animals and consumed those food items that could be stored. In spring, they collected tubers and roots such as onions, agave, and sotol. In summer, they diversified by collecting plants, and hunting animals. Fish, mussels, rabbits, deer, turtles, bison, and other game were probably procured year round. Tool stone was collected as needed, as was cooking stone. Periodically, for short periods, Toyah

groups likely aggregated in one base camp, thereby creating a relatively large encampment in a resource-rich valley setting.

17.3 THE LATE ARCHAIC

The Varga Site Late Archaic component was revealed by excavations focused on a large cooking feature that yielded only 36 g of carbonized plant remains including agave leaves, woody legumes, mesquite, juniper, oak, prickly pear seeds, and lotebush in association with a number of different Late Archaic point types. A compilation of subsistence data and landforms occupied during the Late Archaic in Central Texas provide insights into patterns of land use and mobility during this period (Table 17-2).

Figure 17-1. Schematic Diagram of Hypothesized Annual Cycle of Seasonal Emphases in Resource Use for the Toyah Phase

Table 17-2. Selected Late Archaic Excavated Sites Indicating Subsistence and Settlement Data

Characteristics	41ED28 Varga Site	41WM815 Rice's Crossing	41WM230 Loeve Fox Stratum 6	41TG91 East Levee	41HY209T Mustang Branch	41VV218 Bonfire Shelter	41BX377 Cibola Crossing
Vertebrate Faunal	Present	Present	Unknown	Present	Present	Present	Present
Bison	No	No		Present	Present	Present	No
Deer	Present	Present		Present	Present		Present
Other Game	?	Present		Present	No	No	No
Mussel Shells		Present		Present			Present
Burned Rock Oven	Yes – Basin	Yes – Basin	No	No	Yes – Lined pit	No	No
Site Type							
Landform Occupied	Terrace	Terrace	Terrace	Terrace	Terrace	Rockshelter	Terrace
Seasonality	? Spring	Spring	Unknown	Spring/ Summer	Unknown	Unknown	Unknown
Multiple Point Types	Yes	Yes	Yes	No – Marcos	Yes	Yes	Yes
Exotic Goods	No	No	No	No	No	No	No

The same set of Late Archaic projectile point types is found on the Edwards Plateau, much of inland South Texas, and along the eastern margin of the Blackland Prairie and northward into the southern Plains region.

The vegetation and plant food resources across this broad region are diverse, with many plant food resources (i.e., nuts, berries, cactus, and tubers) primarily available on seasonal bases. The animal resources (i.e., deer, rabbits, etc.) are relatively similar across the region. Densities of plants and animals were probably variable, being higher in the more wooded areas than in open upland grassland settings, with the exception of bison, which occupied grasslands and frequented stream valleys for drinking water. Generally, bison were hunted in limited numbers, with the notable exception at Bonfire Shelter in the Lower Pecos region, where massive bison jump

kills were conducted during this period (Dibble and Lorrain 1968).

Late Archaic sites such as Mustang Branch (41HY209M), Loeve-Fox (41WM230), and Rice's Crossing (41WM815) are all along the eastern margin of the Edwards Plateau and immediately adjacent to the Blackland Prairie. These sites contain burned rock middens that are linked to the cooking of bulk plant foods, possibly camas, onions, and other geophytes, all C₃ plants. The East Levee Site (41TG91) in Tom Green County is along the northern margin of the Plateau region, where the human population exploited bison herds, a C₄ food resource, again probably on a seasonal basis. As mentioned, Bone Bed III at Bonfire shelter, also located along the southwestern margin of the Edwards Plateau, yielded evidence of a mass bison kill. A burned-rock cooking feature (possibly an incipient burned rock midden) that

was used to cook bulk plant foods, probably sotol, which are most often procured in spring (Castetter and Opler 1936), is the primary Late Archaic feature at the Varga Site. The presence of deer, bison, and other game resources at this and other Late Archaic sites, in both Central Texas and in the Lower Pecos regions, testifies to the procurement of animal resources. The findings combine to indicate a pattern of broad-based economic pursuits.

A few authors have discussed the participation of the Late Archaic populations in a much broader exchange network (Hall 1981; Prewitt 1981a), based on a redundancy of exotic goods from Late Archaic mortuary contexts east of the Edwards Plateau, evidence of which has not been found at domestic camp sites; our current knowledge indicates a general lack of exotic goods from most Late Archaic campsites across the Edwards Plateau. The low frequency of exotic goods would imply that many of the Edwards Plateau populations were not participating extensively in these broader interactions. If these populations were involved in a trading network, the network was quite limited, or the archeological evidence is largely restricted to grave offerings. The low frequencies of exotic goods potentially was influenced by the general localized nature of individual group territories within the Edwards Plateau or limited contact with major groups outside the broader Edwards Plateau region.

The small Late Archaic groups that occupied the Varga Site were general foragers that moved across parts of the Edwards Plateau taking advantage of relatively evenly distributed, and stable resources that included tool stone (i.e., Edwards chert), plants (i.e., acorns, berries, prickly pears, and agave), and animals (i.e., small game, deer, antelope, and bison) necessary for their everyday existence. The terrace setting along this creek, within the broader dissected topography, provided a favorable camping

locality. This kind of locale had the greatest concentrations of food and other necessary resources compared to the more open, resource-limited grasslands of the Edwards Plateau or adjacent areas. Consequently, the valley terrace settings have higher densities of Late Archaic sites compared to the more open uplands.

The small groups are postulated to have moved every few days, following a general cyclic pattern of subsistence and settlement not markedly different than that just indicated for the Toyah period (Figure 17.1) that coincided with the ripening of various plant foods. During fall, they undoubtedly collected nuts, berries, and seeds, and hunted primarily deer and a range of smaller game animals. In the short winter season, they mostly hunted large and small game animals, and consumed stored food products (i.e., dried berries, nuts, and/or dried meat). As spring approached, groups moved to resource areas where they collected tubers and roots, such as onions, camas, agave, and sotol, which often grow in large patches that provide easy access to bulk quantities in localized settings. In summer, they diversified by collecting plants such as seeds, fruits, and tubers, and again hunted animals. Fish, mussels, rabbits, deer, turtles, bison, and other fauna may have been procured year round, according to spatial and seasonal availabilities. It may be that mussels were a supplemental food during all seasons or possibly only during times of need. The constant movement and short stays by the groups in any one place also meant that local food resources were not totally depleted, could easily regenerate in at a given location. The burned rock middens often attributed to the Late Archaic populations reflect at least one and possibly two seasons in which bulk foods were collected and processed. The principal season was in spring and early summer when onions, followed by camas, and later agave/sotol were available and edible. Cooking these and other plant foods may actually account for two different periods during

the spring, since these foods do not often become available at the exact same time of the year.

The Late Archaic human populations procured abundant tool stone—Edwards chert—from gravel outcrops along the waterways or upland exposures as needed, and collected readily accessible cooking stone—mostly limestone—from outcrops adjacent to their campsites. The plentiful and high quality tool stone readily available across the Edwards Plateau obviated the need for Late Archaic groups to trade for exotic tool stone. With the readily available tool stone, most if not all, terrace campsites reveal relatively high frequencies of lithic debitage that would include most stages of tool manufacture and reduction stages (i.e., cores, early and late stage reduction flakes, and biface failures). Generally, high frequencies of exhausted tools occur at these campsites, where new tools could be readily manufactured to replace old, worn out tools.

17.4 THE MIDDLE ARCHAIC

The Varga Site yielded a Middle Archaic component that is more distinct than often seen for this period in excavated sites in Central Texas. No other sites in the immediate vicinity of Hackberry Creek are currently identified as representing this particular period (Table 17-3). Although this general time range, from ca. 6,000 to 4,000 B.P., is recognized across a broad region of Central Texas, most often it is represented only by projectile point types considered to be time-diagnostic. We have little data on human adaptations for this period, and there is no substantial, detailed review or compilation of the data that are available (Table 17-4). Collins (1995) lists only three sites for the entire period with moderate to high integrity. Wounded Eye is the only site listed for the “Taylor” period (“Taylor” being another name for Early Triangular points) and that is an

undated burned rock midden site that was excavated in 1977 (Luke 1980).

The general temporal range from ca. 5,000 to 3,000 B.P. was one of general aridity in the Lower Pecos region. Although the environmental data from the Varga Site are quite limited, dry conditions are generally indicated, with vegetation comprised mostly of C_3 grasses. The encampment at the Varga Site is marked by the presence Early Triangular points. Populations employing the points of this type occupied a broad region across Central and South Texas and potentially have counterparts in the Lower Pecos region (i.e., Devils Triangular points at Skyline Shelter). Occupation of the Lower Pecos region by people who made Early Triangular points is still uncertain as Pandale, Langtry, Val Verde, and Almagre points dominate in that region. Often, Early Triangular points have been recovered from a context that contained more than one type of point. Therefore, it is unclear if the different point types in one stratigraphic zone indicate mixing of deposits, or concurrent use of the area by different groups.

At the Varga Site, use-wear analyses and distal snap breaks, strongly indicate that while the Early Triangular points functioned primarily as projectile points, they also served as multifunctional tools, as evidenced by use-wear relating to whittling, gouging, and cutting.

Vertebrate bone preservation is generally quite poor across Texas in Middle Archaic contexts (Table 17-4). The Varga Site vertebrate assemblage is no exception, with only a limited faunal assemblage that indicates deer and rabbits were procured and processed. At least a couple of excavated sites along the eastern margin of the Edwards Plateau (i.e., Landslide and Cervenka) have yielded bison bones associated with Bell/Andice points, which are only slightly later in time.

Table 17-3. Archeological Sites in the Vicinity of the Varga Site in Northern Edwards and Western Real Counties

Time Period	Upland Setting	Canyonlands Rock Outcrops	Alluvial/Colluvial
Paleoindian			
Early Archaic			
Middle Archaic	2 middens – ED50 (Pandale)		
General Archaic	3 middens – ED147 (dart)		2 middens – ED141 (dart)
	2 middens – ED141 (dart)		
Late Archaic	1 midden – ED67 (Pedernales)		9 middens + procurement – ED58 (Pedernales)
	4 middens – ED65 (Pedernales)		4 middens + procurement – ED54 (Pedernales)
	4 middens – ED55 (Arenosa)		1 midden – ED78 (Castroville)
	1 midden – ED74 (Marshall)		1 midden – ED83 (Montell)
	2 middens – ED39 (Pedernales)		1 midden – ED70 (Frio)
	1 midden – ED75 (Frio)		2 middens – RE23 (Frio)
	1 midden – ED76 (Frio)		2 middens – RE26 (Bulverde)
	1 midden – ED81 (Bulverde)		
	1 midden – ED44 (Darl/Marshall)		
Late Prehistoric	Lithics – ED145 (arrow)		
	4 middens – ED65 (dart)		
	Camp – ED40		
Unknown	Lithics – ED149	Procurement – ED146	Buried camp – ED25
	Lithics – ED148	Procurement – ED144	1 midden – Ed26
	1 midden – ED143	Lithics – ED140	Buried camp – ED29
	Lithics – ED142	Rockshelter – ED24	1 midden – ED31
	1 midden – ED56	Rockshelter – ED85	Lithics – ED32
	Lithics – ED30		Lithics – ED33
	Procurement – ED41		Buried camp – ED34
	1 midden – ED43		Lithics – ED35
	Procurement – ED46		Buried camp – ED36
	1 midden – ED47		Buried camp – ED37
	Procurement – RE41		Lithics – ED38
	1 midden – ED51		2 middens – ED45
	2 middens – ED71		1 midden – ED48
	1 midden – ED72		1 midden – ED49
	Procurement – ED77		1 midden – ED68
	2 midden – ED80		Buried camp – ED69
	Camp + procurement – ED82		2 middens – ED57
	1 middens – ED87		Camp – ED73
	1 midden – ED95		1 midden – ED79
	1 midden – ED96		1 midden – ED84
	2 middens – RE37		Buried camp – ED86

Table 17-3. Archeological Sites in the Vicinity of the Varga Site in Northern Edwards and Western Real Counties (Continued)

Time Period	Upland Setting	Canyonlands Rock Outcrops	Alluvial/Colluvial
	Lithics – RE38		Lithics – ED89
	Lithics – RE40		Buried camp – ED90
	Lithics – RE39		1 midden – ED91
			1 midden – ED92
			1 midden – ED93
			Lithics – ED94
			Buried camp – RE12
			Buried camp – RE13
			1 midden – RE18
			1 midden – RE19
			Buried camp – RE21
			Buried camp – RE22
			Buried camp – RE24
			1 midden – RE25
			2 middens – RE27
			1 midden – RE28
			2 middens – RE29
			2 middens – RE31
			Buried camp – RE32
			1 midden – RE33
			2 middens – RE34
			2 middens – RE35
			2 middens – RE36
			1 midden – RE42
			1 midden – RE44
			1 midden – RE45
			Buried midden – RE46
			Buried camp – RE47
Multicomponent	6 middens – ED53		Buried camp – ED23
	4 middens – ED52		Buried camp – ED27
			Buried camp – ED28
			3 middens – RE30 (Clifton)

Site 41ED58 now encompasses 58, 59, 60, 61, 62, 63, 64; Site 41ED65 now encompasses 65 and 66; 41ED88 farmstead

ED = Edwards County, RE = Real County

Table 17-4. Selected Middle Archaic Excavated Sites and Selected Characteristics

Characteristics	41KR107 Wounded Eye	41CM111 Royal Coachman	41BL85 Landslide	41ED28 Varga	41WM267 Cervenka	41HY341 Holt	41BX377 Cibolo Crossing
Vertebrate Faunal	No	Present	Present	Present	Present	No	Present
Bison	No	No	Present	No	Present	No	Unknown
Deer	No	No	No	Present	No	No	Unknown
Other Game	No	No	No	No	Present	No	Unknown
Mussel Shells	No	Yes	Yes	No	Yes	Yes = 1	Yes
Site Type	Midden	Open Camp	Open Camp	Open Camp	Open Camp	Open Camp	Open Camp
Landform Occupied	Upland	Terrace	Terrace	Terrace	Terrace	Terrace	Terrace
Multiple Point Types	Yes	Yes	Yes	No	Yes	No	Yes
Exotic Goods	No	No	No	No	No	No	No

Therefore, bison may have been in the region and provided another food resource. Other than hunting of game, gathering bulk plant foods which required long cooking periods, is also evident from sites such as Wounded Eye. This burned rock midden probably represents a seasonal event where the peoples focused on intensive use of a specific plant resource for a short period of time. At the Varga Site, plant processing is evident from the use-wear analyses that documents that 31 percent of the analyzed chipped stone tools were used on plants. Lipid residues and stable carbon isotopes from burned rocks used in the food cooking process indicate that hot rocks mostly cooked plants. Mussels were also a procured resource.

The populations using the Early Triangular points were highly mobile hunter-gatherers as indicated by their wide distribution across much of Texas. They may have shared camps with groups that employed other point types, perhaps within shared territories. In contrast with other Middle Archaic peoples, the groups using Early Triangular points did not possess non-local

materials (i.e., obsidian, marine shells, exotic lithics) indicative of trading with distant populations. The INAA of Middle Archaic chipped stone tools from Varga Site indicates that the lithic resources were procured from the local southwestern and central regions of the Edwards chert outcrop. The chemical signatures indicate these cherts were procured from multiple sources within that relatively restricted region. The lack of trade goods indicates trade networks were not a significant or necessary part of the technoeconomic system.

Groups associated with these Early Triangular points were small, presumably kin units that moved across the landscape to procure foods as they became seasonally available. Often in spring, they procured bulk plant foods such as agave that required extended cooking times. These and other plants were processed in large rock ovens/burned rock middens. The lack of ground stone tools to indicate plant processing implies that plant processing tasks were probably performed using perishable tools such as wooden mortars or pestles or underwent

limited processing before cooking. Game animals were procured throughout the year without specific focus on any one specific animal, although deer appear most often in the archeological record. Tool stone resources were collected from many sources across the territory in the Edwards Plateau. These mobile foragers interacted and often camped with other groups that did not share the same sociocultural background. The interactions may have been a result of higher population density in the Edwards Plateau during a period that was slightly dryer and warmer than today. The slightly dryer conditions surrounding the Edwards Plateau caused a gradual shift of populations towards, or into, the more amenable habitat of the Plateau. The limited number of campsites of this age may be the result of widespread erosional processes that scoured deposits of this time period in many of the stream valleys of the Edwards Plateau.

17.4 THE EARLY ARCHAIC

The Early Archaic component and recovered cultural assemblage at the Varga Site are similar to a number of other excavated Early Archaic sites across Texas. McKinney (1981) and subsequently Johnson (1991) reviewed a selected suite of excavated Early Archaic sites and discovered that they formed a distributional pattern in the shape of a broad “Crescent”. The distribution map that Johnson provides (Figure 68:150) indicates the Varga Site lies within that previously defined “Crescent” that extends from the Lower Pecos region, across much of the southern Edwards Plateau, and northward through the Llano Uplift region. Undoubtedly, other Early Archaic sites are present outside this restricted region. However, the dissected canyonlands of the Edwards Plateau provides a greater opportunity to locate sites, and the concentrated modern day activities in this same area undoubtedly have contributed

to their discovery and subsequent excavation. Other than the possible greater visibility within the canyonlands, we see the current environmental data from the Varga Site leading to another possible explanation for this apparent site concentration. As stated previously, the environmental data from the surrounding region is interpreted to indicate warm and dry conditions at that time, but the Varga Site data do not reflect such conditions. Consequently, more favorable climatic conditions in the region potentially provided a greater abundance of plant and animal resources that attracted greater human populations and higher site densities within the Edwards Plateau and Balcones Canyonlands. In the lower Pecos region, the large, visible rockshelters with exceptional conditions for preservation have attracted many investigations. Thus, the known Early Archaic sample is very biased for this time period. The known location of most Early Archaic sites is very much a reflection of the preservation of alluvial deposits. As Collins et al. (1990) stated, almost no early Holocene fill is exposed in the major stream valleys and almost no late Holocene fill occurs in the upper reaches of small streams in the local region (cf., Blum and Valastro 1989). Consequently, the upper reaches of drainages are the most likely areas to yield preserved Early Archaic components without always having younger materials on top of them.

General information compiled from a selected sample of excavated Early Archaic sites provides a broad basis for addressing questions of mobility and land use (Table 17-5). Other than the rockshelters in the Lower Pecos, most known Early Archaic sites are located in deep terrace deposits along small streams, with an occasional Early Archaic human burial discovered in sinkholes. Early Archaic components exist, but are often deeply buried and difficult to reach.

Table 17-5. Selected Early Archaic Excavated Sites Indicating Subsistence and Settlement Data

Characteristics	41BC65 Sleepers	41UV88 Woodrow Heard	41BL85 Landslide Stratum V	41BX377 Cibola Crossing	41BL78 Youngsfort Stratum 8	41KR243 Camp Pearl Wheat	41ED28 Varga	41BX831 Richard Beene
Vertebrate Faunal	Present	No	No	Present	No	No	Present	Present
Bison	No			No			No	
Deer	Present			No			Present	Present
Other Game	Present			No			Present	Present
Mussel Shells	Present	?	Present	Present	No	No	No	Present
Burned Rock Oven	No	Present	No	No	No	No	No	No
Landform Occupied	Terrace	Terrace	Terrace	Terrace	Terrace	Terrace	Terrace	Terrace
Seasonality	Unknown	Unknown	Unknown	Late Spring/ Summer	Unknown	Unknown	Unknown	Unknown
Multiple Point Types	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exotic Goods	No	No	No	No	No	No	No	No

Most investigated Early Archaic components have yielded at least two different point types in apparent association, making it unclear if these components were occupied by at least two separate groups, were of mixed deposits, or were palimpsests on stable land surfaces. Also contributing to our limited understanding of this period is the lack of extensive excavations into these deposits, combined with the fact that they often have poor preservation of macrobotanical and vertebrate faunal remains. Consequently, the lack of data from this time period has limited our understanding of the broader patterns of settlement and subsistence.

The Early Archaic assemblage at the Varga Site reflects a residential base camp that was part of a broader foraging system. Multiple groups of people, marked by the presence of different projectile point types, moved about the southern region of the Edwards Plateau in pursuit of food

resources. Although similar styles of projectile points have been recovered across very broad regions of Texas, it does not necessarily follow that the actual human groups were ranging throughout these same broad regions. Apparently, small groups moved in more localized areas, with much smaller home ranges or territories, though information flow extended beyond the territorial range of a given group.

A relatively restricted home range for the Varga population is apparent from the INAA of chipped tool stone that reflects nearly complete reliance on Edwards chert and a high percentage of that from more local regions of the southern Edwards Plateau, rather than distant locales such as Fort Hood. Some chemical signatures on the cherts are similar to chemical signatures obtained from cherts collected from the Hackberry Creek gravels, whereas some signatures represent stone from nearby or

adjacent counties in the southern Edwards Plateau. Regionally, Edwards chert is plentiful and of such good quality that it adequately served the needs of the local populations. Imported (non-local) raw materials (i.e., quartzite, basalt, jasper, obsidian, etc.) were not identified in the Varga Site Early Archaic assemblage that yielded nearly 52,000 pieces of tool stone. Edwards chert from the Fort Hood region on the eastern edge of the Edwards Plateau and the Callahan Divide much further north, was also unidentified in the Varga chipped stone tool assemblage. The lack of imported tool stone, the absence of exotic goods such as marine shells, also reflects the restricted nature of group mobility and external relations. The apparently limited interactions may reflect a low population density throughout the region, or the interactions and material exchanges are simply not visible in the archeological record. However, it is worth remembering that, as stated above, the more widespread distribution of the point types represented at Varga does strongly indicate wide-ranging flow of stylistic information and, presumably, a degree of inter-group communication during the Early Archaic.

These populations camped in a variety of physiographic settings including: terraces in entrenched and broad open valleys, the upper reaches of small streams, and the broad, mostly grass-covered uplands. The stream terraces were the favored camp localities, since they provided the greatest diversity and the highest concentration of necessary resources (i.e., water, fuel, cooking stone, tools stone, and food) in a localized area. The adjacent valley walls and slopes provided ready access to procure various food resources (i.e., nuts, berries, seeds, tubers, and fruit), tool stone, and cooking stone. Large game animals, often more elusive and ranging further than small game, could have been procured from a wider area and brought back to the campsite for processing.

Family units occupied this terrace base camp and conducted multiple tasks represented by the diverse tool assemblage and the types of features recognized. The burned rock features at the Varga Site and other Early Archaic sites such as Camp Pearl Wheat reflect various types of cooking apparatuses. The recovered chipped stone tool assemblage at Varga reflects multiple tasks related to the procurement, initial processing, and subsequent manipulation of by-products of the game resources. The use-wear and residue analyses document diverse tasks directed towards hunting/processing of animals and collecting and processing plants. At Varga, a suite of tool manufacturing activities was carried out, including raw material procurement, core reduction, decortification of cobbles for biface reduction, final stages of biface thinning, and tool resharpening.

Although food resources have been poorly preserved at most Early Archaic components, the Varga Site assemblage yielded burned prickly pear seeds, walnuts, deer, and rabbit bones. The limited evidence indicates a fall occupation for at least one of the occupational episodes at the site. The near absence of large burned rock middens/ovens at Varga, as at most other Early Archaic components, indicates that bulk food collection, such as is evidenced for later time periods, was not a significant subsistence strategy during the Early Archaic across Central Texas. If the interpretation by Kibler and Scott (2000) is correct that one Martindale-age feature (Feature 22) at Cibolo Crossing represents the cooking of *Rabdotus*, then periods of low food supply might have occurred during these times. At certain periods during the year, mussels were also procured. From the limited, but diverse food resources associated with the investigated Early Archaic components, the relevant groups adapted to the Central Texas environment with a broad based foraging strategy.

The Early Archaic family groups, who apparently often intermixed with other groups, were general foragers that moved across the Edwards Plateau. They took advantage of relatively evenly distributed, fine-grained patchwork of stable resources that included tool stone (i.e., Edwards chert), plants (i.e., prickly pears, onions, acorns, berries, and sotol), and animals (i.e., rabbits, deer, etc.) necessary for their daily existence. The terrace settings along creeks and rivers, and rockshelters further west in the Lower Pecos, provided the most favorable camping localities. Valley settings provided the greatest concentrations of necessary resources (i.e., water, fuel, rock, and food) compared to the less favorable uplands covered with a mosaic of grasslands and oak motts. The small family groups probably moved every week or two, a pattern of mobility that coincided with timing of optimal availabilities of various plant resources. In the early spring (March and April) geophytes (i.e., onions and rain lilies) were sought in open grasslands, meadows, across uncovered terraces, and in the uplands. Later in spring, agave and sotol were ripe for collecting. Prickly pear and various grass seeds became available in mid to late summer followed by mesquite beans and other legumes. As fall approached, persimmons and various nut crops became available. Winter was spent searching for whatever food was available, possibly supplemented by consumption of dried/stored products (i.e., dried meat, berries, flower cakes, etc.). Deer and small game (i.e., rabbits, turtles, etc.) were undoubtedly hunted and procured year round.

17.5 SUMMARY

In summary, the generalized foraging pattern detected for the Early Archaic period continued throughout the following 6,000-years, at least during the four identified periods at the Varga Site. Although a general foraging pattern persisted during these four investigated time periods, different groups probably had preferences for food and tool stone procurement localities. Therefore, details of settlement patterns, extremely illusive to archeological detection, undoubtedly changed from one group to the next, and potentially from one territory to the next. Though mobile, these populations had restricted territories or home ranges within which their activities were focused. As a result, we may infer that these hunter-gatherers possessed intimate knowledge of the spatial and temporal distributions of key subsistence resources. The density and location of food resources was influenced by regional climatic and/or local weather changes. As the highly mobile bison populations became available at specific intervals throughout prehistory, human populations adapted to their presence and devised viable procurement strategies. As populations increased and/or decreased in and across the Edwards Plateau, and overall biotic productivity shifted with climatic changes, the human populations would have made relatively minor adaptive adjustments. In general, however, it appears that fundamental strategies for resource procurement and processing saw broad continuity, as our current data base does not indicate any dramatic changes in basic lifeways throughout the millennia represented at the Varga site.

18.0 THE HUMAN ECOSYSTEMS REPRESENTED AT THE VARGA SITE

Paul M. Matchen, J. Michael Quigg and Robert
A. Ricklis

18.1 SUMMARY INTERPRETATION OF PALEOENVIRONMENTAL DATA

Several lines of investigation were performed in an effort to detail past environmental conditions, during which human occupation at 41ED28 transpired. Specifically, samples of the site sedimentary matrices, palynomorphs, phytoliths, stable carbon isotopes, faunal material and macrobotanical material were examined (Table 18-1). By comparing the data collected in the various components, it is possible to assess changes in climate and the biotic environment. In the case of the Varga Site, environmental variables appear to have remained relatively constant over the long-term, with only relatively minor and gradual changes in the biotic composition.

The most obvious differences between components are in faunal and plant diversity, insofar as there is an apparent trend toward an increasing numbers of represented species. This is most evident in the case of bison, which is present in later components, but absent in the Early Archaic component. While it is recognized that differential representation of faunal species might be a bias introduced by preservation factors, we should expect to see the large, dense bones of this ungulate preserved in

the earliest component along with the bones of smaller animals which were, in fact, present and recoverable. In fact, this Early Archaic period actually corresponds, chronologically, with one of Dillehay's (1974) proposed periods of bison absence (8,000-4,500 years ago) in the southern Plains. The cause of this proposed bison absence during the Early Archaic throughout Central Texas is unknown, although Dillehay suggests that the southern Plains landscape may not have been capable of supporting bison populations during this time (1974:182).

The gradual change in grass phytolith composition across the four components provides another measure of environmental variability. Table 18-1 reflects an increasing proportion of C₄ plants in the composition of phytolith remains. This indicates change in the form of a long-term climatic warming trend increasingly favorable to C₄ species. The act of overgrazing via large herbivores could have also contributed to the spread of short grasses (C₄ grasses) (Weaver and Tomanek 1951). Nonetheless, both the phytolith information and carbon isotopic signature values reflect the overall preponderance of C₃ plants in the biotic inventory throughout all periods. The stable isotope data also show a steady trend beginning at the close of the Early Archaic of increasing negative C₃ values which peak near the middle of the Late Archaic.

18.2 THE HUMAN ECOSYSTEMS AS REPRESENTED AT 41ED28

Certainly, a range of factors including environmental setting, with its inherent constraints in terms of distance to food resources, distance to raw materials for tool production, and distance to water, played prominence in the choice of 41ED28 for settlement location in each of the four cultural components.

Table 18-1. Summary of Paleoenvironment

Characteristics	Early Archaic	Middle Archaic	Late Archaic	Toyah
<i>Geomorphic trends</i>	Slow aggradations	High energy flooding interspersed with periodic overbank flooding	Periodic overbank flooding	Periodic overbank flooding
<i>Pollen</i>	Low arboreal; high grass	Low arboreal; high grass	Low arboreal; high grass	Low arboreal; high grass
<i>Phytolith</i>	85% mixed grasses (cool) 15% short grasses (warm)	78% mixed grasses (cool) 22% short grasses (warm)	70% mixed grasses (cool) 30% short grasses (warm)	62% mixed grasses (cool) 38% short grasses (warm)
<i>Stable Carbon Isotope on sediment column</i>	C ₃ dominant plant inventory	C ₃ dominant plant inventory	C ₃ dominant plant inventory	C ₃ dominant plant inventory
<i>Macrobotanical</i>	5 taxa	3 taxa	11 taxa	18 taxa
<i>Faunal</i>	Medium to small vertebrates, and invertebrates	Large, medium, and small vertebrates	Large vertebrates*	Large, medium and small vertebrates, and invertebrates
<i>Excavation Area (volume)</i>	83 m ² (25.9m ³)	83m ² (20.9 m ³)	80.36 m ² (9.2 m ³)	207.75 m ² (42.9m ³)

*Faunal assemblage was very sparse and association with component is questionable.

The material remains that have been documented in this report have been examined for evidence of site function and the concomitant range of on-site human activity. If this information is approached from a human-ecological perspective, it is possible to define and compare system states as represented for the several pertinent time periods. The sections to follow present relevant interpretations whose reliability is constrained by the inherent limitations in the preserved site data.

18.2.1 Hunter-Gatherer Resource Procurement Practices

18.2.1.1 Collector-Forager Dichotomy

Ethnographic data on hunter-gatherer behavior has led to a normative characterization of the range of adaptive strategies along a continuum from foraging at one end of the spectrum, to collecting at the other (Binford 1980; Kelly 1983, 1995; Hayden 1986, 1987). As discussed above, foraging involves the residential movement of people to productive resource locations, and removal to a new residential

location once the resource has been depleted. This process of “mapping onto” resources involves making frequent residential moves combined with short logistical trips, with minimal time or need for food storage (Binford 1980; Kelly 1992, 1995). Residential bases and locations are two site types expected in the archaeological record of a foraging adaptation. Residential bases are places where the foraging group resides and where most processing is carried out. Locations are where “extractive tasks are exclusively carried out” (Binford 1980:9). In short, the foraging scenario involves high residential mobility and logistical forays from residential loci to obtain targeted resources.

Alternately, collectors maintain longer-term residential camps and procure a variety of resources by making logistical forays to surrounding resource patches, bring the procured resources back to a base camp on a recurrent basis (Binford 1980). Food gatherers, in these cases, make relatively infrequent residential moves and store food to assure availability at times of reduced productivity (Kelly 1992). Site types, in addition to locations and residential camps, include field camps, temporary task-oriented operational centers where sleeping, eating, and group maintenance occurs; stations, information gathering areas; and caches, temporary storage places for surplus resources (Binford 1980). In the collector model, residential mobility is limited, since field camps are moved infrequently while logistical mobility is widely implemented in the form of resource-acquisition forays.

Hunter-gatherer resource procurement strategies and the resulting mobility patterns can be discerned in the archeological record on the basis of the distribution and content of materials recovered at any given location. In many cases, however, individual behavioral episodes are indistinguishable, as complex prehistoric itineraries blur the patterns to be interpreted.

There is nothing, for example, that could prevent a field camp from also serving as a station for information gathering, and eventually morphing into a residential base once a group determined that resource were attainable at a favorable cost/benefit ratio. Thus, it must be kept in mind that the archeological definition of the presence and succession of such behaviors likely will be extremely difficult to achieve.

18.2.1.2 The Utility of Optimal Foraging Models

Given that the Varga Site yielded only limited information on resource availability and the exploitable biotic inventory for any one time period, the high-resolution data needed to apply optimal foraging models is not available.

One must assume that hunter gatherers had specific goals for resource acquisition; that they operated under certain time/space constraints, and that they made use of a currency (energy) throughout the process that is expended and acquired through various efforts. Therefore, the availability of these resources is foremost in this process and must be archeologically definable if any reliable modeling of prehistoric resource-procurement behavior and decision-making is to be done. Resources considered for this sort of inquiry would have included water, animals, plants, and raw materials for tool production, cooking, habitation, and other functions. One way to look at resource use is in terms of optimality ranking, which evaluates resources in terms of the costs and benefits inherent in their pursuit and acquisition, and assesses their ranking within forager and collector strategies. Unfortunately, given the fairly poor preservation of the relevant materials at the Varga Site, only a very partial inventory of faunal and floral resources is possible for each of the four represented periods.

It is also possible to look at resource-procurement choices in terms ecological

succession via the exhibited traits of r- and K-selection species (Mac Arthur and Wilson 1967). K- refers to the carrying capacity of the environment for a population, while r- refers to the per capita rate of net increase in a given environment. Each resource selection strategy is related to the reproductive success and relative abundance of a given biotic resource. Unpredictable environments are theorized to promote reliance on r-selected species for which reproductive cycles are short, and little effort is expended by the species in competing with other organisms (Mac Arthur and Wilson 1967). Traits for these species include a small body size, high reproductive capacity with a short reproductive/gestation period, and the ability to disperse offspring throughout a wide area quickly. In contrast, K-selected species dominate in stable environments and have the ability to successfully compete for limited resources. Traits for these species include large body size, relatively long lifespan, and the production of fewer offspring.

18.2.1.3 Diet Breadth and Environmental Constraints on Human Populations

The array of faunal and macrobotanical resources throughout the four cultural components represented at the Varga Site indicate that most if not all of these resources were obtained locally. This seems to indicate that immediate subsistence requirements and other basic needs were perhaps the driving force underlying land use strategies, thus placing the site's occupants toward the foraging end of Binford's (1980) forager-collector continuum. Groups who resided at the Varga Site subsisted by moving their residential encampments more or less frequently in order to procure specific resources and use them until depleted, and then moving on to other locations where these resources were available. Based on faunal

abundance and animal biomass, higher-ranked resources may have included bison (when present and available), deer, and pronghorn antelope.

If it assumed that faunal resource availability was correlated with (paleo) climatic conditions, then these can be used as proxy measures of the constraints that climate imposed on human populations. Species represented in the Varga faunal assemblages represent a combination of r- and K- selected resources, with a mix of species of small body and relatively short reproductive cycles (turtle: 70 days; rabbit: 30 days; fish: 4 days) and those of larger size and with longer reproductive cycles (bison: gestation, 285 days; pronghorn: 220 days; and deer: 200 days). A larger range of species is noted in the Middle Archaic and Toyah components, but both r- and K- selected resources are present. The only exception to this is in the Late Archaic component, where faunal presence is primarily represented by large mammals (possibly biased by mixing with overlying Toyah materials), but where plant processing was relatively significant. An assessment of the four components would indicate that the environment was, at a general level, relatively stable over the 6,300-year period, as medium-to-large mammals with longer birthing periods were present and consistently exploited throughout the sequence.

If a distinction is made between the components, the Early Archaic stands out, with little evidence for large mammal (bison) presence. This could be construed as the result of environmental constraints upon the animal population. Paleoenvironmental data indicates that conditions were relatively cool and dry for the Early Archaic, with the result that surface water may have been at a premium, occurring at springs and seeps with only intermittent flow in rivers and creeks.

Table 18-2. A Comparison of Toyah Reproduction Trait Compositions Using Identified Faunal Remains

Assemblage	K-selected NISP (identified specimens)	r-selected NISP (identified specimens)
Toyah component, Varga Site	1501 (96%)	49 (4%)
Occupation 4, Rush Site	1165 (91%)	111 (9%)

This type of environment might have limited the propagation and residence of larger herbivores such as bison, which need sufficient amounts of water on a daily basis to exist (McHugh 1958). Other smaller animals such as deer and rabbit, which have the ability to survive for longer periods without water [Van Wormer 1969], may have been more viable in this type of environment. In fact, Duncan (1995:101) suggests through a survey of available biological and climatic literature that environmental conditions were “conducive to both species (bison and pronghorn) with pronghorn possible adapting more easily to the decreased availability of water”.

If attention is directed solely to the Varga Toyah component, in which faunal-bone preservation is relatively good, a more confident assessment can be made. For example, a comparison can be made in this regard to another Toyah assemblage from Occupation 4 at the Rush Site, (Table 18-2). There is little difference in percentages of faunal species according to the Number of Individual Specimens (NISP). The proportions represented indicate a stable environment where K-selected animal species with longer birthing cycles and fewer offspring are able to thrive. This comparison supports the conclusion that the Toyah occupants of the Varga site had re-arranged the ranking of preferred subsistence resources to include bison.

18.2.1.4 Subsistence Strategies and Prehistoric Human Diet Breadth

The Toyah population practiced a broad subsistence base that included meat and other byproducts from deer, antelope, bison, and rabbits and possibly other animals with five to 15 individuals represented. The extensive chipped stone tool assemblage reflects a high proportion of activities directed at the procurement and processing of animal products. Various plants were also used and included at least agave heart and leaves (likely sotol or yucca), littleleaf walnut, and prickly pear. While plant procurement and processing tools (i.e., manos, metates, and pestels) are not represented in the recovered artifact assemblage, acquisition and processing of plants is evidenced by lipid residues in the ceramic vessels, burned rocks, use-wear on tools, and plant-part residues observed on the stone tools. The people employed burned rocks and ceramic vessels to cook their foods, although much of the meat was apparently not cooked through the use of hot rocks as the chemical residues from burned rocks and sherds indicate that at least 70 to 75 percent of the residues were from plant products. Burned rock hearths were present as were refuse dumps that contained a diversity of cultural debris. It is these dumps from maintenance activities combined with chipped stone tool manufacturing and maintenance tasks that reflect a general camp. This location apparently served as a campsite of some

unknown duration on a seasonal basis, but that season is not clear from the present evidence. These populations had contact with other peoples/groups from other regions as indicated by a limited number of different forms of projectile points that are more frequent in other regions. Contact either directly or indirectly occurred with coastal groups as indicated by the presence of three marine shells. The Toyah groups apparently utilized a relatively limited territory or range in that the clays used in the ceramic vessels and tool stones were generally from local and surrounding regions, rather than procured from great distances such as the northern or eastern Edwards Plateau. The pollen, phytolith, and carbon isotope data from the Toyah age sediments reflect a vegetation community consisting of various plants with a mixture of arboreal and grassland communities through the identification of some 10 taxa. Oak, pecan, hackberry, and walnut were present together with mostly C₃ grasses, although C₄ species were present in limited numbers.

It has been postulated, based on the multiple lines of zooarchaeological and macrobotanical data that Varga residents in all four identified cultural periods were operating under basically similar conditions, given the lack of evidence for dramatic environmental changes over the long-term. Notably, the data do not indicate that the Altithermal climatic episode of the middle Holocene (7,000 to 4,000 B.P.) had a major influence on hunter-gatherer adaptive strategies as represented at the site. One could also infer that the diet breadth of groups represented did not undergo major fluctuations through time. While this is apparent at a general level, some discernible differences in resource availability amongst the components are indicated by the available evidence. The already mentioned absence of bison remains in the Early Archaic component, followed by presence in the Middle Archaic, Late Archaic, and Toyah components may illustrate presence and absence cycles, as

suggested by Dillehay (1974). During those times when bison was absent, other K-selected faunal resources such as deer, pronghorn, as well as smaller r-selected animals took precedence over less nutritious foods such as, for example, freshwater mussels (Chapter 11, this volume).

Details of plant collection and usage within the human diet are somewhat variable throughout the occupation span of the Varga Site (see Figures 14-1 and 14-2). With the exception of agave heart and leaves, which appear only in the youngest two components, commonalities are noted in identified food resources, such as with prickly pear seeds and littleleaf walnut shells, which were present in all four components. The absence of agave from earlier components may be reflected in differences in features; the large burned rock feature recorded in the Late Archaic component is a probable large cooking feature, possibly an earth-oven, which may have served to intensively process agave. This phenomenon is not represented in the earlier components, so it may represent a degree of shift in dietary strategy, with agave becoming a relatively high-ranked food resource by Late Archaic times.

18.3 THE PREHISTORIC EMIC

Attempts were made during this research to address technological style as it relates to social identity. Two areas where this is most applicable in archaeological analysis is in tool form and ceramic form. As mentioned, variability in projectile point form has been presented as a means of differentiating style amongst social groups. For example, an examination of the morphological and spatial patterning observed in Perdiz points, has been suggested as representing socio-cultural variability, perhaps even distinctiveness among emically defined cultural groups living in a landscape at the same point in time (Johnson 1994). Similarly, many ceramic vessel surface treatments are considered to be the result of

manufacturing technology (e.g., cord-marking, stamping) in vessel formation. In the case of the Toyah component at the Varga Site, much of the vessel surfaces excluding rim characteristics are smooth and otherwise lacking any stylistic elaboration, making differentiation of vessels according to stylistic variables very difficult or impossible. Therefore, a consideration of projectile point forms, an aspect that is much more morphologically variable, was undertaken for points recovered from the Varga Site to address whether quantitative differences could be ascertained in point "groups" from which archeologists infer social identity (see Appendix A).

Although the statistical analyses were rather rigorous, distinct stylistic distinction was difficult to establish among projectile point class groups via quantitative means (see Appendix A). While much of the difficulty hinged upon maintaining the objectivity in data selection, collection, and analysis, a more fundamental problem is the incongruity between measurable attributes and formal variations that are perceptible to the human eye. In other words, we do not as yet have a means of measurement of variability that is readily grasped by visual perception which is, in truth, the basis for distinguishing between projectile point types. The greatest utility of these methods was found in determining variations within an assemblage that may not be recognizable or standardized. Once identified, however, these variations within point groups cannot be securely linked to the perceptual distinctions upon which variable forms (types) are identified (for example, the shape of a side notch is determined by more than its height and depth in mm). It is important to note that simply because typological forms are identifiable in the perceptual dimension beyond our current ability to empirically measure, this does not render typologies either "subjective" or invalid. Given that the identification of "good" types, as recurrent forms, is generally replicable

among observers, and that the types generally have definable limits within time and space, it is reasonable to assume that the diagnostic formalities of the types were also identifiable by the prehistoric craftspeople who produced them and that their distinctive forms thus can be assumed to have been at least as real for those individuals as they are for modern archaeological researchers.

18.4 SUMMARY CONCLUSIONS

The Varga Site (41ED28), a multiple component, stratified site, revealed four major use periods at this one specific location during the last 6,300-years. The four use periods include a Toyah phase (ca. 300 to 600 B.P.), a Late Archaic period (ca. 1,700 to 2,300 B.P.), a Middle Archaic period (ca. 3,900 to 4,800 B.P., as reflected by Early Triangular points), and an Early Archaic period (ca. 5,200 to 6,300 B.P., as reflected by a palimpsest or mixture of at least nine different projectile point types).

The Toyah cultural assemblage is remarkably similar and consistent to most other excavated Toyah sites/camps across much of Central Texas and fits within Johnson's (1994) Classic Toyah concept. The Toyah component yielded a large and diverse cultural assemblage reflecting diverse activities. No domestic structural remains were identified, although discard features reflecting general camp maintenance and in situ hearths were identified. This possible spring-side campsite adds understanding to this highly mobile Toyah population and their subsistence strategies that focused on diverse food resources comprised mostly of C₃ plants and animals that ate C₃ plants. Their movements followed a foraging pattern within a relatively restricted home range as reflected by the local procurement of tool stone.

The Late Archaic component reflects primarily the cooking of bulk plant foods, apparently agave in an incipient burned rock oven. The

sparse, broken, and unwanted chipped stone tools and waste debitage discarded along the margins of this feature indicate sparse retooling activities while individuals tended the cooking of foods. Apparently mixed groups of people employing different types of projectile points coalesced to procure and process quantities of C₃ plants that required extended cooking times. This component reflects similarities to many other Late Archaic sites that reveal similar cooking features.

Early Triangular points document the use of this site during the poorly known Middle Archaic period. Three radiocarbon dates provide a use period of potentially 900-years. The limited cultural assemblage is comprised mostly of lithic debitage, with few formal and informal tools, and limited burned rocks. The Middle Archaic assemblage is not significantly different than other hunter-gatherer camps.

The Early Archaic component contained dense quantities of cultural debris and reflects a mixture of multiple events that could not be separated. Fifteen radiocarbon dates document at least a 1,100-year time period for these early events. This early chipped stone tool assemblage was plentiful but not diverse. The stone artifacts reflect intense animal procurement and processing activities, but no plant procurement or processing. This Early Archaic component yielded relatively high frequencies of individual point types, some for the first time (i.e., Merrill).

One obvious change in the chipped stone assemblage over time is within the projectile point class, which not only reveals hafting changes over time, but also reveals hafting differences within specific time periods. The instruments that propelled the projectile points also changed from the Late Archaic to the Toyah components. This is quite visible in the much smaller arrow points in use during Late

Prehistoric times compared to the more massive dart points in use before that time. It is assumed that changes in hafting technologies to the projectile points are clues to cultural differences and/or identities.

In contrast to visible changes in the hafting technology employed in the projectile points over time, the broader chipped stone tool assemblage and cooking technologies (burned rocks features) reflected by these early hunter-gatherer groups was remarkably consistent. Throughout what is generally referred to as the Archaic period, the Varga Site assemblages of nearly 5,000-years of prehistory, from ca. 6,300 to 1,350 B.P., reveals minor change to the preserved material assemblages. The same cooking technologies, similar formal and informal chipped stone tools, continual reliance on local Edwards chert, and general subsistence resources persisted throughout most of this period. During the last ca. 600-year period, the Toyah group(s) added two new technologies, the bow and arrow and the ceramic industry, which are reflected at most other Toyah camps. This latest use period also revealed a broadening of the subsistence resources utilized with the addition of bison and antelope to the already diverse package. Remarkably, the tools associated with plant procurement and/or processing were nearly absent from all assemblages. However, the chemical analyses employed (i.e., lipids and isotopes) combined with the residue identifications on the chipped stone tools, document a significant use and consumption of C₃ plant foods. Without this chemical evidence we would have no indication that these peoples gathered or consumed plants.

The paleoenvironmental data obtained from multiple lines of evidence and interpretations indicate limited change to the past climate and vegetation communities during the 6,300-years represented at this locale. A hint at a possible change to dryer or warmer conditions is the

appearance of the bison and antelope in the Toyah subsistence base within the last 600-years. The appearance of these two species potentially reflects the presence of more open grasslands during this period, but human selection cannot be ruled out. This limited environmental change over time may be an influencing factor contributing to the relatively consistent archeological record from the Varga Site and its repeated use of this locality.

The combined results from the various technical analyses on samples from the four components provides invaluable information to many different aspects and made significant contributions to a greater understanding of many aspects of the specific cultural assemblages and activities. The extensive radiocarbon dating of the diverse materials proved invaluable in determining more precise ages for the use periods, the associated cultural assemblages, and internal movement of individual objects and classes of objects. Without this intensive dating program, many questions concerning specific material classes and associations would have

been left open to question. Use-wear on chipped stone tools documented that general tool form does not provide an adequate indication of tasks employed by that tool or the material it was used on. Use-wear on the edge-modified flakes revealed many tasks that would have gone undetected. The INAA on natural and cultural tool stone provides a greater understanding of the procurement territory of the populations in question and the distance the materials may have been transported. Continued employment of INAA on ceramics and tool stone will help to define where these mobile groups moved and how far, and to establish the group's procurement and use territory.

With the caveats presented in the next chapter, most of these and other technical analyses should be employed at other prehistoric campsites in the future to broaden our understanding of the populations as a whole and throughout the region. Critical use of these and similar analyses will add to an understanding to human behavior, prehistoric lifeways and environmental contexts across Texas.

19.0 EVALUATIONS AND ASSESSMENTS OF ANALYTICAL TECHNIQUES

J. Michael Quigg and Robert A. Ricklis

19.1 THE RESULTS

The Varga Site investigations resulted in the documentation of four stratified archeological components. Three components are robust and clearly defined and radiocarbon date to the Toyah phase (ca. 290 to 660 B.P.) of the Late Prehistoric period, the Late Archaic period (ca. 1,700 to 2,310 B.P.), and the Early Archaic period (ca. 5,200 to 6,280 B.P.). The fourth, a somewhat dispersed Middle Archaic component dates to ca. 3,900 to 4,800 B.P. In Block A, the 100 to 150 cm thick fine-grained sediments yielded all four cultural components, more or less intact. The impacted surface disturbed the upper part of the Toyah component. Krotovina disturbance was relatively extensive in various parts of the excavation blocks, and burned trees and tree roots were also encountered. Small diameter modern fence posts also penetrated the upper components in Block A. Nevertheless, the cultural deposits exhibited a high degree of contextual integrity in relatively flat, stratified zones in a region that is largely archeologically unknown through major excavations. Even though the components were identifiable, they were not “sealed”, as no sterile sediments were encountered between the components. Each component may represent multiple episodes of human occupation that cannot be distinguished

one from the other. East of the road, hand-excavations in Block B targeted only the Toyah component in the upper 20 to 30 cmbs. Road maintenance activities and the installation of an in-ground phone cable had disturbed parts of this near surface component.

Each of the four identified components is briefly summarized below beginning with the youngest and proceeding to the oldest. All four components reflect cultural assemblages that appear more closely linked with prehistoric cultural patterns of Central Texas than those of the Lower Pecos region (Table 19-1). Although the Lower Pecos region is, in geographic terms, relatively close (approximately 120 km), the near absence of artifact styles reminiscent of that area indicates a disproportionately greater *cultural* distance. Generally, the Varga site occupants had greater cultural affinity to Central Texas than they did with the Lower Pecos area, a factor that appears to have operated throughout the millennia represented at the site.

19.2 THE TECHNICAL ANALYSES: ASSESSMENTS OF RESULTS

A rather wide range of technical analyses have been conducted for the Varga site. These include:

1. Radiocarbon dating of 66 samples;
2. OSL dates of six samples;
3. Use-wear analyses and organic residue identifications on 156 stone specimens;
4. Petrographic analyses on 20 samples, pollen and phytolith analyses on 25 samples;
5. Microbotanical (pollen, phytoliths) analyses;
6. INAA on 261 chert and 19 pottery samples;

7. Fatty acid composition on eight pottery sherds and 94 burned rocks;
8. Stable carbon and nitrogen isotope analyses on 112 samples;
9. Macrobotanical analyses on 44 flotation (573 liters) and 75 individual samples;
10. Granulometry studies on 10 samples.

The combined results have contributed toward understanding prehistoric behavior and human ecology at the site and it is hoped that these and other technical analyses will be conducted at other excavated sites in the future to broaden our understanding of the populations as a whole and throughout the region. Continued use of diverse technical analyses will add information to the growing database, which will allow a greater understanding and broader interpretation of the prehistoric lifeways across Texas. Given this aspiration, it is appropriate here to review the contributions made, and of equal importance to make a candid assessment of the limitations that are perceptible in each of our approaches, in the hope of helping optimize future application of time and resources in the analyses of hunter-gatherer archaeological sites in the greater Central Texas region.

19.2.1 Radiocarbon Dating

The 66 radiocarbon dates were obtained from two laboratories—Beta Analytic and the University of Georgia in Athens. The submitted samples primarily targeted the four principal components—the Toyah, Late Archaic, Middle Archaic, and Early Archaic. Radiocarbon dating was done on charcoal in 34 cases, but also included 32 additional dates on diverse materials including: 11 dates on organics extracted from potsherds, eight dates on faunal bone collagen, five dates on carbonized walnut shells, five dates on organic fractions in bulk sediment samples, one *Rabdotus* snail-shell date, one burned

prickly pear seed date, and one date on organic residue in burned limestone clast. The charcoal, bone and walnut shell results provide the ages of selected individual features, age ranges for the broad components, concrete data to discuss turbation problems, and a comprehensive basis for assessing the absolute ages of burned rock residues identified. The dated burned rock from Feature 38 in the Toyah component provides an unacceptable age of 11,980 B.P. that is significantly older than any realistic age range for the Toyah occupation. The 11 sherd dates are also unacceptable as they date from 60 to 26,510 B.P. and provide no consistent age pattern. The one *Rabdotus* shell from the Early Archaic component yielded an acceptable date of 5,880 B.P. from the same level as an acceptable burned walnut shell date of 5,500 B.P.

In sum, then, it would appear that organic remains found in direct association with definable features provide reliable results, as should be expected given that (a) the features can be assumed to rest in relatively undisturbed contexts by virtue of their identifiable and more or less intact morphology, and (b) organic materials associated with features are perhaps more likely to represent directly related activities, and thus pertain to the cultural events that are the target of the radiocarbon dating. On the other hand, the residues extracted from the limestone clast and the potsherds seem less reliable. The reason(s) for this is/are not readily apparent, though we can suspect some sort of contamination of factors; perhaps old geologic carbonates in the limestone and in the sherds caused the results to be out of line with reasonable expectations. We suggest, therefore, that this approach to radiocarbon dating be further tested; if future results prove to be consistently mixed or outside the bounds of chronological expectations, the method must be regarded with some skepticism.

Table 19-1. Summary of Cultural Materials by Component from the Varga Site (41ED28) Investigations

Cultural Material Classes	Toyah Component (290 to 660 B.P.)	Late Archaic Component (1,700 to 2,310 B.P.)	Middle Archaic Component (3,910 to 4,820 B.P.)	Early Archaic Component (5,200 to 6,280 B.P.)	Miscellaneous Materials	Totals
Bone Fragments*	17,348.9 g	13.6 g	402.2 g	109.7 g	4.5 g	17,879.4 g
Mussel Shell**	25.5 g	5.9 g	0	21.3 g	0	52.7 g
Burned Rock	15,934	3,965	810	3,044	325	24,078
Features	11	10	2	9	0	32
Dart Points	13	14	10	170	5	212
Arrow Points	216	3	0	0	3	224
Bifaces	96	9	11	198	2	316
Scrapers	65	3	3	27	2	100
Drills	16	0	0	17	1	34
Edge-Modified Flakes	1,380	69	122	1,038	36	2,645
Lithic Debitage	26,323	1,801	4,387	51,869	1,103	85,483
Cores	37	10	8	25	8	88
Ground/Pecked Stone	2	1	0	1	0	4
Unifaces	7	0	0	4	1	12
Gouges	0	0	0	3	0	3
Hammerstones/Choppers	0	0	1	3	0	4
Ceramic Sherds	115	2	0	0	3	119
Bone Tools	3	0	0	1	0	4
Socialtechnic Objects	4	0	0	0	0	4
Carbonized Plant Remains	196 g	36 g	2.5 g	223.5 g	0	458 g
Total Materials	64,679	5,931	6,079	56,644	1,499	134,832
Volume Excavated (m³)	42.9	9.2	20.9	25.9	5.6	104.5

This table does not include materials from float samples

* Bone, mussel shell, and carbonized remain totals are weights in grams

** Mussel shell from testing not weighed

The seemingly successful result on dating the *Rabdotus* snail shell is encouraging, as shells of this gastropod are particularly abundant in archeological contexts throughout much of the state. We recommend further application, with close monitoring and evaluation of the outcomes.

19.2.2 Optically Stimulated Luminescence

Six OSL samples targeted the Toyah, Late Archaic, and Early Archaic components. The individual quartz grain results are quite variable, erratic, complex, and unacceptable. However, the fine grain results provide central ages that are remarkably similar to the accepted radiocarbon dates from each of the three components. The Late Prehistoric component sediments yielded ages from 1,030 to 1,130 B.P. The Late Archaic sediments yielded ages of 2,210 and 2,400 B.P. The Early Archaic sediments yielded ages of 5,000 and 6,670 B.P. Besides the slightly older Late Prehistoric ages, which may be quite acceptable since two charcoal dates are in that same age range, there is a remarkable correlation of these OSL ages with the obtained radiocarbon ages. In situations where organic preservation is lacking, it would appear that OSL dating would provide a reasonable means of obtaining a relative age on the sediments involved. Moreover, when the sedimentary matrices can be shown (on the basis of stratigraphic associations) to have accumulated in tandem with occupational sequences, OSL can serve as a useful technique for building cultural chronologies. Results at other sites (e.g., Ricklis 2001; 2007) have shown OSL to be a feasible approach to augmenting the chronological data obtained from both radiocarbon dating and from age estimates based on time-diagnostic artifact types (usually, but not always, projectile points).

It is most interesting that the OSL results appear to be valid, considering that they are derived from sand grains within alluvial sediments. Theoretically, we could expect that stream-suspended sands were not fully “reset” (exposed to sunlight) in turbid stream waters. Perhaps turbidity was less of a factor in a relatively small stream such as Hackberry Creek than would be the case in a major river. Alternatively, it may be that the actual use of the site by prehistoric people resulted in ground disturbance that exposed resident sediments to sunlight (through treadage and other ground-disturbing factors) with sufficient frequency to reset the sand grains at the time(s) of occupation. Despite such taphonomic questions, it does seem that OSL is a highly useful technique that should be further utilized and tested in more archeological contexts.

19.2.3 Use-Wear Analysis and Residue identifications

The high-powered use-wear analysis and residue identifications on 156 specimens provide valuable and interesting results. The analyses were conducted on points, scrapers, bifaces, unifaces, drills, and edge-modified flakes, and include: 59 chipped stone tools from the Toyah component, 17 tools from the Late Archaic component, 17 tools from the Middle Archaic component, and 63 tools from the Early Archaic component. The sample is remarkable for the high percentage of artifacts that exhibit functional evidence and for the high proportion of specimens that were found to retain identifiable residues. Preservation is excellent in the Toyah component with observed residues that include plant remains, starch grains, hair, feather barbules, wood fragments, and possible blood. Similar residues of hair, wood fragments, plant fibers and tissue, and raphides were observed on chipped stone tools from the Late Archaic component. Residues observed on Middle Archaic tools include hair, wood

fragments, and plant tissue. The Early Archaic sample also had well-preserved residues that include raphides, plant tissue, starch grains, plant fibers, wood fragments, bone/antler, hair, possible blood, and charcoal. Many Early Archaic tools exhibit raphides randomly distributed across their surface indicating that raphides may be depositional rather than use-related.

The use-wear results reveal that all artifacts from the Toyah sample exhibit evidence of use, either through residues or use-wear. This incredibly high percentage of tools with functional evidence indicates that the occupants were conducting intensive processing of a wide range of materials including wood, starchy plants (possibly roots or tubers), mammals, birds, and other types of plants. The Late Archaic tool sample preserves evidence for exploitation of a more narrow range of materials than the Toyah component. Hafting is limited to bifacially retouched tools and does not occur in high frequencies (3 of 17 tools were hafted). Wood and hide are the most commonly used materials. The Middle Archaic tools reveal a high frequency of use on hard, high silica materials with a broad range of use actions. The Early Archaic materials also reveal a broad range of use actions primarily on plants, hard, high silica material, with many unknowns. Use-actions include whittling, slicing, scraping, cutting, boring/drilling, and planing. General artifact typology based on form is not a good predictor of stone tool function. Most tool types appear to have been used for a variety of different tasks on more than one material. The use-wear analysis has provided extensive and important data on the analyzed tools and should be incorporated into most analyses of tool assemblages.

In sum, these findings indicate that formal tools were functionally a good deal more versatile than may be inferred by the functional labels routinely applied to them (e.g., “scraper”,

“projectile point”, “gouge”, etc). While beyond the scope of the present research, we believe that systematic collection of this sort of data will eventually make possible a coherent study concerning the validity of archeological assumptions about tool forms. Such a study might offer the benefit of a better understanding of the ranges of functions represented by archeological assemblages, with obvious potential for improving our understanding of past adaptive behavior.

19.2.4 Petrographic Analysis

The petrographic analyses on 19 plainware pottery sherds and one local matrix sample include 11 Toyah pottery samples and one local matrix sample from the Varga Site, five bone tempered sherds from the San Juan Mission (41BX5) in San Antonio, and three sherds from the San Lorenzo Mission (41RE1) at Camp Wood. The aboriginal mission ceramics were analyzed to provide temporal comparisons and allow for discussions on technological change. Analysis of a Varga Site matrix sample was valuable in distinguishing local from non-local paste groups. Variability lies largely with tempering agents and particles resident in the ceramic clays. Analysis of the mission ceramic sherds documents that Toyah bone-tempered ceramic technology persisted into the Protohistoric period with aboriginal populations who occupied at least the San Juan Mission. The analysts identified nine distinct paste groups, not all of which are bone-tempered. The paste groups represented in the Varga sample were then compared to paste groups from other analyzed Toyah site assemblages within the broader Toyah interval. The shared paste groups show that locally produced ceramics were transported from site to site. Investigating the means and mechanisms of this transport through hypothesis testing and the application of other analytical technologies may be a fruitful avenue for future research.

19.2.5 Pollen and Phytolith Analysis

Twenty-five paired pollen and phytolith samples collected from a single column in Block A, including two dated sediment samples from Trench 1 and three dated samples from Trench 7, provide indications of past environments. Two dated samples are of Late Archaic age, and three are of Early Archaic age. These samples yielded various frequencies and information on plant types that reflect minimal and gradual environmental changes through the 6,300-years of deposits.

Pollen data was very poorly preserved throughout the column and individual dated samples. Juniper pollen is absent from these assemblages, a reflection of the poor preservation. As expected, the youngest Toyah component samples were better preserved than those from earlier periods. The limited evidence indicates that the arboreal component remained rather stable over time and consisted primarily of oak, pecan, and probably smaller numbers of hackberry and walnut. The vegetation community was likely a mixture of arboreal and grassland meadow components.

These results are, unfortunately, not as helpful as hoped in terms of reconstructing paleoenvironments and tracking possible long-term changes in floral communities and, by extension, climatic patterns. It must be concluded that pollen samples derived from *relatively shallow site deposits* (such as is the case at Varga) are unlikely to provide very reliable results. More than likely, the pollen at such sites suffered from long-term exposure to near-surface biotic activity that degraded/destroyed pollen grains. Therefore, we strongly recommend that future pollen studies be done, if feasible within the spatial windows of projects and the constraints of project scopes/budgets, on samples derived from off-site cores extracted from more deeply deposited

alluvium in the vicinity of sites or, preferably, from anaerobic contexts such as bogs. Only in this way are we likely to recover a microbotanical record that will accurately represent the floral communities that existed during targeted time periods, and concomitantly, sequences that will permit reliable reconstruction of climatic and related environmental trends over the long-term.

Phytoliths were generally well-preserved in most column samples with dominant forms that included Chloridoids, Panicoids, and a small number of Festucoid types. A few Sabal-type palm phytoliths were also present reflecting probable Cretaceous or Tertiary aged re-worked phytoliths. In general, the phytolith column reflects a dominance of C₃ Pooideae grasses during the Early to Middle Archaic Periods. C₄ grasses appear in the area sometime during the Middle Archaic, but not in significant frequencies. Panicoideae and Chloridae grasses gradually increase in proportions during the Middle Archaic, but do not appear as a prominent part of the phytolith assemblage until the later part of the Late Archaic or into the Toyah component. Phytoliths are much better preserved than pollen and provide a greater insight of the past grassland communities.

19.2.6 Instrumental Neutron Activation Analysis

INAA was conducted on 154 chert tools, 19 pottery samples, one sediment sample from Varga Site, plus 107 natural chert samples from across the central and southern reaches of the Edwards Plateau to investigate possible procurement sources, movement of populations, lithic materials, and pottery across Central Texas. The chert tool samples include parts of chipped stone tools that represent a wide variety of tool classes from each component. These include parts of 17 chipped stone tools from the Middle Archaic, parts of 66 chipped stone tools

from the Early Archaic, 23 chipped stone tool pieces from the Late Archaic, and 48 pieces of chipped stone tools from the Toyah component. Comparisons between the current natural source samples from the Edwards Plateau and previous analyses indicate that the new natural source samples are significantly different from the varieties of Edwards chert samples collected from the Fort Hood area, but they overlap with earlier collections of Edwards Formation chert. Analyses of the Varga Site cultural artifacts reveal that they are compositionally different from the Fort Hood Edwards chert varieties. The Varga Site artifacts are similar to both collections of natural Edwards Formation source specimens from the central plateau and local river gravels.

While it should come as no surprise that the lithic tools at the Varga site were not made from cherts from the Fort Hood area, the fact that the closest similarities in chemical signatures for cherts at the site are from local sources or from sources in the surrounding part of the Edwards Plateau, significantly and strongly indicate that tool stone was procured either through relatively short-distance logistical forays made from the site, or by a resource-extraction strategy that was embedded (*sensu* Binford 1979) in a residential mobility pattern that was restricted to the sub-regional environment around the site. We believe this insight is a worthwhile contribution, as it suggests that the hunter-gatherer groups who produced the Toyah and earlier artifact assemblages had fairly localized operational areas, or territories, despite the obviously broad distribution of the classic Toyah archaeological assemblage and the various earlier dart point styles found at the site. In other words, these groups generally were engaged in patterns of spatially constrained settlement/subsistence mobility. At least this is the inference that we make from the Varga data. Given the important implications this has for understanding group mobility as a basic adaptive strategy, we believe

that acquisition of comparable data from other sites is a worthwhile goal for future research.

The potsherds submitted for INAA included three non-bone tempered sherds from the historic Mission San Lorenzo (41RE1) in Camp Wood, five bone tempered sherds from the historic Mission San Juan (41BX5) in San Antonio, and ten bone tempered sherds from the Toyah component at the Varga Site. The latter ten samples represent at least four different vessel groups. Based on the 29 chemical elements used for quantitative analysis, all samples have less than a four percent probability of membership in the previously analyzed Central Texas-1 and 2 compositional reference groups (Creel 2002, 2003). The exception is one thin igneous tempered sherd collected from the surface, which has high probability of membership in the El Paso Polychrome reference group. Clear chemical patterning is apparent in the remaining 18 specimens. The five samples from Mission San Juan form a distinct compositional group. The Varga Site sherds form two distinct groups. Two of the three samples from Mission San Lorenzo cluster together. Three samples are unassigned. Because the four groups are represented by so few samples, any attempt to statistically validate these groups is unwarranted at this time. Despite the small sample size, the INAA indicates that continued analyses of pottery from archeological sites would result in identification of several chemically distinct reference groups. Establishing a database for these samples could ultimately aid in assessing Late Prehistoric movements of pottery and people across Texas. An important part of the understanding of the movement of vessels and populations is a better understanding of the clay sources from different regions, and thus is a definite need to run tests on more natural clay samples from the state. We believe that a systematic approach in this kind of data gathering in future work will ultimately provide useful insights into the movement of

human populations and materials during the Late Prehistoric.

19.2.7 Lipid Residue Analysis of Pottery and Burned Rocks

Fatty acid composition on eight potsherds, including two sherds from Mission San Juan, and 94 limestone burned rocks from 23 identified Varga Site features, was conducted to identify the kinds of foods cooked in, respectively, ceramic vessels and hot-rock features. Ninety-nine percent of the samples yielded sufficient fatty acids for such identification. Residues extracted from the eight pottery sherds include two residues interpreted as representing large herbivores and three residues interpreted as moderate-high-fat-content food likely of plant origin. The other three residues fall on the border between moderate-high- and high-fat-content food and are all likely to be of plant origin.

Seventy-three burned limestone pieces, representing 77.7 percent of all burned rock residues analyzed, contain significantly elevated levels of fat or oil. Nearly 87 percent are consistent with nuts or seeds with fat contents ranging from moderately high to very high. Nearly 15 percent of the burned rock residues were identified as very-high-fat-content food; all of which are probably of plant origin. About seven percent of the burned rock residues fall on the border between high- and very-high-fat-content foods, again likely to be of plant origin. Just over 24 percent of the residues were identified as high-fat-content food, with nearly 88 percent probably reflecting plants. Another 8.5 percent of the residues fall on the border between high and moderate-high-fat-content food; all were probably of plant origin. A further 33 percent of the residues were identified as moderate-high-fat-content foods, of which 50 percent were probably plants.

Twenty burned limestone pieces, representing 21 percent, exhibit somewhat lower levels of fat or oil. Nine percent of the residues fall on the border between moderate-high- and medium-fat-content foods; all but one of these residues probably originated from plants. Near two percent were identified as medium-fat-content food, both of which are likely to be of plant origin. One percent of the residues were consistent with a low-fat-content plant. Eight percent may reflect the preparation of large herbivore products. One percent fell on the border between medium-fat-content plant and large herbivore prepared with plant or bone marrow. One percent was identified as large herbivore prepared with plant or bone marrow. Six percent of the residues are consistent with fatty or somewhat fatty large herbivore meat prepared alone or with plants.

The overall results reflect extensive cooking of plant foods during all four component periods, with a low (6 to 20 percent) incidence of large herbivore residues represented in the Toyah component. Based on these findings, taken at face value, it appears that a sizeable majority of the foods cooked at the site were plants. Even in the Toyah component, wherein large herbivore meat constitutes a significant minority of the cooked foods, probable plant residues continue to dominate. These indications, relied upon throughout this report, point to a very high dietary importance of plants in the diets of the prehistoric hunter-gatherers (or, more accurately, gatherer-hunters) who occupied the site. Unless these results are regionally anomalous—and there is no apparent reason to assume they are—the fats and carbohydrates provided by plant foods probably comprised the bulk of the general caloric intake for Archaic and Late Prehistoric peoples of Central Texas. Such a conclusion makes sense, insofar as a diet involving more than around 40 percent calories in the form of protein would be biochemically detrimental to human health and would not be

sustainable for extended lengths of time (Noli and Avery 1988; Speth 1983).

At present, however, it must be recognized that the interpretations of the residues are inherently rather ambiguous. At best, as a review of Appendix G shows, even the most basic distinctions between the residues of plant vs. animals can only be stated as “likely” or “probable”. Moreover, when taxa identifications are made, based on identified isotopic values such as “elevated C18:0”, it is concluded that the resources represented could be large herbivores, javelina, *or* sotol seeds. In other cases, very high fat content is interpreted to represent seeds *or* animal fat, while moderate fat content could represent either beaver *or* Texas ebony, and moderate fat content could indicate mesquite beans, corn, *or* fish. Since, in all these instances, various animals or plants could be represented by a single sample, we are not left with a basis for very confident reconstruction of prehistoric subsistence patterns, much less “hard” data upon which to model systemically inter-related human-behavioral patterns resource extraction, settlement and residential mobility.

For these reasons, we believe that a good deal of refinement and improvement of residue analysis/interpretation is needed before additional extensive work, such as we have carried out in the present project, is included in research designs for future archaeological projects. The problem here is not a strictly archeological one—no amount of archeological rigor or procedural exactitude will resolve the issue. Rather, the problem is one of *chemical taphonomy*. What is required is a more reliable understanding of the correspondences between the chemistry of modern species and the chemical signatures of plant and animal residues after long periods of degradation in archaeological contexts. If and when this is accomplished, further studies of this nature can

be expected to yield data in which greater interpretive confidence can be placed.

19.2.8 Stable Carbon and Nitrogen Isotope Analyses

Stable carbon and nitrogen isotope analyses were conducted on 158 samples to assess the relative proportion of C₃ or C₄/CAM photosynthetic pathways of the plant residues, or animals that ate these plants, and were cooked by these artifacts. The isotope results were combined with the lipid residue results to aid in the interpretations of the resources processed. The selected samples included the interiors of 87 burned limestone rocks, six Varga Toyah ceramic sherds, five ceramic sherds from Mission San Lorenzo, two ceramic sherds from Mission San Juan, 20 sediment samples from one column and five other dated sediments from trenches, and 33 modern plant samples to facilitate the interpretations. The isotope results from the cultural artifacts reflect an extensive use of C₃ plants and/or animals that ate C₃ plants. Only about two percent of the isotope results from the cultural artifacts indicate possible mixtures of C₃ and C₄/CAM plant use with no direct indication that C₄ foods (lechuguilla, buffalo meat, corn, etc.) were cooked. The background sediment also reflects complete dominance of C₃ vegetation through time, with no obvious surge in C₄ vegetation to signal the presence of a warm and/or dry period during these 6,300-years of prehistory.

The most useful outcome of this line of work relates to interpretation of broad patterns of environmental change or stability. As just stated, our findings support the notion that there were no dramatic changes in climate or floral community composition during the last six-plus millennia (seven-plus, in calibrated terms). The stable isotope analyses are less informative concerning the more specific concern of the kinds of resources that were processed by

prehistoric people, since evidence for a dominance of C_3 plants can also be interpreted to represent human procurement/processing of animals that ate C_3 plants; obviously the stable carbon data do not contribute toward a better understanding of the relative dietary importance of plants versus animals. At the same time, they do indicate general environmental conditions, and future use of this approach in identifying broad environmental trends should prove useful.

19.2.9 Macrobotanical Analysis

Macrobotanical remains from 44 flotation samples (573 liters) extracted from 18 cultural features and 75 individual pieces from across the excavations were analyzed. Preservation was very good, with 20 taxa identified. Edible plant parts were represented by Agavaceae leaf and caudex (i.e., heart) fragments, prickly pear seeds, mesquite seeds, cheno-am seeds (achenes), and nut fragments, both littleleaf walnut and a thin nutshell, probably pecan. Wood types include mesquite, woody legume, hickory family (e.g., pecan), buttonbush, cottonwood/willow, juniper, sycamore, Mexican buckeye, pinyon, agarita, oak, buckthorn, elm, and lotebush. Cottonwood/willow wood, littleleaf walnut, sycamore, Mexican buckeye, oak, buttonbush, elm, and pecan are indicative

of a typical western Edwards Plateau canyon or riparian environment. Mesquite, juniper, pinyon, oak, and lotebush are indicative of upland vegetation communities. Prickly pear seeds, Agavaceae (yucca, sotol, or agave) leaf and caudex fragments, cheno-am seeds, littleleaf walnuts, possible pecan nut fragments, and mesquite seeds characterize desert food foraging activities in the western Edwards Plateau region.

These findings are informative and contribute directly to the empirical data base relevant to prehistoric patterns of resource use. Extraction of flotation samples and identification of macrobotanical taxa thereby recovered should be an ongoing requirement in archeological contexts where preservation is adequate for recovery of these kinds of materials.

19.2.10 Granulometry

Granulometry and chemical analyses were conducted on 10 sediment samples from the sediment column near the middle of Block A. The analyses were on the same samples that were used for the pollen, phytolith, and isotope analyses. These results contribute to the soil identifications and provide indications as to preservation problems and depositional characteristics.

20.0 MANAGEMENT CONSIDERATIONS AND RECOMMENDATIONS

J. Michael Quigg

The two part data recovery program and subsequent reporting here constitute the implementation of the Section 106 process of the National Historic Preservation Act (16U.S.C. 407f) pursuant to 35 CFR Part 800. Through this regulatory process, the archeological investigations and analyses of recovered cultural assemblages in that part of 41ED28 within the area of potential effect in the existing Ranch to Market Road right-of-way have contributed significant information towards understanding four prehistoric components and the prehistoric peoples that created those components in the canyonlands of the Edwards Plateau.

The archeological materials at the Varga Site, 41ED28 definitely continue beyond the existing Ranch to Market Road right-of-way to the east and west and possible to the north. If future plans call for widening the existing right-of-way in either direction, unassessed cultural deposits outside the current right-of-way will be encountered and potentially disturbed in construction activities. We recommend assessing proposed development areas beyond the existing right-of-way if any land disturbance activities are pending.

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22.0 GLOSSARY OF TECHNICAL TERMS

A Horizon: The near surface horizon of a natural soil. This is a carbon rich soil horizon characterized by an accumulation of partially decomposed to decomposed organic matter and eluvial loss of constituents such as clays and carbonates, which tend to accumulate in the deeper B horizon. The A horizon represents the upper solum of a soil. Lower case letters with the upper case A indicate specific characteristics of that A horizon. An Ab designation indicates the A horizon is buried. An Ap designation indicates a disturbed or anthropically modified soil such as in a plow zone.

Accelerated Mass Spectrometry (AMS): Laboratory technique that separates and identifies ions based on their mass to charge ratios. This technique is used in radiocarbon dating tiny particles of carbon in organic remains and residues.

Agavaceae: A plant family name that refers to fiber, vascular bundle, or the central stem fragment that could not be specifically identified as agave (*Agave*), yucca (*Yucca*) or sotol (*Dasyllirion*).

Allostratigraphic Unit: Depositional unit made up of sediments dating to a coeval period of deposition.

Alluvium: Clastic sediments deposited by a flowing stream, either in the channel or material deposited outside the channel during overbank flooding.

Anisotropic: The action of cross-polarization of light under a microscope as it passes through material. If the material causes any deviation in the transmission of light then the material will have illumination in the microscope in a pattern characteristic of the material and its properties.

Argillic Horizon: A soil horizon (Bt horizon) that exhibits significant enrichment in illuvial clay minerals or clay-sized particles. Such clays typically form grain coats, grain bridges, and ped-face coats of oriented clay that are visible in thin sections, and usually can be identified with a hand lens.

B Horizon: The lower solum of a natural soil. A B horizon is a mineral soil horizon characterized by an accumulation of constituents such as clays, carbonates or salts, or organic complexes that have been translocated from the A horizon. Common subordinates include lowercase letters such as *t*, which indicates accumulation of illuvial clays. The lowercase *k* indicates accumulation of carbonate. The lower case *w* indicates structural or color changes with no significant accumulations of alluvial material.

Bioclasts: These are tiny fossils particles within limestone that may belong to any invertebrate phylum. These were observed in the petrographic analysis of the pottery sherds.

Bioturbation: The churning and mixing of sediments by living organisms, including burrowing rodents, insects, worms, and plant roots.

Biplot: A biplot is a special type of graph following from principal component analysis on which both the samples and elements are displayed. Examination of biplot from the principal component analysis of ceramic specimens often lead to identification of the

analyzed elements responsible for differentiating groups of specimens from one another.

Bivariate Plot (Scatter Plot): A two-dimensional graph where the x-axis and y-axis symbolize a pair of measured or calculated variables. The points on a bivariate plot represent the position of individual samples. These graphs are used to recognize possible structure in a data set.

B.P.: An abbreviation for before present, which in radiocarbon dating is referenced to the standard year A.D. 1950.

Burned Rock Dump: A loose cluster of heated rocks that exhibits no horizontal patterning to the positions of the rocks and lacks indications of in situ heating/burning, such as a prepared basin, lenses of charcoal or ash, and/or the absence of an oxidation rim. Scattered charcoal or other cultural items may be present between or around the burned rocks.

C Horizon: Weathered, but relatively minimally altered parent material at the base of a soil profile. This term is roughly synonymous with subsoil, although the latter term is often used to encompass the lower B horizon.

Calcareous: Rocks, minerals, or sediment containing calcium carbonates.

Calcite: A common rock-forming mineral like calcium carbonate. It is the principal mineral in limestone.

CAM Plants: A photosynthetic pathway for assimilating carbon dioxide into plants that can change from C₃-like to C₄-like plants depending on the diurnal (day or night) cycle. Most succulents such as cactus are crassulacean acid metabolism (CAM) plants. The carbon isotope values of most CAM plants in Texas such as

Agave lechuguilla and *Opuntia engelmannii*, are similar to the values in C₄ plants (see Eickmeier and Bender 1976).

C₃ Plants: A photosynthetic pathway that most trees and flowering bushes use to assimilate carbon dioxide into their systems. The average carbon isotope of C₃ matter is -26.5‰ with a range from about -24.0‰ to -34.0‰.

C₄ Plants: A photosynthetic pathway used by most xeric (arid) grasses and corn to assimilate carbon dioxide into their systems. The average carbon isotope of C₄ matter is -12.5‰ with a range of -6‰ to -19‰. These plants are more resistant to water stress, but more susceptible to cold temperatures.

Carbonates: These are rock or mineral class including limestone, calcite, ooids, and bioclasts and used in the petrographic analysis of the pottery sherds. The calcite staining in the thin section preparation marked all these bodies with a carmine red color.

Cheno-am: An artificial term used in botanical classification that includes the family of Chenopodiaceae (goosefoot) and the genus *Amaranthus* (pigweed), which are indistinguishable from each other.

Clast: Any detrital particle (sediment) created by the weathering and disintegration of a larger rock mass and transported by, or subjected to physical transport by water, wind, or ice. Clast also includes discrete particulates created and deposited by volcanic action.

Computer Aided Drafting (CAD): A method for drafting maps, features, and stratigraphic sketches using computers.

Context: The association and position of artifacts, materials, and cultural features that are

used by archeologists to interpret space, time, and cultural.

Crinoid Fossils: These are known as sea lilies, invertebrates that lived on ocean floors. They usually have long jointed stems with spiny skin and topped by a platy flower-like body of tentacles. The stem has a central canal or tubular cavity. Fossil crinoids are found in the Pennsylvanian Formation that outcrops in Central Texas mineral belt and northward.

Criterion of Abundance: If a large group of the specimens in a ceramic assemblage is represented by a single, homogenous, compositional fingerprint and the actual source of clay is unknown, then the criterion of abundance suggests that there is a high probability the group was produced locally or very near the site where it is most heavily represented.

Cumulic Soil: A soil formed in a setting experiencing relatively slow deposition, so that freshly introduced sediment is incorporated into the A horizon, leading to overthickening of the surface horizon. Cumulic soils are common in alluvial overbank and colluvial settings.

Curie Temperature: The temperature at which the magnetic properties of a substance change from ferromagnetic to paramagnetic. Magnetite has a Curie point of 580 degrees Celsius (C).

Deposition: The accumulation of sediment or gravels laid down by natural agencies such as water deposited, or artificial agencies such as dumping.

Dose Rate: Is the rate at which the radiation or the amount of light has been delivered to the object. The dose rate is obtained by measuring the radioactivity of the sample and the surrounding soil.

Ecologically Diagnostic Xylem Analysis (EDXA): A method that measures the size and abundance of cells and other anatomical features, which are visible in a transverse section of wood and/or wood charcoal. The documentation of differences in mesquite wood charcoal from different occupation periods provides information about varying moisture and temperature conditions.

Eluvial: The movement of materials such as clay or organic matter from a soil horizon by percolating water.

Eocene Epoch: The period of time between 37 and 58 million years ago, and a subdivision of the Tertiary Period of the Cenozoic era.

Erosional Unconformity: A significant break or gap in the record, indicative of erosion of the older unit prior to renewed deposition.

Factor Analysis: This is concerned with determining whether the covariances or correlations between a set of observed variables p can be explained in terms of a minimum number of unobserved, latent variables.

Fatty Acids: The major constituents of fats and oils (lipids) that occur in nature in plants and animals. They are insolubility in water and relatively abundant compared to other classes of lipids. Fatty acids may be absorbed into porous archeological materials during cooking, including heated rocks and ceramics, or ground into manos, metates, or mortar holes.

Feldspar: A group of aluminum silicate minerals that are the most common of any mineral group, making up about 60 percent of the earth's crust.

Ferric Iron: This is an iron in the form commonly of specular hematite or magnetite and is less common in the region than ferrous iron. These particles were observed in the petrographic analysis of the pottery sherds.

Ferrous Iron: This is a common residual mineral in the form of hematite in the limestone of the Edwards Plateau. It is a red color. This was observed in the petrographic analysis of the pottery sherds.

Gas Chromatography (GC): This highly technical measuring instrument that separates and measures the amount of elemental components of a specific sample by the measurement of light passed through gas at regulated temperatures, which allows the detection of fatty acids at the nonogram (1×10^{-9} g) level.

Graticule: A device used in the microscope to measure the size of items under magnification.

HCL: Hydrochloric acid.

Holocene: Geological time period spanning roughly the last 10,000 years before present. The Holocene is roughly equivalent to the Post-glacial period, and often referred to as the “Recent” period in geology. Many investigations consider the Holocene to be an *interstadial* in the ongoing Pleistocene epoch.

Horizon: A discrete, relatively uniform layer in a soil profile that is typically subparallel with the surface and formed as the result of pedogenic process.

Humic: A dark, organic-rich material generally caused by the decay of organic material.

IFB: Invitation for bids.

Igneous: Rocks that are formed by the solidification of magma from volcanic activity.

Illuvial: Material in a soil profile that has moved downward into another soil horizon by water.

In Situ: Something, generally referring to an artifact, in its original position that was placed or deposited within the landscape.

Integrity: This refers to the degree on intactness of archeological deposits, components, features, or artifacts.

Instrumental Neutron Activation Analysis (INAA): This is a method of chemical analysis involving the exposure of unknown samples and standards to a neutron flux from a nuclear reactor without the use of chemical separation. The exposure to neutrons produces several short- and long-lived radioactive isotopes that emit characteristic gamma rays. The energy of the emitted gamma rays provides information to identify the constituent elements, while the intensity of the emitted radiation is proportional to the amount of the element present in the sample. Gamma-ray spectroscopy is performed at different times after irradiation to measure isotopes with different half-lives. The method is particularly sensitive to a large number of trace elements, minor, and major elements, including the rare-earth elements, transition metals and other.

Iron Stain: These resemble a blood-red smear or splash on the matrix when using a cross polarized light in viewing a petrographic slide of a pottery sherd. The stained zone had irregular rounded shapes and commonly there were discontinuous zones or strips of several rounded iron stain smears. The source of the iron stain in the ceramic fabric is problematic.

Isotope: One of two or more species of a chemical element, differentiated by the number of neutrons contained in the nucleus.

Isotropic: The behavior of cross-polarization of light as it passes through material, especially crystalline material. This means the same change on light passing through the material, without interruption and the material remains dark.

Kinematics: A friction-related feature of surface to surface contact observed under a microscope in the use-wear analyses of stone tools.

Knapping: A term used to describe the manufacturing of prehistoric chipped stone tools using different techniques, such as pressure and or percussion methods, to chip/flake a target mass of material to form a useful tool.

Krotovina: A discrete, anomalous area visible in plan or profile in a soil resulting from the infilling of a void (e.g. a burrow or root) with dissimilar sediment. Some investigators prefer to limit the term to animal burrows, preferring the term “root trace” for filling related to decayed roots. Some krotovina are obvious, whereas others are tiny and may only be identified in thin sections.

Legume: A plant that produces a bean or seedpod in various forms consisting of one cell and/or two valves. Common legume plants across Texas include; mesquite, Texas ebony, various acacia, retama, *Dalea* sp., mimosa, and rattlebush.

Lipids: These are hydrophobic constituents of living tissues including fatty acids, alcohols, triacylglycerols, sterols, bile acids, and waxes. Lipids are present in tissues of all living organisms in varying proportions. These are

insoluble in water, relatively easily extractable, and are readily amenable to separation and characterization.

Lycopodium Spores: These are marker grains used in the pollen analyses. Two tablets of $13,500 \pm 500$ spores were added to each sub-sample to permit calculation of pollen concentration values and provide an indicator for accidental destruction of pollen during the laboratory procedures.

M.A.S.C.A.: Museum of Applied Science Center for Archaeology, University Museum, University of Pennsylvania. One instrument that has studied tree-ring calibrations of radiocarbon dates.

Manuport: An object, usually some rock that was transported by humans to the place it was recovered, but its general appearance did not indicate it had been culturally altered to form a specific tool type.

Matrix: In geoarcheological usage, refers to the sediments in which the artifacts at an archeological site are encased.

Mesic Condition: A relatively moist interval generally used in the context of climatic conditions.

Molar Solutions: A Molar (M) is a solution that contains one mole of solute in each liter of solution. A mole is the molecular weight expressed as grams. Therefore, $1 \text{ M} = 1 \text{ g of molecular weight of solution per liter of solution}$.

Normal Solutions: A Normal (N) is a solution that contains one “gram equivalent weight” of solute per liter of solution. The gram equivalent weight is equal to the molecular weight expressed, as grams divided by the “valency” of

the solution is the molecular weight expressed as grams.

Ooids: These are tiny particles within the limey matrix of limestone. These were observed during the petrographic analysis using a high-powered microscope.

Overbank Deposits: The deposition of fine silts and clay particles that are left on terrace tops and banks when water in creeks exceeds the capacity of the channel and drops the suspended sediments load in the lower energy environment. Overbank depositional processes usually cause minimal movement to large objects on the terrace top.

Oxidation: A chemical process where oxygen is added to minerals or other compounds; weathering oxidizes minerals; burning wood and rusting metal are types of oxidation.

Paleosol: Generally refers to a buried soil that developed an A horizon and was subsequently buried.

Palimpsest: Archeologically, refers to the inability to distinguish and separate material remains from repeated occupations by a succession of cultural events of different ages due to their deposition over time on relatively stable surfaces. Some palimpsest assemblages are buried following a long period of exposure.

Pedogenesis: The dynamic process of soil formation and development, which typically leads to the formation of a darkened, organic-rich A-horizon at or near the surface, and the downward movement of fine clays and/or the formation of carbonate nodules in lower B horizons.

Phytoliths: Tiny microscopic silica particles that develop within the cells of most plants.

Dissolved silica is transported into growing plants through water and then deposited along cell walls as silica particles. Different kinds of plants and different parts of a plant develop phytoliths of various shapes. After the plants die, the silica bodies become part of the mineral component of soils left in the ground.

Pleistocene: The first epoch, which with the Holocene period constitutes the Quaternary period, spanning the time between roughly 2.0 or 1.65 million years ago and 10,000 years ago. Characterized by repeated continental glaciations, the Pleistocene witnessed the evolution of modern humans.

Polyunsaturated Fatty Acids: Pertaining to long-chain carbon compounds (e.g., C18:2) like fats with multiple double bonds. These fats are very unstable and degrade very rapidly over time.

Principal Component Analysis (PCA): This is a pattern recognition technique used for reducing the dimensionality of multivariate data similar to factor analysis. It uses all of the variables measured in a sample and calculates the variation among those variables.

Profile: A sequence of horizons that make up a soil, or a description or depiction of the horizons in cross section.

Provenience: The specific vertical and horizontal location where an object is found.

Provenance Postulate: This states that chemical analysis can successfully trace artifacts to their source if the differences in chemical composition between different natural sources that exceed, in some recognizable way, the differences observed within a given source.

Quaternary: The second period, which along with the Tertiary Period, make up the Cenozoic Era, encompassing the Pleistocene and Holocene epochs; roughly the last 2.0 or 1.65 million years.

Raphides: Needle-shaped crystals in a plant cell, typically of calcium oxalate. These are often found in plants of the Agavaceae family such as sotol, yucca, agave, and lechuguilla. They are not diagnostic of any particular plant. Bohrer (1987) and Kwiatkowski (1992) believe that only agave contain these crystals. In contrast, Dering (2003b) believes these occur in a variety of Agavaceae including sotol, yucca, agave, and beargrass.

Rhyolite: A very fine-grained, extrusive igneous rock, same composition as granite.

Root Etching: These are thin, shallow lines or pits that are etched into the surfaces of bones by acids associated with plant roots that grown against the bone.

Saturated Fatty Acids: Each carbon in the chain is connected to its neighboring carbon by a single bond, which makes them relatively stable. The most abundant saturated fatty acids have chain-lengths of either, 14, 16, or 18 carbons. Mammal fats primarily consist of saturated fatty acids and are solid at room temperature.

Silt: A particle size that has a range from 0.06 mm to 0.002 mm.

Siliceous: A silicon dioxide, the most common chemical constituent on earth, a dominant component of chert and quartz.

Site Structure: The spatial distribution of features, artifacts, and debris across a single occupation (or within a component) of an archeological site that is used to reconstruct

manufacturing, maintenance, processing, production, and disposal activities at specific loci, and the spatial ways prehistoric groups organized their space at a site.

Soluble Inorganic Residues: These are silica gel residues that build up with moisture availability and as use progresses to form discrete microplates. These are impervious to most acids and strong bases. These are quite common wear traces on the Varga Site artifacts and are valuable wear traces because of their long term stability, sensitivity to motion, and affects on the microgemometry of a tool edge. They exhibit flow characteristics of a viscous liquid and desiccation cracks as they harden.

Stable Isotope: An isotope not subjected to radioactive decay, such as carbon (C^{13}) or nitrogen (N^{15}) isotopes. This contrasts with radioactive isotopes.

Turbation: Disturbance to the natural matrix deposits generally caused by biological (burrowing rodents, insects, worms, and plant roots) and natural (soil creep, desiccation crack displacement, frost heaving, landslides, etc.) processes.

Unsaturated Fatty Acids: These types of fatty acids contain at least one carbon-carbon double bond or point of unsaturation. That point of unsaturation is susceptible to additional reactions. Unsaturated fatty acids are the primary constituents of plant and fish oils and tend to be in liquid-state at room temperature. Their chain-lengths vary with a minimum of 12 carbons but most common ones contain at least 18 carbons.

Use-wear: The high-powered microscopic evidence on a stone tool that was created from long-term use. The wear may appear as striations, tiny nicks, abrasive particles, polish,

rounding, soluble inorganic residues, etc. The present study used magnification between 100x and 500x to observe edge modification on selected artifacts.

Uvalde Gravel: A gravel deposit throughout much of south and east Texas attributed to the late Miocene to early Pleistocene. The deposits are composed of pebbles, cobbles, and boulders of vein quartz, quartzite, chert, jasper, silicified wood, and limestone. The ultimate source of the lithology indicates the Llano Uplift likely the Ogallala Formation (see Byrd 1971 for more details).

Variance-covariance Matrix: This is the matrix of covariances between all pairs of measured variables in a study.

Voids: These are gaps, holes, pores, or space observed in the pottery matrix when viewed

under a microscope during petrographic analysis. This is often used as an indirect measure of vessel porosity.

Vulnerability Index: A calculated by dividing the mean vessel diameter by the mean vessel density for wood sample. A higher vulnerability index results from the presence of fewer, but larger vessels in the wood, reflecting a condition indicating a wetter climate. A lower vulnerability index is a result of numerous but smaller vessels in the wood, a condition encouraged by low rainfall conditions.

Xeric Condition: A dry or relatively arid condition often in reference to discussing climatic conditions.

Xylem Analysis: The study of the shape, size, and arrangement cells in wood.

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APPENDIX A:

QUANTITATIVE APPROACHES TO ANALYZING PROJECTILE POINT VARIABILITY AT THE VARGA SITE

Jeffrey D. Owens and
Eric R. Oksanen

A.1 INTRODUCTION

The purpose of this study was to use statistical methods for an exploratory examination of a projectile point assemblage from one site. From a system of measurements collected from the assemblage, an attempt was made to create statistical groupings and examine whether these groupings correspond to the traditional named projectile point types. The advantage of using a statistical method for examining assemblages for affiliations is that it analyzes large amounts of data quickly using computer software. There is also the assumption that statistical typologies are less prone to subjective measurements and the inherent biases and experience of a typologist. Ideally, numerical coding of projectile points would be reproducible and eliminate intra-analyst discrepancies. The main difficulty in creating automatic typologies is knowing which particular traits to measure and analyze and interpreting the outcome (Adam and Adams 1991; Aldenderfer 1998; Doran and Hodson 1976; Shennan 1988, Spaulding 1953). Traits may be derived from or constrained by cultural practices and traditions, the expertise of the maker, functionality, style, and raw material characteristics and availability for example. A valid typology should create groupings that have relevance and meaning that exists beyond the analytical classification (Banning 2000). Classification is the ordering of phenomena within a particular domain. Artifact classification asserts that the domain is structured from a material and morphological basis that also embodies ideational properties pertaining to culture, and that the classifications contain information about cultural systems (Read 1989).

A.2 THEORETICAL BACKGROUND

The organization of archeological materials arose out of the antiquarians in the early nineteenth century. The classification of materials based upon use, material and form

correlated to temporal periods was first published by C. J. Thomsen in 1836. Thomsen's organization of the Three Age System of Stone, Bronze and Iron Ages was to establish typological thinking, the application of ethnographic analogy, and the application of a progressional history to chronological ordering (Rodden 1981). Thomsen's division into three major categories was not arbitrary. Thomsen had extensive knowledge of the archeological context from which to base his structure and accompanied the three divisions with detailed accounts of associated artifacts, placing more emphasis on the systematic recording of material context (Gräslund 1981). Although Thomsen's system did not address technological, economic, or artistic developments, it was used on artifacts to illustrate chronology. His system of classification was the first detailed, scholarly, chronological archeological history (Gräslund 1981).

In "The Typological Concept," Alex Krieger intended to rescue the use of archeological typologies from the abuse of over-use and poorly expressed definitions (Krieger 1944). The creation of typologies should, as their basis, address human behavior. If the typologies cannot interpret or reconstruct human behavior, assumptions based upon the typologies are probably incorrect and fictitious. Groupings of artifacts had been used to create "culture complexes" and demonstrate "culture change," geographically and temporally. These groupings were referred to as "types," the medium for comparisons and analysis in archeology. Krieger's intent was to standardize the creation of typologies and the naming of types.

Krieger's type should represent a cultural practice, much as the ethnologist defines a "culture trait." Like the culture trait, an archeological type should convey a recognized pattern of behavior that is transmitted between individuals, and through the study of styles, a genetic path similar to a phylogenetic tree can be

followed to the origin of the particular style, or in the case of a culture trait, the origin of the practice. The archeological type is an organizational tool used for creating groups of materials that have a recognizable historical context and illustrate a particular behavior.

In North America, the search for *types* specifically using quantitative methods was proposed by Albert Spaulding in a 1953, *American Antiquity* article, “Statistical Techniques for the Discovery of Artifact Types.” Spaulding agreed with the basis of Krieger’s definition of type, but disagreed with the technique of how to determine a type. Krieger’s method emphasized site-to-site comparisons of assemblages and components to evaluate the full range of type attributes, while Spaulding claimed he only needed sufficient material from a single site and component to use his technique. Using chi-squared contingency tables, Spaulding demonstrated that with certain criteria, he could define and detect types (Spaulding 1953:305). James Ford, writing shortly after Spaulding (Ford and Steward 1954), agreed with the portions of the concept of type used by both Krieger and Spaulding that it must be restricted temporally and geographically; however, Ford doubted that they were true cultural designations, and doubted that types were analogous to biological organisms waiting to be discovered through new methodologies. Types were inherently the product of the typologist, *abstracted by the observer at a point in time*. Morphological types were those with measurements clustered around the mean values that exist at a particular place and moment in time. Steward, in the second portion of Ford’s essay, raised a question still central to typologies: “How different is different?” Anthropological data is conceived qualitatively, yet is recorded and measured both qualitatively and quantitatively, and discrepancy and arguments arise because of the mixing of qualitative and quantitative traits.

The essential issues between Krieger, Spaulding, and Ford continue to today. The *New Archeology* of the 1960’s introduced supposedly scientifically rigorous methods including the increased use of multivariate statistics to analyze assemblages, as was done by Louis and Sally Binford for the Middle Paleolithic. Binford and Binford (1966:205) critiqued traditional systems of taxonomy for masking behavioral and cultural indicators because they were agglomerative methods that combined traits according to variables that otherwise could be discrete phenomena using other taxonomies.

A recent Master’s thesis by Anne Kerr (2000) examined unfluted lanceolate projectile points primarily from Texas. Kerr (2000) used cluster analysis, analysis of variance, visual observation, and chronological context to identify “discrete morphological patterns with chronological integrity” for Thrall, St. Mary’s Hall, and Plainview points. Morphological traits and technological attributes distinguished Angostura, Lubbock, and Golondrina-Barber, and Dalton points (Kerr 2000). Many of these types had been poorly defined as to morphology, location, and chronology. Previously, Plainview had incorporated Golondrina and St. Mary’s Hall points, which are now thought of as distinct from one another. Such analyses demonstrate the utility of computer-based investigations of assemblages to detect variability and refine or define culturally significant types. The underlying premise is that types exist independent of the analyst, are constrained and defined by measurable morphological variables, are confined temporally and geographically, and therefore, represent a cultural design template.

There is a difference in comparing assemblages from a single site or component and across components and sites (Cowgill 1990). Cowgill (1990) defines an assemblage as a discrete collection of objects used by a community during a period of little sociocultural change. He uses the terms Internal Cohesion (IC) to

show the relationship between chosen variables within an assemblage and External Isolation (EI), how the assemblage compares with similar assemblages examined for the same attributes. The examination of variability within a single assemblage is frequently overlooked. Within a discrete assemblage, artifacts have been created in a relatively short period of time, and the makers of the artifacts are aware of the variations in the produced products. Certain variations in properties are unimportant, while others are significant: if one goal is to maintain standards, there must be mechanisms to ensure the replication of the object and reject or discourage the production of objects that deviate from shared standards (Cowgill 1990:68). The maintaining of standards can be expected to differ geographically and temporally and some sort of “drift” should be expected. The more separation between artisans, the less comparison or agreement to a particular set of standards would occur. Cowgill (1990:69) defines a type as having *internal cohesion and external isolation*. Types are groups of objects defined by a set of characteristics or classes that are more similar to each other than to objects in other groups. Groups of objects may be formed that differ from each other by a single variable, such as color, to numerous variables. The selection of appropriate variables can create different groupings and be significant within, and particular to, an individual assemblage.

Statistical analysis, particularly cluster analysis and principal component analysis, of artifact assemblages has become a goal in itself, as the defining characteristics of artifact groups are quantitative measurements that provide an illusion of objectivity (Dunnell 1986; Read 1989). The purpose of the current analysis was an attempt to detect and define Cowgill’s *internal cohesion* within the types and *external isolation* between them.

A.3 ANALYTICAL STRATEGIES

A.3.1 Typological Analysis

The projectile points, dart types and arrow points, were placed within the standard Texas point typological names as defined in Turner and Hester (1993) and by Elton Prewitt (Table A-1). Prewitt’s analysis uses metric attributes or continuous scale measurements from some traits, and nominal and ordinal measurements for additional traits such as base shape, flake orientation, and presence of grinding. These types are assumed to be cultural types, as intended by Suhm and Jelks (1962) in the Handbook of Texas Archeology: Type Descriptions, in that they represent a *cultural entity* with both geographical and temporal continuity (Suhm and Jelks 1962). It is worth noting that 69 of the 215 dart points and 147 of the 226 arrow points were untyped because of physical condition and/or they were not within the recognized criteria or atypical for any of the known types.

The assemblage of 441 projectile points included in this study does not include two missing specimens (#117-019 and #193-010), nor one specimen (#578-015) that was submitted for instrumental neutron activation analysis (INAA), which was a small fragment of an unknown dart. The two missing specimens were misplaced after being cataloged and were not available for typological or quantitative analyses. No information about these two specimens is available, and it not known whether they are dart or arrow points. The single specimen that was submitted for INAA before being measured is a fragment of an unclassified dart point. As this item will be destroyed as the result of INAA, no additional information about this implement will be forthcoming.

Table A-1. Summary of Projectile Point Types

Dart Point Types	No.	Dart Point Types (cont.)	No.
Baker	12	Pandale	1
Bandy	21	Taylor	1
Bell	1	Unclassified Dart Points	69
Carrizo	3	Subtotal Dart Points	215
Castroville	1	Arrow Point Types	No.
Early Triangular	8	Bonham	6
Edgewood	1	Cliffton	12
Ensor	1	Cuney	1
Frio	7	Edwards	1
Gower	32	Guerrero	2
Group 1	15	Harrell	1
Group 2	7	Padre	1
Marcos	1	Perdiz	53
Martindale	22	Scallorn	2
Merrell	11	Unclassified Arrow Points	147
Montell	1	Subtotal Arrow Points	226
Total Projectile Points			441

In addition, four of the points included in this analysis represent refitted complete specimens composed of two fragments each. During laboratory processing, each fragment was given separate catalog numbers; however, for the purposes of this analysis, the points are treated as single implements. As the stem represents the portion of the tool that yields the most information pertinent to this study, each of the four refitted points are referred to using the catalog number of the basal fragment. Thus, #650-016 and #213-012 (a Carrizo point) are referred to collectively as #650-016, #282-017 and #159-023 (a Bonham point) are discussed as #282-017, #525-005-013 and #526-011 (a Frio point) are treated as #525-005-013, and #523-025 and #463-021 (a Merrell point) are referenced as #523-025.

A.3.2 Data Recording Techniques

TRC laboratory personnel in preparation for analysis of the projectile point assemblage recorded a total of 36 observations, 18 are metric and 18 are non-metric measurements. The metric measurements represent continuous (i.e., scale) ranges of variability, whereas the non-metric measures represent nominal, ordinal, or interval-scale variability. While it is possible to include both continuous and interval-scale variables in many statistical routines, the hierarchical agglomerative technique used in this study employed Ward's method to measure the distances between each specimen and the mean (or center) of the cluster to which each belongs. Ward's method will be discussed in more detail below, but it is worth noting in the present context that this method is designed for use with variables that have a continuous range of variability (Shennan 1988:217). In the interest

of using the most directly comparable variables in this study, only the 18 metric variables were included in the statistical analyses.

Each of these 18 metric variables is discussed in detail below. Figure A-1 shows the locations on representative contracting-and expanding-stemmed points where each measurement was taken. All linear measurements were recorded using Mitutoyo™ digital calipers and recorded to the nearest 0.1 millimeter. Angle measurements were recorded using Ward's contact goniometer to the nearest whole degree. Weight was recorded using a digital scale and recorded to the nearest 0.1 gram. TRC laboratory personnel collected all metric measurements and recorded them on paper data entry forms, and the senior author performed a quality assurance (QA) review of all measurements before they were entered into the electronic, Microsoft Access database. The QA review consisted of visually comparing each specimen with the set of recorded measurements and spot-checking some of the metric measurements randomly. While many of the measurements could be taken directly on the specimen, it was necessary to photocopy many of the specimens so that baselines involved in numerous measurements could be drawn. As the paper copies also provided an opportunity to double-check the measurements during the QA review, paper copy versions of all specimens were maintained showing exactly where the various measurements were recorded. Derivative (e.g., ratio) linear variables were calculated to two decimal places.

General Characteristics

Maximum Length—*Maximum Length* refers to the total length of the specimen from the distal tip to the furthest extent of the stem or base. This metric measurement is designed to measure the total length of complete implements; therefore, it was recorded only for specimens that were relatively complete along their

longitudinal axis. If small portions of the distal tip were missing, this measurement was recorded only if the original outline could be reasonably estimated without stretching the imagination. Also, no attempt was made to discriminate between distal resharpening versus original manufacture in collecting this measurement. As long as the point was relatively complete, it was assumed to have been a potentially viable, functional object and the measurement was recorded.

Maximum Thickness—*Maximum Thickness* represents the thickness at the thickest point of the specimen, whether that occurs at the mid-point of the blade, the blade/stem interface, or the stem. This metric measurement provides a general measure of tool thickness. More importantly, it figures into the calculation of the *Width to Thickness Ratio*, which provides an overall measure of the lithic reduction strategies brought to bear during projectile point manufacture. On point fragments, it was generally necessary for at least a short segment of the medial ridge to be present for laboratory analysts to assess whether or not the thickest part of the point was present; nevertheless, it was possible to record this measurement on most of the specimens in the assemblage.

Weight—*Weight* refers to the total weight of the specimen. This metric measurement was designed to provide a measure of the weight of complete artifacts; consequently, this measure was recorded only for relatively complete specimens. This condition, that specimens be relatively complete, was applied rigorously in the interest of providing a measure of the aerodynamic and penetration capacities of complete points rather than a measure of broken artifact fragments.

Figure A-1. Locations of Metric Measurements on Projectile Points

Blade Characteristics

Maximum Blade Length—*Maximum Blade Length* represents the total longitudinal distance of the blade from the distal tip to the blade/stem interface. This measurement was designed to measure the total length of complete blades; therefore, it was recorded only for specimens that had relatively complete blades (longitudinally). If small portions of the distal tip were missing, this measurement was recorded only if a reasonable extrapolation of the original outline could be made. Also, no attempt was made to discriminate between distal resharpening versus original manufacture in collecting this measurement. Assuming that the specimen was relatively complete (longitudinally), *Maximum Blade Length* plus *Maximum Stem Length* should equal *Maximum Length*.

Maximum Blade Width—*Maximum Blade Width* refers to the maximum width of the blade at the appropriate point. This may be at the mid-blade, distal tip, or just above the shoulders (i.e., this measurement was never taken at the shoulder or barbs). This measurement was designed to provide a measure of blade width as distinct from the width of the blade/stem interface (i.e., shoulders or barbs), and it was anticipated that it may yield information about the extent of lateral blade resharpening. Thus, it was necessary for the blade to be relatively complete (transversely) for laboratory personnel to be sure that the widest point of the blade was represented. In the numerical classification analysis, however, it became clear that the variety of locations along the blade at this measurement was taken failed to provide a systematic measure of artifact width. Consequently, the *Maximum Width* variable was ultimately created, taking the greater value of either *Maximum Blade Width* or *Maximum Barb/Shoulder Width* to provide an overall measure of implement width.

Barb and Shoulder Characteristics

Maximum Barb/Shoulder Width—*Maximum Barb/Shoulder Width* represents the maximum width of the specimen across the shoulder or barb area; thus, it was taken at the shoulder or the widest extent of the barbs, which may occur at or near the shoulders or near the proximal end of the point. This measurement required that the barb/shoulder area of the specimen be relatively complete. As this portion of most projectile points is rather fragile, shoulder “ears” and barbs tend to exhibit a high rate of breakage; consequently, it was possible to record this measurement on only a limited proportion of the assemblage. Like the *Maximum Blade Width* measure, the *Maximum Width* variable was ultimately used as a replacement for this measure. The *Maximum Width* variable used the greater value of either *Maximum Blade Width* or *Maximum Barb/Shoulder Width* to provide an overall measure of implement width.

Notch Characteristics

Notch Depth (Left and Right)—This paired set of observations encodes the length (i.e., depth) of proximal/lateral notches (i.e., corner and side notches) on one or both edges of the point, as appropriate. The measurement was taken along the centerline between the distal end of the notch to a baseline drawn between the tip of the shoulder or barb to the nearest end of the base. The prerequisite for taking this measurement was that the adjacent portions of the barb or shoulder and the base must be present (so that the baseline could be drawn). If both edges of the point were intact, this measurement was collected for both notches; however, it was also collected if only one of the notches was complete. The same left-right orientation was used when recording all measurements related to the notches (i.e., *Notch Depth [Left]* was recorded on the same notch as *Notch Width [Left]* and *Notch Angle [Left]*). Later in the

analysis, derivative variables using the average of and the difference between the two notches' depths were used instead of the raw measurements.

Notch Width (Left and Right)—This paired set of observations represents the width of the proximal end of proximal/lateral notches (i.e., corner and side notches) on one or both edges of the point, as appropriate. The measurement was taken along a baseline drawn between the tip of the shoulder or barb to the nearest end of the base. Thus, this measurement required that the adjacent portions of the barb or shoulder and the base be present (so that the baseline could be drawn). If both edges of the point were intact, this measurement was collected for both notches; however, it was also recorded if only one of the notches was complete. The same left-right orientation was used when recording all measurements related to the notches (i.e., *Notch Width [Left]* was recorded on the same notch as *Notch Depth [Left]* and *Notch Angle [Left]*). Later in the analysis, derivative variables using the average of and the difference between the two notches' widths were used instead of the raw measurements.

Notch Angle (Left and Right)—This paired set of observations refers to the angle of the proximal/lateral notches (i.e., corner and side notches) in relation to an idealized 90° angle formed by a baseline drawn across the blade/stem interface and the orientation of the stem. To take this measurement, a baseline was first drawn across the blade/stem interface (usually, this baseline connected the distal extent of the side or corner notches). Next, a perpendicular line was dropped down from this baseline toward the base of the point. The intersection of these two lines was at the distal extent of the proximal/lateral notch. Using a standard protractor, the angle of the notch in relation to the baseline and its perpendicular was recorded. The angle was recorded in degrees between 0° and 90° moving outwards from the

perpendicular. Thus, a 0° angle would represent a perfectly longitudinal basally derived notch, whereas a 90° angle would represent a perfectly transverse side notch. Thus, this measurement required that the adjacent portions of the barb or shoulder and the base be present (so that the baseline could be drawn). If both edges of the point were intact, this measurement was collected for both notches; however, it was also recorded if only one of the notches was complete. The same left-right orientation was used when recording all measurements related to the notches (i.e., *Notch Angle [Left]* was recorded on the same notch as *Notch Width [Left]* and *Notch Depth [Left]*). Later in the analysis, derivative variables using the average of and the difference between the two notches' angles were used instead of the raw measurements.

Stem Characteristics

Maximum Stem Length—*Maximum Stem Length* refers to the maximum longitudinal length of the stem from the blade/stem interface to the base. On notched and barbed specimens, the blade/stem interface is the greatest extent of the notches toward the distal tip. On shouldered or contracting-stemmed specimens, the blade/stem interface is the point at which noticeable flare toward the shoulders or barbs begins. The baseline is the furthest proximal extent of the stem. This measurement was recorded only on those specimens that had longitudinally complete stems. It could still be recorded if portions of the stem were missing, but at least one complete longitudinal cross-section needed to be present. Assuming that the specimen was relatively complete (longitudinally), *Maximum Blade Length* plus *Maximum Stem Length* should equal *Maximum Length*.

Stem Distal Width (i.e., Neck Width)—*Stem Distal Width* represents the width of the stem at the blade/stem interface. On notched and barbed

specimens, this measurement was taken at the greatest extent of the proximal/lateral notches toward the distal tip. On shouldered or contracting-stemmed specimens, this measure was recorded at the point at which noticeable flare toward the shoulder or barb begins. On contracting-stemmed specimens, this measure is assumed to represent the approximate diameter of the hafting device into which the point was set. This measurement was taken only on those stems on which the distal end was complete.

Stem Proximal Width—*Stem Proximal Width* refers to the width of the proximal end of the stem. On expanding-stemmed specimens, this measurement was taken at the widest extent of the stem, which occurred either at mid-stem (on curved, bifurcate-stemmed styles) or along the base (on expanding-stemmed styles). On straight- or parallel-sided stems, this value was recorded at the base. On contracting-stemmed specimens, this measure was taken at the point at which a noticeable break initiates the (usually convex) base). On expanding-stemmed specimens, this measure is assumed to represent the approximate diameter of the hafting device into which the point was set. This measurement was taken only on those stems on which the proximal end was complete.

Stem Thickness—*Stem Thickness* represents the average thickness of the stem. This measurement was taken approximately half-way up the stem or at an appropriate, representative location. This measurement was generally reserved for relatively complete stems, but if two-thirds or more of the stem was represented, it was generally possible to take the measurement with some confidence that a representative cross-section was present.

Base Characteristics

Base Depth—*Base Depth* refers to the longitudinal distance from the baseline of the stem to the proximal or distal extent of any basal modification. On concave- or notched-base

specimens (usually expanding-stemmed forms), this measurement represents the distance from the baseline to the greatest extent of the basal notch or concavity (assigned a [+] value). On convex-based specimens (usually contracting-stemmed forms), this measurement is taken from the point at which noticeable flare towards the base occurs (coincides with the point at which the *Stem Proximal Width* measurement is taken on contracting-stemmed forms) to the base (assign a [-] value). On straight-based specimens (usually triangular forms), *Base Depth* is assigned a value of “0.” This measurement was recorded on for those specimens that possess a relatively complete basal stem element.

Base Notch Width—*Base Notch Width* refers to the width of the basal concavity or notch along the baseline of the stem. Clearly, this measurement could only be taken on specimens that exhibited an appropriate basal concavity (i.e., contracting-stemmed and straight-based forms were not included). This measurement was recorded only when the basal stem element was relatively complete.

Derivative Variables

Several derivative variables were calculated based on the primary variables described above, including averages and differences for the three paired sets of variables (*Notch Depth*, *Notch Width*, and *Notch Angle*) and six ratios.

Notch Depth Average—*Notch Depth Average* was calculated by finding the average of the two *Notch Depth* measurements (i.e., *Left* and *Right*). This variable could only be calculated when both notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the average could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch depth, the requirements of the calculation

resulted in a variable with a relatively minimal number of observations.

Notch Depth Difference—*Notch Depth Difference* was computed by taking the difference between the two *Notch Depth* measurements (i.e., *Left* and *Right*). This variable was designed to serve as a proxy measure of stem asymmetry, as initial observations of the point assemblage indicated that some specimens were strongly symmetrical while others were highly asymmetrical. This variable could only be calculated when both notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the difference could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch depth, the requirements of the calculation resulted in a variable with a relatively minimal number of observations.

Notch Width Average—*Notch Width Average* was calculated by finding the average of the two *Notch Width* measurements (i.e., *Left* and *Right*). This variable could only be calculated when both notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the average could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch width, the requirements of the calculation resulted in a variable with a relatively minimal number of observations.

Notch Width Difference—*Notch Width Difference* was computed by taking the difference between the two *Notch Width* measurements (i.e., *Left* and *Right*). This variable was designed to serve as another proxy measure of stem asymmetry, as initial observations of the point assemblage indicated that some specimens were strongly symmetrical while others were highly asymmetrical. This variable could only be calculated when both

notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the difference could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch width, the requirements of the calculation resulted in a variable with a relatively minimal number of observations.

Notch Angle Average—*Notch Angle Average* was calculated by finding the average of the two *Notch Angle* measurements (i.e., *Left* and *Right*). This variable could only be calculated when both notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the average could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch angle, the requirements of the calculation resulted in a variable with a relatively minimal number of observations.

Notch Angle Difference—*Notch Angle Difference* was computed by taking the difference between the two *Notch Angle* measurements (i.e., *Left* and *Right*). This variable was designed to serve as another proxy measure of stem asymmetry, as initial observations of the point assemblage indicated that some specimens were strongly symmetrical while others were highly asymmetrical. This variable could only be calculated when both notch measurements were recorded (i.e., on relatively complete specimens). If only one of the two notch measurements was available, the difference could not be computed. While this variable distilled two separate, redundant observations into a single measure of notch angle, the requirements of the calculation resulted in a variable with a relatively minimal number of observations.

Stem Length:Width Ratio—The *Stem Length:Width Ratio* represents the *Stem Length* divided by *Stem Average Width*. *Stem Average*

Width, in turn, is the average of *Stem Proximal Width* and *Stem Distal Width* (i.e., $[Stem\ Proximal\ Width + Stem\ Distal\ Width] / 2 = Stem\ Length:Width\ Ratio$). Values greater than 1.00 represent stems that are relatively longer than wide, while values less than 1 represent stems that are relatively wider than long. Computation of this ratio required that values for both *Stem Length* and *Stem Average Width* (which in turn required that values for both *Stem Proximal Width* and *Stem Distal Width*) be available.

Stem Distal:Proximal Width Ratio—The *Stem Distal:Proximal Width Ratio* (alternately known as the *Stem Shape Ratio*) provides another overall measure of stem shape that describes the relative expanding- versus contracting-stemmed form of the stem. This ratio was calculated by dividing *Stem Distal Width* by *Stem Proximal Width* (i.e., $Stem\ Distal\ Width / Stem\ Proximal\ Width$). Values less than about 0.90 represent expanding or curved-stemmed forms and values greater than about 1.10 represent contracting-stemmed forms. Values between about 0.90 and 1.10 (average 1.00) represent essentially straight-stemmed forms. Computation of this ratio required that values for both *Stem Distal Width* and *Stem Proximal Width* be available.

Thickness:Width Ratio—The *Thickness:Width Ratio* provides a measure of the overall thickness of bifaces relative to their width. This ratio was calculated by dividing *Maximum Thickness* by *Maximum Width* (*Maximum Width*, in turn, represents the greater value of either *Maximum Blade Width* or *Maximum Barb/Shoulder Width*). The lower this value, the wider the point is relative to its thickness; conversely, the higher this value, the thicker the point is relative to its width. In general, this ratio may broadly refer to the level of control that a flintknapper was able to exert during tool production (Callahan 1979), but it may also serve as an indication of the extent of lateral blade edge resharpening. In the former case, more “finely” manufactured points tend to

be relatively thin and wide, resulting in a lower-value *Thickness:Width Ratio*. “Poorly” manufactured points may be relatively thick and narrow and have a correspondingly higher-value for this variable. In the latter case, extensively resharpened points tend to grow progressively narrow and thicker relative to their original form, resulting in a higher-value *Thickness:Width Ratio*, while the opposite would be true of points that were not laterally resharpened. Computation of this ratio required that both *Maximum Thickness* and *Maximum Width* values be available.

Stem:Maximum Thickness Ratio—The *Stem:Maximum Thickness Ratio* was an experimental value calculated by dividing *Stem Thickness* by *Maximum Thickness*. Assuming that the longitudinal mid-point of all point stems (which represents the point at which the *Stem Thickness* measure was recorded) is thinner than the maximum thickness of the whole implement (usually mid-blade), the *Stem:Maximum Thickness Ratio* would yield a value between 0.00 and 1.00, with 0.00 representing a hypothetically paper-thin stem relative to the overall point thickness and 1.00 representing a stem of equal thickness to the overall point. Thus, values approaching 1.00 represent relatively thick-stemmed points, while lower values represent relatively thin-stemmed points. Computation of this ratio was possible only when both *Stem Thickness* and *Maximum Thickness* were available; consequently, it could only be calculated for relatively complete specimens.

Stem Thickness:Width Ratio—The *Stem Thickness:Width Ratio* was calculated by dividing *Stem Thickness* by *Stem Distal Width*. Originally, this ratio was intended to serve as a measure of stem thickness relative to overall stem width, and it probably would have been wiser to use the *Stem Average Width* instead of the *Stem Distal Width* as the divisor. However, whether due to a variable-selection error or to

the possibility that this ratio was calculated before the *Stem Average Width* variable was created, *Stem Distal Width* was selected as the divisor for the equation underlying the *Stem Thickness:Width Ratio*. As it stands, this ratio probably serves more directly as a measure of the robusticity of the blade/stem interface; as such, it may indicate the relative resistance of the stem element to breakage upon impact. The patterning of values for this ratio are the opposite of those in the *Thickness:Width Ratio* (discussed above). Larger values represent distal stem cross-sections that are thicker relative to their width (and presumably more resistant to breakage), whereas smaller values are thinner relative to their width (and presumably less resistant to breakage). Computation of this ratio was dependent upon the availability of both *Stem Distal Width* and *Stem Thickness* values.

Base Depth:Width Ratio—The *Base Depth:Width Ratio* was used to measure the relative shape of the basal concavity or convexity of the base of the stem. Thus, this ratio was calculated using slightly different, yet related, primary variables for darts and arrows. For dart points, the *Base Depth:Width Ratio* was calculated by dividing *Base Depth* (which would have a positive [+] value representing a basal notch or concavity) by *Base Notch Width*. For arrow points, however, *Base Notch Width* was not recorded as arrow points usually have contracting stems and convex bases; therefore, the *Base Depth:Width Ratio* was calculated by dividing *Base Depth* (which would have a negative [-] value for convex bases) by *Proximal Stem Width* (which represents the point on the stem below which there is noticeable basal contraction). Thus, while the variables used to calculate this ratio varied between dart and arrow points, the dimension of the stem measured by the divisor is comparable; in this context, a convex, contracting-stemmed base may be viewed as the inverse of a basal notch or concavity. Theoretically, the value of this ratio

could exceed 1.00 (for dart points) or -1.00 (for arrow points), but in practice it ranged between 1.00 and -1.00 because the width of the relevant stem element was always greater than the depth (or extent) of the basal notch (or convexity). Thus, as this value approached 0.00 (from either the positive or negative directions), the flatter the basal element was. As this value moved toward 1.00 or -1.00, the more pronounced the basal element was. Computation of this ratio required that values for both *Base Depth* and *Base Notch Width* (for darts) or *Proximal Stem Width* (for arrows) be available.

A.3.3 Numerical Classification

In essence, classification is concerned with identifying groups of similar objects within the set of objects under study (in this sense, the “objects” may be individual objects or attributes [Cowgill 1982; Doran and Hodson 1975; Hodson 1982; Shennan 1988:195; Spaulding 1977]). Classification is a process of simplification that allows generalizations to be made and used based on similarities both within and between groups. Such generalizations may be purely descriptive or serve as the basis for defining hypotheses that may be tested by other means. Broadly speaking, classification is concerned with defining groupings (or “clusters”) within a data set that are more similar to one another than they are to members of other groupings (Shennan 1988:195-196). In practice, real data rarely behave this well:

A preferable definition of an object-cluster type is a subset of an assemblage, each member of which is more similar to at least one other member of the same subset than to any member of the assemblage that is not in the same subset, and where at least most members of the subset are more similar to at least most other members of the same subset than to at least most members of the assemblage that are assigned (by the same criteria) to any other type...The definition...requires that no object should be more similar to some object assigned to

another type than to *any* other object assigned to the same type, but allows that *some* objects assigned to different types *may* be more similar to one another than each is to *some* of the objects in the types to which each is assigned (Cowgill 1982:32-33 [emphases in original]).

While the similarity to the traditional intuitive approach to classification in archeology may appear obvious, the most compelling reasons to employ numerical classification are to make classification decisions explicit, to make handling of large data sets easier, to make the grouping process more consistent (and replicable), and to reveal patterning not easily apparent in large, complex, data sets (Kerr and Dial 1998:450; Shennan 1988:195). Thus, the process is one of discovery or exploratory data analysis. It is intended to highlight relationships that exist among variables and cases that may subsequently be investigated through hypothesis formulation and testing.

Within numerical classification proper, distinctions may be drawn among the ways in which groups (or clusters) are formed. The two main categories involve *partitioning* versus *hierarchical* methods (Shennan 1988:197). *Partitioning* methods involve making a decision about the number of groups to be formed; individuals are then grouped together with those with which they are in some defined sense the most similar so that the requisite number of groups may be formed. *Hierarchical* methods may be further subdivided into *agglomerative* and *divisive* grouping techniques. *Divisive* methods start with all items in a single group, and then proceed to divide the groups up successively according to some criterion. *Agglomerative* methods start with all items under consideration as separate entities, then build up groups from these, starting by grouping the most similar items together, then grouping the groups thus formed at increasingly low levels of similarity until finally all the items are linked together in one large group, usually at a

very low level of similarity. In both types of hierarchical method, the relationships among the items and groups may be represented in the form of a *dendrogram*, a tree diagram that illustrates the branching and grouping of items and groups. This study employs a hierarchical agglomerative method for developing groupings of projectile points.

All cluster analysis methods use a matrix composed of measures of similarity (or distance) among the individual cases included in the analysis (Shennan 1988:198). Thus, measures of numerical classification are based not on the raw data encoded in the variables incorporated within the analysis, but rather on an *n*-by-*n* matrix of similarities or distances among the *n* objects under study. There are numerous similarity or distance coefficients that may be used to generate such a matrix (cf. Sneath and Sokal 1973; Wishart 1978). Some are appropriate for quantitative numeric data, while others are based on qualitative presence/absence data.

Ward's method is only one of the numerous hierarchical agglomerative techniques, though it has proved to be particularly useful in archeology for analyzing continuous metric data (Shennan 1988:217). The idea behind it is that satisfactory clusters should be as homogeneous as possible. One way to define homogeneity is in terms of the distance of the members of a cluster from the mean of that cluster. In Ward's method, this distance is measured by the *error sum of squares*, the total sum of squared deviations or distances of all points from the means of the clusters to which they belong. The method's goal is to join individuals and groups successively in such a way that, at each step of the fusion process, the error sum of squares is the minimum possible; in other words, the clusters remain as homogeneous as possible.

The most commonly used measure of similarity in numerical classification is the *Euclidean distance coefficient*. Basically, this coefficient

measures the straight-line distance between two points, measured in terms of a number of variables, using the Pythagorean Theorem (Pimentel and Smith 1985:117-123; Shennan 1988:198-199). However, the Euclidean distance coefficient is usually used with interval- or ratio-scale data, rather than with continuous numeric data. In addition, as Ward's method uses the error sum of squares, it requires that the coefficients in the matrix of similarity be based on the *squared Euclidean distance* among objects. Squared Euclidean distance is simply the square of the regular Euclidean distance coefficient.

Using this method, hierarchical groups were then built beginning with the most similar items, then adding less similar items successively until all items were linked in a single large group displayed as a dendrogram. Clusters and the specimens are along the vertical axis, while the horizontal axis shows the relative distance between clusters. The unit of measurement in Ward's Method is *error sum of squares* (ESS): the total sum of squared deviations or distances of all points from the means of the clusters to which they belong (Shennan 1988: 217). Measurements are then converted proportionally along a scale from 1 to 25. All statistical transformations and permutations in this study were accomplished using statistical package for the social sciences (SPSS) version 12.0 for Windows statistical software.

A.3.4 Process of Validation

To a greater or lesser extent, cluster analysis methods impose their own patterning on the data (Shennan 1988:228). Divisive methods, for example, impose a series of divisions upon a set of data regardless of whether the resulting groups represent genuine distinctions or arbitrary dissections. Agglomerative methods, such as the one used in this study, are somewhat less guilty of imposing such patterning, but hierarchical methods do force a vertical taxonomy of relationships upon a data set that

may or may not represent the actual relationships among the individual objects or attributes. As the resulting clusters may reflect real similarities or be somewhat arbitrary, it is necessary to apply some independent process of validation to evaluate the clusters (Shennan 1988:197-228-232).

One way of attempting to ensure the validity of clustering results on a particular data set is to analyze it by a variety of different methods. If they all result in similar patterns of strongly overlapping cluster membership, then the patterning is likely to be genuine. Alternately, if different methods do not provide the same results, it does not necessarily mean that there is not real patterning to be found, or that one of the methods is not representing it correctly. It may be that the cluster structure is successfully identified by one method based on one set of assumptions but not by another based on a different set (Shennan 1988:229-230).

The hierarchical agglomerative cluster analyses performed for this study were validated by employing discriminant function analysis, analysis of variance, and visual observation of clustered specimens with the assistance of descriptive statistics.

A.3.4.1 Discriminant Function Analysis

Discriminant function analysis was used as one validation method to check the results of the hierarchical agglomerative cluster analysis. This method presupposes the existence of a given number of known groups and is concerned with the allocation of individual items to those groups to which they most appropriately belong (Shennan 1988:196); as such, it may be used to refine the groups and to improve upon the initial cluster results.

Discriminant analysis is useful for building a predictive model of group membership based on observed characteristics of each case. The

procedure generates a discriminant function (or, for more than two groups, a set of discriminant functions) based on linear combinations of the predictor variables that provide the best discrimination among the groups. The functions are generated from a sample of cases for which group membership is known (i.e., the clusters formed through hierarchical agglomerative cluster analysis) and can then be applied to new cases with measurements for the predictor variables but unknown group membership. In the current study, group membership was determined by the clusters resulting from the cluster analysis, and the predictor variables included those metric variables included in the cluster analysis.

For each discriminant function analysis performed, variable entry and removal was controlled using the stepwise method (as opposed to the forced-entry method, which enters all independent variables that satisfy tolerance criteria simultaneously). Means and standard deviations were first calculated for every variable in each cluster, and two statistics—Wilks' lambda and the F statistic—were calculated to provide a measure of within-group variation. Wilks' lambda is a variable selection method for stepwise discriminant analysis that chooses variables for entry into the equation on the basis of how much they lower Wilks' lambda. The Wilks' lambda statistic is a measure based on the ratio of within-group variation to overall variation in the data, tested by means of a randomization procedure (Aldenderfer 1982; Shennan 1988:229). At each step, the variable that minimizes the overall Wilks' lambda is entered. The F statistic measures the relative influence of each variable on group membership and assesses whether or not each variable contributes in a significant manner to group formation. By comparing the resulting F statistics for each variable to the full table of F probabilities (p), it is possible to discern not only whether or not each variable influences the overall cluster membership in a

significant manner (and at which significance level), but also how strongly each variable influences cluster membership. In general, the higher the value of the F statistic, the more strongly it influences cluster formation. All statistical transformations and permutations in this study were accomplished using SPSS statistical software.

A.3.4.2 Analysis of Variance

Analyses of variance were performed on the results of the cluster analysis to further clarify the significance of the morphological variability arrayed by the cluster analysis. Analysis of variance (ANOVA) “partitions the total variation in a data set according to the sources of variation that are present” (Johnson and Bhattacharyya 1985:466). The one-way analysis of variance procedure produces a one-way analysis of variance for one or more quantitative dependent variables (i.e., metric variables) by a single-factor variable (i.e., cluster membership). Analysis of variance is used to test the hypothesis that several means are equal; thus, this technique is an extension of the two-sample t -test.

When comparing any number of means, the differences between means (or variation among groups) and inherent variation (or variation within groups) are the two sources of variation evaluated. The F ratio tests the significance of the difference between means and will be greater than the relevant F distribution point as determined by the appropriate degrees of freedom when there is a significant difference between means and distributions. All statistical transformations and permutations in this study were accomplished using SPSS statistical software.

A.3.4.3 Visual Examination and Descriptive Statistics

The results of cluster analyses, discriminant function analyses, and analyses of variance were

further checked by direct visual examination of the original artifacts or photographic facsimiles of those specimens that were sent out for specialized analyses (i.e., microscopic use-wear analysis, instrumental neutron activation analysis) and were not available for physical inspection. While visual inspection is an intuitive validation procedure, it allows for a subjective assessment of dimensions of variability that may be apparent to the eye but that were not encoded for systematic analyses. The human eye was aided in this effort by reference to descriptive statistics generated for each cluster, such as the sample mean, median, standard error of the mean, standard deviation, variance, kurtosis, and skewness. Examination of the original artifacts and descriptive statistics for each cluster helped to illustrate the key morphological characteristics of each cluster.

A.3.5 Dimensionalization of Data

Before any set of raw data can be used in pattern recognition studies, such as cluster analysis, the data must first be dimensionalized in such a way that they are appropriate for the analytical techniques to be employed. This section describes data manipulation, transformation, and elimination procedures applied to the projectile point data.

First, dart points and arrow points were segregated into two separate data sets. This seemed a natural division, and dart and arrow points have clear chronological and morphological differences in Central Texas that justified analyzing them separately. For example, the relative size differences between arrow and dart points alone would have skewed the results of any statistical analysis using a pooled data set including all points. This is the only primary partition that was applied to either data set. While the arrow points from the Varga Site appear to span a relatively limited range of cultural/chronological periods (ca. 1,250 to 200 B.P.), the dart point assemblage includes named types dating to the

Early, Middle, and Late Archaic periods—spanning some 4,800 years of time. The temptation to subdivide further the dart point data set based on cultural/chronological periods was resisted. Doing so would have resulted in a sizable Early Archaic assemblage that may have yielded statistically significant results by itself, but the Middle and Late Archaic groups would have been represented by only a handful of individual specimens each. Therefore, all dart points were analyzed as a single population despite their cultural, chronological, and stratigraphic differences.

It was necessary to perform a series of runs of the data through cluster analysis, discriminant function analysis, and analysis of variance, followed by visual examination of the clustered artifacts and inspection of descriptive statistics for each cluster to understand the behavior of the variables included in the analysis and to assess their ability to represent meaningful dimensions of variability. As will be discussed in more detail below, it was necessary to perform multiple runs of the dart point data before a satisfactory group of clusters was achieved. Unfortunately, the arrow point data required less manipulation and produced much less informative results.

Table A-2 summarizes the number of observations recorded for each variable among the dart and arrow point assemblages. All data dimensionalizing strategies and analyses were applied equally to both the dart and arrow point data sets. For purposes of discussion, each is discussed separately in this appendix.

A.4 RESULTS OF STATISTICAL ANALYSES

A.4.1 Dart Point Analyses

One goal of this study was to use the maximum possible number of specimens in the statistical analysis. The highly fragmented nature of the assemblage, however, imposed certain restrictions upon the selection of specimens and

Table A-2. Summary of Projectile Point Metric Observations

Variable	N		Variable	N	
	Dart	Arrow		Dart	Arrow
Maximum Length	51	38	Notch Angle Difference	81	64
Weight	75	75	Maximum Stem Length	118	74
Blade Length	48	52	Stem Distal Width (i.e., Neck Width)	119	115
Blade Width	112	116	Stem Proximal Width	107	79
Barb/Shoulder Width	86	67	Stem Average Width	95	75
Notch Depth (Left)	91	56	Stem Length:Width Ratio	92	71
Notch Depth (Right)	90	49	Stem Distal:Proximal Width Ratio	95	75
Notch Depth Average	26	41	Stem Thickness	130	92
Notch Depth Difference	69	41	Maximum Width	116	122
Notch Width (Left)	90	56	Maximum Thickness	138	170
Notch Width (Right)	89	49	Thickness:Width Ratio	111	114
Notch Width Average	26	41	Stem:Maximum Thickness Ratio	110	79
Notch Width Difference	67	41	Stem Thickness:Width Ratio	115	89
Notch Angle (Left)	100	84	Base Depth	146	76
Notch Angle (Right)	99	79	Base Notch Width	109	3
Notch Angle Average	34	64	Base Depth:Width Ratio	119	75

N refers to the number of observations recorded for each variable within the entire projectile point assemblage of 441 specimens. Measurements were recorded only when the relevant portion of the point was complete or relatively complete. Derivative variables include values only when primary variables used to calculate derivative variables contained sufficient data to perform calculations.

variables that could be included. Hierarchical clustering methods require that each case (i.e., each point) contribute a value in each variable included in the study (i.e., the methods have no tolerance for missing values). In other words, any point to be included needed to be sufficiently complete that a measurement could be taken and recorded for every variable used in the statistical analysis. Specimens that were relatively complete but lacked even a single measurement in a key variable had to be excluded from the analysis. Thus, part of the initial examination of data involved determining which variables had a sufficiently large number of values to contribute to statistically significant results.

First, several of the primary variables that were used to calculate derivative variables (i.e., averages, differences, and ratios) were excluded from the analysis. The use of both primary and derivative variables in the same analysis tends to over-represent the influence of certain dimensions of variability. For instance, six of the measures recorded on the points—*Notch Width (Left and Right)*, *Notch Depth (Left and Right)*, and *Notch Angle (Left and Right)*—represent paired observations made on opposite edges of the same specimen. Thus, whereas most variables recorded only a single value for each point, these six variables represented dual measurements that artificially doubled the size of the data set. It was therefore necessary to

calculate single variables for each of these pairs that represented a blending of the two. Thus, each pair of notching variables was replaced with two other variables that represented the average of the two and the difference between the two (e.g., *Notch Width Average*, *Notch Width Difference*). In all analyses, only the average and difference variables were used; the original width, depth, and angle measurements were removed from consideration early in the analytical process.

Second, after the paired variables were replaced by single variables, the number of values available in each of the remaining primary and derivative metric variables was summed. This resulted in the identification of numerous variables that simply did not have enough values in them to be included in the analysis. Use of all of 26 variables (excluding the paired notch observations) in a test run of the cluster analysis produced only 27 of the total 215 dart points (12.6 percent) with values recorded in all selected variables. Clearly, this was not a suitable population size to yield statistically significant results.

Therefore, all metric variables with less than 100 values in them were removed from the data set. This resulted in a smaller data spread composed of only 13 variables. These 13 variables were submitted to a test run of the cluster analysis algorithm; however, only 71 of the total 215 dart points (33 percent) were represented in the results. This still seemed to be too small a population to yield statistically valid results.

Next, a similar problem to that associated with the paired notch variables was observed with the *Barb/Shoulder Width* and *Blade Width* variables. These two variables represented measurements of a single dimension of variability (width) at either one or two different places on a single specimen. Because these two measurements were not necessarily recorded in the same places on every point, they needed to be standardized to

some degree. Thus, the larger of either the *Barb/Shoulder Width* or the *Blade Width* values was exported into the *Maximum Width* variable, providing a single variable that could be used to represent the width of the specimen. This also resulted in an overall increase in the number of observations, as *Maximum Width* ($n=116$) exceeded the maximum number of values in either the *Blade Width* ($n=112$) or *Barb/Shoulder Width* ($n=86$) variables. In all subsequent analyses, the *Maximum Width* variable was used instead of either *Barb/Shoulder Width* or *Blade Width*.

Finally, all unclassified dart points were removed from the data set. Only 2 of the total 69 unclassified dart points were showing up in the data spread, so it seemed a small sacrifice to remove the unclassified dart points in exchange for reducing the overall size of the population. A final test run of the 146 typed dart points with the reduced array of 12 variables resulted in the inclusion of 69 of the 146 specimens (47.3 percent). While still under half of the total assemblage of typed points, this represented the largest possible population based on the degree of tool fragmentation in the point assemblage.

The final suite of 12 variables included in the cluster analysis was composed of *Maximum Stem Length*, *Stem Distal Width*, *Stem Proximal Width*, *Stem Thickness*, *Maximum Width*, *Maximum Thickness*, *Thickness:Width Ratio*, *Stem:Maximum Thickness Ratio*, *Stem Thickness:Width Ratio*, *Base Depth*, *Base Notch Width*, and *Base Depth:Width Ratio*. Clearly, some of these variables are ratios calculated from other variables that were also included in the analysis. Thus, certain dimensions of point variability, such as thickness and width, may be overrepresented in the analytical results. However, as the results of the discriminant function analyses and analyses of variance presented below show, all but one of these variables (*Stem:Maximum Thickness Ratio*) meaningfully influence the formation of clusters.

Consequently, there seemed to be no reason to trim the variable array any further.

A.4.1.1 Cluster Analysis Results

The initial results of cluster analysis produced nine clusters with no outliers from the culled data set composed of 12 variables and 146 typed dart points (Figure A-2). The nine groups of dart points defined by the cluster analysis were used as the predefined groups in a discriminant function analysis. A variable entitled *Cluster* was added to the data set, each point was assigned the cluster number (1 to 9) into which it was placed during the cluster analysis, and the *Cluster* variable was used as the grouping variable for the discriminant function analysis. The probability of accurate assignment of specimens to clusters was assessed using stepwise discriminant function analysis. Means and standard deviations were calculated for each of the 12 variables in each cluster (Table A-3), and two statistics—Wilks' lambda and the *F* statistic—were calculated to provide a measure of within-group variation (Table A-4).

Based on the results of the discriminant function analysis, it is apparent that most of the included variable contribute significantly to the membership of clusters at the $p=.001$ significance level. Only two variables are exceptions to this rule. *Base Notch Width* is significant only at the $p=0.01$ level; the *F* ratio for this variable just barely exceeds the *F* distribution point at this significance level given the specified degrees of freedom ($F=2.82$). *Stem:Maximum Thickness Ratio*, however, does not contribute significantly to the membership of clusters identified during the cluster analysis. The *F* ratio fails to exceed the necessary *F* distribution point for the given degrees of freedom even at the $p=.05$ significance level ($F=2.10$). This indicates that, of these 12 variables, *Stem:Maximum Thickness Ratio* does not significantly influence the membership of the identified clusters at the $p=.001$

significance level. *Base Notch Width* does contribute significantly to group membership, but it only barely exceeds the necessary *F* distribution point ($F=2.82$) at the $p=.01$ significance level. One variable, *Stem:Maximum Thickness Ratio*, fails to exceed the necessary *F* distribution point given the appropriate degrees of freedom ($F=2.10$) at the $p=0.5$ significance level.

A.4.1.2 Analysis of Variance Results

By means of analysis of variance, the significance of the differences among the clusters was delineated according to group means and within-group variance from the mean. As Table A-5 shows, the analysis of variance results are identical to the results from the discriminant function analysis for the hierarchical agglomerative cluster analysis on the set of dart point data. Values of lambda which are near zero denote high discrimination between groups.

A.4.1.3 Final Clustering Results

Based on the results of discriminant function analysis and analysis of variance, it is apparent that one variable included in the initial run of the dart point data—*Stem:Maximum Thickness Ratio*—failed to contribute in a significant manner to the membership of the nine clusters defined in the initial cluster analysis results. To determine whether or not the inclusion of the *Stem:Maximum Thickness Ratio* introduced statistical noise into the original clustering algorithm, the dart point data was rerun without this variable in the data set. The remaining 11 variables were resubmitted to hierarchical agglomerative cluster analysis using the same procedures described for the initial run of the data (Figure A-3).

In contrast to the initial cluster analysis results, which included nine clusters of dart points, the second cluster analysis produced eight clusters of dart points (Table A-6). Therefore, it appears

that the inclusion of the *Stem:Maximum Thickness Ratio* had, in fact, introduced statistical noise into the data array. The eight clusters incorporate the ten named dart point types.

The clusters are based primarily on the general outline of the point types, particularly the base and stem attributes and the maximum width. This groups the clusters into two main groups; large triangular blade and expanding stemmed points, and narrower, smaller stemmed expanding base and straight stemmed points.

The revised cluster groupings were subjected to discriminant function analysis and analysis of variance to determine the validity of the cluster memberships. The second application of these analyses followed the same procedures as those described above for the initial cluster analysis results. Table A-7 presents means and within-group variance about the mean for each of the eight clusters defined during the second cluster analysis. As Tables A-8 and A-9 show, all but one of the 11 variables included in the final cluster analysis contribute significantly to the overall group membership at the $p=.001$ significance level based on the given degrees of freedom. The single exception to this rule is the *Stem Thickness:Width Ratio*, which is significant at the $p=.01$ level. Therefore, the discriminant function analysis and analysis of variance performed on the results of the second cluster analysis provide identical results supporting the significance of each variable in the definition of each of the eight dart point clusters.

A.4.2 Arrow Point Analyses

As was the case with the statistical analyses performed on the assemblage of dart points, the arrow point study sought to use the maximum possible number of specimens in the statistical analysis that contributed the most relevant information. Due to the high rate of tool breakage that characterized the collections from the Varga Site, however, it was necessary to use

highly selective criteria in choosing the arrow point specimens and variables that could be included in the study. Because of the small size and overall thinness of the arrow points, the rate of tool breakage was far higher than among the dart points; consequently, fewer specimens yielded a complete set of measurements that could be used in the analyses. More importantly, far fewer variables could be included, which ultimately makes the results of the analyses highly suspect and of limited interpretive value.

As previously discussed in connection with the dart points, hierarchical clustering methods require that each case (i.e., each point) contribute a value in each variable included in the study (i.e., the methods have no tolerance for missing values). In other words, any point to be included needed to be sufficiently complete that a measurement could be taken and recorded for every variable used in the statistical analysis. Specimens that were relatively complete but lacked even a single measurement in a key variable had to be excluded from the analysis. Thus, part of the initial examination of data involved determining which variables had a sufficiently large number of values to contribute to statistically significant results.

First, several of the primary variables that were used to calculate derivative variables (i.e., averages, differences, and ratios) were excluded from the analysis. The use of both primary and derivative variables in the same analysis tends to over-represent the influence of certain dimensions of variability. For instance, six of the measures recorded on the points—*Notch Width (Left and Right)*, *Notch Depth (Left and Right)*, and *Notch Angle (Left and Right)*—represent paired observations made on opposite edges of the same specimen.

Figure A-2. Hierarchical Cluster Analysis Dendrogram of Dart Points (Initial Results)

Based on a dissimilarity matrix composed of squared Euclidean distance values calculated using Ward's Method (SPSS 12.0 for Windows).

Table A-3. Group Statistics Comparing Dart Point Clusters 1 to 9 (Initial Results)

Cluster No.	Variable	Mean	Std. Deviation	Valid N (list wise)	
				Unweighted	Weighted
1	Stem Length	12.0231	1.91492	13	13.000
	Stem Dist Width	18.1308	1.27173	13	13.000
	Stem Prox Width	23.6615	1.21212	13	13.000
	Stem Thickness	4.9615	0.87516	13	13.000
	Maximum Width	30.4846	2.13848	13	13.000
	Max Thickness	6.8615	0.64490	13	13.000
	Thickness:Width Ratio	0.2256	0.02118	13	13.000
	Stem:Max Thick Ratio	0.7228	0.11007	13	13.000
	Stem Thick:Width Ratio	0.2747	0.05085	13	13.000
	Base Depth	2.8462	1.21629	13	13.000
	Base Notch Width	11.1615	2.39984	13	13.000
	Base Depth:Width Ratio	0.2633	0.11188	13	13.000
2	Stem Length	15.7200	1.18617	5	5.000
	Stem Dist Width	18.3600	1.24016	5	5.000
	Stem Prox Width	22.2200	1.92666	5	5.000
	Stem Thickness	4.6600	0.82946	5	5.000
	Maximum Width	34.1200	3.22909	5	5.000
	Max Thickness	7.8400	1.16748	5	5.000
	Thickness:Width Ratio	0.2317	0.04397	5	5.000
	Stem:Max Thick Ratio	0.5979	0.08836	5	5.000
	Stem Thick:Width Ratio	0.2554	0.05140	5	5.000
	Base Depth	3.7000	1.37659	5	5.000
	Base Notch Width	11.0000	2.02361	5	5.000
	Base Depth:Width Ratio	0.3271	0.09568	5	5.000
3	Stem Length	11.6667	1.15902	3	3.000
	Stem Dist Width	19.9000	0.70000	3	3.000
	Stem Prox Width	29.9333	0.60277	3	3.000
	Stem Thickness	4.8333	0.95044	3	3.000
	Maximum Width	30.9000	3.45977	3	3.000
	Max Thickness	8.9667	2.99388	3	3.000
	Thickness:Width Ratio	0.2925	0.09860	3	3.000
	Stem:Max Thick Ratio	0.5803	0.23407	3	3.000
	Stem Thick:Width Ratio	0.2440	0.05581	3	3.000
	Base Depth	3.5667	0.55076	3	3.000
	Base Notch Width	13.2667	4.96521	3	3.000
	Base Depth:Width Ratio	0.2835	0.06533	3	3.000
4	Stem Length	10.6500	0.12910	4	4.000
	Stem Dist Width	14.7500	1.50222	4	4.000
	Stem Prox Width	19.4750	1.18708	4	4.000
	Stem Thickness	4.7750	0.12583	4	4.000
	Maximum Width	35.0250	2.95790	4	4.000
	Max Thickness	6.9750	1.27115	4	4.000
	Thickness:Width Ratio	0.1998	0.03641	4	4.000
	Stem:Max Thick Ratio	0.7034	0.13795	4	4.000
	Stem Thick:Width Ratio	0.3266	0.03755	4	4.000
	Base Depth	2.1750	1.41274	4	4.000
	Base Notch Width	11.6750	2.79687	4	4.000
	Base Depth:Width Ratio	0.1896	0.10824	4	4.000
5	Stem Length	8.4167	1.11609	6	6.000
	Stem Dist Width	12.8333	1.14833	6	6.000
	Stem Prox Width	15.5167	1.17033	6	6.000
	Stem Thickness	3.3167	0.26394	6	6.000
	Maximum Width	36.5667	2.18693	6	6.000
	Max Thickness	4.5833	0.31252	6	6.000
	Thickness:Width Ratio	0.1255	0.00769	6	6.000
	Stem:Max Thick Ratio	0.7276	0.08706	6	6.000
	Stem Thick:Width Ratio	0.2611	0.03857	6	6.000
	Base Depth	1.4667	0.58878	6	6.000
	Base Notch Width	8.8000	2.88721	6	6.000
	Base Depth:Width Ratio	0.1734	0.06286	6	6.000

Table A-3. Group Statistics Comparing Dart Point Clusters 1 to 9 (Initial Results) (Continued)

Cluster No.	Variable	Mean	Std. Deviation	Valid N (list wise)	
				Unweighted	Weighted
5	Stem Length	8.4167	1.11609	6	6.000
	Stem Dist Width	12.8333	1.14833	6	6.000
	Stem Prox Width	15.5167	1.17033	6	6.000
	Stem Thickness	3.3167	0.26394	6	6.000
	Maximum Width	36.5667	2.18693	6	6.000
	Max Thickness	4.5833	0.31252	6	6.000
	Thickness:Width Ratio	0.1255	0.00769	6	6.000
	Stem:Max Thick Ratio	0.7276	0.08706	6	6.000
	Stem Thick:Width Ratio	0.2611	0.03857	6	6.000
	Base Depth	1.4667	0.58878	6	6.000
	Base Notch Width	8.8000	2.88721	6	6.000
	Base Depth:Width Ratio	0.1734	0.06286	6	6.000
6	Stem Length	12.3000	1.77726	16	16.000
	Stem Dist Width	13.8625	1.26221	16	16.000
	Stem Prox Width	17.2563	1.61161	16	16.000
	Stem Thickness	4.5938	0.88654	16	16.000
	Maximum Width	18.5375	2.50915	16	16.000
	Max Thickness	6.7438	0.92662	16	16.000
	Thickness:Width Ratio	0.3698	0.07013	16	16.000
	Stem:Max Thick Ratio	0.6912	0.15806	16	16.000
	Stem Thick:Width Ratio	0.3345	0.07295	16	16.000
	Base Depth	4.5688	1.08118	16	16.000
	Base Notch Width	8.8063	1.08595	16	16.000
	Base Depth:Width Ratio	0.5238	0.12605	16	16.000
7	Stem Length	7.4400	1.58524	5	5.000
	Stem Dist Width	13.5600	0.50299	5	5.000
	Stem Prox Width	16.3200	0.59749	5	5.000
	Stem Thickness	2.9600	0.65038	5	5.000
	Maximum Width	24.8800	3.09871	5	5.000
	Max Thickness	4.2800	0.57184	5	5.000
	Thickness:Width Ratio	0.1734	0.02702	5	5.000
	Stem:Max Thick Ratio	0.6912	0.11462	5	5.000
	Stem Thick:Width Ratio	0.2183	0.04803	5	5.000
	Base Depth	1.3000	0.46368	5	5.000
	Base Notch Width	8.9200	3.51383	5	5.000
	Base Depth:Width Ratio	0.1513	0.04300	5	5.000
8	Stem Length	10.9167	1.56258	6	6.000
	Stem Dist Width	15.7000	1.18322	6	6.000
	Stem Prox Width	21.9167	1.02258	6	6.000
	Stem Thickness	4.4500	0.56480	6	6.000
	Maximum Width	24.8333	0.71181	6	6.000
	Max Thickness	6.9500	1.11131	6	6.000
	Thickness:Width Ratio	0.2803	0.04739	6	6.000
	Stem:Max Thick Ratio	0.6578	0.14937	6	6.000
	Stem Thick:Width Ratio	0.2849	0.04316	6	6.000
	Base Depth	2.3333	0.52026	6	6.000
	Base Notch Width	10.2833	2.13581	6	6.000
	Base Depth:Width Ratio	0.2316	0.05007	6	6.000
9	Stem Length	14.0636	1.92368	11	11.000
	Stem Dist Width	14.8455	1.27622	11	11.000
	Stem Prox Width	19.8909	1.33974	11	11.000
	Stem Thickness	4.8545	0.91144	11	11.000
	Maximum Width	22.6000	1.85580	11	11.000
	Max Thickness	6.6273	0.56761	11	11.000
	Thickness:Width Ratio	0.2959	0.04162	11	11.000
	Stem:Max Thick Ratio	0.7341	0.12523	11	11.000
	Stem Thick:Width Ratio	0.3284	0.06072	11	11.000
	Base Depth	5.7818	0.89534	11	11.000
	Base Notch Width	8.5455	1.64886	11	11.000
	Base Depth:Width Ratio	0.6915	0.12655	11	11.000

Table A-4. Tests of Equality of Group Means for Dart Point Clusters 1 to 9 (Initial Results)

Variable	Wilks' Lambda	F	df1	df2	Sig.
Stem Length	0.347	14.137	8	60	0.000
Stem Dist Width	0.227	25.584	8	60	0.000
Stem Prox Width	0.115	57.455	8	60	0.000
Stem Thickness	0.597	5.060	8	60	0.000
Maximum Width	0.113	58.674	8	60	0.000
Max Thickness	0.422	10.253	8	60	0.000
Thickness:Width Ratio	0.266	20.667	8	60	0.000
Stem:Max Thick Ratio	0.893	0.895	8	60	0.526
Stem Thick:Width Ratio	0.663	3.809	8	60	0.001
Base Depth	0.297	17.767	8	60	0.000
Base Notch Width	0.716	2.970	8	60	0.007
Base Depth:Width Ratio	0.217	27.034	8	60	0.000

Table A-5. Analysis of Variance (ANOVA) Comparing Dart Point Clusters 1 to 9 (Initial Results)

Variable		Sum of Squares	df	Mean Square	F	Sig.
Stem Length	Between Groups	311.468	8	38.933	14.137	0.000
	Within Groups	165.242	60	2.754		
	Total	476.710	68			
Stem Dist Width	Between Groups	300.531	8	37.566	25.584	0.000
	Within Groups	88.100	60	1.468		
	Total	388.631	68			
Stem Prox Width	Between Groups	826.169	8	103.271	57.455	0.000
	Within Groups	107.846	60	1.797		
	Total	934.015	68			
Stem Thickness	Between Groups	25.322	8	3.165	5.060	0.000
	Within Groups	37.529	60	0.625		
	Total	62.851	68			
Maximum Width	Between Groups	2,663.829	8	332.979	58.674	0.000
	Within Groups	340.505	60	5.675		
	Total	3,004.333	68			
Max Thickness	Between Groups	78.321	8	9.790	10.253	0.000
	Within Groups	57.289	60	0.955		
	Total	135.611	68			
Thickness:Width Ratio	Between Groups	0.392	8	0.049	20.667	0.000
	Within Groups	0.142	60	0.002		
	Total	0.534	68			
Stem:Max Thick Ratio	Between Groups	0.129	8	0.016	0.895	0.526
	Within Groups	1.077	60	0.018		
	Total	1.205	68			
Stem Thick:Width Ratio	Between Groups	0.099	8	0.012	3.809	0.001
	Within Groups	0.195	60	0.003		
	Total	0.294	68			
Base Depth	Between Groups	145.511	8	18.189	17.767	0.000
	Within Groups	61.424	60	1.024		
	Total	206.935	68			
Base Notch Width	Between Groups	125.522	8	15.690	2.970	0.007
	Within Groups	317.018	60	5.284		
	Total	442.539	68			
Base Depth:Width Ratio	Between Groups	2.410	8	0.301	27.034	0.000
	Within Groups	0.669	60	0.011		
	Total	3.079	68			

Thus, whereas most variables recorded only a single value for each point, these six variables represented dual measurements that artificially doubled the size of the data set. It was, therefore, necessary to calculate single variables for each of these pairs that represented a blending of the two. Each pair of notching variables was replaced with two other variables that represented the average of the two and the difference between the two (e.g., *Notch Width Average*, *Notch Width Difference*). In all analyses, only the average and difference variables were used; the original width, depth, and angle measurements were removed from consideration early in the analytical process.

Also, a similar problem to that associated with the paired notch variables was observed with the *Barb/Shoulder Width* and *Blade Width* variables. These two variables represented measurements of a single dimension of variability (width) at either one or two different places on a single specimen. Because these two measurements were not necessarily recorded in the same places on every point, some degree of standardization was needed. The larger of either the *Barb/Shoulder Width* or the *Blade Width* values was exported into the *Maximum Width* variable, providing a single variable that could be used to represent the width of the specimen. This also resulted in an overall increase in the number of observations, as *Maximum Width* ($n=122$) exceeded the maximum number of values in either the *Blade Width* ($n=116$) or *Barb/Shoulder Width* ($n=67$) variables. In all subsequent analyses, the *Maximum Width* variable was used instead of either *Barb/Shoulder Width* or *Blade Width*.

Second, after the paired variables were replaced by single variables, the number of values available in each of the remaining primary and derivative metric variables was summed. This resulted in the identification of numerous variables that simply did not have enough values in them to be included in the analysis.

Exploratory data analysis, combined with the previous results of preliminary inspections of the behavior of the variables in the dart point data set, led to using the same exclusionary principles for the arrow point data. Therefore, all metric variables with less than 100 values in them were removed from the data set. This resulted in a smaller data spread composed of only three primary variables—*Stem Distal Width*, *Maximum Width*, *Maximum Thickness*, and one derivative variable *Thickness:Width Ratio*. Clearly, overall measures of artifact size, including width and thickness, represent the primary dimensions of variability represented by three of these four variables.

Finally, all unclassified points were removed from the data set. A final test run of the 79 typed arrow points with the reduced array of four variables resulted in the inclusion of 56 of the 79 specimens (70.9 percent). While this sample population included almost three-quarters of the assemblage of typed arrow points, the use of only four variables, three of which provided measures only of overall artifact dimensions, promised to yield only marginal analytical results.

A.4.2.1 Cluster Analysis Results

The cluster analysis created eight clusters, with Clusters 7 and 8 being composed of single points (Figure A-4). Specimen #0918-010 is a Clifton point with a *Stem Distal Width* of 14.2 mm that is significantly larger than any other specimen. Specimen #0914-011 is also a Clifton point, with an above average *Stem Distal Width* of 12.0 mm, and is unusually thick at 17.4 mm, more than four times as thick as any other specimen. Both of these specimens can be considered atypical Clifton points when compared with the rest of the assemblage and the other Clifton points. Clusters 7 and 8 are not illustrated. There are six named arrow point types within the groupings, and none of the clusters are composed of a single named arrow point type.

Figure A-3. Hierarchical Cluster Analysis Dendrogram of Dart Points (Final Results)

Based on a dissimilarity matrix composed of squared Euclidean distance values calculated using Ward's Method (SPSS 12.0 for Windows).

Table A-6. Descriptive Statistics for Dart Point Clusters 1 to 8 (Final Results)

Cluster No.	Statistic	Stem Length	Stem Distal Width	Stem Proximal Width	Stem Thickness	Maximum Width	Max Thickness	Width:Thickness Ratio	Stem Thick:Width Ratio	Base Depth	Base Notch Width	Base Depth:Width Ratio
1	N	12	12	12	12	12	12	12	12	12	12	12
	Mean	13.925	18.142	22.667	4.858	30.975	7.225	0.2338	0.2696	3.433	10.367	0.3280
	Median	13.850	18.100	22.300	4.800	30.850	7.150	0.2293	0.2637	3.200	10.450	0.3194
	Std. Error of Mean	0.6067	0.2734	0.4349	0.2423	0.6339	0.2652	0.00832	0.01567	0.3585	0.4739	0.02672
	Minimum	10.6	16.3	20.5	3.5	27.0	6.2	0.18	0.18	1.6	6.9	0.16
	Maximum	17.8	19.7	25.2	6.2	34.2	9.3	0.30	0.36	5.9	13.1	0.52
	Std. Deviation	2.1016	0.9472	1.5066	0.8393	2.1959	0.9186	0.02882	0.05429	1.2419	1.6417	0.09257
	Variance	4.417	0.897	2.270	0.704	4.822	0.844	0.001	0.003	1.542	2.695	0.009
	Kurtosis	-0.633	0.225	-1.039	-0.869	-0.598	1.093	1.573	-0.675	-0.166	0.920	1.045
	Skewness	0.178	-0.276	0.174	0.099	-0.089	1.097	0.545	-0.054	0.535	-0.487	0.288
2	N	8	8	8	8	8	8	8	8	8	8	8
	Mean	10.975	18.800	26.500	5.013	31.063	7.575	0.2451	0.2675	2.950	13.463	0.2241
	Median	11.100	18.400	25.150	5.050	31.300	7.000	0.2292	0.2832	2.950	13.000	0.2086
	Std. Error of Mean	0.4511	0.6239	1.0316	0.3056	0.9358	0.7345	0.02417	0.01604	0.3746	1.0119	0.03082
	Minimum	8.6	16.5	23.6	3.7	27.3	5.7	0.18	0.19	0.9	10.4	0.07
	Maximum	12.9	21.5	30.5	6.0	34.2	12.4	0.40	0.33	4.1	19.0	0.35
	Std. Deviation	1.2759	1.7647	2.9179	0.8643	2.6468	2.0776	0.06835	0.04536	1.0596	2.8620	0.08717
	Variance	1.628	3.114	8.514	0.747	7.006	4.316	0.005	0.002	1.123	8.191	0.008
	Kurtosis	1.123	-1.403	-2.012	-1.077	-1.312	5.397	3.951	-0.807	0.989	0.922	0.054
	Skewness	-0.546	0.297	0.551	-0.504	-0.317	2.163	1.876	-0.494	-0.916	0.958	-0.315
3	N	6	6	6	6	6	6	6	6	6	6	6
	Mean	8.417	12.833	15.517	3.317	36.567	4.583	0.1255	0.2611	1.467	8.800	0.1734
	Median	8.550	12.900	15.400	3.350	35.950	4.700	0.1246	0.2651	1.300	8.550	0.1628
	Std. Error of Mean	0.4556	0.4688	0.4778	0.1078	0.8928	0.1276	0.00314	0.01575	0.2404	1.1787	0.02566
	Minimum	7.0	11.6	13.8	2.9	34.5	4.0	0.12	0.21	0.9	4.7	0.11
	Maximum	9.8	14.0	17.1	3.7	40.2	4.8	0.14	0.31	2.4	13.2	0.26
	Std. Deviation	1.1161	1.1483	1.1703	0.2639	2.1869	0.3125	0.00769	0.03857	0.5888	2.8872	0.06286
	Variance	1.246	1.319	1.370	0.070	4.783	0.098	0.000	0.001	0.347	8.336	0.004
	Kurtosis	-1.779	-3.044	-0.261	1.252	0.081	2.736	-1.180	-1.839	-0.642	0.509	-1.976
	Skewness	-0.172	-0.054	-0.072	-0.268	0.985	-1.657	0.292	-0.255	0.825	0.219	0.395
4	N	5	5	5	5	5	5	5	5	5	5	5
	Mean	11.520	15.620	20.480	4.600	35.900	7.180	0.2005	0.3021	2.020	10.900	0.1876
	Median	10.700	14.400	20.400	4.800	36.300	7.000	0.2030	0.3357	1.900	12.100	0.1795
	Std. Error of Mean	0.8714	1.0466	1.1052	0.1817	1.4415	0.5333	0.01412	0.02847	0.5687	1.3319	0.04197
	Minimum	10.5	13.4	18.4	3.9	30.8	5.5	0.16	0.20	0.7	7.6	0.06
	Maximum	15.0	19.1	24.5	4.9	39.4	8.6	0.24	0.36	4.1	13.6	0.30
	Std. Deviation	1.9486	2.3403	2.4712	0.4062	3.2234	1.1925	0.03157	0.06367	1.2716	2.9783	0.09385
	Variance	3.797	5.477	6.107	0.165	10.390	1.422	0.001	0.004	1.617	8.870	0.009
	Kurtosis	4.934	-0.546	1.896	3.543	1.669	-0.269	-0.306	0.066	2.470	-3.151	-0.445
	Skewness	2.218	0.949	1.331	-1.865	-1.057	-0.341	-0.499	-1.123	1.309	-0.453	-0.264

Table A-6. Descriptive Statistics for Dart Point Clusters 1 to 8 (Final Results) (Continued)

Cluster No.	Statistic	Stem Length	Stem Distal Width	Stem Proximal Width	Stem Thickness	Maximum Width	Max Thickness	Width:Thickness Ratio	Stem Thick:Width Ratio	Base Depth	Base Notch Width	Base Depth:Width Ratio
5	N	16	16	16	16	16	16	16	16	16	16	16
	Mean	12.300	13.863	17.256	4.594	18.538	6.744	0.3698	0.3345	4.569	8.806	0.5238
	Median	12.950	13.550	17.500	4.700	18.550	6.750	0.3448	0.3400	4.900	8.650	0.5279
	Std. Error of Mean	0.4443	0.3156	0.4029	0.2216	0.6273	0.2317	0.01753	0.01824	0.2703	0.2715	0.03151
	Minimum	8.7	11.6	13.9	2.6	14.2	5.5	0.25	0.18	2.5	6.8	0.26
	Maximum	15.3	15.8	19.4	5.7	23.2	8.3	0.52	0.44	6.2	10.6	0.74
	Std. Deviation	1.7773	1.2622	1.6116	0.8865	2.5091	0.9266	0.07013	0.07295	1.0812	1.0860	0.12605
	Variance	3.159	1.593	2.597	0.786	6.296	0.859	0.005	0.005	1.169	1.179	0.016
	Kurtosis	0.204	-0.895	-0.290	-0.094	-0.574	-1.125	-0.328	-0.075	-0.551	-0.464	0.628
	Skewness	-0.692	-0.041	-0.570	-0.644	-0.016	0.167	0.478	-0.464	-0.442	0.059	-0.532
6	N	5	5	5	5	5	5	5	5	5	5	5
	Mean	7.440	13.560	16.320	2.960	24.880	4.280	0.1734	0.2183	1.300	8.920	0.1513
	Median	7.600	13.400	16.500	2.700	24.400	4.400	0.1571	0.2015	1.300	10.100	0.1364
	Std. Error of Mean	0.7089	0.2249	0.2672	0.2909	1.3858	0.2557	0.01209	0.02148	0.2074	1.5714	0.01923
	Minimum	5.4	13.1	15.6	2.4	21.5	3.4	0.15	0.18	0.6	4.4	0.12
	Maximum	9.0	14.4	17.0	3.8	29.5	4.9	0.20	0.29	1.9	12.9	0.23
	Std. Deviation	1.5852	0.5030	0.5975	0.6504	3.0987	0.5718	0.02702	0.04803	0.4637	3.5138	0.04300
	Variance	2.513	0.253	0.357	0.423	9.602	0.327	0.001	0.002	0.215	12.347	0.002
	Kurtosis	-2.166	2.699	-2.335	-2.522	0.185	0.875	-3.148	-0.463	2.000	-1.902	3.832
	Skewness	-0.320	1.551	-0.271	0.578	0.755	-0.924	0.550	0.949	-0.527	-0.372	1.902
7	N	6	6	6	6	6	6	6	6	6	6	6
	Mean	10.917	15.700	21.917	4.450	24.833	6.950	0.2803	0.2849	2.333	10.283	0.2316
	Median	11.100	15.700	22.050	4.300	24.700	7.050	0.2835	0.2811	2.400	10.400	0.2403
	Std. Error of Mean	0.6379	0.4830	0.4175	0.2306	0.2906	0.4537	0.01935	0.01762	0.2124	0.8719	0.02044
	Minimum	8.8	14.0	20.3	4.0	24.1	5.6	0.23	0.24	1.7	7.6	0.14
	Maximum	12.9	17.0	23.0	5.5	25.8	8.5	0.34	0.36	3.1	12.6	0.30
	Std. Deviation	1.5626	1.1832	1.0226	0.5648	0.7118	1.1113	0.04739	0.04316	0.5203	2.1358	0.05007
	Variance	2.442	1.400	1.046	0.319	0.507	1.235	0.002	0.002	0.271	4.562	0.003
	Kurtosis	-1.359	-1.546	-0.476	2.706	-2.005	-1.388	-2.413	3.019	-0.590	-1.803	2.616
	Skewness	-0.211	-0.313	-0.672	1.603	0.395	0.110	0.048	1.362	0.137	-0.149	-1.009
8	N	11	11	11	11	11	11	11	11	11	11	11
	Mean	14.064	14.845	19.891	4.855	22.600	6.627	0.2959	0.3284	5.782	8.545	0.6915
	Median	13.900	15.300	20.100	4.700	22.000	6.600	0.3000	0.3312	5.800	8.100	0.7463
	Std. Error of Mean	0.5800	0.3848	0.4039	0.2748	0.5595	0.1711	0.01255	0.01831	0.2700	0.4971	0.03815
	Minimum	11.7	11.4	18.0	3.5	20.3	5.8	0.23	0.24	3.9	6.7	0.45
	Maximum	19.0	16.1	22.2	7.0	25.4	7.5	0.36	0.43	7.5	11.8	0.82
	Std. Deviation	1.9237	1.2762	1.3397	0.9114	1.8558	0.5676	0.04162	0.06072	0.8953	1.6489	0.12655
	Variance	3.701	1.629	1.795	0.831	3.444	0.322	0.002	0.004	0.802	2.719	0.016
	Kurtosis	4.367	5.839	-0.912	2.521	-1.385	-0.956	-1.030	-0.633	2.099	-0.173	-0.316
	Skewness	1.724	-2.201	0.136	1.121	0.511	0.110	-0.162	0.403	-0.301	0.936	-1.130

Table A-7. Tests of Equality of Group Means for Dart Point Cluster 1 to 8 (Final Results)

Cluster No. 2	Variable	Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
1	Stem Length	13.9250	2.10157	12	12.000
	Stem Dist Width	18.1417	0.94720	12	12.000
	Stem Prox Width	22.6667	1.50655	12	12.000
	Stem Thickness	4.8583	0.83933	12	12.000
	Maximum Width	30.9750	2.19592	12	12.000
	Max Thickness	7.2250	0.91862	12	12.000
	Thickness:Width Ratio	0.2338	0.02882	12	12.000
	Stem Thick:Width Ratio	0.2696	0.05429	12	12.000
	Base Depth	3.4333	1.24194	12	12.000
	Base Notch Width	10.3667	1.64169	12	12.000
	Base Depth:Width Ratio	0.3280	0.09257	12	12.000
2	Stem Length	10.9750	1.27588	8	8.000
	Stem Dist Width	18.8000	1.76473	8	8.000
	Stem Prox Width	26.5000	2.91792	8	8.000
	Stem Thickness	5.0125	0.86427	8	8.000
	Maximum Width	31.0625	2.64680	8	8.000
	Max Thickness	7.5750	2.07760	8	8.000
	Thickness:Width Ratio	0.2451	0.06835	8	8.000
	Stem Thick:Width Ratio	0.2675	0.04536	8	8.000
	Base Depth	2.9500	1.05965	8	8.000
	Base Notch Width	13.4625	2.86204	8	8.000
	Base Depth:Width Ratio	0.2241	0.08717	8	8.000
3	Stem Length	8.4167	1.11609	6	6.000
	Stem Dist Width	12.8333	1.14833	6	6.000
	Stem Prox Width	15.5167	1.17033	6	6.000
	Stem Thickness	3.3167	0.26394	6	6.000
	Maximum Width	36.5667	2.18693	6	6.000
	Max Thickness	4.5833	0.31252	6	6.000
	Thickness:Width Ratio	0.1255	0.00769	6	6.000
	Stem Thick:Width Ratio	0.2611	0.03857	6	6.000
	Base Depth	1.4667	0.58878	6	6.000
	Base Notch Width	8.8000	2.88721	6	6.000
	Base Depth:Width Ratio	0.1734	0.06286	6	6.000
4	Stem Length	11.5200	1.94859	5	5.000
	Stem Dist Width	15.6200	2.34030	5	5.000
	Stem Prox Width	20.4800	2.47123	5	5.000
	Stem Thickness	4.6000	0.40620	5	5.000
	Maximum Width	35.9000	3.22335	5	5.000
	Max Thickness	7.1800	1.19248	5	5.000
	Thickness:Width Ratio	0.2005	0.03157	5	5.000
	Stem Thick:Width Ratio	0.3021	0.06367	5	5.000
	Base Depth	2.0200	1.27161	5	5.000
	Base Notch Width	10.9000	2.97825	5	5.000
	Base Depth:Width Ratio	0.1876	0.09385	5	5.000
5	Stem Length	12.3000	1.77726	16	16.000
	Stem Dist Width	13.8625	1.26221	16	16.000
	Stem Prox Width	17.2563	1.61161	16	16.000
	Stem Thickness	4.5938	0.88654	16	16.000
	Maximum Width	18.5375	2.50915	16	16.000
	Max Thickness	6.7438	0.92662	16	16.000
	Thickness:Width Ratio	0.3698	0.07013	16	16.000
	Stem Thick:Width Ratio	0.3345	0.07295	16	16.000
	Base Depth	4.5688	1.08118	16	16.000
	Base Notch Width	8.8063	1.08595	16	16.000
	Base Depth:Width Ratio	0.5238	0.12605	16	16.000

**Table A-7. Tests of Equality of Group Means for Dart Point Cluster 1 to 8 (Final Results)
(Continued)**

Cluster No. 2	Variable	Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
6	Stem Length	7.4400	1.58524	5	5.000
	Stem Dist Width	13.5600	0.50299	5	5.000
	Stem Prox Width	16.3200	0.59749	5	5.000
	Stem Thickness	2.9600	0.65038	5	5.000
	Maximum Width	24.8800	3.09871	5	5.000
	Max Thickness	4.2800	0.57184	5	5.000
	Thickness:Width Ratio	0.1734	0.02702	5	5.000
	Stem Thick:Width Ratio	0.2183	0.04803	5	5.000
	Base Depth	1.3000	0.46368	5	5.000
	Base Notch Width	8.9200	3.51383	5	5.000
	Base Depth:Width Ratio	0.1513	0.04300	5	5.000
7	Stem Length	10.9167	1.56258	6	6.000
	Stem Dist Width	15.7000	1.18322	6	6.000
	Stem Prox Width	21.9167	1.02258	6	6.000
	Stem Thickness	4.4500	0.56480	6	6.000
	Maximum Width	24.8333	0.71181	6	6.000
	Max Thickness	6.9500	1.11131	6	6.000
	Thickness:Width Ratio	0.2803	0.04739	6	6.000
	Stem Thick:Width Ratio	0.2849	0.04316	6	6.000
	Base Depth	2.3333	0.52026	6	6.000
	Base Notch Width	10.2833	2.13581	6	6.000
	Base Depth:Width Ratio	0.2316	0.05007	6	6.000
8	Stem Length	14.0636	1.92368	11	11.000
	Stem Dist Width	14.8455	1.27622	11	11.000
	Stem Prox Width	19.8909	1.33974	11	11.000
	Stem Thickness	4.8545	0.91144	11	11.000
	Maximum Width	22.6000	1.85580	11	11.000
	Max Thickness	6.6273	0.56761	11	11.000
	Thickness:Width Ratio	0.2959	0.04162	11	11.000
	Stem Thick:Width Ratio	0.3284	0.06072	11	11.000
	Base Depth	5.7818	0.89534	11	11.000
	Base Notch Width	8.5455	1.64886	11	11.000
	Base Depth:Width Ratio	0.6915	0.12655	11	11.000

Table A-8. Tests of Equality of Group Means for Dart Point Cluster 1 to 8 (Final Results)

Variable	Wilks' Lambda	F	df1	df2	Sig.
Stem Length	0.394	13.378	7	61	0.000
Stem Dist Width	0.279	22.537	7	61	0.000
Stem Prox Width	0.192	36.653	7	61	0.000
Stem Thickness	0.595	5.942	7	61	0.000
Maximum Width	0.112	68.887	7	61	0.000
Max Thickness	0.511	8.349	7	61	0.000
Thickness:Width Ratio	0.284	22.005	7	61	0.000
Stem Thick:Width Ratio	0.701	3.724	7	61	0.002
Base Depth	0.294	20.949	7	61	0.000
Base Notch Width	0.635	4.999	7	61	0.000
Base Depth:Width Ratio	0.202	34.502	7	61	0.000

**Table A-9. Analysis of Variance (ANOVA) Comparing Dart Point Clusters 1 to 8
(Final Results)**

Variable		Sum of Squares	df	Mean Square	F	Sig.
Stem Length	Between Groups	288.670	7	41.239	13.378	0.000
	Within Groups	188.040	61	3.083		
	Total	476.710	68			
Stem Dist Width	Between Groups	280.263	7	40.038	22.537	0.000
	Within Groups	108.367	61	1.777		
	Total	388.631	68			
Stem Prox Width	Between Groups	754.607	7	107.801	36.653	0.000
	Within Groups	179.408	61	2.941		
	Total	934.015	68			
Stem Thickness	Between Groups	25.481	7	3.640	5.942	0.000
	Within Groups	37.370	61	0.613		
	Total	62.851	68			
Maximum Width	Between Groups	2,666.960	7	380.994	68.887	0.000
	Within Groups	337.373	61	5.531		
	Total	3,004.333	68			
Max Thickness	Between Groups	66.353	7	9.479	8.349	0.000
	Within Groups	69.258	61	1.135		
	Total	135.611	68			
Thickness:Width Ratio	Between Groups	0.382	7	0.055	22.005	0.000
	Within Groups	0.151	61	0.002		
	Total	0.534	68			
Stem Thick:Width Ratio	Between Groups	0.088	7	0.013	3.724	0.002
	Within Groups	0.206	61	0.003		
	Total	0.294	68			
Base Depth	Between Groups	146.143	7	20.878	20.949	0.000
	Within Groups	60.792	61	0.997		
	Total	206.935	68			
Base Notch Width	Between Groups	161.321	7	23.046	4.999	0.000
	Within Groups	281.218	61	4.610		
	Total	442.539	68			
Base Depth:Width Ratio	Between Groups	2.458	7	0.351	34.502	0.000
	Within Groups	0.621	61	0.010		
	Total	3.079	68			

Cluster 1 ($n=17$) is the closest to containing a single point type, Perdiz ($n=16$). Perdiz points account for 70 percent of the analyzed arrow points and are included in six of the eight clusters (Table A-10). Clifton points are the second largest group ($n=8$) and are found in five clusters.

The closeness of many measurements between clusters, especially the *Maximum Thickness* variable, suggests that minor discrepancies during data recording could significantly affect cluster composition. This is particularly worrisome given the fragmentary nature of the assemblage. The clusters incorporate the variation in the Perdiz assemblage, especially the *Maximum Width* measurement. Overall, because only three variables were used in the analysis, the fourth being a derivative of two of these variables, variations in stem shape, barb size, and base shape were not fully investigated, and this was the result of the fragmented condition of the assemblage. Excluding Clusters 7 and 8, Perdiz points account for 94 percent of Cluster 1, 67 percent of Cluster 2, 50 percent of Cluster 3, 44 percent of Cluster 4, 60 percent of Cluster 5, and 80 percent of Cluster 6; therefore, it not surprising that the variations along the Perdiz assemblage continuum dictates the composition of the clusters.

A.4.2.2 Discriminant Function Analysis Results

The four selected measurements all contribute significantly to the Clusters. Means and standard deviations were calculated for each of the 4 variables in each cluster (Table A-11). The derivative *Width:Thickness Ratio* is significant because of the strong influence of the *Width* and *Thickness*; and therefore, its significance is from being covariant. The Tests of Equality (Table A-12) and the Analysis of Variance (Table A-13) both indicate that all of

Table A-10. Arrow Point Types and Hierarchical Cluster Affiliations

Point type	Number ($n=56$)	Clusters ($n=8$)
Bonham	5	1,2,5
Clifton	8	3,4,6,7,8
Cuney	1	4
Harrell	1	1
Perdiz	39	1,2,3,4,5,6
Scallorn	2	5,6

the variables are significant at the $p=0.001$ level, and that they all contribute to the formation of the clusters. The low Wilks' Lambda values also indicate that there is a strong correlation between the variables and clusters. Thickness was the most discriminatory variable, while *Stem Distal Width* was the least discriminatory.

A.5 INTERPRETATION OF CLUSTER ANALYSIS RESULTS

A.5.1 Dart Points

The eight clusters form two principle groups or megaclusters, Clusters 1 through 4 and Clusters 5 through 8, which are defined by maximum width. A *t*-test performed on the *Maximum Width* for the two megaclusters demonstrates that there is a significant difference at $p=0.01$ (Table A-14).

Figure A-4. Hierarchical Cluster Analysis Dendrogram of Arrow Points

Based on a dissimilarity matrix composed of squared Euclidean distance values calculated using Ward's Method (SPSS 12.0 for Windows).

Table A-11. Group Statistics Comparing Arrow Point Clusters 1 to 8

Cluster No.	Variable	Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
1	Stem Dist Width	5.8941	0.70929	17	17.000
	Maximum Width	14.6941	0.98582	17	17.000
	Max Thickness	2.7824	0.54913	17	17.000
	Thickness:Width Ratio	0.1904	0.04109	17	17.000
2	Stem Dist Width	6.0333	0.66833	6	6.000
	Maximum Width	11.2000	0.61644	6	6.000
	Max Thickness	2.9167	0.44008	6	6.000
	Thickness:Width Ratio	0.2609	0.04008	6	6.000
3	Stem Dist Width	10.5500	1.76777	2	2.000
	Maximum Width	25.1500	1.34350	2	2.000
	Max Thickness	4.0500	1.06066	2	2.000
	Thickness:Width Ratio	0.1624	0.05085	2	2.000
4	Stem Dist Width	7.8556	1.53713	9	9.000
	Maximum Width	22.3111	0.94399	9	9.000
	Max Thickness	3.9889	0.87670	9	9.000
	Thickness:Width Ratio	0.1799	0.04453	9	9.000
5	Stem Dist Width	5.7100	0.79505	10	10.000
	Maximum Width	19.0600	1.21947	10	10.000
	Max Thickness	2.9600	0.44522	10	10.000
	Thickness:Width Ratio	0.1559	0.02575	10	10.000
6	Stem Dist Width	8.8300	0.69290	10	10.000
	Maximum Width	17.4900	1.45713	10	10.000
	Max Thickness	2.8700	0.32335	10	10.000
	Thickness:Width Ratio	0.1654	0.02600	10	10.000
7	Stem Dist Width	14.2000	(a)	1	1.000
	Maximum Width	17.6000	(a)	1	1.000
	Max Thickness	3.4000	(a)	1	1.000
	Thickness:Width Ratio	0.1932	(a)	1	1.000
8	Stem Dist Width	12.0000	(a)	1	1.000
	Maximum Width	16.6000	(a)	1	1.000
	Max Thickness	17.4000	(a)	1	1.000
	Thickness:Width Ratio	1.0482	(a)	1	1.000
Total	Stem Dist Width	7.1393	2.02885	56	56.000
	Maximum Width	17.2821	3.76279	56	56.000
	Max Thickness	3.3554	2.03728	56	56.000
	Thickness:Width Ratio	0.2000	0.12408	56	56.000

a = Insufficient data

Table A-12. Tests of Equality of Group Means

Variable	Wilks' Lambda	F	df1	df2	Sig.
Stem Dist Width	.187	29.826	7	48	.000
Maximum Width	.076	83.838	7	48	.000
Max Thickness	.069	92.265	7	48	.000
Thickness:Width Ratio	.077	81.721	7	48	.000

Table A-13. Analysis of Variance (ANOVA) Comparing Arrow Point Clusters 1 to 8

Variable		Sum of Squares	df	Mean Square	F	Sig.
Stem Dist Width	Between Groups	184.074	7	26.296	29.826	0.000
	Within Groups	42.320	48	0.882		
	Total	226.394	55			
Maximum Width	Between Groups	719.846	7	102.835	83.838	0.000
	Within Groups	58.876	48	1.227		
	Total	778.722	55			
Max Thickness	Between Groups	212.486	7	30.355	92.265	0.000
	Within Groups	15.792	48	0.329		
	Total	228.278	55			
Thickness:Width Ratio	Between Groups	0.781	7	0.112	81.721	0.000
	Within Groups	0.066	48	0.001		
	Total	0.847	55			

Table A-14. t-Test: Two-Sample Assuming Equal Variances

	Maximum Width Clusters 1-4	Maximum Width Clusters 5-8
Mean	32.87419	21.54211
Variance	12.15598	12.08845
Observations	31	38
Pooled Variance	12.11869	
Hypothesized Mean Difference	0	
df	67	
t Stat	13.45025	
P(T<=t) one-tail	5.21E-21	
t Critical one-tail	2.383304	
P(T<=t) two-tail	1.04E-20	
t Critical two-tail	2.651213	

Cluster 1

Cluster 1 ($n=12$) is composed of five Martindale points and seven Group 1 points (Table A-15). Morphologically, the cluster is defined by the outline shape of the base, measured with the proximal and distal stem width and stem length. An examination of the illustrated points from Dart Cluster 1 shows that it is composed of two types, Martindale and Group 1, and the difference between the two within Cluster 1 is the depth of the basal notching (Figure A-5). In the Group 1 points, the depth is greater and the

Base Notch Depth to Width Ratio is generally greater than the Martindale points. The general dimensions of the base and stem and the overall width created the composition of Cluster 1 more than the actual shape of the base with the characteristic fishtail of the Martindale points. Specimen #0077-013 is a Martindale point with a base that has been refitted which may have affected the measurements for *Base Notch Depth* and *Base Notch Width*, since the base notch is shallower and wider than the other Martindale points.

Figure A-5. Selected Projectile Points from Dart Cluster 1

Top row (left to right): #39-015, #40-013, #77-013, #730-013 (all Martindale)
Bottom row (left to right): #141-020, #193-018, #334-023, #694-018, #1203-010 (all Group 1)

Table A-15. Cluster 1

Catalogue Number	Point Type	Base Notch Depth: Width Ratio	Proximal base width: base notch width
0039-015	Martindale	0.347826	3.231884
0040-013	Martindale	0.221053	2.431579
0077-013	Martindale	0.16	2.23
0193-018	Group 1	0.517544	2.131579
0334-023	Group 1	0.277228	2.207921
0591-019	Martindale	0.341176	2.835294
0694-018	Group 1	0.314815	2.018519
0730-013	Martindale	0.3	2.52
0141-020	Group 1	0.435185	1.898148
0599-017	Group 1	0.320611	1.580153
0670-005-011	Group 1	0.382114	1.731707
1203-010	Group 1	0.318182	2.190909
	Mean	0.327978	2.250641

Cluster 2

Cluster 2 ($n=8$) is comprised of five different dart types (Table A-16). The cluster is defined by having the greatest mean distal stem width (18.8 mm) and proximal stem width (26.5 mm). The measurements fail to discriminate the distinctive basal shapes of the points, which accounts for the grouping of visually dissimilar types (Figure A-6). The derivative measurement that further describes the shape of the base is created from dividing the proximal stem width by the basal notch width. Narrower stemmed points with prominent basal notching have a lower ratio. The *Base Notch Depth:Width Ratio* identifies the prominence of the basal notching, with relatively straight bases such as the Marcos point, having a low number (0.0714), while the Frio points have values of 0.3462 and 0.2885.

Cluster 3 and Cluster 6

The selected variable measurements have created morphologically defined clusters that agree in part with some of the named dart types, specifically Clusters 3 and 6, which were both composed of Bandy points (Tables A-17 and A-18; Figures A-7 and A-8). The significant difference between these two clusters is mean maximum width, 36.57 $\pm$ 2.187 mm in Cluster 3 and 24.88 $\pm$ 3.10 mm in Cluster 6. The Bandy dart points as a group are significantly thinner than the other dart point types with a mean of 4.64 mm while the mean of the remaining point types is 6.99 mm. In Cluster 6, the *Stem Distal Width* and *Proximal Widths* varies by standard deviations of 0.60 mm or less, the least variation. *Stem Thickness* is also significantly thinner than the other clusters. The smaller size of Cluster 6 may be from the selection of smaller and thinner blanks.

Table A-16. Cluster 2

Catalogue Number	Point Type	Base Notch Depth: Width Ratio	Proximal base width: base notch width
0009-014	Martindale	0.183333	2.058333
0187-010	Marcos	0.071429	1.920635
0230-013	Martindale	0.201389	1.777778
0370-010	Group 2	0.180645	1.554839
1202-010	Group 1	0.305970	1.761194
0187-011	Frio	0.288462	2.932692
0283-014	Group 2	0.215789	1.542105
0525-005-013	Frio	0.346154	2.884615
	Mean	0.224146	2.054024

Figure A-6. Selected Projectile Points from Dart Cluster 2

Top row (left to right): #9-014 (Martindale), #230-013 (Martindale), #187-010 (Marcos)
Bottom row (left to right): #187-011 (Marcos), #525-005-013 (Frio), #370-010 (Group 2), #1202-010 (Group 1)

Table A-17. Cluster 3 Point Types

Catalogue Number	Point Type	Maximum Thickness	Stem Thickness
0390-010	Bandy	4.0	3.3
0531-018	Bandy	4.8	3.2
0651-011	Bandy	4.8	3.4
0689-020	Bandy	4.6	3.4
0713-016	Bandy	4.5	3.7
0746-014	Bandy	4.8	2.9
	Mean	4.583	3.317

Table A-18. Cluster 6 Point Types

Catalogue Number	Point Type	Maximum Thickness	Stem Thickness
0334-022	Bandy	4.4000	3.8000
0346-022	Bandy	4.1000	2.4000
0400-011	Bandy	4.6000	2.7000
0599-015	Bandy	3.4000	2.4000
0694-017	Bandy	4.9000	3.5000
	Mean	4.2800	2.96

Figure A-7. Selected Projectile Points from Dart Cluster 3

Top row (left to right): #390-010, #531-018 (all Bandy)
Bottom row (left to right): #651-011, #689-020, #746-014 (all Bandy)

Figure A-8. Selected Projectile Points from Dart Cluster 6

Left to right: #346-022, #400-011, #599-015, #694-017 (all Bandy)

Cluster 4

Cluster 4 ($n=5$) contains four different named types and have the greatest maximum mean width. The measurements do not describe the variety of base shapes, but the algorithm has clustered the specimens according to the general physical measurements of the base (Table A-19). These specimens appear to be heavily reworked, while Specimen #0854-010, a Martindale, appears to be unfinished (Figure A-9). The cluster does not define a true cultural type.

Cluster 5

Cluster 5 ($n=16$) is the first cluster in Megacluster 2, which are narrower than Megacluster 1 projectile points (Figure A-10). The cluster also contains the most dart points (Table A-20). As depicted in Figure A-10, the bases are straight sided and expanding stemmed and deeply basal notched. The algorithm failed to detect the shape of the basal ears of the Merrell points (#532-022, #584-015), grouping them with the rounded basal notch shape of the Gower specimens, and also included a Frio point with reworked basal ears (#562-012), and a Frio with a complete base (#220-014). Both Frio points are readily detected in the data using the *Basal Depth: Width Ratio*. The Cluster is similar to Cluster 8, since both clusters have the deepest basal notching and base depth to width ratios. All of the specimens appear to have been extensively reworked which could account for their narrow overall width.

Cluster 7

Cluster 7 ($n=6$) contains four named types (Table A-21). Again, the program does not differentiate the characteristic “fishtail” of the Martindale points and they are grouped because of their wide and shallow basal notching (Figure A-11). The bases are expanding and are more similar to Megacluster 1 dart points. The

narrow overall width of the specimens appears to be from extensive reworking of the points, including the barbs and shoulders of the points. The diverse number of points represents a morphological outline rather than true cultural types.

Cluster 8

Cluster 8 is a large group ($n=11$) of narrow, straight to expanding stemmed projectile points, with deep U-shaped basal notching. Gower, Baker, and Merrell points comprise the cluster, and again, the algorithm does not discriminate for the shape of the basal ears. The high *Base Notch Depth: Base Notch Width Ratio* (0.6195) distinguishes the group as narrow split stemmed projectile points (Table A-22). These specimens appear to have been extensively modified (Figure A-12).

A.5.2 Arrow Points

The assemblage is divided into two megaclusters, Megacluster 1 contains Clusters 1 and 2, while Megacluster 2 contains Clusters 3 through 8. The difference between these clusters is *Maximum Width*. Clusters 1 and 2 have the least mean *Maximum Width* and a higher mean *Width: Thickness Ratio*. As mentioned previously, the arrow point assemblage represents the variation of Perdiz point manufacturing. Because of the small size of the arrow points and their relative thinness and variation in manufacturing due to the skill of the knapper, raw material and size of the flake used to make the point will be reflected in the overall measurements. The algorithm detected significant statistical variability within the arrow point assemblage, but the variation may be unintentional and represent acceptable variations.

Table A-19. Cluster 4

Catalogue Number	Point Type	Base Notch Depth: Width Ratio	Proximal base width: base notch width
0671-011	Group 1	0.1795	3.141026
0142-011	Bandy	0.0579	1.528926
0412-010	Group 2	0.3015	1.5
0523-021	Group 2	0.1493	1.537313
0854-010	Martindale	0.2500	2.421053
	Mean	0.1876	2.025664

Figure A-9. Selected Projectile Points from Dart Cluster 4

Left to right: #142-011 (Bandy), #523-021 (Group 2), #671-011 (Group 1), #854-010 (Martindale)

Figure A-10. Selected Projectile Points from Dart Cluster 5

Top row (left to right): #523-022 (Merrell), #584-015 (Merrell), #192-011 (Gower), #255-030 (Gower), #289-022 (Gower)

Middle row (left to right): #333-022 (Gower), #411-016 (Gower), #591-017 (Gower), #1206-010 (Gower), #220-014 (Frio)

Bottom row (left to right): #562-012 (Frio), #28-014 (Baker), #346-023 (Baker), #462-015 (Baker), #653-012 (Baker)

Table A-20. Cluster 5

Catalogue Number	Point Type	Base Notch Depth:Width Ratio	Proximal base: base notch width
0028-014	Baker	0.581395	1.965116
0192-011	Gower	0.547945	2.410959
0220-014	Frio	0.264151	1.726415
0255-030	Gower	0.74359	2.166667
0289-022	Gower	0.50495	1.881188
0333-022	Gower	0.538462	1.912088
0346-023	Baker	0.46988	1.795181
0391-011	Gower	0.681319	1.945055
0411-016	Gower	0.41573	1.876404
0462-015	Baker	0.576471	1.8
0523-022	Merrell	0.517241	2.229885
0562-012	Frio	0.290698	2.255814
0584-015	Merrell	0.50495	1.792079
0591-017	Gower	0.567308	1.788462
0653-012	Baker	0.6625	2
1206-010	Gower	0.514706	2.044118
	Mean	0.523831	1.974339

Table A-21. Cluster 7

Catalogue Number	Point Type	Base Notch Depth: Width Ratio	Proximal base width: base notch width
0011-005-014	Edgewood	0.142857	1.722222
0268-021	Martindale	0.235294	2.235294
0324-016	Group 2	0.245283	2.009434
0412-011	Group 2	0.246032	1.611111
0599-016	Group 1	0.296296	2.839506
0658-018	Martindale	0.223684	2.947368
	Mean	0.231574	2.227489

Figure A-11. Selected Projectile Points from Dart Cluster 7

Top row (left to right): #412-011 (Group 2), #658-018 (Martindale), #599-016 (Group 1)
 Bottom row (left to right): #324-016 (Group 2), #268-021 (Martindale)

Table A-22. Cluster 8

Catalogue Number	Point Type	Base Notch Depth: Width Ratio	Proximal base: base notch width
0086-020	Gower	0.81690	2.746479
0117-020	Merrell	0.77922	2.623377
0203-014	Merrell	0.79268	2.54878
0289-021	Gower	0.72115	1.836538
0299-014	Merrell	0.45349	2.406977
0345-027	Gower	0.75309	2.222222
0431-010	Baker	0.73418	2.341772
0479-013	Merrell	0.50000	1.805085
0523-025	Merrell	0.55238	2.114286
0569-013	Baker	0.74627	2.731343
0658-016	Merrell	0.75714	2.871429
	Mean	0.69150	2.386208

Figure A-12. Projectile Points from Dart Cluster 8

Top row (left to right): #86-020, #345-027, #289-021 (all Gower)

Middle row (left to right): #431-010 (Baker), #569-013 (Baker), #117-020 (Merrell), #203-014 (Merrell)

Bottom row (left to right): #299-014, #479-013, #523-025, #658-016 (Merrell)

Arrow Point Cluster 1 ($n=17$)

From the Figure A-13, Arrow Cluster 1 demonstrates the varying condition and resultant size of the specimens. The solitary Bonham point, Specimen #0262-020 has a square base and straight-sided stem in contrast to the tapered or constricting stem of the Perdiz. Cluster 1 represents the smaller dimensioned Perdiz points. The defining attributes of the cluster are its narrow width and thinness (Table A-23). The Perdiz points in Cluster 1 are from various levels and units at the Varga site and do not appear to represent an isolatable temporal or spatial group.

Arrow Point Cluster 2 ($n=6$)

This cluster is composed of four Perdiz, one Harrell, and one Bonham point (Figure A-14). Cluster 2 is defined by the narrow *Maximum Width* (mean 11.2 mm) and the resulting high value for the ratio of *Thickness:Width* (mean=0.2609) (Table A-24). The affiliation between the points is morphological, since four of the six points are Perdiz and the other two points are stylistically dissimilar to the Perdiz points and each other. Cluster 2's closest affiliation is with Cluster 1.

Arrow Point Cluster 3 ($n=2$)

Cluster 3 is the smallest cluster analyzed, and is comprised of a Perdiz point and a Clifton point (Figure A-15). The two specimens are the widest, and the Clifton point is one of the thickest arrow points in the assemblage (Table A-25). Because of its high mean width, the cluster is more associated with Cluster 4 than with Clusters 1 and 2.

Arrow Point Cluster 4 ($n=9$)

The cluster is composed of equal numbers of Clifton and Perdiz points, with a solitary Cuney

point (Figure A-16; Table A-26). Cluster 4 is closely associated with Cluster 3 (Figure A-4), so that Cluster 3 represents outliers among their type. Clusters 4 is defined by a high *Maximum Width* and mean *Thickness*, while *Stem Length* would have eliminated the Cuney specimen and a Clifton from the cluster.

Arrow Point Cluster 5 ($n=10$)

Cluster 5 contains six Perdiz points, three Bonham, and a Scallorn point (Figure A-17; Table A-27). This Cluster has wide, relatively thin blades, resulting in the lowest *Thickness:Width Ratio*. Cluster 5 is equally associated with Cluster 6 and the solitary Clifton in Cluster 7. The *Maximum Width* has decreased from Cluster 4. The composition of the cluster is defined by the fragmentary condition of several of the specimens that limited discriminatory variables, since only specimens able to provide a value for each of the three primary variables. Different temporal time periods are represented by the types.

Arrow Point Cluster 6 ($n=10$)

Cluster 6 is defined by a decreasing *Maximum Width*, a high *Stem Distal Width*, and relatively thin specimens (Figure A-18; Table A-28). The closest affiliation is with Cluster 7, a Clifton point, with the next cluster being Cluster 5. *Maximum Stem Length* and more descriptive shape variables would change the composition of the cluster. Eight out of the ten specimens are Perdiz points, and Cluster 6 contains broader points with a higher *Stem Distal Width*, than the largest population of Perdiz points, found in Cluster 1. The dendrogram demonstrates that Clusters 1 and 6 are the ends of the range of variability recorded for the Perdiz points.

Figure A-13. Points from Arrow Cluster 1

Top row (left to right): #262-020 (Bonham), #489-010, #533-017, #602-018, #781-012, #782-016 (all Perdiz)

Middle row (left to right): #825-010, #862-020, #863-012, #885-022, #939-013, #949-016,
#1256-005-010 (all Perdiz)

Bottom row (left to right): ##1008-017, #1137-012, #1176-010, #1215-010 (all Perdiz)

Table A-23. Arrow Point Measurement from Arrow Cluster 1

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0262-020	Bonham	6.4000	16.3000	2.5000	0.1533742
0489-010	Perdiz	5.0000	14.7000	2.6000	0.1768707
0533-017	Perdiz	6.4000	13.3000	3.0000	0.2255639
0602-018	Perdiz	6.4000	16.2000	2.1000	0.1296296
0781-012	Perdiz	4.9000	14.7000	2.4000	0.1632653
0782-016	Perdiz	5.0000	13.5000	2.6000	0.1925926
0825-010	Perdiz	5.5000	14.9000	3.4000	0.2281879
0862-020	Perdiz	5.9000	13.3000	3.0000	0.2255639
0863-012	Perdiz	6.7000	15.0000	3.1000	0.2066667
0885-022	Perdiz	6.0000	14.6000	2.9000	0.1986301
0939-013	Perdiz	6.1000	15.9000	3.2000	0.2012579
0949-016	Perdiz	6.4000	14.6000	2.3000	0.1575342
1008-017	Perdiz	6.9000	14.2000	4.3000	0.3028169
1137-012	Perdiz	4.4000	13.1000	2.3000	0.1755725
1176-010	Perdiz	5.7000	15.1000	2.4000	0.1589404
1215-010	Perdiz	6.1000	14.8000	2.2000	0.1486486
1256-005-010	Perdiz	6.4000	15.6000	3.0000	0.1923077
	Mean	5.8941176	14.694118	2.7823529	0.1904367

Figure A-14. Selected Points from Arrow Cluster 2

Left to Right: #903-028 (Perdiz), #1100-016 (Perdiz), #271-016 (Perdiz),
#726-010 (Perdiz), #882-011 (Harrell)

Table A-24. Arrow Point Measurement from Arrow Cluster 2

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0220-013	Bonham	5.3000	11.2000	3.1000	0.2767857
0271-016	Perdiz	5.9000	10.1000	3.1000	0.3069307
0726-010	Perdiz	5.9000	11.3000	2.3000	0.2035398
0882-011	Harrell	5.8000	11.2000	2.5000	0.2232143
0903-028	Perdiz	7.3000	11.4000	3.0000	0.2631579
1100-016	Perdiz	6.0000	12.0000	3.5000	0.2916667
	Mean	6.0333333	11.2	2.9166667	0.2608825

Figure A-15. Points from Arrow Cluster 3

Left to Right: #405-015 (Perdiz), #1002-013 (Cliffon)

Table A-25. Arrow Point Measurement from Arrow Cluster 3

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0405-015	Perdiz	9.3000	26.1000	3.3000	0.1264
1002-013	Cliffon	11.8000	24.2000	4.8000	0.1983
	Mean	10.5500	25.1500	4.0500	0.1624

Figure A-16. Selected Points from Arrow Cluster 4

Top row (left to right): #176-015 (Perdiz), #913-017 (Cliffton)
 Bottom row (left to right): #930-016 (Perdiz), #967-024 (Cliffton), #1021-011 (Perdiz)

Table A-26. Arrow Point Measurement from Arrow Cluster 4

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0022-014	Cliffton	9.2000	22.3000	4.4000	0.1973094
0176-015	Perdiz	10.2000	20.9000	5.5000	0.2631579
0349-013	Cuney	5.7000	22.8000	4.2000	0.1842105
0441-016	Perdiz	6.2000	23.0000	3.4000	0.1478261
0913-017	Cliffton	8.4000	22.2000	3.4000	0.1531532
0930-016	Perdiz	6.9000	22.9000	3.1000	0.1353712
0943-018	Cliffton	6.9000	23.2000	4.8000	0.2068966
0967-024	Cliffton	7.9000	20.6000	4.3000	0.2087379
1021-011	Perdiz	9.3000	22.9000	2.8000	0.1222707
	Mean	7.8555556	22.311111	3.9888889	0.1798815

Figure A-17. Selected Points from Arrow Cluster 5

Top row (left to right): #158-021 (Perdiz), #159-024 (Perdiz)
Bottom row (left to right): #405-016 (Perdiz), #534-014 (Scallorn), #876-013 (Perdiz)

Table A-27. Arrow Point Measurement from Arrow Cluster 5

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0158-021	Perdiz	5.6000	17.8000	2.7000	0.1516854
0159-024	Perdiz	6.7000	21.1000	2.7000	0.1279621
0159-025	Perdiz	5.9000	19.7000	3.7000	0.1878173
0282-017	Bonham	6.0000	20.8000	2.8000	0.1346154
0405-016	Perdiz	4.3000	18.7000	3.1000	0.1657754
0473-010	Bonham	5.3000	19.5000	3.3000	0.1692308
0482-010	Perdiz	6.2000	18.7000	2.9000	0.1550802
0534-014	Scallorn	4.5000	17.8000	2.7000	0.1516854
0562-010	Bonham	6.4000	17.6000	3.5000	0.1988636
0876-013	Perdiz	6.2000	18.9000	2.2000	0.1164021
	Mean	5.7100	19.0600	2.9600	0.1559118

Figure A-18. Selected Points from Arrow Cluster 6

Top row (left to right): #525-010, #526-010, #602-017, #945-016, #989-020 (all Perdiz)
 Bottom row (left to right): #1092-015 (Scallorn), #1125-017, #1162-011, #1214-010 (all Perdiz)

Table A-28. Arrow Point Measurement from Arrow Cluster 6

Catalogue Number	Point Type	Distal Stem Width	Maximum Width	Maximum Thickness	Width:Thickness
0525-010	Perdiz	8.9000	18.8000	2.7000	0.143617
0526-010	Perdiz	8.8000	18.6000	2.6000	0.1397849
0602-017	Perdiz	8.6000	17.3000	2.9000	0.1676301
0945-016	Perdiz	8.3000	16.4000	3.3000	0.2012195
0989-020	Perdiz	9.3000	16.2000	2.3000	0.1419753
1092-015	Scallorn	8.5000	15.6000	3.4000	0.2179487
1125-017	Perdiz	7.8000	15.9000	2.7000	0.1698113
1154-010	Cliffon	9.1000	17.4000	2.9000	0.1666667
1162-011	Perdiz	10.4000	19.0000	2.9000	0.1526316
1214-010	Perdiz	8.6000	19.7000	3.0000	0.1522843
	Mean	8.8300	17.4900	2.8700	0.1654

A.6 SUMMARY AND CONCLUSIONS

It is important to remember that individual clusters do not necessarily represent types in the sense employed in traditional intuitive classification techniques. To move from morphological clusters to types, it is necessary to examine the pattern of similarities or differences among pairs or groups of clusters. The inclusion of specimens from different identified types across clusters, in the formation of morphological clusters suggests that the observed clusters were not true cultural types. While some of the patterning revealed by cluster analysis may be referable to types, there is not a necessary connection between traditional typological groups and morphological cluster groups. Numerical classification serves as a basis for defining patterning in a data set, and while it highlights patterns of correlation and covariation, it makes no arguments about cause. The causal relationships that underlie such patterning may or may not have anything to do stylistic or sociocultural variation, which is usually understood as the causal framework in traditional typological approaches to classification.

Hierarchical analysis may be useful in the situation for hypothesis testing such as dart shaft diameters, hafting depth, and prey size, and it is probable that different points may have been used for the same purpose through time. A strictly quantitative approach cannot resolve the issue of emic and etic types. The strength of the method is examining homogenous assemblages for variation, and it is up to the researcher to design the investigation to test a particular set of hypotheses.

A.6.1 Dart Points

The utility of using agglomerative hierarchical clustering methods is limited when there is readily observed variability in an assemblage

that is not adequately recorded or coded, and is not used as a discriminant. This is noticeable in the shapes of Martindale points, Bandy points, Frio points, and Gower points for example. The method is best applied to determine variations within an assemblage that may not be recognizable or standardized. Although the stated intent of this examination was to provide an objective exploratory examination of projectile points from a single site, many of the decisions regarding the selection, collection, and analysis of the data were not entirely objective, and in some instances were subjective determinations such as limiting the number of cluster analysis runs, or the number of variables used for the analysis. By testing specific within named point types, variations or patterning may emerge that could have behavioral meaning such as a reduction in overall size measurements during times of stress, or limited access to lithic resources. Changes may have occurred in hafting length and diameter through time and may represent a change in hunting strategy or prey availability. Groups were created that closely corresponded to traditional named types, but other specimens of the same type, were excluded from particular groups. Bandy points were found in two principal clusters (Clusters 5 and 7), and were separated by the selected criteria, primarily reduced to overall size of the specimens.

A.6.2 Arrow Points

The arrow point analysis suffers from limited data even more than the dart points. Perdiz points were found in all of the analyzed arrow point clusters and the assemblage represents how the use of only a few variables can create groups that incorporate a range of forms that are visually and morphologically different and do not represent a true type as Krieger envisioned. Within a defined type, variations may represent the acceptable natural deviation. The limited number of measurements was further

constrained by technology since the use of the bow dictated the limits of an efficient lithic design.

A.7 REFERENCES

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APPENDIX B:

RADIOCARBON ASSAYS

RADIOCARBON ASSAYS

By:

**Darden Hood, Beta Analytic and
Randy Culp, Center for Applied Isotopic Studies**

Prepared for:

**TRC Environmental Corporation
505 East Huntland Drive, Suite 250
Austin, Texas 78752**

Prepared by:

**Darden Hood
Beta Analytic
4985 SW 74 Court
Miami, Florida 33155**

and

**Randy Culp, Ph.D.
Center for Applied Isotopic Studies
The University of Georgia
120 Riverbend Road
Athens, Georgia 30602**

November 25, 2003

FROM: Darden Hood, Director (mailto:<mailto:dhoo@radiocarbon.com>)
(This is a copy of the letter being mailed. Invoices/receipts follow only by mail.)

October 3, 2002

Dr. James Abbott
Texas Department of Transportation
Cultural Resource Management
Environmental Affairs Division
125 East 11th Street
Austin, TX 78701
USA

RE: Radiocarbon Dating Results For Samples ED28/100-1A, ED28/102-1B, ED28/103-1

Dear Jim:

Enclosed are the radiocarbon dating results for three samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses went normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice is enclosed. Please, forward it to the appropriate officer or send VISA change authorization. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

A handwritten signature in black ink that reads "Darden Hood". The signature is written in a cursive, flowing style with a large initial "D".

Dr. James Abbott

Report Date: 10/3/02

Texas Department of Transportation

Material Received: 9/6/02

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 170400 SAMPLE : ED28/100-1A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 370 to 100 (Cal BP 2320 to 2050)	2130 +/- 40 BP	-22.3 o/oo	2170 +/- 40 BP
Beta - 170401 SAMPLE : ED28/102-1B ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1490 to 1660 (Cal BP 460 to 290)	290 +/- 40 BP	-25.2 o/oo	290 +/- 40 BP
Beta - 170402 SAMPLE : ED28/103-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (shell): acid etch 2 SIGMA CALIBRATION : Cal BC 4810 to 4680 (Cal BP 6760 to 6640)	5600 +/- 40 BP	-7.7 o/oo	5880 +/- 40 BP

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.3:lab. mult=1)

Laboratory number: Beta-170400

Conventional radiocarbon age: 2170±40 BP

2 Sigma calibrated result: Cal BC 370 to 100 (Cal BP 2320 to 2050)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 200 (Cal BP 2150)

1 Sigma calibrated results: Cal BC 350 to 300 (Cal BP 2300 to 2250) and
(68% probability) Cal BC 220 to 170 (Cal BP 2170 to 2120)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

Beta Analytic Inc.

4985 SW 74 Court, Miami, Florida 33155 USA • Tel: (305) 667 5167 • Fax: (305) 663 0964 • E-Mail: beta@radiocarbon.com

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory number: Beta-170401

Conventional radiocarbon age: 290±40 BP

2 Sigma calibrated result: Cal AD 1490 to 1660 (Cal BP 460 to 290)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1640 (Cal BP 310)

1 Sigma calibrated results: Cal AD 1520 to 1580 (Cal BP 430 to 380) and
(68% probability) Cal AD 1630 to 1650 (Cal BP 320 to 300)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

Beta Analytic Inc.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-7.7;lab. mult=1)

Laboratory number: Beta-170402

Conventional radiocarbon age: 5880±40 BP

2 Sigma calibrated result: Cal BC 4810 to 4680 (Cal BP 6760 to 6640)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 4730 (Cal BP 6680)

1 Sigma calibrated result: Cal BC 4780 to 4710 (Cal BP 6730 to 6660)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

Beta Analytic Inc.

4985 SW 74 Court, Miami, Florida 33155 USA • Tel: (305) 667 5167 • Fax: (305) 663 0964 • E-Mail: beta@radiocarbon.com

FROM: Darden Hood, Director (mailto:mailto:dhoo@radiocarbon.com)
(This is a copy of the letter being mailed. Invoices/receipts follow only by mail.)

February 25, 2003

Dr. James Abbott
Texas Department of Transportation
Cultural Resource Management
Environmental Affairs Division
125 East 11th Street
Austin, TX 78701
USA

RE: Radiocarbon Dating Results For Samples ED28/1211-4-A, ED28/1209-4-A, ED28/1208-4-A, ED28/1210-4-A, ED28/1207-4-A, ED28/76-011, ED28/158-005-7-1A, ED28/159-005-7-1A, ED28/160-005-7-1, ED28/1030-005-7-1, ED28/1055-005-7-1, ED28/171-007-1A, ED28/273-004-2-1, ED28/830-005-4-1, ED28/843-005-7-1A, ED28/154-007-1, ED28/735-005-7, ED28/203-005-4-2-1, ED28/739-005-7, ED28/100-007-1, ED28/89-007-1

Dear Jim:

Enclosed are the radiocarbon dating results for 21 samples recently sent to us. They each provided plenty of carbon for accurate measurements and all the analyses went normally. As usual, the method of analysis is listed on the report with the results and calibration data is provided where applicable.

As always, no students or intern researchers who would necessarily be distracted with other obligations and priorities were used in the analyses. We analyzed them with the combined attention of our entire professional staff.

If you have specific questions about the analyses, please contact us. We are always available to answer your questions.

Our invoice is enclosed. Please, forward it to the appropriate officer or send VISA change authorization. Thank you. As always, if you have any questions or would like to discuss the results, don't hesitate to contact me.

Sincerely,

A handwritten signature in black ink that reads "Darden Hood". The signature is written in a cursive, flowing style.

Dr. James Abbott

Report Date: 2/25/2003

Texas Department of Transportation

Material Received: 1/24/2003

Sample Data	Measured Radiocarbon Age	$^{13}\text{C}/^{12}\text{C}$ Ratio	Conventional Radiocarbon Age(*)
Beta - 175390 SAMPLE : ED28/1211-4-A ANALYSIS : Radiometric-Standard delivery (bulk low carbon analysis on sediment) MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 30 to Cal AD 240 (Cal BP 1980 to 1710)	1860 +/- 60 BP	-22.8 o/oo	1900 +/- 60 BP
Beta - 175391 SAMPLE : ED28/1209-4-A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 4220 to 3960 (Cal BP 6170 to 5910)	5190 +/- 50 BP	-22.6 o/oo	5230 +/- 50 BP
Beta - 175392 SAMPLE : ED28/1208-4-A ANALYSIS : Radiometric-Standard delivery (bulk low carbon analysis on sediment) MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 10 to Cal AD 330 (Cal BP 1960 to 1620)	1840 +/- 70 BP	-23.3 o/oo	1870 +/- 70 BP
Beta - 175393 SAMPLE : ED28/1210-4-A ANALYSIS : Radiometric-Standard delivery (bulk low carbon analysis on sediment) MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 3710 to 3500 (Cal BP 5660 to 5450) AND Cal BC 3440 to 3380 (Cal BP 5390 to 5330)	4790 +/- 70 BP	-23.0 o/oo	4820 +/- 70 BP
Beta - 175394 SAMPLE : ED28/1207-4-A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (organic sediment): acid washes 2 SIGMA CALIBRATION : Cal BC 5330 to 5070 (Cal BP 7280 to 7020)	6220 +/- 50 BP	-21.9 o/oo	6270 +/- 50 BP

Sample Data	Measured Radiocarbon Age	¹³ C/ ¹² C Ratio	Conventional Radiocarbon Age(*)
Beta - 175396 SAMPLE : ED28/76-011 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (bone collagen): collagen extraction: with alkali 2 SIGMA CALIBRATION : Cal BC 4660 to 4640 (Cal BP 6610 to 6590) AND Cal BC 4620 to 4460 (Cal BP 6570 to 6400)	5580 +/- 40 BP	-17.8 o/oo	5700 +/- 40 BP
Beta - 175397 SAMPLE : ED28/158-005-7-1A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1430 to 1530 (Cal BP 520 to 420) AND Cal AD 1560 to 1630 (Cal BP 390 to 320)	420 +/- 40 BP	-26.5 o/oo	400 +/- 40 BP
Beta - 175398 SAMPLE : ED28/159-005-7-1A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1010 to 1190 (Cal BP 940 to 760)	950 +/- 40 BP	-25.5 o/oo	940 +/- 40 BP
Beta - 175399 SAMPLE : ED28/160-005-7-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1020 to 1210 (Cal BP 930 to 740)	930 +/- 40 BP	-25.6 o/oo	920 +/- 40 BP
Beta - 175400 SAMPLE : ED28/1030-005-7-1 ANALYSIS : Radiometric-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1420 to 1650 (Cal BP 530 to 300)	390 +/- 60 BP	-25.3 o/oo	390 +/- 60 BP

Sample Data	Measured Radiocarbon Age	$^{13}\text{C}/^{12}\text{C}$ Ratio	Conventional Radiocarbon Age(*)
Beta - 175401 SAMPLE : ED28/1055-005-7-1 ANALYSIS : Radiometric-Standard delivery (with extended counting) MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1640 to 1950 (Cal BP 310 to 0)	170 +/- 60 BP	-25.4 o/oo	170 +/- 60 BP
Beta - 175402 SAMPLE : ED28/171-007-1A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 360 to 290 (Cal BP 2310 to 2240) AND Cal BC 230 to 50 (Cal BP 2180 to 2000)	2120 +/- 40 BP	-23.7 o/oo	2140 +/- 40 BP
Beta - 175403 SAMPLE : ED28/273-004-2-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 410 to 360 (Cal BP 2360 to 2310) AND Cal BC 280 to 240 (Cal BP 2230 to 2190)	2300 +/- 40 BP	-24.5 o/oo	2310 +/- 40 BP
Beta - 175404 SAMPLE : ED28/830-005-4-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1280 to 1400 (Cal BP 670 to 550)	660 +/- 40 BP	-25.0 o/oo	660 +/- 40 BP
Beta - 175405 SAMPLE : ED28/843-005-7-1A ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1680 to 1730 (Cal BP 260 to 220) AND Cal AD 1810 to 1930 (Cal BP 140 to 20) Cal AD 1950 to 1950 (Cal BP 0 to 0)	40 +/- 30 BP	-22.5 o/oo	80 +/- 30 BP

Sample Data	Measured Radiocarbon Age	$^{13}\text{C}/^{12}\text{C}$ Ratio	Conventional Radiocarbon Age(*)
Beta - 175406 SAMPLE : ED28/154-007-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 4690 to 4370 (Cal BP 6640 to 6320)	5680 +/- 60 BP	-24.4 o/oo	5690 +/- 60 BP
Beta - 175407 SAMPLE : ED28/735-005-7 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 5340 to 5200 (Cal BP 7290 to 7150) AND Cal BC 5180 to 5080 (Cal BP 7130 to 7020)	6290 +/- 50 BP	-25.6 o/oo	6280 +/- 50 BP
Beta - 175408 SAMPLE : ED28/203-005-4-2-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal BC 390 to 190 (Cal BP 2340 to 2140)	2180 +/- 40 BP	-21.9 o/oo	2230 +/- 40 BP
Beta - 175409 SAMPLE : ED28/739-005-7 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 1310 to 1370 (Cal BP 640 to 580) AND Cal AD 1380 to 1430 (Cal BP 570 to 520)	550 +/- 40 BP	-25.1 o/oo	550 +/- 40 BP
Beta - 175411 SAMPLE : ED28/100-007-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 220 to 400 (Cal BP 1730 to 1550)	1770 +/- 40 BP	-26.7 o/oo	1740 +/- 40 BP

Dr. James Abbott

Report Date: 2/25/2003

Sample Data	Measured Radiocarbon Age	$^{13}\text{C}/^{12}\text{C}$ Ratio	Conventional Radiocarbon Age(*)
Beta - 175412 SAMPLE : ED28/89-007-1 ANALYSIS : AMS-Standard delivery MATERIAL/PRETREATMENT : (charred material): acid/alkali/acid 2 SIGMA CALIBRATION : Cal AD 240 to 420 (Cal BP 1710 to 1530)	1710 +/- 40 BP	-25.5 o/oo	1700 +/- 40 BP

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.8;lab. mult=1)

Laboratory number: Beta-175390

Conventional radiocarbon age: 1900±60 BP

2 Sigma calibrated result: Cal BC 30 to Cal AD 240 (Cal BP 1980 to 1710)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 100 (Cal BP 1860)

1 Sigma calibrated result: Cal AD 50 to 150 (Cal BP 1900 to 1800)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.6:lab. mult=1)

Laboratory number: **Beta-175391**

Conventional radiocarbon age: **5230±50 BP**

2 Sigma calibrated result: **Cal BC 4220 to 3960 (Cal BP 6170 to 5910)**
(95% probability)

Intercept data

Intercepts of radiocarbon age

with calibration curve: Cal BC 4030 (Cal BP 5980) and
Cal BC 4020 (Cal BP 5970) and
Cal BC 4000 (Cal BP 5950)

1 Sigma calibrated result: **Cal BC 4050 to 3980 (Cal BP 6000 to 5920)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.3:lab. mult=1)

Laboratory number: Beta-175392

Conventional radiocarbon age: 1870±70 BP

2 Sigma calibrated result: Cal BC 10 to Cal AD 330 (Cal BP 1960 to 1620)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 130 (Cal BP 1820)

1 Sigma calibrated result: Cal AD 70 to 230 (Cal BP 1880 to 1720)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23;lab. mult=1)

Laboratory number: **Beta-175393**

Conventional radiocarbon age: **4820±70 BP**

2 Sigma calibrated results: **Cal BC 3710 to 3500 (Cal BP 5660 to 5450) and**
(95% probability) Cal BC 3440 to 3380 (Cal BP 5390 to 5330)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 3640 (Cal BP 5590)**

1 Sigma calibrated results: **Cal BC 3660 to 3620 (Cal BP 5610 to 5570) and**
(68% probability) Cal BC 3590 to 3530 (Cal BP 5540 to 5480)

References:

Database used

INTCAL98

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-21.9;lab. mult=1)

Laboratory number: **Beta-175394**

Conventional radiocarbon age: **6270±50 BP**

2 Sigma calibrated result: **Cal BC 5330 to 5070 (Cal BP 7280 to 7020)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 5280 (Cal BP 7230)**

1 Sigma calibrated result: **Cal BC 5310 to 5220 (Cal BP 7260 to 7170)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-17.8;lab. mult=1)

Laboratory number: **Beta-175396**

Conventional radiocarbon age: **5700±40 BP**

2 Sigma calibrated results: **Cal BC 4660 to 4640 (Cal BP 6610 to 6590) and
(95% probability) Cal BC 4620 to 4460 (Cal BP 6570 to 6400)**

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 4520 (Cal BP 6470)**

1 Sigma calibrated result: **Cal BC 4560 to 4480 (Cal BP 6510 to 6430)**
(68% probability)

References:

Database used

INTCAL98

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et al., 1998, Radiocarbon 40(3), p1041-1083

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.5:lab. mult=1)

Laboratory number: **Beta-175397**

Conventional radiocarbon age: **400±40 BP**

2 Sigma calibrated results: **Cal AD 1430 to 1530 (Cal BP 520 to 420) and**
(95% probability) Cal AD 1560 to 1630 (Cal BP 390 to 320)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal AD 1460 (Cal BP 490)**

1 Sigma calibrated result: **Cal AD 1440 to 1500 (Cal BP 510 to 450)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5;lab. mult=1)

Laboratory number: **Beta-175398**

Conventional radiocarbon age: **940±40 BP**

2 Sigma calibrated result: Cal AD 1010 to 1190 (Cal BP 940 to 760)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal AD 1040 (Cal BP 910)**

1 Sigma calibrated result: Cal AD 1030 to 1160 (Cal BP 920 to 790)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6:lab. mult=1)

Laboratory number: **Beta-175399**

Conventional radiocarbon age: **920±40 BP**

2 Sigma calibrated result: **Cal AD 1020 to 1210 (Cal BP 930 to 740)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve:

Cal AD 1060 (Cal BP 890) and
Cal AD 1080 (Cal BP 860) and
Cal AD 1150 (Cal BP 800)

1 Sigma calibrated result: **Cal AD 1030 to 1180 (Cal BP 920 to 780)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.3;lab. mult=1)

Laboratory number: **Beta-175400**

Conventional radiocarbon age: **390±60 BP**

2 Sigma calibrated result: Cal AD 1420 to 1650 (Cal BP 530 to 300)
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1470 (Cal BP 480)

1 Sigma calibrated results: Cal AD 1440 to 1520 (Cal BP 510 to 430) and
(68% probability) Cal AD 1580 to 1630 (Cal BP 380 to 320)

References:

Database used

INTCAL98

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.4:lab.m ult=1)

Laboratory number: **Beta-175401**

Conventional radiocarbon age: **170±60 BP**

2 Sigma calibrated result: Cal AD 1640 to 1950 (Cal BP 310 to 0)
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve:

Cal AD 1680 (Cal BP 270) and
Cal AD 1770 (Cal BP 180) and
Cal AD 1800 (Cal BP 150) and
Cal AD 1940 (Cal BP 10) and
Cal AD 1950 (Cal BP 0)

1 Sigma calibrated results: Cal AD 1660 to 1700 (Cal BP 290 to 250) and
(68% probability) Cal AD 1720 to 1820 (Cal BP 230 to 130) and
Cal AD 1840 to 1880 (Cal BP 110 to 70) and
Cal AD 1920 to 1950 (Cal BP 30 to 0)

References:

Database used

INTCAL98

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-23.7;lab. mult=1)

Laboratory number: **Beta-175402**

Conventional radiocarbon age: **2140±40 BP**

2 Sigma calibrated results: **Cal BC 360 to 290 (Cal BP 2310 to 2240) and**
(95% probability) Cal BC 230 to 50 (Cal BP 2180 to 2000)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 180 (Cal BP 2130)**

1 Sigma calibrated result: **Cal BC 200 to 110 (Cal BP 2150 to 2060)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.5:lab. mult=1)

Laboratory number: **Beta-175403**

Conventional radiocarbon age: **2310±40 BP**

2 Sigma calibrated results: Cal BC 410 to 360 (Cal BP 2360 to 2310) and
(95% probability) Cal BC 280 to 240 (Cal BP 2230 to 2190)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal BC 390 (Cal BP 2340)

1 Sigma calibrated result: Cal BC 400 to 380 (Cal BP 2350 to 2330)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25:lab. mult=1)

Laboratory number: **Beta-175404**

Conventional radiocarbon age: **660±40 BP**

2 Sigma calibrated result: **Cal AD 1280 to 1400 (Cal BP 670 to 550)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal AD 1300 (Cal BP 650)**

1 Sigma calibrated results: **Cal AD 1290 to 1310 (Cal BP 660 to 640) and**
Cal AD 1360 to 1390 (Cal BP 590 to 560)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-22.5;lab. mult=1)

Laboratory number: **Beta-175405**

Conventional radiocarbon age: **80±30 BP**

2 Sigma calibrated results: Cal AD 1680 to 1730 (Cal BP 260 to 220) and
(95% probability) Cal AD 1810 to 1930 (Cal BP 140 to 20) and
Cal AD 1950 to 1950 (Cal BP 0 to 0)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1950 (Cal BP 0)

1 Sigma calibrated results: Cal AD 1700 to 1720 (Cal BP 250 to 230) and
(68% probability) Cal AD 1820 to 1840 (Cal BP 130 to 110) and
Cal AD 1880 to 1920 (Cal BP 70 to 30) and
Cal AD 1950 to 1950 (Cal BP 0 to 0)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-24.4;lab. mult=1)

Laboratory number: **Beta-175406**

Conventional radiocarbon age: **5690±60 BP**

2 Sigma calibrated result: **Cal BC 4690 to 4370 (Cal BP 6640 to 6320)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 4510 (Cal BP 6460)**

1 Sigma calibrated result: **Cal BC 4580 to 4460 (Cal BP 6530 to 6410)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.6;lab. mult=1)

Laboratory number: **Beta-175407**

Conventional radiocarbon age: **6280±50 BP**

2 Sigma calibrated results: **Cal BC 5340 to 5200 (Cal BP 7290 to 7150) and**
(95% probability) Cal BC 5180 to 5080 (Cal BP 7130 to 7020)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal BC 5290 (Cal BP 7240)**

1 Sigma calibrated result: **Cal BC 5310 to 5230 (Cal BP 7260 to 7180)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-21.9:lab. mult=1)

Laboratory number: **Beta-175408**

Conventional radiocarbon age: **2230±40 BP**

2 Sigma calibrated result: **Cal BC 390 to 190 (Cal BP 2340 to 2140)**
(95% probability)

Intercept data

Intercepts of radiocarbon age

with calibration curve: Cal BC 360 (Cal BP 2310) and
Cal BC 280 (Cal BP 2230) and
Cal BC 240 (Cal BP 2190)

1 Sigma calibrated results: Cal BC 380 to 340 (Cal BP 2330 to 2290) and
(68% probability) Cal BC 320 to 210 (Cal BP 2270 to 2160)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, *Radiocarbon* 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, *Radiocarbon* 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, *Radiocarbon* 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1;lab. mult=1)

Laboratory number: Beta-175409

Conventional radiocarbon age: 550 ± 40 BP

2 Sigma calibrated results: Cal AD 1310 to 1370 (Cal BP 640 to 580) and
(95% probability) Cal AD 1380 to 1430 (Cal BP 570 to 520)

Intercept data

Intercept of radiocarbon age
with calibration curve: Cal AD 1410 (Cal BP 540)

1 Sigma calibrated result: Cal AD 1400 to 1420 (Cal BP 550 to 530)
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.7:lab. mult=1)

Laboratory number: **Beta-175411**

Conventional radiocarbon age: **1740±40 BP**

2 Sigma calibrated result: **Cal AD 220 to 400 (Cal BP 1730 to 1550)**
(95% probability)

Intercept data

Intercepts of radiocarbon age

with calibration curve: Cal AD 260 (Cal BP 1690) and
Cal AD 290 (Cal BP 1660) and
Cal AD 320 (Cal BP 1630)

1 Sigma calibrated result: **Cal AD 240 to 370 (Cal BP 1710 to 1580)**
(68% probability)

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxii-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

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CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.5:lab. mult=1)

Laboratory number: **Beta-175412**

Conventional radiocarbon age: **1700±40 BP**

2 Sigma calibrated result: **Cal AD 240 to 420 (Cal BP 1710 to 1530)**
(95% probability)

Intercept data

Intercept of radiocarbon age
with calibration curve: **Cal AD 370 (Cal BP 1580)**

1 Sigma calibrated results: **Cal AD 260 to 290 (Cal BP 1690 to 1660)** and
(68% probability) **Cal AD 320 to 400 (Cal BP 1630 to 1550)**

References:

Database used

Calibration Database

Editorial Comment

Stuiver, M., van der Plicht, H., 1998, Radiocarbon 40(3), pxi-xiii

INTCAL98 Radiocarbon Age Calibration

Stuiver, M., et. al., 1998, Radiocarbon 40(3), p1041-1083

Mathematics

A Simplified Approach to Calibrating C14 Dates

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The University of Georgia

Center for Applied Isotope Studies

RADIOCARBON AGE ANALYSIS REPORT

November 25, 2003

Dr. James T. Abbott
Staff Geosarcheologist
Cultural Resources Management
Texas Department of Transportation
Dewitt C. Greer State Highway Bldg.
125 E. 11th Street
Austin, TX 78701-2483

Dear Dr. Abbott,

Enclosed please find the results for the Radiocarbon (^{14}C) analysis including Stable Isotope Ratio analysis ($\delta^{13}\text{C}$) correction for the samples received by our laboratory on October 6, 2003.

UGA# Sample
I.D.

	Radiocarbon		$\delta^{13}\text{C}$
	Age (YBP $\pm 1\sigma$)	$\delta^{13}\text{C}$ Corrected Age (YBP $\pm 1\sigma$)	(Years corrected)
12704 41ED28/11-005-004-007-1a:	1,380 $\pm$ 40	1,390 $\pm$ 40	-24.27 (+12)
12705 41ED28/37-005-004-007-1a:	4,230 $\pm$ 40	4,260 $\pm$ 40	-23.37 (+26)
12706 41ED28/76-002-11c:	5,180 $\pm$ 40	5,270 $\pm$ 40	-19.71 (+85)
12707 41ED28/78-005-007-1a:	380 $\pm$ 40	380 $\pm$ 40	-24.85 (+2)
12708 41ED28/89-005-002-1:		To be determined	
12709 41ED28/128-005-004-007-1a:	5,220 $\pm$ 40	5,200 $\pm$ 40	-26.23 (-20)
12710 41ED28/159-0005-008-1a:	2,920 $\pm$ 40	3,080 $\pm$ 40	-15.35 (+157)
12711 41ED28/179-005-004-007-1a:	2,240 $\pm$ 40	2,290 $\pm$ 40	-21.69 (+53)
12712 41ED28/255-002-1:	5,270 $\pm$ 40	5,340 $\pm$ 40	-21.00 (+65)
12713 41ED28/293-002-1:	610 $\pm$ 40	860 $\pm$ 40	-9.80 (+248)
12714 41ED28/298-005-007-1a:	560 $\pm$ 40	550 $\pm$ 40	-25.34 (-5)
12715 41ED28/344-007-1a:	5,440 $\pm$ 40	5,410 $\pm$ 40	-26.59 (-26)
12716 41ED28/418-002-1:	2,230 $\pm$ 40	2,290 $\pm$ 40	-21.48 (+57)
12717 41ED28/418-007-1a:	4,740 $\pm$ 40	4,770 $\pm$ 40	-23.32 (+27)
12718 41ED28/515-005-004-007-1:	2,000 $\pm$ 40	1,990 $\pm$ 40	-25.67 (-11)
12719 41ED28/522-002-1a:	3,850 $\pm$ 40	3,910 $\pm$ 40	-21.21 (+61)
12720 41ED28/531-007-1a:	5,500 $\pm$ 40	5,500 $\pm$ 40	-25.16 (-3)
12721 41ED28/570-007-1a:	6,090 $\pm$ 40	6,100 $\pm$ 40	-24.65 (+6)
12722 41ED28/607-007-1a:	5,580 $\pm$ 40	5,560 $\pm$ 40	-26.22 (-20)
12723 41ED28/615-005-007-2a:	5,440 $\pm$ 40	5,660 $\pm$ 40	-11.61 (+218)
12724 41ED28/616-005-007-1a:	5,610 $\pm$ 40	5,640 $\pm$ 40	-23.17 (+29)

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The University of Georgia

Center for Applied Isotopic Studies

Dr. James T. Abbott

Page 2 of 2

November 25, 2003

UGA# Sample

I.D.

	Age (YBP $\pm 1\sigma$)	Radiocarbon $\delta^{13}\text{C}$ Corrected Age (YBP $\pm 1\sigma$)	$\delta^{13}\text{C}$ (Years corrected)
12725 41ED28/801-005-004-007-2a:	2,130 $\pm$ 40	2,140 $\pm$ 40	-24.54 (+7)
12726 41ED28/865-005-004-007-1a:	640 $\pm$ 40	620 $\pm$ 40	-26.69 (-21)
12727 41ED28/987-008-1a:	26,510 $\pm$ 40	26,960 $\pm$ 40	+1.99 (+446)
12728 41ED28/1026-005-007-1a:	320 $\pm$ 40	320 $\pm$ 40	-24.81 (+3)
12729 41ED28/1030-005-003-2c:	11,690 $\pm$ 40	11,980 $\pm$ 40	-7.08 (+293)
12730 41ED28/1089-008-1a:	190 $\pm$ 40	310 $\pm$ 40	-17.76 (+117)
12731 41ED28/1118-008-1a:	21 $\pm$ 40	60 $\pm$ 40	-22.77 (+36)
12732 41ED28/1217-005-004-007-1d:	630 $\pm$ 40	600 $\pm$ 40	-26.61 (-26)
12733 41ED28/1218-007-1d:	5,430 $\pm$ 40	5,400 $\pm$ 40	-26.66 (-27)
12734 41ED28/1219-005-007-1c:	300 $\pm$ 40	300 $\pm$ 40	-24.72 (+4)
12735 41BX5/SAAN13002-c:	1,760 $\pm$ 40	1,900 $\pm$ 40	-16.41 (+139)
12736 41BX5/SAAN13011-a:	360 $\pm$ 40	490 $\pm$ 40	-17.07 (+128)
12737 41KM16/25:	810 $\pm$ 40	850 $\pm$ 40	-22.53 (+40)
12738 41KM16/385:	980 $\pm$ 40	1,030 $\pm$ 40	-22.22 (+45)
12739 41KM16/481:	1,140 $\pm$ 40	1,200 $\pm$ 40	-21.49 (+57)
12740 41RE1/1872-6a:	2,420 $\pm$ 40	2,500 $\pm$ 40	-19.91 (+82)
12741 41RE1/1872-48a:	1,100 $\pm$ 40	1,200 $\pm$ 40	-18.83 (+100)

All the above listed samples were pretreated with acid, alkali and acid to remove potential contaminants from the surface and interior prior to processing for AMS dating.

If you have any questions, or need additional information, please do not hesitate to call.

Sincerely,

Randy Culp
Research Coordinator

C.A.I.S. Inv. No. 6061

All dates are reported in years before present (0 YBP=1950 A.D.). By international convention, the half-life of radiocarbon is taken to be 5568 years. Standardization is with the National Institute of Standards and Technology's Oxalic Acid SRM-4990C, which is taken to be 129% modern (1950). The uncertainty in the reported age is at a one standard deviation confidence level (68% probability). Stable carbon isotope ratios ($\delta^{13}\text{C}$) are given both as per mil (‰) difference from PDB-1 standard ratio and as the corrected radiocarbon age, in YBP. The corrected age facilitates the comparison of different materials which form in nature with different carbon isotope ratios. To obtain a corrected date, this correction factor should be added to the reported age (YBP).

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Atmospheric data from Stuiver et al. (1998); OxCal v3.5 Bronk Ramsey (2000), calb r=4 sd:12 probd asp[chron]

UGA12727 : 26960±40BP

68.2% probability
25050BC (68.2%) 24965BC
95.4% probability
25100BC (95.4%) 24920BC

APPENDIX C:

**RESULTS OF MICROSCOPIC USE-WEAR AND RESIDUE ANALYSES FROM THE
VARGA SITE 41ED28, TEXAS**

RESULTS OF MICROSCOPIC USE-WEAR AND RESIDUE ANALYSES FROM THE VARGA SITE 41ED28, TEXAS

By:

Bruce L. Hardy, Ph.D.

Prepared for:

**TRC Environmental Corporation
505 East Huntland Drive, Suite 250
Austin, Texas 78752**

Prepared by:

**Bruce L. Hardy, Ph.D.
Department of Anthropology
Grand Valley State University
Allendale, MI 49401**

April 19, 2004

C.1 INTRODUCTION

A sample of 154 artifacts from the Varga Site (41ED28) in southwest Texas was analyzed microscopically for evidence of residues and use-wear. The Varga Site is a multi-component site ranging in age from ca. 170 to 6300 B.P. The youngest component is referred to as Toyah and dates from approximately 170 to 700 B.P. Directly underneath the Toyah component is a Late Archaic component (ca. 1700 to 2200 B.P.) characterized by a large cluster of burned rocks (6 m wide). An underlying Middle Archaic component dates from 3900 to 4820 B.P. and probably represents multiple events accumulated over a long period of time. The lowest archaeological level at the site is a 30 cm thick Early Archaic component that dates between ca. 5200 and 6300 B.P. The vast majority of these artifacts were not washed prior to analysis.

Typologically, the sample includes edge-modified flakes, bifaces, scrapers, gouges, spokeshaves, drills, gravers, and a variety of different styles of projectile points. Stone tool type and function are not necessarily linked. Scrapers, for example have been shown to have been used in hide processing (Schultz 1992; McDevitt 1994; Sliva and Keeley 1994; Boszhardt and McCarthy 1999; Petraglia *et al.* 1996) as well as plant and wood processing (Anderson-Gerfaud 1990; Hardy and Garufi 1998; Hardy and Kay 1999; Hardy *et al.* 2001). Different styles of projectile points may likewise have performed various functions (Shea 1992; Hardy and Kay 1998; Hardy *et al.* 2001).

C.2 METHODS

All artifacts were examined using bright field reflected light microscopy at magnifications ranging from 100 to 500 diameters using an Olympus BX-30 microscope for the presence of residues or wear related to use. Artifacts were examined in the condition in which they arrived

in order to identify potential residues, which can sometimes survive artifact washing. Line drawings of each artifact were used to record the location of any wear or residues. All residues and wear patterns were photographed and compared with experimental and published material for identification (Anderson-Gerfaud 1990; Beyries 1988; Brunner and Koman 1974; Fullagar 1991; Hardy 1994; Hardy and Garufi 1998; Hoadley 1990; Hather 1993; Kardulias and Yerkes 1996). Potentially recognizable residues include animal (hair, feather, skin, bone, antler, and blood) and plant (starch grains, cellular tissue, wood fragments, and phytoliths) material (Anderson 1980; Anderson-Gerfaud 1981, 1986, 1990; Barton *et al.* 1998; Briuer 1976; Fullagar and Field 1997; Gorski 1997; Hardy 1994; Hardy 1998; Hardy and Kay 1998; Hardy and Garufi 1998; Hurcombe 1992; Jahren *et al.* 1997; Kealhofer *et al.* 1999; Loy 1983, 1986, 1993; Loy and Wood 1989; Loy and Hardy 1992; Loy *et al.* 1992; Shafer and Holloway 1979; Sobolik 1996). Use-wear identification concentrated on striations, polish, and edge rounding to help identify the area of an artifact that was used and the use-action. Use-wear was not used to identify specific use-materials beyond the level of hard/high silica vs. soft material (Fullagar 1991). Hard/high silica material includes bone, antler, wood and high silica plants such as certain grasses. All of these materials produce polish, which is highly reflective with high areas rounded or domed. In the case of hard materials (antler, bone, and wood), the polish is most likely produced by abrasion and subtraction of material from the surface. High silica plants (grasses, some wood) probably produce the same type of polish through the addition of silica to the tool surface. It is extremely difficult to distinguish between these types of polish without other functional evidence (Fullagar 1991). The soft category includes animal tissue other than bone (hide,

muscle, hair) as well as plants that are not highly siliceous.

Use-actions

Use-actions were determined based on the distribution of use-wear, particularly striations, and residues on the tool surface. Use-actions include scraping, planning, slicing, whittling, boring, and cutting. These use-actions conform to common definitions used in lithic functional analysis literature (Keeley 1980; Mansur-Franchomme 1986). Boring may also be referred to as perforating. Cutting indicates that an edge was clearly used, but the orientation and direction of use is indeterminate. Direction of use is indicated by two parallel lines (||) to indicate use was parallel to the long axis while actions perpendicular to the long axis is indicated by a symbol $\perp$.

C.3 RESULTS

Toyah Component ca. 290 to 700 B.P. (n=57)

The Toyah sample is comprised of projectile points (Cliffton, Perdiz, Gurrero, Bonham and leaf-shaped), drills, scrapers, edge-modified rejuvenation flakes, spokeshaves, graters, bifaces, and edge-modified flakes. Preservation is excellent in the Toyah component. Residues observed include plant remains, starch grains, hair, feather barbules, wood fragments, and possible blood. Table C-1 summarizes the range of findings for each typological category with details on individual tools presented in Table C-2.

Late Archaic Component ca. 1700 to 2300 B.P. (n=17)

The Late Archaic sample is composed of bifaces, scrapers, edge-modified flakes, and projectile points (Montell and Edgewood) and one uniface rejuvenation flake. Residues from

this component include hair, wood fragments, plant fibers and tissue, and raphides. Raphides are calcium oxalate crystals that can occur in the cells of some plants (Fahn 1982). Because they are high in inorganic components, they often survive well in archaeological settings. Table C-3 summarizes the range of evidence for each typological category with details on individual tools presented in Table C-4.

Middle Archaic Component ca. 3900 to 4800 B.P. (n=17)

The Middle Archaic sample includes bifaces, scrapers, edge-modified flakes, and Early Triangular points. Residues found in this sample include hair, wood fragments, and plant tissue. Table C-5 summarizes the range of evidence for each tool type with details on individual tools presented in Table C-6.

Early Archaic Component ca. 5200 to 6300 B.P. (n=63)

The Early Archaic sample includes projectile points (Martindale, Bandy, Early Corner-notched [Group 2], Baker, Gower, Untyped Group I), drills, gouges, scrapers, bifaces, unifaces, edge-modified flakes, and rejuvenation flakes. This level preserves numerous residues including raphides, plant tissue, starch grains, plant fibers, wood fragments, bone/antler, hair, possible blood, and charcoal. Many of the tools exhibit raphides randomly distributed across their surface suggesting that raphides may be depositional rather than use-related. Table C-7 summarizes the range of evidence for each tool type with details on individual tools presented in Table C-8.

Table C-1. Summary of Toyah Component Results by Tool Type

Type	N	Haft Residues	Use Residues	Wear	Hafted	Use-actions	Use-materials
Cliffton Points	4	Plant fiber	Wood	Striae	Yes	Unknown, cutting	Unknown, wood
Perdiz Point	1	None	None	H/HS polish	Yes	Projectile point	Unknown
Gurrero Point	1	None	None	None	Unknown	Unknown	Unknown
Bonham Point	1	Resin	None	Light polish	Yes	Projectile point	Unknown
Leaf shaped Point	1	Plant fragments	None	None	Yes	Unknown	Unknown
Drills	2	None	None	H/HS polish	1 of 2	Cutting	H/HS, unknown
Scrapers	6	Resin	Plant, possible blood, starch grains, hair	Striae, H/HS polish, edge rounding, soft polish	2 of 6	Planing, scraping	H/HS, plant, starchy plant, hide
Rejuvenation flakes	5	None	None	H/HS, soft polish	No	Planing, scraping	H/HS, soft
Spoke-shaves	3	None	Plant fibers, wood fragments	H/HS polish, striae	No	Scraping, planing	Wood, H/HS plant
Gravers	3	Abraded ridges	Hair, plant	Soft, H/HS polish, striae	1 of 3	Cutting, scraping, slicing	Animal, wood, H/HS
Biface	7	Wood, plant	Hair, starch grains, feathers, wood, possible blood, plant	H/HS, soft polish, striae	2 of 7	Projectile, cutting, scraping, planing, whittling	Plant, animal, bird, soft, H/HS, wood
Edge-modified flakes	23	None	Plant, starch gains, hair, wood	Soft, H/HS polish, striae, edge rounding	1 of 23	Scraping, planing, whittling, slicing, cutting	H/HS, soft, starchy plant, animal, wood

^a Hafting residues are confined to the proximal 1/3 to 1/2 portion of the artifact; ^bHafting wear confined to proximal 1/3 to 1/2 of the artifact. || and ⊥ refer to parallel and perpendicular to the long axis of the artifact respectively; ^cUse-residues are confined to the distal portion of the artifact near or on the working edge; ^dUse-wear is confined to the distal portion of the artifact near or on the working edge. || and ⊥ refer to parallel and perpendicular to the working edge respectively.

Table C-2. Toyah Component (ca. 300-650 B.P.), Individual Residue and Use-wear Results

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
22-014	Clifton point	-----	Abraded ridges	-----	-----	Hafted, unknown	Unknown
109-011	Edge-modified	-----	-----	-----	H/HS polish, striae $\perp$	Scraping	H/HS
159-5-27	Edge-modified flake	-----	-----	Plant fiber, starch grains	H/HS polish	Scraping	H/HS plant with starch
159-5-28	Biface	Wood	Striae $\perp$, impact striae	Hair, starch grains	H/HS polish	Multiple uses, projectile, cutting	H/HS plant, animal
168-10	Edge-modified flake	-----	-----	Wood fragments	H/HS polish	Scraping	Wood
207-011	Edge-modified flake	-----	-----	-----	H/HS polish, edge rounding	Scraping	H/HS
220-15	Biface tip Distal snap	-----	-----	Feather barbules, wood (scalariform pitting)	Striae $\parallel$ to edge Light polish	Cutting	Bird, wood
281-015	Edge-modified flake	-----	-----	-----	H/HS polish	Scraping	H/HS
314-10	Edge-modified flake	-----	-----	-----	H/HS polish, striae $\perp$	Whittling	H/HS
358-010	Spokeshave	-----	-----	Plant fibers	H/HS polish	Scraping	H/HS plant
406-010	Guerrero pt.	-----	-----	-----	-----	Unknown	Unknown
441-016	Perdiz pt.	-----	H/HS polish	-----	H/HS polish	Proj. pt.	H/HS
473-010	Bonham point	Resin	Polish	-----	Impact fracture	Hafted proj. pt.	Unknown

Table C-2: Toyah Component (ca. 300-650 B.P.), Individual Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
474-010	Edge-modified	-----	-----	-----	H/HS polish, striae, multiple orientations	Whittling	H/HS
781-010	Edge-modified	-----	Striae, multiple orientations, H/HS polish	-----	Soft polish	Hafted, scraping	Soft
800-10	Drill	-----	-----	Plant frag	Light polish	Unknown	Plant
800-11	Scraper	Resin	-----	-----	Striae $\parallel$ to edge, H/HS polish	Planing/ scraping (both surfaces in contact)	H/HS material (wood, bone, or antler)
800-012	Edge-modified flake	-----	-----	-----	H/HS polish	Cutting	H/HS
805-013	Uniface rejuvenation flake	-----	-----	-----	H/HS polish	Planing	H/HS
806-017	Edge-modified flake	-----	-----	Hair w/ scales and medulla	Striae oblique, $\parallel$	Slicing	Animal
811-02	Edge-rejuvenation flake	-----	-----	-----	H/Hs polish	Scraping	H/HS
836-010	Graver	-----	-----	Hairs	Striae, multiple orientations, soft polish	Cutting	Animal
837-019	Perforator-edge-modified	-----	-----	-----	Striae, mult. Orientations, H/HS polish	Boring	H/HS
841-013	Rejuvenation flake	-----	-----	-----	Soft polish, striae $\perp$	Scraping	Soft

Table C-2. Toyah Component (ca. 300-650 B.P.), Individual Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
881-17	Edge-modified flake	-----	-----	Wood fragments	H/HS polish, microflake scars	Whittling	Wood
885-010	Edge-modified	-----	-----	Wood fragments	Edge rounding, striae oblique	Slicing	Wood
888-14	Scraper	Resin	Striae in resin	Plant fiber	Striae ⊥, H/HS polish	Planing (ventral surface in contact)	H/HS plant
893-016	Drill	-----	H/HS polish	-----	Light polish	Hafted, cutting	Unknown
903-12	Scraper- side	-----	-----	Additive residue (PBR?)	Soft polish	Scraping	Soft material
903-22	Biface	-----	-----	Wood	H/HS polish	Whittling	Wood
903-24	Scraper- side/end	-----	-----	Plant tissue, starch grains	H/HS polish, striae ⊥	Planing	H/HS plant, starch present
914-011	Cliffion point	-----	H/HS polish	Wood fragments	Striae, mult. Orientations	Cutting	Wood
931-011	Edge-modified flake	-----	-----	-----	H/HS polish, striae ⊥	Whittling	H/HS
934-011	Graver	-----	Abraded ridges	-----	H/HS polish, striae, mult. Orientations	Hafted, scraping	H/HS
934-19	Biface (snap)	-----	-----	Plant tissue- wood	H/HS polish	Cutting	Wood
937-010	Biface	-----	-----	Wood fragments	H/HS polish	Scraping	Wood
943-018	Cliffion point	Plant fragments	Striae, mult. Orientations	-----	-----	Hafted, plant binding, unknown use	Unknown
999-010	Edge-modified flake	-----	-----	Hair, possible blood residue	Striae oblique,	Scraping	Hide

Table C-2. Toyah Component (ca. 300-650 B.P.), Individual Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
999-013	Uniface rejuvenation flake	-----	-----	-----	HHS polish, striae ⊥	Scraping	H/HS
1019-010	Edge-modified flake	-----	-----	-----	H/HS polish, striae	Slicing	H/HS
1019-18	Edge-modified flake	-----	-----	-----	Soft polish	Scraping	Soft
1020-010	Edge-modified flake	-----	-----	Wood fragments	H/HS polish	Scraping	Wood
1023-12	Side/end scraper	-----	-----	-----	H/HS polish, edge rounding, striae ⊥	Planing	H/HS
1024-11	Spokeshave	-----	-----	Wood fragments	H/HS polish, striae ⊥	Scraping	Wood
1029-005-11	Edge-modified flake	-----	-----	-----	H/HS polish, striae ⊥	Scraping	H/HS
1030-005-10	Padre Point-Leaf Shaped	Striae oblique, polish	Plant fragments	-----	-----	Hafted, unknown use	Unknown
1032-10	Edge-modified flake	-----	-----	-----	H/HS polish	Scraping	H/HS
1036-015	Spokeshave	-----	-----	Wood fragments	Striae oblique, ⊥	Planing	Wood
1038-012	Uniface rejuvenation flake	-----	-----	-----	H/Hs polish	Scraping	H/HS

Table C-2. Toyah Component (ca. 300-650 B.P.), Individual Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
1041-14	Biface frag	-----	-----	Plant tissue	Striae, mult. Orientation, ⊥	Whittling, cutting w/ mult. Orientations	Plant
1074-11	Edge-modified flake	-----	-----	Plant tissue	H/HS polish, striae ⊥	Whittling	H/HS plant
1088-010	Scraper/graver	-----	-----	Plant cells	Striae	Slicing	Wood
1132-10	Side scraper/unifacete	-----	-----	Hair	Edge rounding, marginal polish	Scraping	Hide
1154-010	Cliffion pt.	-----	Striae	-----	-----	Hafted, unknown	Unknown
1190-010	Edge-modified	-----	-----	-----	H/HS polish	Planing	H/HS
1194-10	Edge-modified flake	-----	-----	-----	H/HS polish	Planing	H/HS
1256-11	Biface frag	Plant fibers	Striae	-----	-----	Projectile- impact/haft striae	Unknown

^a Hafting residues are confined to the proximal 1/3 to 1/2 portion of the artifact; ^b Hafting wear confined to proximal 1/3 to 1/2 of the artifact. || and ⊥ refer to parallel and perpendicular to the long axis of the artifact respectively; ^c Use-residues are confined to the distal portion of the artifact near or on the working edge; ^d Use-wear is confined to the distal portion of the artifact near or on the working edge. || and ⊥ refer to parallel and perpendicular to the working edge respectively.

Table C-3. Summary of Late Archaic Component Results by Tool Type

Type	N	Haft Residues	Use Residues	Wear	Hafted	Use-actions	Use-materials
Bifaces	4	Clear residue (resin?)	Wood, plant, skin	Striae, H/HS, soft, edge rounding	1 of 4	Cutting, scraping, unknown	Wood, hide, H/HS plant, unknown
Scrapers	3	None	Wood, plant	Striae, H/HS polish	No	Scraping, planning	H/HS plant, wood
Edge-modified flakes	8	None	Plant fibers, raphides, hair	H/HS, soft polish, striae	No	Scraping, whittling, cutting, slicing	Hide, H/HS, soft, H/HS plant, unknown
Edgewood point	1	None	Wood	H/HS, polish	Yes	Cutting	Wood
Montell point	1	None	None	Impact	Yes	Projectile	Unknown

Table C-4. Late Archaic Component (ca. 1700-2200 B.P.), Individual Residue and Use-wear Results

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
2-10	End scraper	-----	-----	-----	H/HS polish	Scraping	H/HS
2-11	Edge-modified flake	-----	-----	Degraded hair	Striae ⊥	Scraping	Hide
2-12	Biface	-----	-----	Wood fragments	Striae, mult. Orientations Invasive H/HS polish	Cutting, multiple orientations	Wood
3-010	Side and end scraper	-----	-----	Wood fragments	H/HS polish	planing	Wood
11-5-14	Edgewood proj. pt.	-----	Polish, striae	Wood fragments	H/HS polish	Cutting	Wood (wood could be haft related)
98-11	Edge-modified flake	-----	-----	-----	Light polish	Cutting	Unknown
98-012	Edge-modified flake	-----	-----	Hair	Light polish	Scraping	Hide
198-010	Montell point	-----	Heavy polish	-----	Impact fracture	Proj. point	Unknown
208-010	Graver	-----	-----	Plant fibers	H/HS polish, striae ⊥	Scraping/boring	H/HS plant
233-10	Biface	-----	-----	Plant tissue	Heavy polish, edge rounding	Scraping	H/HS plant
263-10	Biface	-----	-----	Plant, skin?	Soft polish	Cutting	Skin/hide
274-5-11	Biface	Additive residue, clear	Polish, striae	-----	Polish	Hafted, use unknown	Unknown
283-012	Edge-modified	-----	-----	-----	H/HS polish, striae	Slicing	H/HS
293-5-13	Scraper side/end	-----	-----	Plant tissue	H/HS polish, striae ⊥	Scraping- all retouched edges used	H/HS plant (wood)
353-10	Edge-modified	-----	-----	-----	H/HS polish	Whittling	H/HS
491-010	Edge-modified	-----	-----	-----	Soft polish, striae oblique	Cutting	Soft
543-12	Edge-modified	-----	-----	Plant fibers, raphides	H/HS polish	Scraping, whittling	H/HS plant

^a Hafting residues are confined to the proximal 1/3 to 1/2 portion of the artifact; ^b Hafting wear confined to proximal 1/3 to 1/2 of the artifact. || and ⊥ refer to parallel and perpendicular to the long axis of the artifact respectively; ^c Use-residues are confined to the distal portion of the artifact near or on the working edge; ^d Use-wear is confined to the distal portion of the artifact near or on the working edge. || and ⊥ refer to parallel and perpendicular to the working edge respectively.

Table C-5. Summary of Middle Archaic Component Results by Tool Type

Type	N	Haft Residues	Use Residues	Wear	Hafted	Use-actions	Use-materials
Bifaces	2	None	None	H/HS polish, striae	No	Cutting, scraping	H/HS
Scrapers	2	None	Hair	Striae, soft polish	No	Planing, scraping	Hide, soft
Edge-modified flakes	9	None	Wood, plant fibers, plant tissue	H/HS polish, striae	No	Whittling, scraping, cutting, planing	Wood, H/HS, soft, plant
Early Triangular points	4	None	Hair	H/HS polish, striae	2 of 3	Gouging, cutting, whittling unknown	Hide, H/HS

Table C-6. Middle Archaic Component (ca. 3900-4820 B.P.), Individual Residue and Use-wear Results

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-Wear ^d	Inferred Use	Contact Material
56-011	Edge-modified flake	-----	-----	Wood fragments	H/HS polish, striae ⊥	Whittling	Wood
100-11	End scraper	-----	-----	Hair	Striae ⊥, oblique	Planing	Hide
182-013	Early Triangular point	-----	-----	Hair fragment	Light polish at either end	Unknown	Hide
274-005-10	Edge-modified	-----	-----	-----	H/HS polish	Cutting	H/HS
308-011	Early Triangular point	-----	Abraded ridges	-----	H/HS polish, edge damage (step fractures)	Hafted, gouging	H/HS
387-10	Edge-modified flake	-----	-----	Plant fibers	H/HS polish, striae ⊥	Planing	H/HS plant
397-010	Edge-modified flake	-----	-----	-----	Soft polish	Scraping	Soft
397-013	Edge-modified flake	-----	-----	-----	H/HS polish, striae multiple orientations	Scraping	H/HS
409-011	Edge-modified flake	-----	-----	Plant fragment	Striae ⊥	Whittling	Plant
417-010	Edge-modified flake	-----	-----	-----	H/HS polish	Whittling	H/HS
418-28	Biface frags	-----	-----	-----	Polish, striae multiple orientations	Cutting- multiple orientations	Hard
419-12	Biface	-----	-----	-----	H/HS polish	Scraping	H/HS
484-16	Edge-modified	-----	-----	Wood fragments	H/HS polish, striae ⊥	Planing	Wood
484-17	Edge-modified flake	-----	-----	Plant fragments	H/HS polish, striae	Slicing	H/HS plant
537-017	Early Triangular point	-----	-----	-----	Striae, mult. Orientations, H/HS	Cutting	H/HS
662-010	Edge-modified	-----	-----	-----	Soft	Scraping	Soft
729-010	Early Triangular	-----	H/HS polish	-----	H/HS polish	Whittling	H/HS

^a Hafting residues are confined to the proximal 1/3 to 1/2 portion of the artifact; ^b Hafting wear confined to proximal 1/3 to 1/2 of the artifact. || and ⊥ refer to parallel and perpendicular to the long axis of the artifact respectively; ^c Use-residues are confined to the distal portion of the artifact near or on the working edge; ^d Use-wear is confined to the distal portion of the artifact near or on the working edge. || and ⊥ refer to parallel and perpendicular to the working edge respectively.

Table C-7. Summary of Early Archaic Component (ca. 5200-6300 B.P.) Results by Tool Type

Type	N	Haft Residues	Use Residues	Wear	Hafted	Use-actions	Use-materials
Martindale points	2	Plant tissue	Raphides	Light polish	Yes	Unknown, cutting	Unknown
Bandy points	2	None	Bone/antler fragments	H/HS polish	Yes	Projectile	Bone/antler, unknown
Early Corner-notched points	2	Wood, resin, plant fiber	Wood, possible blood	None	Yes	Unknown	Wood, animal?
Baker point	1	None	None	Impact fracture	Yes	Projectile	Unknown
Gower point	1	None	Plant fiber	H/HS polish	No	Boring	Plant
Untyped Group I pts.	2	None	None	None	Yes	Projectile	Unknown
Drills	4	None	Raphides, wood	Striae, H/HS polish	No	Boring, cutting	Unknown hard, plant, wood
Gouges	2	None	Plant or bone, hair	H/HS , soft polish	No	Planing, scraping	H/HS, hide
Scrapers	5	None	Raphides, plant	Striae, H/HS polish	No	Cutting, planing, scraping	Plant, H/HS plant
Bifaces	10	Plant fibers	Raphides, red mineral, plant	Light polish, striae	4 of 10	Cutting, unknown	Unknown, plant, red mineral
Uniface	1	None	Wood	H/HS polish	No	Whittling	Wood
Edge-modified flakes	24	None	Plant, starch grains, bone/antler, wood, raphides, hair, charcoal	H/HS, soft polish, striae	No	Planing, scraping, cutting, whittling, slicing, unknown	Starchy plant, bone/antler, wood, plant, unknown
Rejuvenation flakes	7	Plant tissue	Plant, raphides, starch grains	H/HS, soft polish, striae	1 of 7	Planing, slicing, cutting, unknown	H/HS, starchy plant, plant, soft, unknown

Table C-8. Early Archaic Component (ca. 5200-6300 B.P.), Summary of Residue and Use-wear Results

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-wear ^d	Inferred Use	Contact Material
28-11	Biface—edge-modified	-----	-----	-----	Light polish Polish on one included flake- resharpening	Unknown	Unknown
29-12	Scraper	-----	-----	-----	H/HS polish	Scraping	H/HS
49-12	Biface (proximal snap)	No raphides on proximal 1/4	-----	Raphides	Striae ⊥	Cutting	Plant (raphides)
50-11	Edge-modified rejuvenation flake	-----	-----	Raphides (use-related?)	Striae, multiple orientations, H/HS polish	Cutting	H/HS (raphides?)
61-016	Biface	-----	-----	-----	Light polish	Cutting	Unknown
128-14	Edge-modified flake	-----	-----	Plant tissue, starch grains	H/HS polish	Planing	Starchy plant
140-024	Baker dart point	-----	-----	-----	Polish and impact fracture	Projectile	Unknown
141-021	Martindale Point	-----	Light polish	-----	-----	Hafted, unknown action	Unknown
153-031	Rejuvenation flake	-----	-----	-----	H/Hs polish, edge damage	Planing	Hard
154-024	Biface	Plant fibers	Light polish, striae and ⊥	Red staining (ochre?), confined to tip	H/HS polish	Unknown	Red mineral (ochre?)
205-10	Biface	-----	-----	Plant tissue	Striated polish, multiple orientations	Cutting, multiple orientations	H/HS plant
255-11	Rejuvenation flake	-----	-----	Plant fibers	H/HS polish, striae ⊥	Scraping	H/HS plant
278-026	Possible drill	-----	-----	Raphides, pollen grains (use-related?)	Striated polish	Boring, tip used	Unknown

Table C-8. Early Archaic Component (ca. 5200-6300 B.P.), Summary of Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-wear ^d	Inferred Use	Contact Material
283-014	Group 2 pt.-Early Corner notched	Wood frags	Polish	Wood fragments	-----	Unknown, hafted	Wood scattered over entire surface, use-related?
288-010	Edge-modified flake	-----	-----	-----	H/HS polish, edge rounding, striae $\perp$	Whittling	H/HS
312-019	Side scraper	-----	-----	Plant fiber	H/HS polish, Striae $\parallel$	Scraping	H/HS plant
323-20	Scraper-side/end	-----	-----	-----	Striae $\perp$, H/HS polish	Planing, ventral surface in contact	H/HS
334-022	Brandy point	-----	H/HS polish	Bone/antler fragments	H/HS polish	Hafted proj. pt.	Bone/antler
343-010	Drill tip	-----	-----	-----	Abraded ridges, striae, mult. Orientations	Boring (drilling)	Hard
345-023	Rejuvenation flake	-----	-----	-----	Light polish ventral	Planing	Unknown
346-011	Uniface (gouge)	-----	-----	Plant or bone fragment	H/HS polish	Planing/scraping	H/HS (bone or wood)
346-012	Edge-modified flake	-----	-----	-----	Light polish	Planing	Unknown
366-13	Edge-modified flake	-----	-----	Bone/antler fragments	H/HS polish	Planing/scraping	Bone/antler
367-14	Edge-modified flake	-----	-----	Raphides	H/HS polish, striae oblique, $\perp$	Whittling	H/HS
387-10	Edge-modified flake	-----	-----	Raphides, plant fibers	H/HS polish, striae $\perp$	Planing	H/HS plant
391-11	Gower point	-----	Abraded ridges	Plant fiber	H/HS polish	Cutting (boring)	Plant
400-10	Edge-modified-graver	-----	-----	-----	-----	Unknown	Unknown

Table C-8. Early Archaic Component (ca. 5200-6300 B.P.), Summary of Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-wear ^d	Inferred Use	Contact Material
401-036	Edge-modified flake	-----	-----	Raphides?, plant fiber	H/HS polish, edge rounding	Planing, ventral surface in contact	H/HS
412-010	Group 2 Pt.-Corner notch	Resin, plant fibers	Polish	Possible blood residue	-----	Unknown, hafted with resin	Animal?
412-013	Edge-modified-Graver	-----	-----	Hair frag., Starch grains and raphides	H/HS polish	Scraping	Plant, animal?
421-11	Edge-modified flake	-----	-----	-----	Soft polish	Cutting	Soft
422-19	Biface fragment	Plant tissue	Striae ⊥	Raphides	-----	Unknown, possibly hafted	Unknown- raphides over entire surface
431-011	Edge-modified flake	-----	-----	Plant fibers, raphides	H/HS polish	Planing	H/HS plant
446-11	Edge-modified flake	-----	Abraded ridges	Charcoal fragments	H/HS, striae oblique, ⊥	Whittling, slicing	H/HS
449-010	Edge-modified flake	-----	-----	Wood fragments	H/HS	Planing	Wood
455-016	Drill	-----	-----	Raphides	Striae, multiple orientations	Cutting	Plant
465-010	Edge-modified flake	-----	-----	Hair tip, raphides (random distribution), plant tissue	H/HS polish, marginal	Planing	Plant
477-010	Edge-modified flake	-----	-----	Plant tissue	H/HS polish	Cutting	H/HS plant
539-012	Edge-modified/rejuv.	-----	-----	Plant tissue	Light polish	Planing	Plant
546-014	Uniface	-----	-----	Wood fragments	H/HS polish	Whittling	Wood

Table C-8. Early Archaic Component (ca. 5200-6300 B.P.), Summary of Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-wear ^d	Inferred Use	Contact Material
563-19	Biface (proximal snap)	Raphides Plant tissue	-----	Raphides	-----	Unknown	Raphides spread over entire surface
577-011	Edge-modified flake	-----	-----	Raphides, plant tissue	Striae ⊥	Planing	Plant
590-10	Edge-modified flake	-----	-----	-----	Marginal light polish	Slicing	Unknown
591-019	Martindale Point	Plant tissue	Striae ⊥	Raphides-random distribution	-----	Hafted, unknown use	Unknown (plant?)
591-024	Biface	Wood fibers	-----	Plant fibers, raphides	Light polish	Hafted, cutting	Unknown
592-010	Spoke-shave edge-modified	-----	-----	-----	Light polish	Planing	Unknown
592-011	Edge-modified flake	-----	-----	-----	Light polish	Unknown	Unknown
598-13	Biface (proximal snap)	Raphides?	-----	Raphides	-----	Unknown	Unknown-raphides may be haft related
599-017	Untyped Group 1 point	-----	Abraded ridges, impact fracture	-----	-----	Hafted proj. pt.	Unknown
616-010	Edge-modified flake	-----	-----	Wood tissue, raphides	H/HS polish	Planing, ventral surface in contact	Wood
627-013	End scraper	-----	-----	-----	H/HS polish	Cutting	H/HS
628-11	Edge-modified rejuvenation flake	-----	-----	-----	Polish, striae ⊥	Unknown	Unknown
670-005-11	Untyped Group 1 Point	-----	H/HS polish	-----	Impact fracture	Hafted proj. pt.	Unknown

Table C-8. Early Archaic Component (ca. 5200-6300 B.P.), Summary of Residue and Use-wear Results (Continued)

Cat. #	Tool Type	Hafting Residue ^a	Hafting Wear ^b	Use-Residue ^c	Use-wear ^d	Inferred Use	Contact Material
670-005-11	Drill	-----	Abraded ridges	Wood fragment, raphides	H/HS polish, striae ⊥ (confined to tip)	Boring (drilling)	Wood
671-10	Edge-modified graver	-----	-----	-----	Light polish	Planing	Unknown
677-011	Edge-modified-rejuvenation flake	-----	-----	Raphides, starch grains	H/HS polish, Striae	Slicing	Starchy plant tissue
699-20	Biface-oblique snap	-----	Striae ⊥, high areas polished	-----	-----	Hafted, broken during use	Unknown
712-014	Brandy Point	-----	H/HS polish	-----	Impact striae	Hafted, proj. pt.	Unknown
718-015	Rejuvenation flake	Plant fibers	Striae , ⊥	-----	Soft polish	Cutting, hafted	Soft material
724-12	Edge-modified flake	-----	-----	Plant tissue	Striae	Slicing	Plant
724-13	Scraper/ gouge	-----	-----	Hair	Soft polish	Planing	Animal (hide)
725-014	Edge-modified flake	-----	-----	-----	Soft polish	Scraping	Soft
94-10	Rejuvenation flake	-----	-----	-----	H/HS polish	Scraping	H/HS

^a Hafting residues are confined to the proximal 1/3 to 1/2 portion of the artifact; ^b Hafting wear confined to proximal 1/3 to 1/2 of the artifact. || and ⊥ refer to parallel and perpendicular to the long axis of the artifact respectively; ^c Use-residues are confined to the distal portion of the artifact near or on the working edge; ^d Use-wear is confined to the distal portion of the artifact near or on the working edge. || and ⊥ refer to parallel and perpendicular to the working edge respectively.

C.4 DISCUSSION

Toyah Component

The Toyah component is the youngest of the samples and exhibits remarkable preservation. Hair fragments, feather barbules, wood anatomy, starch grains, resin and possible blood residues are all present (Figures C-1 through C-7). Figure C-2 shows artifact #220-15, a biface tip with both feather barbules and wood cells with scalariform pitting. Numerous feather barbules (> 50) are found along one edge. On the same edge, wood fragments with scalariform pitting are visible. Among common hardwood trees, scalariform intervessel pitting is found in magnolia, sweetgum, and black tupelo (Hoadley 1990). While these wood fragments could derive from one of these tree species, numerous other woody shrubs from southwest Texas have not been characterized anatomically. At the least, it is possible to say that these fragments come from hardwood (angiosperm).

Overall, typological categories demonstrate a variety of different uses. Scrapers, for example, although used exclusively for scraping and planing, worked a variety of materials including both plant and animal. The same is true for edge-modified flakes, except that they also exhibit a wide range of use-actions including scraping, planing, whittling, slicing, and cutting. Bifaces were used on a similarly wide range of use-materials with a variety of use-actions.

Among the variety of projectile points, several show evidence of hafting in the form of plant fibers involved in binding, resin used as mastic, and abraded ridges from movement against the haft. The use-material for the projectile points is generally not known. This is consistent with their use as projectile points where contact with the use-material is usually brief.

All of the artifacts from the Toyah sample show some evidence of use, either through residues or use-wear. This incredibly high percentage of tools with functional evidence suggests that the occupants of the site were conducting intensive processing of a wide range of materials including wood, starchy plants (possibly roots or tubers), mammals, birds, and other types of plants.

Late Archaic Component

The Late Archaic sample is relatively small ($n=17$) and preserves evidence for exploitation of a more narrow range of materials than the Toyah component. Hafting is limited to bifacially retouched tools and does not occur in high frequencies (3 of 16 tools are hafted). Wood and hide are the most commonly used materials (Figures C-8 and C-9). Typology is once again not a good predictor of stone tool function. Although sample sizes are small, most typological categories show a range of use-actions on different materials. Residue preservation is generally good. Figure C-8 shows evidence of hide scraping on #98-12 with preserved hair fragments with the cuticle and scale pattern preserved. Unfortunately, it is usually difficult to identify species of origin of isolated hair fragments due to variations in scale pattern on different parts of a hair (root or tip) as well as on different parts of the body (Bruner and Koman 1974).

Middle Archaic Component

The Middle Archaic sample includes 17 artifacts. Hafting evidence is limited to two of the four Early Triangular points, although none show evidence of use as projectile points. Multiple uses of tool types are evident, despite the small sample size (Figures C-10–C-11). Edge-modified flakes were used on wood and plant tissue and undetermined soft material.

Figure C-1. Top #98-012, Late archaic Component, Edge modified flake, A) hair fragment in matrix (original mag. 100x); B) hair fragment with scales visible (original mag. 500x); C) polish on edge. Bottom #1041-14, Toyah Component, Biface, A) wood fiber, alternate pitting (original magnification 500x); B) hard/high silica polish (original mag. 100x)

Figure C-2. Top #220-015, Toyah Component, Biface Tip, A) Wood fragment with scalariform pitting (original mag. 500x); B) cluster of feather barbules (original mag. 500x); C) wood fragments (original mag. 500x). Bottom #724-13, Early Archaic, scraper/gouge, A) hair fragment (original magnification 100x); B) hair fragment with scales visible (original mag. 500x); C) soft polish (orig. mag. 100x)

Figure C-3. Selected Toyah Artifacts Part 1, Indicating Location of Use-wear and/or Residue Observed

Figure C-4. Selected Toyah Artifacts Part 2, Indicating Location of Use-wear and/or Residue Observed

Figure C-5. Selected Toyah Artifacts Part 3, Indicating Location of Use-wear and/or Residue Observed

Figure C-6. Selected Toyah Artifacts Part 4, Indicating Location of Use-wear and/or Residue Observed

Figure C-7. Selected Toyah Artifacts Part 5, Indicating Location of Use-wear and/or Residue Observed

Figure C-8. Selected Late Archaic Artifacts Part 1, Indicating Location of Use-wear and/or Residue Observed

Figure C-9. Selected Late Archaic Artifacts Part 2, Indicating Location of Use-wear and/or Residue Observed

Figure C-10. Selected Middle Archaic Artifacts Part 1, Indicating Location of Use-wear and/or Residue Observed

Figure C-11. Selected Middle Archaic Artifacts Part 2, Indicating Location of Use-wear and/or Residue Observed

Use-actions include whittling, scraping, cutting, and planning. Hair fragments are preserved on two artifacts (one scraper and one Early Triangular point) demonstrating butchery or hide processing. Even with the small sample size, both plant and animal residues are present.

Early Archaic Component

The Early Archaic sample ($n=62$) is comparable in size to the Toyah ($n=57$). Despite the much greater antiquity of the Early Archaic, a wide range of residues are preserved including raphides, bone/antler fragments, wood, plant fibers and tissue, hair, starch grains, and charcoal (Figures C-12 through C-16). Numerous artifacts exhibit raphides scattered over their surfaces. Raphides are calcium oxalate crystals that form in some plant cells and often serve as a defense mechanism against predators. These crystals preserve well due to their high inorganic component. The patterning of the raphides on most tools is random, covering most of the tool surface. Based on this patterning, it is not possible to confidently attribute them to tool use.

Other residues, however, provide good functional evidence. Plant processing, both woody and non-woody, is evident in all typological categories including several projectile point types (Gower and Early Corner-notched). Edge-modified flakes and rejuvenation flakes were both used to process plants, including wood, starchy plants, and soft plants. Two artifacts from this level, one edge-modified flake and one Bandy point, exhibit bone/antler residue. The overall picture, as with other levels at this site, is one of intensive tool use on a wide range of materials with a wide range of use actions.

C.5 CONCLUSIONS

The Varga Site (41ED28) is remarkable for the high percentage of artifacts that exhibit

functional evidence. Of the 153 artifacts examined, all have some form of functional evidence, either of hafting or of use. A small number have minimal functional evidence in the form of light polish that is not diagnostic to category of use-material. This high degree of functional evidence suggests that throughout the sequence, the site was used for processing a wide range of materials, particularly wood and other types of plants. Residue preservation is also remarkable at this site. In particular, animal and bird residues (hair and feathers) are present in much greater frequency than is typical at prehistoric sites (Hardy *et al.* 2001). Plant residues are also well preserved and include anatomy that is potentially diagnostic to species level (e.g., scalariform intervessel pitting). Overall, stone tool typology is not a good predictor of tool function. Instead, most tool types seem to have been used for a variety of different tasks on more than one material.

Figure C-12. Selected Early Archaic Artifacts Part 1, Indicating Location of Use-wear and/or Residue Observed

Figure C-13. Selected Early Archaic Artifacts Part 2, Indicating Location of Use-wear and/or Residue Observed

Figure C-14. Selected Early Archaic Artifacts Part 3, Indicating Location of Use-wear and/or Residue Observed

Figure C-15. Selected Early Archaic Artifacts Part 4, Indicating Location of Use-wear and/or Residue Observed

Figure C-16. Selected Early Archaic Artifacts Part 5, Indicating Location of Use-wear and/or Residue Observed

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APPENDIX D:

PETROGRAPHIC ANALYSIS OF TOYAH CERAMICS FROM THE VARGA SITE, 41ED28, AND COMPARATIVE SITES

PETROGRAPHIC ANALYSIS OF TOYAH CERAMICS FROM THE VARGA SITE, 41ED28, AND COMPARATIVE SITES

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D.1 INTRODUCTION

In November and December 2003, a petrographic analysis was performed on 19 plainware pottery sherds and one local soil sample from the Varga site, 41ED28, and other regional sites. The 12 ceramic samples from the Varga site are from the Toyah phase, or horizon, component of the Late Prehistoric period. The ceramics came from a zone 0 to 30 centimeters below the ground surface. A suite of radiocarbon dates from this zone ranges from 170 to 700 B.P. The Toyah zone lies above and in direct contact with a Late Archaic component. The other sites contributing ceramic samples to the study are the San Juan Mission (41BX5, five samples) and the San Lorenzo Mission (41RE1, three samples). The aboriginal mission ceramics are thought to offer temporal comparisons and potentially a view of technological change.

D.1.1 Research Questions

The major research questions addressed in this study are written in a letter from the principal investigator, J. Michael Quigg of TRC (Quigg 2003), to the author. The research questions are reproduced here, reorganized to group them according to similarity.

- 1. Is ceramic technology at the Varga Site similar to Infierno phase (Lower Pecos Late Prehistoric [Turpin and Robinson 1998, Robinson 1999]), Classic Toyah (Central Texas Late Prehistoric [Johnson 1994, and others]), and/or Protohistoric/Historic (Mission San Lorenzo and Mission San Juan) period ceramics?
- 2a. Is there continuity between regions and/or between the Late Prehistoric and Protohistoric periods?

- 2b. Is the same technology being used across these different culture areas and/or through time?
- 3a. To what does variability in ceramics refer?
- 3b. What arguments best account for variability in the ceramic assemblages?
- 3c. Does variability represent stylistic or functional variability?

These are the guiding questions of the petrographic analysis. Others may be addressed as time allows.

D.1.2 Paste Groups

The best way to examine or address the research questions is to construct a paste group classification of the analyzed thin sections. This allows a consistent description of variation in the technology. Following this, comparisons with other sites and clay samples also allow archaeologists to distinguish local from non-local ceramics and make inferences on vessel transport and trade. Reese-Taylor (1995: F13) made the signal observation, with evidence, that the Toyah ceramic tradition is one of homogeneity in its commitment to tempering with bone as part of the manufacturing process. Within this homogeneity, variability is found in the identified paste groups. Many of them are distinguished by aplastic inclusions naturally resident in ceramic clay. Because this variability may be readily observed, the varying paste groups may have local signatures and retain value for regional comparisons in addition to variability in technology. This study examines paste groups for comparative purposes as the best single way to assess the variability in the regional ceramic technology.

D.2 METHODOLOGY

D.2.1 Microscopy and Point Counting

This study is an exercise in the petrographic analysis of ceramic material. The principal method of study is microscopic thin section analysis of potsherds. This method provides fine-scale information on ceramic fabrics and the solid particles, termed aplastic inclusions that are found in the ceramic fabrics of low-fired prehistoric wares. The many petrographic techniques for identifying bone, minerals, rock particles, and other bodies have been developed by the field of geology and its sub-branch of optical mineralogy. Thin section microscopy and petrography in ceramic analysis was pioneered in archaeology by Shepard (1942, 1954).

The ceramic thin sections for this study were prepared by National Petrographic Service, Inc. of Houston, Texas. The sections were stained for carbonates, and the finished thin sections were left without cover slips, by request. Microscopic identifications and point counting were conducted on a stereographic Olympus microscope with rotating stage and polarizing light in the Microscopy Laboratory of the Texas Archeological Research Laboratory, the University of Texas at Austin. Initially, the matrix colors of the sections were recorded under plain light, isotropy was determined, and the character of the matrix, voids, and aplastic inclusions was surveyed. Unidentified and unfamiliar bodies were sought for possible follow-on research and identification in published mineralogical literature. After this primary effort, the point-counting was conducted following the method of Chayes (1949). The method involves a series of visual traverses of the thin section. Every body falling under the cross-hairs at regular intervals was counted

and tabulated. Information included mineral or rock class; and for each class size, shape, and incidental traits. Bodies large enough to cover the traverse interval were not counted twice. Species observed but not falling under the cross-hairs, thus not entering the point count, were recorded as trace, “tr”. In this way all the observed contents of the sections could be reported. The point count halted at 200 counts. The voids and aplastic inclusions were classed for size by using the Wentworth size classification scale. The successful outcome of the point count permitted a quantified assessment of the attributes of the collection, a body of data comparable to other regional petrographic data, and manipulation by a variety of statistical measures.

D.2.2 Observational Conventions

For the sake of communication and gaining common understandings of microscopic observations, this section provides discussions on the major classes of materials and common structures of the ceramic fabrics in the study collection. The goal here is to provide some clarification of terminology that is obscure by its very nature. Further, terminology varies among microscopic analysts, and this section provides a partial synonymy with the other comparative studies referenced here. The aspects given attention are: matrix and voids, bone, carbonates, iron, and color and isotropy.

D.2.2.1 Matrix and Voids

Matrix refers to the material in which the voids and aplastic inclusions are mixed. Matrix is the fired clay ceramic of the vessel, and may also be referred to as ceramic body, clay paste, paste, ceramic, or, to an optical mineralogist, the groundmass. The matrix is characterized here in textural

terms, the Varga collection falling into classes described as dense, massive, or moderate. Dense matrix has fewer or small voids or aplastic inclusions. Massive matrix has uniform color, few voids, and a continuous, uninterrupted appearance. Moderate matrix appears to cover less area of the visual field than dense or massive matrices and is interrupted by large gaps, or voids, and many solid bodies of varying sizes and shapes. Color and isotropy were also recorded on the matrix; these attributes are discussed below.

Voids are the gaps in the matrix, as viewed in the microscope. They are also termed pores or pore space. Kittleman (1994: 308) refers to voids simply as porosity. Voids entered the point count to provide a quantitative, albeit indirect, measure of ceramic vessel porosity. This overarching quality of ceramics is a function not merely of pore numbers but of structure, patterning, and how well pores communicate with the surface and through the paste. Counting the pores in a two dimensional plane through the paste will not give a direct measure of this quality, but it will contribute a measure of structure and aspects of manufacture such as surface finishing. Adding to this value is a description of pore shapes: jagged or long strips, ovoids, and gaps around bodies.

D.2.2.2 Bone

Bone tempering is perhaps the single most important trait or ingredient of Toyah ceramics. It is available to megascopic identification and is frequently cited by typological analysts as a Toyah identifier. Reese-Taylor (1993: 18) declared, from experimental studies, that most of the bone in her sample was sun-dried prior to grinding and mixing into the ceramic paste. Both she and Kittleman (1994) observed occasional ceramic firing alterations of the

bone in their respective samples. Furthermore, Kittleman 1994:308) assessed his bone tempering as having derived from mammalian sources, based largely on the absence of observable features of fish or bird bone. This study offers no observations counter to these, with the small exception that ceramic firing alterations of bone were entirely lacking in the Varga site ceramic sample. With one exception, the bone fraction in the Varga site sample was observed to extend across a range of particle sizes. In order to track any pronounced bimodality of bone particle sizes, bone counts were recorded separately. “Small bone” was tabulated for bone particle sizes up to and including medium sand, and “big bone” was tabulated on particles coarse sand-sized and larger. In this way, gross size patterns could be identified.

D.2.2.3 Carbonates

In this study, carbonates are a rock and mineral class including limestone, calcite, ooids, and bioclasts; each of these was recorded and counted separately. Calcite staining marked all of these bodies with a carmine red color. Reese-Taylor (1993) identified all carbonates with an acid effervescence test, hence lumping the structural forms together, but distinguishing dolomite (dolomite was not observed in the Varga site sample). She reported carbonates as carbonates, calcium carbonate, or ooids, in the same fashion as her study of the Rush site (41RG346) and comparative samples (Reese-Taylor 1995). Kittleman (1994) reported carbonates as calcitization (largely as secondary alteration growths on or in bone particles), calcite rhombs, limestone shell, and mollusk shell. It remains unknown if the mollusk shell was fossilized or unfossilized. Ooids and bioclasts are common particles within the limey matrix of

limestone, and bioclasts are fossils that may belong to any invertebrate phylum (Folk 1980). They may or may not be index fossils that provide identification keys to specific rock formations. Turpin and Robinson (1998) reported limestone and calcite, and Robinson (1999) distinguished limestone, dolomitic limestone, and calcite. Paste group comparisons among these studies acknowledge, with due caution, the varying terminology and identification tests for carbonates.

D.2.2.4 Iron

This study reports different forms of iron in the ceramic samples—ferrous iron, ferric iron, and iron stain. Ferrous iron is iron with a valence of +2. It is most commonly in the form of the mineral hematite, and it is a common residual mineral in the limestones of the Edwards Plateau. Ferric iron is iron with a valence of +3, and it takes the form commonly of specular hematite or magnetite. These forms are less common in the region, but may also be found as residuals. Both ferrous and ferric iron were observed in the ceramic sample as rounded and subrounded particles of usually medium sand size. Iron stain, “Fe-stain,” resembles a blood-red smear or splash on the matrix. The staining observed in the Varga site collection was not inclusive of coarse sand and granule sized aplastic inclusions, but in many cases it appeared to cover and include silt and fine sand sized aplastics. The stained zone had irregular rounded shapes, and commonly there are discontinuous zones or strips of several rounded iron stain smears. Any such discontinuous cluster of iron stain was counted as one. The source and behavior of iron stain in the ceramic fabric is problematic and not readily interpretable currently, although sources in clay residents are likely. All these forms of

iron were readily distinguished by a simple reflected light test, whereby a strong light was shone onto the microscope slide with sufficient intensity to reflect up through the barrel of the microscope. Turpin and Robinson (1998) reported iron as iron-stain (one sample of which was reported as black particles rather than red patches). Robinson (1999) listed hematite and iron stain as forms of iron, and Reese-Taylor (1993, 1995) reported only hematite in her studies and made no finer distinctions. Kittleman (1994: 308) speculated that opaque rims around bone fragments in his sample were iron oxides, and probably magnetite, but he reported no form of iron on his tables or in section or paste group descriptions. A qualitative analysis of part of his collection employing the reflected light test found additional iron.

D.2.2.5 Color and Isotropy

The color of bone particles or the matrix varies with chemical composition and firing circumstances that affect the chemistry of the material. Resulting colors may reflect a fair amount of complexity. The value of color as a comparative variable is that the colors of thin sections in plain or plain-polarized light may be compared with sherd colors determined by megascopic analysis. A complication is that it is difficult to take Munsell readings of color from a thin section in the microscope. Accordingly, color comparisons with other reported studies translate Munsell colors into their plain-language equivalents. This creates broader rather than finer comparisons, but this is cautionary, it being well to remember that there is wide variation in human color perception. The colors of matrix and bone particles under cross-polarized light depend on their isotropy.

Isotropy is a quality of materials, especially crystalline materials, that refers to the behavior of light transmitted through them. “Iso” means same, and “trop” or “trope” means change. An optically *isotropic* material imposes the same change on light passing through the material. The illustrative image is of a point of light within a material. As it radiates outward in all directions as a sphere of light, it proceeds without any deviation, refraction, reflection, or retardation caused by the structure or composition of the material. The effect in a microscope under cross-polarized light is that the material remains dark. If the material causes any deviation in the transmission of light, then the material will have illumination in the microscope in a pattern characteristic of the material and its properties. Thereby hang many optical tests for minerals that are said to be *anisotropic*. Recording whether a material is isotropic or anisotropic in cross-polarized light gives a basic measure of this property and indications of similarities and differences in chemical composition and ceramic firing effects. Isotropy was recorded for the ceramic matrices and bone. This dimension allowed an additional comparison with Kittleman’s (1994) study.

D.3 OBSERVATIONS AND FINDINGS

Microscopy was completed with point counts of 19 ceramic thin sections, qualitative analysis of one soil sample thin section, and a qualitative reanalysis of 13 ceramic thin sections from the Buckhollow site. The results of the analysis are presented here, followed by brief descriptions of the paste groups, and the qualitative analyses.

D.3.1 Section Descriptions

Table D-1 provides the non-quantified attribute data collected on the thin sections and presents the point counts. The following text descriptions of the thin sections are summary statements on those data. Note that the sections are listed on the table in their paste groupings in order to show graphically their affinities and distinctions. The sections are described textually in this order as well.

ED28-799-8-1a, Section 12. The section has copious bone and carbonate (limestone and calcite) tempering, all at the expense of the matrix, which is considered moderate. The matrix is also medium greenish brown and anisotropic. The section has minor amounts of quartz and ferrous iron, probable clay residents.

ED28-937-8-1b, Section 14. Large amounts of bone and carbonates comprise the temper. Small bone particles exceed large bone in amount in this section. The matrix is massive, reddish gray and brown, and isotropic. Quartz and ferrous iron are minor clay residents. A minor inclusion is clay balls—small bodies of clay matrix of different color, rounded shape, with fine sand quartz particles inside them.

ED28-1181-8-1b, Section 17. Copiously bone and carbonate tempered, the matrix of the section is medium greenish brown to gold and anisotropic. This section has minimal voids and a small amount of iron stain.

ED28-799-8-2a, Section 20. Of the heavily bone-and-carbonate-tempered sections, this specimen is the most similar to Section 17, notably in having the same low number of voids and the small amount of iron stain.

The matrix likewise is greenish brown to gold and anisotropic. Section 20 and Section 17 could readily be from the same vessel.

ED28-840-8-1a, Section 13. This section was tempered by bone in notably smaller sizes than the other sections and also has a dense matrix that is light tan to greenish gray and isotropic. Ferrous iron is the next most numerous aplastic body, followed by an unidentified mineral of coarse silt and fine sand sizes, doubtless a clay resident. The mineral was not found in any other section in the study sample.

ED28-159-5-8-1b Section 9. The section is tempered with copious bone and minor amounts of limestone. The matrix is moderate, light greenish tan and anisotropic. The section and paste group have few other clay resident and incidental aplastic particles. The clay resident form of iron is ferrous.

ED28-168-8-1b Section 10. The section is tempered with copious bone and minor amounts of limestone. Orthoclase is a minor clay resident. The matrix is moderate, light greenish tan and anisotropic.

ED28-481-8-1b Section 11. The section is tempered with abundant bone and minor limestone. In this it is similar to Section 10. The matrix, however, is reddish tan to gold and anisotropic. The section has quartz and ferrous iron and no other incidental aplastics.

ED28-1054-8-1b Section 15. The section is tempered with bone and proportionally more limestone temper. The massive matrix is tan to greenish gray and anisotropic. Distinctive

clay residents are quartz, ferrous iron, clay balls and orthoclase (trace).

ED28-1089-8-1b Section 16. The section is closely similar to Section 15, is tempered with bone and secondary limestone, and has virtually the same amounts of orthoclase and clay balls. The matrix is moderate, greenish gray to gold and isotropic.

BX5-13008b Section 6. The section has a dense matrix, plentiful bone tempering, and few other aplastics. The matrix is light gray and light tan and isotropic. The only other particles in the section are quartz (7%), ferrous iron (5.5%), and limestone (0.5%).

BX5-13010b Section 7. The section has dense matrix that is dark reddish brown and anisotropic. Tempering is bone, quartz, and probably grog. The grog tempering is problematic in that it occurs at one percent of the point count. This amount could have little effect on the ceramic, but it is present nonetheless. Other minor constituents are ferrous iron (6.5%) and pyroxene (trace). Pyroxene is also problematic in that it is usually an alteration product of igneous rocks and minerals, yet it occurs without any igneous companions in the section. The matrix is dark reddish brown and anisotropic.

BX5-13002b Section 4. The section is bone-tempered. The matrix is moderate, dark greenish brown, and isotropic. The matrix has a large proportion (15%) of quartz sand, all in coarse silt to fine sand sizes. Limestone is also a clay resident, not a tempering agent. The section is distinguished by having three forms of iron: ferrous, ferric, and iron stain.

Table D-1

Aplastic Inclusions																																	
Identifiers				Matrix Characterization					Bone		Carbonates				Silicates				Iron			Igneous							Other				
Site	Thin-Section No.	Cat. No.	Paste Group	Character	Matrix Color	Isotropy	Percent Matrix	Voids in Matrix	Large Bone	Small Bone	Limestone	Calcite	Ooids	Bioclasts	Quartz	Comp. Quartz	Chert	Sandstone	Ferrous	Ferric	Fe-stain	Granitic Rock A	Orthoclase	Microcline	Plagioclase	Chlorite	Biotite	Pyroxene	Grog Temper	Clay Balls	Unknown Mineral A	Row Percent Total	
Varga (41ED28)	12	ED28-799-8-1a	B-a	moderate	medium greenish brown	aniso	11.5	12.5	26.5	20.5	9.5	8.5	0.5		7.5				3													100	
Varga (41ED28)	14	ED28-937-8-1b	B-a	massive	reddish gray and brown	iso	26.5	7.5	17	21.5	10	2.5	1		5				8											1		100	
Varga (41ED28)	17	ED28-1181-8-1b	B-a	massive	medium greenish brown to gold	aniso	31.5	2.5	16.5	11.5	10	4.5	3	4	9				6		1.5											100	
Varga (41ED28)	20	ED28-799-8-2a	B-a	massive	greenish brown to gold	aniso	38.5	2.5	15.5	12.5	11.5	2.5	6	1	5.5				2.5		2											100	
Varga (41ED28)	13	ED28-840-8-1a	B-b	dense	light tan to greenish gray	iso	45	12	10		tr				7.5				16		1.5		tr								8		100
Varga (41ED28)	9	ED23-159-5-8-1b	B-c	moderate	light greenish tan	iso	27	6.5	28	19	4	3			10				2.5													100	
Varga (41ED28)	10	ED28-168-8-1b	B-c	moderate	light greenish tan	aniso	22.5	11	30	22.5	5	2			4				1.5				1.5									100	
Varga (41ED28)	11	ED28-481-8-1b	B-c	moderate	reddish tan to gold	aniso	37.5	5	20	19	5	1	0.5		8				4													100	
Varga (41ED28)	15	ED28-1054-8-1b	B-c	massive	tan to greenish gray	aniso	34.5	9.5	12.5	15	8.5	4			2.5				8.5				1.5							3.5		100	
Varga (41ED28)	16	ED28-1089-8-1b	B-c	moderate	greenish gray to gold	iso	28	8.5	14	10	9	1.5			3.5				20.5				0.5							4.5		100	
Mission San Juan	6	BX5-13008b	B-d	dense	light gray and light tan	iso	43.5	13	14.5	16	0.5				7				5.5														100
Mission San Juan	7	BX5-13010b	B-e	dense	dark reddish brown	aniso	47.5	7.5	10	13	2.5				12				6.5									tr	1				100
Mission San Juan	4	BX5-13002b	B-f	moderate	dark greenish brown	iso	26.5	12	12.5	17.5	5.5				15				5	2	4												100
Mission San Juan	5	BX5-13006b	B-f	massive	medium gray to greenish brown	iso	42	5	14	20	1.5				12.5				2.5		2.5												100
Mission San Juan	8	BX5-13013b	B-f	dense	very light greenish tan	iso	46.5	5	12	12	3	2			8				9.5		0.5		0.5					1					100
Varga (41ED28)	18	ED28-1261-8-2a	V-a	moderate	greenish gray to black	aniso	24.5	4.5							17.5					8		4	27.5	5.5	1	5.5	2						100
Mission San Lorenzo	1	RE1-1872-66	V-b	massive	dark brown to greenish gold	iso	31.5	16.5							14	1		4.5	4			18.5	6.5		3		tr	0.5					100
Mission San Lorenzo	3	RE1-1872-32-b	V-b	massive	charcoal gray to black	iso	27.5	10							22.5	0.5		1.5	3.5	1		15	15		2		0.5	1					100
Mission San Lorenzo	2	RE1-1872-b	C/S-a	massive	dark brown to greenish gold	iso	33	11.5			18.5	11	5		11.5	2.5	0.5			6.5													100

BX5-13006b Section 5. The section is quite similar to Section 4; it is bone-tempered, with secondary clay resident quartz and limestone. Additional features are ferrous iron and iron stain. The matrix is massive, medium gray to greenish brown and isotropic.

BX5-13013b Section 8. The section is bone-tempered with secondary clay resident quartz and limestone. The matrix is exceptionally dense, very light greenish tan and isotropic. The section has incidental calcite but significant ferrous iron and iron stain. It has a small amount of orthoclase feldspar (0.5%) and companion pyroxene (1.0%).

ED28-1261-8-2a Section 18. The section has a moderate matrix, greenish gray to black and anisotropic. The tempering agents are various volcanic rocks and minerals, including orthoclase, microcline and plagioclase feldspars, and a granitic rock termed Granitic Rock A. This rock is comprised of orthoclase, microcline and masses of biotite, a probable alteration product. Quartz, much of it weathered, is also significant, and some of it may have entered the section as temper. Accessory volcanic minerals are chlorite and biotite. Iron is represented by specular hematite (ferric) exclusively.

RE1-1872-66 Section 1. The section has a massive matrix, dark brown to greenish gold and isotropic. The section is tempered with particles of a granitic rock, fresh quartz, plagioclase, sandstone, and composite quartz. Companion volcanic minerals are biotite, orthoclase and pyroxene. Ferrous iron is a clay resident.

RE1-1872-32-b Section 3. The section is very similar to Section 1, and may come from the same original vessel. The matrix is massive, charcoal gray to black and isotropic. The temper is granitic rock, fresh quartz, plagioclase, sandstone and orthoclase. Volcanic incidentals are biotite and pyroxene. There is a trace amount of composite quartz. In addition to ferrous iron there is a small amount of ferric iron (1.0%), the only compositional difference from Section 1.

RE1-1872-b Section 2. The section is tempered with a combination of carbonates and silicates, including limestone, calcite, fresh quartz, composite quartz, and chert. Additional particles in the matrix are ooids and ferric iron. The matrix itself is massive, dark brown to greenish gold and isotropic.

D.3.2 Paste Group Classification

The paste groups were defined first on dominant temper type, then on ancillary aplastic companions (either temper or clay residents), thirdly on matrix/void characteristics, and lastly on minor but key components, usually rare or trace aplastics. A total of nine paste groups were defined in this way, divided broadly into three major classes of matrix particles. The classes are bone, prefix B with six subordinate groups (a-f); igneous rocks and minerals class, prefix V with two subordinate groups (a-b); and a carbonate and silicate class, prefix C/S with one paste group (a).

D.3.2.1 Bone Paste Groups (B-a-f)

Paste group B-a. This paste group is tempered with abundant bone particles and significant amounts of limestone and other carbonates. The paste also has minor amounts of quartz and hematite (ferrous iron), both of which are clay residents.

Matrix is moderate to massive and generally anisotropic. Pastes have occasional iron stain and clay balls.

ED28-799-8-1a, ED28-937-8-1b, ED28-1181-8-1b, ED28-799-8-2a

Paste group B-b. The paste is tempered with bone exclusively. Clay residents include quartz, significant amounts of hematite, traces of limestone and orthoclase, and an unidentified mineral that suggests origin in another locality. Matrix is dense and isotropic.

ED28-840-8-1a

Paste group B-c. The paste is tempered with copious bone and carbonates in lesser amounts than those in Paste group B-a. Clay residents are an intermittent array of hematite, orthoclase, and clay balls. Matrices are largely moderate and anisotropic.

ED28-159-5-8-1b, ED28-168-8-1b, ED28-481-8-1b, ED28-1054-8-1b, ED28-1089-8-1b

Paste group B-d. Tempered exclusively with bone, the paste also has significant amounts of quartz and hematite. Other than these particles, only a single grain of limestone was observed in the paste, which is also dense and isotropic.

BX5-13008b

Paste group B-e. The group is tempered with bone and small amounts of limestone, quartz and grog. A significant clay resident is hematite, and the matrix is dense and anisotropic. Key minor particles are pyroxene and the grog temper.

BX5-13010b

Paste group B-f. The group is tempered with bone and a small amount of limestone. The paste has large proportions of quartz. The matrix is variable, either moderate, massive, or dense, but it is uniformly isotropic. A key particle is iron stain, and there are intermittent occurrences of calcite, ferric iron, orthoclase, and pyroxene.

BX5-13002b, BX5-13006b, BX5-13013b

D.3.2.2 Igneous Paste Groups (V-a-b)

Paste group V-a. The paste is tempered with granitic rock fragments, orthoclase, quartz, plagioclase and microcline. Matrix is moderate and anisotropic. Clay residents are chlorite, biotite, and specular hematite.

ED28-1261-8-2

Paste group V-b. The tempering particles are granitic rock fragments, orthoclase, fresh quartz, and sandstone. Matrix is massive and isotropic. Clay residents are ferrous and ferric iron, composite quartz, biotite and pyroxene.

RE1-1872-66, RE1-1872-32-b

D.3.2.3 Carbonate/Silicate Paste Group (C/S-a)

The only paste group in this class is tempered with both carbonates and silicates (limestone, calcite, ooids, fresh quartz, composite quartz, chert). The matrix is massive and isotropic. The only other type of particle in the clay is ferric iron.

RE1-1872-b

D.3.3 Qualitative Analysis of Varga Site Soil Sample

Table D-2 presents the qualitative information on the aplastics in the soil sample (#1259-4a).

The soil sample matrix is light red to tan and anisotropic. The sample is notable for its carbonates, particularly limestone particles. Calcite crystals and oolites are weathering out of the limestone. Quartz is composite, but weathered and angular. The sample contained only the ferrous, hematitic form of iron.

Similar ceramic pastes are found in Paste group B-a. In complementary fashion, the soil sample contains no igneous components; therefore ceramic paste groups with these types of clay resident particles in significant amounts would be of non-local manufacture. These paste groups include B-b and V-a. A problematic paste group is B-c, which resembles the local soil save for persistent but small traces of orthoclase. No statement on its origins is offered at this time.

D.4 QUALITATIVE ANALYSIS OF BUCKHOLLOW CERAMICS

A qualitative analysis was made on the ceramic thin sections made on the Buckhollow site (41KM16) Toyah pottery (Johnson 1994) and currently under curation at Texas Archeological Research Laboratory. The analysis was made to allow closer comparisons with the work originally reported by Kittleman (1994). Thirteen thin sections from the Buckhollow sample were examined for this analysis.

Section 1. 385a. The section is bone-tempered with isotropic bone, but the matrix is entirely anisotropic. There are few clay residents, the most common being calcite in the fine sand size category. The section also has a sprinkling of coarse silt- and fine sand-sized specks of ferrous iron.

Section 5. 357-25A. The section is heavily bone-tempered; most of the bone is isotropic although about five percent is anisotropic. Ferrous iron is a clay resident. There is much pore space, notably in rings or gaps around the solid particles. There is one species of unidentified rock particle.

Table D-2

Particle	Size	Shape	Visual Percent Est.
Composite quartz	Coarse silt to coarse sand	Angular	5
Limestone	Silt to medium sand	Angular	5
Calcite	Fine sand to medium sand	Subangular to euhedral	1 to 2
Oolites	Fine sand to medium sand	Rounded	<1
Ferrous iron	Fine sand to medium sand	Rounded	1

Section 8. 357-18a. The bone temper is abundant and both isotropic and anisotropic, while the matrix is dark reddish brown and isotropic. Quartz is a dominant mineral perhaps contributing to the tempering. The section has igneous minerals orthoclase, microcline, and plagioclase.

Section 9. 357-18b. Very similar to Section 8, but the matrix is a darker reddish brown, although still isotropic. Bone is about 95 percent isotropic. Additional particles are quartz and orthoclase, and one specimen of ferrous iron in what may be a red slip along one edge.

Section 10. 357-6b. Similar to sections 8 and 9, the matrix is isotropic and reddish brown. The common clay residents are orthoclase and quartz, and there is rare ferrous iron and a definite red slip along one edge. Bone temper is 95 percent isotropic.

Section 11. 357-4a. The matrix is reddish brown and isotropic. The abundant bone temper is about half isotropic and half anisotropic. A major particle is a rock formed of orthoclase and quartz. One edge of the ceramic has a red slip, and ferrous iron is scattered throughout the matrix (1-2% visual estimate).

Section 14. 41KM16-3h. Heavily bone-tempered, both the bone and matrix are entirely isotropic. The matrix has abundant ferrous iron particles and a few probable sandstone grains.

Section 15. 343. The section is bone-tempered, and the bone is isotropic. Matrix is medium reddish brown and anisotropic. Aplastics include quartz, feldspar, and ferrous iron. The section has an unidentified rock component also. Altogether, the

section is dissimilar from any section in the Varga sample collection.

Section 16. 341. Similar to Section 15, the matrix is medium reddish brown and anisotropic. The bone temper is isotropic. The matrix has a low frequency of aplatitics quartz, feldspar, and ferrous iron.

Section 18. 481. The section is bone-tempered, and both the bone and matrix are isotropic. Clay residents are limestone and quartz, and there is a small amount of ferrous iron.

Section 19. 481 Xa. The section is bone-tempered with bone in a wide range of sizes, from about coarse silt to coarse sand. The bone is about 95 percent isotropic, five percent anisotropic. The matrix is anisotropic. Quartz is a clay resident, accompanied by abundant ferrous iron.

Section 20. 481 Xb. The section is tempered with bone that is entirely isotropic, while the matrix is anisotropic. Major clay residents are limestone and calcite, with additional quartz in notably small size ranges (coarse silt and fine sand). There is plentiful ferrous iron, and although there is no red slip on any edge, there are several patches of iron stain within the matrix.

Section 25. 3b. The section is tempered with isotropic bone. The matrix is also isotropic. Clay residents are quartz and orthoclase with minor amounts of plagioclase and microcline. Peculiarly, the section has an iron-rich red slip along one edge, but no iron stain or ferrous iron within the matrix.

The qualitative analysis provides a basis for similarity of comparisons with paste groups

at the Buckhollow site and other reported Toyah sites. These comparisons are discussed in a later section.

D.5 IV. COMPARISONS AND DISCUSSION

D.5.1 Technology and Variability

This petrographic analysis of Toyah pottery thin sections has been motivated by a series of research questions on technology and variability of Toyah ceramics, presented in the introduction of this appendix (Quigg 2003). The questions are addressed individually here, with reference to the petrographic analysis.

- **1. Is ceramic technology at the Varga Site similar to Infierno phase (Lower Pecos Late Prehistoric [Turpin and Robinson 1998, Robinson 1999]), Classic Toyah (Central Texas Late Prehistoric [Johnson 1994, and others]), and/or Protohistoric/Historic (Mission San Lorenzo and Mission San Juan) period ceramics?**

Points of similarity between the Infierno phase/Lower Pecos Late Prehistoric and the Classic Toyah/Central Texas Late Prehistoric are: (1) earthenwares with oxidizing firings, (2) a commitment to bone tempering, and (3) use of local ceramic resources. On the third point, differences in the non-tempering aplastic inclusions demonstrate clear local acquisition of ceramic materials, and the analysis of the Varga site soil sample established one strong case study for the use of local clays. On the issue of local verses regional distinctions, this means that Toyah ceramics will most frequently have a strong local stamp, highly visible petrographically, especially the non-bone aplastics. The technological concepts of the ceramics, notably the ways aplastics

are mixed into the ceramic, are shared region wide, from central Texas to the Lower Pecos, and thus are an overarching commonality. Strengthening this relationship is the detectable regional movement of a portion of the finished vessels. The scale and modes of this ceramic movement are just now being studied.

Comparisons between the prehistoric sites and the Historic missions show specific similarities and differences. The mission/prehistoric similarities are the above points. The difference is the adoption of new pastes and tempering sources, or an abatement of the common use of bone temper (although note that some prehistoric pastes also lack bone). In the Historic period, we see the coexistence of several ceramic paste groups, followed by the gradual replacement of aboriginal technology.

- **2a. Is there continuity between regions and/or between the Late Prehistoric and Protohistoric periods?**

Continuity can be seen between regions in the similarity of technology and shared paste groups, discussed in a following section. Shared paste groups show continuity through direct contact by a variety of mechanisms such as trade or movement in seasonal residential moves. Toyah ceramic technology indeed continued into the Protohistoric, where it was gradually replaced by Historic technologies.

- **2b. Is the same technology being used across these different culture areas and/or through time?**

From the petrographic analysis, the technology appears the same. Such traits as the angularity and sizes of tempering

particles suggest consistent ways of preparing temper for addition to paste, hence the same recipe or step-by-step manufacturing sequence for the ceramics across regions and through time. A problematic issue is the observable variation in the amounts of tempering in the paste. Clearly, the differences in proportions of temper to clay made no difference to the success of firing the ceramics. The proportions of igneous, carbonate, and silicate tempers vary similarly in the pastes in which they are found. This shows the robustness of the earthenware technology, and that, within limits, temper proportions were in free variation and subject to individual potter choices.

Similarly, variability in the firing process itself appears to be consistent across the entire region and through time. Specifically, pastes and bone temper tends to have the same range of colors in their paste groups in all the sites examined. This suggests that the control of firing—temperatures achieved, atmospheres created and maintained, and other variables—was about the same in character and degree across the region and suffered the same vagaries.

- **3a. To what does variability in ceramics refer?**

On the technological level, variability refers to ceramic ingredients, modes of preparation, clay residents, and firing vagaries that can affect the outcome of the ceramics (interior carbon streaks, paste and bone colors, and other variables). It should be cautioned, however, that technological variability is only a partial list of total ceramic difference, and that typological variability is also crucial to understanding Toyah earthenwares and their changes.

Typology is discussed in the main body of the Varga report.

- **3b. What arguments best account for variability in the ceramic assemblages?**

First, local acquisition of materials introduces a wide range of particles to ceramic matrices. They are peripheral or irrelevant to the success or functioning of the ceramics, but they provide markers of place and origin. Secondly, tempering agents are critical factors in variability. Step-by-step procedures for preparing bone tempering material result in consistency and little observable variation, but the use of other tempers entirely, as in the igneous and carbonate/silicate paste groups, produce striking variations observable on both the megascopic and microscopic levels. Thirdly, finishing and decorative manufacturing choices create pronounced variability. Several of the Buckhollow sections have a red slip on their edges, but these are entirely lacking in the Varga sample.

- **3c. Does variability represent stylistic or functional variability?**

On the petrographic level, almost all the variability in ceramic pastes, temper, and clay residents revolve around gaining a successful ceramic, i.e. a ceramic vessel that survives its earthenware firing. In this, variability regards function, not style. Variability in porosity also involves function, but as stated previously, porosity measured in thin sections is an indirect measure of vessel porosity. The observations of surface slips on the Buckhollow sections are observations of stylistic variability and are an exception to this general pattern of functional variability.

D.5.2 Paste Group Comparisons

The comparisons of paste groups were made by examining recent literature on petrographic studies of Toyah ceramics. The question here is how many paste groups are similar enough to be considered as shared between sites? In other words, were any of these locally produced ceramic vessels transported from site to site? Table D-3 cites the studies consulted and lists the paste groups identified in those studies.

The descriptions of these paste groups were examined for their essential similarities and distinctions. The following list presents those paste groups considered by the author to be essentially the same, thus shared across regions and sites.

1. B-a, RT-93-2, RT-95-2, RT-95-5, RT-95-8, R-99-1.
2. B-c, RT-93-3, RT-95-10, TR-98-2.
3. B-d, RT-93-2, RT-95-1.

It should also be noted that RT-93-2 is shared between two sites in different counties, and TR-98-5 is also shared between two sites separated by more than 20 miles.

This examination of paste groups has identified five suites of paste groups that are shared among two or more sites. It is an important distinction that manufacture of ceramics from local resources does not preclude transport of the vessels to other sites during their use-life by various mechanisms and for various purposes. It is also significant that the identification of shared paste groups does not contradict any assessment of local or non-local manufacture, to wit, paste group B-b, which appears clearly to be of non-local origin

relative to the Varga site, but is not shared with any other known paste group. The identification of shared paste groups is a step toward elucidating mechanisms of transport and larger issues of hunter-gatherer mobility and systemic processes. These studies can be advanced by the application of two parallel approaches:

- (1) geographic and geological studies of ceramic resource availability, similar to Robinson's (1999) study of Lower Pecos ceramic materials, and
- (2) neutron activation analysis (NAA) of ceramics and environmental samples.

D.6 SUMMARY AND DISCUSSION

The petrographic analysis of the Varga site sample, inclusive of ceramics from a total of three sites, two of which are Historic missions, identified nine distinct paste groups, not all of which are bone-tempered. Analysis of a Varga site soil sample was valuable in distinguishing local from non-local paste groups and is a recommended strategy for future petrographic studies.

Variability lies largely with tempering agents and particles resident in the ceramic clays. This variability comments more on function than style. Analysis of the Historic ceramics shows that Toyah bone-tempered ceramic technology persisted into the Historic period with aboriginal populations who settled at Spanish missions. The aboriginal technology was gradually replaced by European technology and ceramics. This finding may assist colonial period research by helping to distinguish earlier from later mission occupations.

Table D-3

Reference	ID Code	Paste Groups
Reese-Taylor (1993)	RT-93	<ol style="list-style-type: none"> 1. RN169 bone and carbonates 2. RN3 and CN95 bone only 3. CC131 bone and lesser carbonates
Reese-Taylor (1995)	RT-95	<ol style="list-style-type: none"> 1. Bone-tempered 2. Bone-tempered w/ calcite inclusions 3. Sand and bone-tempered w/ orthoclase, biotite and some calcite 4. Sand and clay grit 5. O. H. Ivie bone/high carbonates, hematite 6. O. H. Ivie bone/low carbonates 7. HY209 bone/quartz/feldspar 8. HY209 bone/high carbonates, hematite 9. HY209 quartz/bone, addl hematite 10. HY209 quartz/bone/carbonates, feldspar and hematite
Turpin and Robinson (1998)	TR-98	<ol style="list-style-type: none"> 1. MSL Bone and addl quartz 2. MSL Bone, minor limestone and clay balls 3. RG26 Volcanics, quartz and iron-stain 4. Javelina Bluff low bone/high carbonates 5. Devil's Mouth and Infierno Camp bone, limestone and quartz 6. Black Cave Camp high bone/low carbonates
Robinson (1999)	R-99	<ol style="list-style-type: none"> 1. San Felipe Springs high bone/low carbonates, hematite
Kittleman (1994)	K-94	<ol style="list-style-type: none"> 1. Bone exclusively, mostly crystalline paste 2. Bone and minimal carbonates, crystalline or vitric pastes 3. Bone and minimal carbonates, crystalline or vitric pastes 4. Bone and minimal carbonates, crystalline or vitric pastes 5. Bone and minimal carbonates, vitric pastes 6. Substantial carbonates, vitric paste 7. Substantial carbonates, vitric paste

The identification of paste groups in the Varga sample collection was a useful way of ordering the data. Furthermore, the effort to identify paste groups shared with other sites and regions within the larger Toyah Central Texas area was successful. The shared paste groups showed that locally produced ceramics were transported from site to site. Investigating the means and mechanisms of

this transport through hypothesis-testing and the application of other analytical technologies may be a fruitful avenue for future research.

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APPENDIX E:

**POLLEN AND PHYTOLITH ANALYSES OF SAMPLES FROM THE VARGA SITE,
41ED28, EDWARDS COUNTY, TEXAS**

POLLEN AND PHYTOLITH ANALYSES OF SAMPLES FROM THE VARGA SITE, 41ED28, EDWARDS COUNTY, TEXAS

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E.1 INTRODUCTION

A total of 25 paired pollen and phytolith samples were sent for analysis to Quaternary Services. These samples were collected from the Varga Site (41ED28) from Edwards County, Texas in conjunction with TRC Project 35319. Twenty of the paired samples were taken from a column at the junction of backhoe trenches 1 and 2. Two samples from dated sections were sent from backhoe trench 1, located in the southwestern corner of the site, while three additional samples from dated sections were sent from backhoe trench 7, located in the extreme northeastern corner.

The column samples contained strata associated with the Toyah component, dated to ca. 300-650 years B.P. and three divisions within the Archaic period. The Late Archaic component dated to between 1700-2300 years B.P., the Middle Archaic dated to between 3900-4800 years B.P., and the Early Archaic dated to between 5200-6300 years B.P. The sections from trench M1 were taken from strata 2Ab dating to the Late Archaic (1870 years B.P.) and from strata 2Bw, dating to the Early Archaic period (6279 years B.P.). The sections from backhoe trench 7 were taken from a cultural level dating to the Late Archaic period (1900 years B.P.), strata 2Bk, which dated to the Early Archaic (4820 years B.P.) and from strata Bk2 which also dated to the Early Archaic (5230 years B.P.).

The Varga site is located in northeastern Edwards County at an elevation of 1980' AMS. It is located just below the top of the Edwards Plateau above Hackberry Creek, which flows into the Nueces River. The modern vegetation consists of a Juniper-oak savannah with a dense to open canopy of broadleaf deciduous and needleleaf conifer shrubs and low trees (Table E-1). The

dominant vegetation consists of *Juniperus* sp. (Mountain Juniper), and *Quercus virginiana* (Live Oak). *Andropogon scoparius* (Little bluestem) is the dominant grass. Mesic forests containing several species of *Quercus* sp. (oak), *Ulmus* sp. (elm), *Pinus* sp. (pine), *Celtis* sp. (Hackberry), *Carya illinoensis* (pecan), *Juglans microcarpa* (walnut), and a variety of berry-bearing shrubs are present along the stream floodplains.

E.1 METHODS AND MATERIALS

E.1.1 Pollen Extraction Methods

Chemical extraction of pollen samples was conducted at the Palynology Laboratory at Texas A&M University, using a procedure designed for semi-arid Southwestern sediments. The method, detailed below, specifically avoids use of such reagents as nitric acid and bleach, which have been demonstrated experimentally to be destructive to pollen grains (Holloway 1981).

From each pollen sample submitted, 15 grams (g) of soil were sub-sampled. Prior to chemical extraction, two tablets of concentrated *Lycopodium* spores (batch #307862, Department of Quaternary Geology, Lund, Sweden; 13,500 ∇ 500 marker grains per tablet) were added to each sub-sample. The addition of marker grains permits calculation of pollen concentration values and provides an indicator for accidental destruction of pollen during the laboratory procedure.

The samples were treated with 35 percent Hydrochloric Acid (HCl) overnight to remove carbonates and to release the *Lycopodium* spores from their matrix. After neutralizing the acid with distilled water, the samples were allowed to settle for a period

of at least three hours before the supernatant liquid was removed. Additional distilled water was added to the supernatant, and the mixture was swirled and then allowed to settle for 5 seconds. The suspended fine fraction was decanted through 150 Φ mesh screen into a second beaker. This procedure, repeated at least three times, removed lighter materials, including pollen grains, from the heavier fractions. The fine material was concentrated by centrifugation at 2,000 revolutions per minute (RPM).

The fine fraction was treated with concentrated Hydrofluoric Acid (HF) overnight to remove silicates. After completely neutralizing the acid with distilled water, the samples were treated with a solution of darvan, and sonicated in a Delta D-9 Sonicator for 30 seconds. The Darvan solution was removed by repeated washing with distilled water and centrifuged (2,000 RPM) until the supernatant liquid was clear and neutral. This procedure removed fine charcoal and other associated organic matter and effectively deflocculated the sample.

The samples were dehydrated in glacial acetic acid in preparation for acetolysis. Acetolysis solution (acetic anhydride: concentrated sulfuric acid in 9:1 ratio) following Erdtman (1960), was added to each sample. Centrifuge tubes containing the solution were heated in a boiling water bath for approximately eight minutes and then cooled for an additional eight minutes before centrifugation and removal of the acetolysis solution with glacial acetic acid followed by distilled water. Centrifugation at 2,000 RPM for 90 seconds dramatically reduced the size of the sample, yet from periodic examination of the residue, did not remove fossil palynomorphs.

Heavy density separation ensued using zinc bromide (ZnBr₂), with a specific gravity of

2.00, to remove much of the remaining detritus from the pollen. The light fraction was diluted with distilled water (10:1) and concentrated by centrifugation. The samples were washed repeatedly in distilled water until neutral. The residues were rinsed in a 1% solution of potassium hydroxide (KOH) for less than one minute, which was effective in removing the majority of the unwanted alkaline soluble humates.

The material was rinsed in Ethanol (ETOH) stained with safranin-O, rinsed twice with ETOH, and transferred to 1-dram vials with Tertiary Butyl Alcohol (TBA). The samples were mixed with a small quantity of glycerine and allowed to stand overnight for evaporation of the TBA. The storage vials were capped and were returned to TRC Inc. at the completion of the project.

A drop of the polliniferous residue was mounted on a microscope slide for examination under an 18 X 18 mm cover slip sealed with fingernail polish. The slide was examined using 200X or 100X magnification under an aus-Jena Laboval 4 compound microscope. Occasionally, pollen grains were examined using either 400X or 1,000X oil immersion to obtain a positive identification to either the family or genus level.

Abbreviated microscopy was performed on each sample in which either 20 percent of the slide (approximately four transects at 200X magnification) or a minimum of 50 marker grains were counted. If warranted, full counts were conducted by counting to a minimum of 200 fossil grains. Regardless of which method was used, the uncounted portion of each slide was completely scanned at a magnification of 100X for larger grains of cultivated plants such as *Zea mays* and *Cucurbita*, two types of Cactus (*Platyopuntia* and *Cylindropuntia*), and other large pollen types such as members of the

Malvaceae, or Nyctaginaceae families. Because corn pollen was very common in many of these samples, corn grains were tabulated during the scans only if an unequal distribution of this taxon on the microscope slide was observed.

For those samples warranting full microscopy, a minimum of 200 pollen grains per sample were counted as suggested by Barkley (1934), which allows the analyst to inventory the most common taxa present in the sample. All transects were counted completely (Brookes and Thomas 1967), resulting in various numbers of grains counted beyond 200. Pollen taxa encountered on the uncounted portion of the slide during the low magnification scan are tabulated separately.

Total pollen concentration values were computed for all taxa. In addition, the percentage of Indeterminate pollen was also computed. Statistically, pollen concentration values provide a more reliable estimate of species composition within the assemblage. Traditionally, results have been presented by relative frequencies (percentages) where the abundance of each taxon is expressed in relation to the total pollen sum (200+ grains) per sample. With this method, rare pollen types tend to constitute less than 1 percent of the total assemblage. Pollen concentration values, provide a more precise measurement of the abundance of even these rare types. The pollen data are reported here as pollen concentration values using the following formula:

$$PC = \frac{K * 3_p}{3_L * S}$$

Where: PC = Pollen Concentration
K = *Lycopodium* spores added
3_p = Fossil pollen counted

3_L = *Lycopodium* spores counted
S = Sediment weight

The following example should clarify this approach. Taxon X may be represented by a total of 10 grains (1 percent) in a sample consisting of 1,000 grains, and by 100 grains (1 percent) in a second sample consisting of 10,000 grains. Taxon X is 1 percent of each sample, but the difference in actual occurrence of the taxon is obscured when pollen frequencies are used. The use of "pollen concentration values" are preferred because it accentuates the variability between samples in the occurrence of the taxon. The variability, therefore, is more readily interpretable when comparing cultural activity to noncultural distribution of the pollen rain.

The pollen concentration values for pollen wash samples were calculated using a modification of the above formula. This modification involved the substitution of the area washed (in cm²) for the sediment weight (S) variable in the denominator from the above equation because the sample was in liquid form. The resulting concentration value is thus expressed as estimated grains per cm². The resulting pollen concentration values from pollen wash samples are treated independently of those from soil samples in the results and discussion sections, although the data are presented with the other samples in the tables. The use of pollen concentration values from these particular samples is preferred, as explained above, in order to accentuate the variability between pollen wash samples. The use of the area washed also provides a mechanism for the comparison of calculated pollen concentration values between artifacts.

Variability in pollen concentration values can also be attributed to deterioration of the grains through natural processes. In his

study of sediment samples collected from a rockshelter, Hall (1981) developed the “1000 grains/g” rule to assess the degree of pollen destruction. This approach has been used by many palynologists working in other contexts as a guide to determine the degree of preservation of a pollen assemblage and, ultimately, to aid in the selection of samples to be examined in greater detail. According to Hall (1981), a pollen concentration value below 1000 grains/gm indicates that forces of degradation may have severely altered the original assemblage. However, a pollen concentration value of fewer than 1000 grains/g can indicate the restriction of the natural pollen rain. Samples from pit structures or floors within enclosed rooms, for example, often yield pollen concentration values below 1000 grains/g.

Pollen degradation also modifies the pollen assemblage because pollen grains of different taxa degrade at variable rates (Holloway 1981, 1989; Holloway and Bryant 1983). Some taxa are more resistant to deterioration than others and remain in assemblages after other types have deteriorated completely. Many commonly occurring taxa degrade beyond recognition in only a short time. For example, most (ca. 70 percent) Angiosperm pollen has either tricolpate (three furrows) or tricolporate (three furrows each with pores) morphology. Because surfaces erode rather easily, once deteriorated, these grains tend to resemble each other and are not readily distinguishable. Other pollen types (e.g. Cheno-am) are so distinctive that they remain identifiable even when almost completely degraded.

Pollen grains were identified to the lowest taxonomic level whenever possible. The majority of these identifications conformed to existing levels of taxonomy with a few

exceptions. For example, Cheno-am is an artificial, pollen morphological category which includes pollen of the family Chenopodiaceae (goosefoot) and the genus *Amaranthus* (pigweed) which are indistinguishable from each other (Martin 1963). All members are wind pollinated (anemophilous) and produce very large quantities of pollen. In many sediment samples from the American Southwest, this taxon often dominates the assemblage.

Pollen of the Asteraceae (Sunflower) family was divided into four groups. The high spine and low spine groups were identified on the basis of spine length. High spine Asteraceae contains those grains with spine length greater than or equal to 2.5Φ while the low spine group have spines less than 2.5Φ in length (Bryant 1969; Martin 1963). *Artemisia* pollen is identifiable to the genus level because of its unique morphology of a double tectum in the mesocopial (between furrows) region of the pollen grain. Pollen grains of the Liguliflorae are also distinguished by their fenestrate morphology. Grains of this type are restricted to the tribe Cichoreae which includes such genera as *Taraxacum* (dandelion) and *Lactuca* (lettuce).

Pollen of the Poaceae (Grass) family are generally indistinguishable below the family level, with the single exception of *Zea mays*, identifiable by its large size (ca 80μ), relatively large pore annulus, and the internal morphology of the exine. All members of the family contain a single pore, are spherical, and have simple wall architecture. Identification of non-corn pollen is dependent on the presence of the single pore. Only complete or fragmented grains containing this pore were tabulated as members of the Poaceae.

Clumps of four or more pollen grains (anther fragments) were tabulated as single grains to avoid skewing the counts. Clumps of pollen grains (anther fragments) from archaeological contexts are interpreted as evidence for the presence of flowers at the sampling locale (Bohrer 1981). This enables the analyst to infer possible human behavior.

Finally, pollen grains in the final stages of disintegration but retaining identifiable features, such as furrows, pores, complex wall architecture, or a combination of these attributes, were assigned to the Indeterminate category. The potential exists to miss counting pollen grains without identifiable characteristics. For example, a grain that is so severely deteriorated that no distinguishing features exist, closely resembles many spores. Pollen grains and spores are similar both in size and are composed of the same material (Sporopollenin). So that spores are not counted as deteriorated pollen, only those grains containing identifiable pollen characteristics are assigned to the Indeterminate category. Thus, the Indeterminate category contains a minimum estimate of degradation for any assemblage. If the percentage of Indeterminate pollen is between 10 and 20 percent, relatively poor preservation of the assemblage is indicated, whereas Indeterminate pollen in excess of 20 percent indicates severe deterioration to the assemblage.

In those samples where the total pollen concentration values are approximately at or below 1000 grains/g, and the percentage of Indeterminate pollen is 20 percent or greater, counting was terminated at the completion of the abbreviated microscopy phase. In some cases, the assemblage was so deteriorated that only a small number of taxa remained. Statistically, the

concentration values may have exceeded 1000 grains/gm. If the species diversity was low (generally these samples contained only pine, Cheno-am, members of the Asteraceae (Sunflower) family and Indeterminate category, counting was also terminated after abbreviated microscopy even if the pollen concentration values slightly exceeded 1000 grains/g.

E.1.2 Phytolith Extraction Procedures

Phytoliths were isolated using a conservative extraction technique. The soil samples were screened through 1/16th inch mesh to remove larger materials. Five-gram sediment samples were placed in beakers and concentrated HCL was added to remove carbonate materials. The residues were rinsed and consolidated and screened through 150 Φ mesh to remove unwanted larger materials. A series of short centrifuge spins removed unwanted fine clays smaller than 3 Φ . The residues were washed with KOH (5%) to remove alkaline soluble humates and then rinsed until neutral.

Organic traces were removed by adding Schulze's solution (concentrated Nitric Acid and Potassium Chlorate) and heating in a water bath for approximately 30 minutes to 1 hour. Following the removal of organic materials, the samples were rinsed until neutral and were fractionated in a water column. This procedure separated the phytoliths into 2 size fractions; 3-25 Φ , the fine fraction and 25-150 Φ , the coarse fraction. This step is necessary as each fraction usually contains a unique set of phytolith types. Next, the samples were transferred to 15 ml tubes for heavy density fractionation. Zinc Bromide (S.G. 2.38) was added to the samples, which were centrifuged at high speed on a clinical centrifuge. Following this procedure, phytoliths floating on the heavy liquid were

carefully pipetted off. The heavy density separation was repeated twice to ensure that a total phytolith recovery was made. Phytoliths were rinsed, dehydrated and curated in ethanol.

Permanent slides were prepared using Meltmount adhesive (refractive index 1.539). The slide was routinely examined using 200X - 400X magnification, using Phase Contrast Microscopy, under an aus-Jena Laboval 4 compound microscope. Occasionally, phytoliths were examined using either 400X or 1,000X oil immersion to obtain a positive identification.

E.2 RESULTS

The raw counts of the pollen assemblages are presented in Table E-2 while Table E-3 contains the calculated pollen concentration values from each assemblage. Table E-4 contains the raw counts of the phytolith samples and Table E-5 contains the calculated phytolith relative frequencies. The individual results are detailed below by period and depth.

E.2.1 Column Samples

E.2.1.1 Toyah Component (ca. 300-650 years B.P.)

Sample 1217-b was taken from the 3-6 cmbs level and contained 7633 grains/ml total pollen concentration values and was based on a pollen sum of 229 grains. *Pinus* (233 grains/ml) pollen was very low with a high amount of *Quercus* (267 grains/ml) and a small amount of *Carya* (33 grains/ml) pollen. Poaceae (67 grains/ml) was moderate with high amounts of Chen-am (5333 grains/ml), high (667 grains/ml) and low spine (467 grains/ml) Asteraceae and a moderate to low amount of *Artemisia* (33 grains/ml). A high number of Chen-am

pollen clumps (67/ml) were also present. Apiaceae (100 grains/ml) was high with moderate to high amounts of *Opuntia* (33 grains/ml) pollen. A small amount of trilete spores (14.29/ml) were also present.

The phytolith sample was based on a count of 557 and was crenate forms (42.55%) and secondarily by saddle forms (19.93%). Smaller percentages of Pyramidal (0.18%) Simple Lobate (9.52%), Panicoid (0.36%), other lobate (7.54%), square (0.18%), Rhomboidal (9.87% each), cross-shaped (1.26%), and Sabal (0.54%) were also present in the assemblage.

Sample 1218-b was taken from the 13-15 cmbs level and contained 3430 grains/ml total pollen concentration values and was based on a pollen sum of only 101 grains. *Pinus* (136 grains/ml) was very low with moderate amounts of *Carya* (34 grains/ml) and high amounts of *Quercus* (136 grains/ml). Chen-am (2411 grains/ml) was high and dominated the assemblage along with high (102 grains/ml) and low spine (408 grains/ml) Asteraceae. Chen-am clumps (13.84/ml) and trilete spores (27.67/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 458 and was dominated by Crenate forms (65.28%). Smaller percentages of Rhomboidal (10.26%), simple lobate (13.10%), Saddle (7.21%), Square (2.40%), Stipa type (0.87%), hair bases (0.44%), Irregular and Conical (0.22% each) were also present.

Sample 1219-b was taken from the 19-20 cmbs level and contained 4345 grains/ml total pollen concentration values and was based on a pollen sum of 140 grains. *Pinus* (124 grains/ml) was very low with moderate amounts of *Quercus* (31 grains/ml) and *Carya* (62 grains/ml). Poaceae (31

grains/ml) was low with high amounts of Cheno-am (3693 grains/ml), and both high and low spine (93 grains/ml each) Asteraceae. Trilete spores (7.16/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 489 and was dominated by crenate (55.21%) and secondarily by simple lobate forms (29.86%). Smaller percentages of Rhomboidal (9.61%), Saddle (2.45%), Square (1.23%), Stipa type (1.02%), cross-shaped (0.41%), and Sabal (0.20%) were also present.

Sample 1220-b was taken from the 23-24 cmbs level and contained 8400 grains/ml total pollen concentration values and was based on a pollen sum of 252 grains. *Pinus* (233 grains/ml) was very low with high amounts of *Quercus* (100 grains/ml) and moderate amounts of *Celtis* (33 grains/ml). Poaceae (33 grains/ml) was low with very high amounts of Cheno-am (4400 grains/ml), high (2900 grains/ml) and low spine (300 grains/ml) Asteraceae, and *Artemisia* (133 grains/ml). *Juglans* pollen and trilete spores (10.26 grains/ml) was present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 357 and was dominated by crenate (57.14%), and secondarily by simple lobate (16.25%) and rhomboidal (13.17%) forms. Smaller percentages of square (2.80%), Saddle (9.52%), Panicoid (0.56%) hair bases and Sabal (0.28% each) were also present.

E.2.1.2 Late Archaic (ca. 1700-2300 years B.P.)

A total of 3 samples were submitted from this time period. Sample 1221-b was taken from the 28-29 cmbs level and contained 3665 grains/ml total pollen concentration

values and was based on a pollen sum of only 112 grains. *Pinus* (229 grains/ml) was very low with moderate amounts of both *Quercus* and *Carya* (33 grains/ml each) pollen. Poaceae (33 grains/ml) was low with high amounts of Cheno-am (2160 grains/ml) pollen, high (327 grains/ml), and low spine (425 grains/ml) Asteraceae, and *Artemisia* (98 grains/ml). Trilete spores (7.55/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 376 and was dominated by crenate (60.11%) forms and secondarily by simple lobate (14.63%) and rhomboidal (11.44%) forms. Smaller percentages of saddle (9.57%), irregular (2.13%), stipa type and hair bases (0.80% each), and conical (0.53%) were also present.

Sample 1222-b was taken from the 33-34 cmbs level and contained 2682 grains/ml total pollen concentration values and was based on a pollen sum of only 112 grains. *Pinus* (35 grains/ml) was present in trace amounts only with moderate to high amounts of *Quercus* (71 grains/ml) pollen. Poaceae (71 grains/ml) was high along with moderate amounts of Cheno-am (1235 grains/ml) pollen, and high amounts of high (635 grains/ml), and low spine (388 grains/ml) Asteraceae, and moderate to low amounts of *Artemisia* (35 grains/ml).

The phytolith sample was based on a sum of 328 and was dominated by crenate (33.23%), rhomboidal (24.39%), and panicoid (27.74%) forms. Smaller percentages of saddle (0.307%), irregular (1.22%), hair bases (1.83%), square (11.28%) and saddle (0.30%) were also present.

Sample 1223-b was taken from the 40-41 cmbs level and contained only 1233 grains/ml total pollen concentration values and was based on a pollen sum of only 37

grains. *Pinus* (33 grains/ml) was present in trace amounts only. Poaceae (33 grains/ml) was low with low amounts of Cheno-am (833 grains/ml) pollen, moderate amounts of low spine (67 grains/ml) Asteraceae, and low to moderate quantities of *Artemisia* (33 grains/ml).

The phytolith sample was based on a sum of 332 and was dominated by crenate (66.27%) forms. Smaller percentages of saddle (5.42%), square (4.22%), simple lobate (12.35%), Stipa type (0.90%), hair bases (1.20%), rhomboidal (7.83%), conical (0.90%), cross (0.30%) and cf. *Zea mays* (0.60%) were also present.

E.2.1.3 Middle Archaic (ca. 3900-4800 years B.P.)

Sample 1224-b was taken from the 46-47 cmbs level and contained only 1624 grains/ml total pollen concentration values and was based on a pollen sum of only 46 grains. *Pinus* (71 grains/ml) was present in trace amounts only. Cheno-am (1094 grains/ml) was low to moderate but dominated the assemblage. Both high (106 grains/ml) and low spine (71 grains/ml) Asteraceae were present in high to moderate amounts with small amounts of *Artemisia* (35 grains/ml). Trilete spores (7.56/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 344 and was dominated by crenate (63.95%) forms and secondarily by simple lobate (10.76%). Smaller percentages of saddle (7.85%), irregular (0.87%), stipa type (0.58%), hair bases (0.29% each), conical (0.87%), square (8.43%), rhomboidal (6.10%), and cross (0.29%) were also present.

Sample 1225-b was taken from the 50-51 cmbs level and contained only 1306 grains/ml total pollen concentration values

and was based on a pollen sum of only 37 grains. *Pinus* (71 grains/ml) was present in trace amounts only with a small amount of *Carya* (35 grains/ml) pollen. Poaceae (35 grains/ml) was very low with very low Cheno-am (494 grains/ml) pollen and high amounts of both high (106 grains/ml) and low spine (282 grains/ml) Asteraceae.

The phytolith sample was based on a sum of 292 and was dominated by crenate (63.36%) forms and secondarily by simple lobate (11.64%) and saddle (11.30%). Smaller percentages of stipa type (0.34%), conical (1.37%), square (3.77%), rhomboidal (7.88%), stipa type and cross (0.34%) were also present.

Sample 1226-b was taken from the 55-56 cmbs level and contained only 2186 grains/ml total pollen concentration values and was based on a pollen sum of only 68 grains. *Pinus* (96 grains/ml) was present in trace amounts only. Poaceae (32 grains/ml) was present in low amounts with moderate amounts of Cheno-am (1157 grains/ml) and high amounts of both high (257 grains/ml) and low spine (418 grains/ml) Asteraceae. A larger sized grass grain (32 grains/ml) was also present. The phytolith sample from this level was not countable.

Sample 1227-b was taken from the 60-61 cmbs level and contained only 1129 grains/ml total pollen concentration values and was based on a pollen sum of only 32 grains. *Pinus* (35 grains/ml) was present in trace amounts only with moderate to high amounts of *Carya* (71 grains/ml) and *Celtis* (35 grains/ml). Poaceae (35 grains/ml) was low with low amounts of Cheno-am (318 grains/ml) and high amounts of both high (106 grains/ml) and low spine (353 grains/ml) Asteraceae. *Ephedra* (35 grains/ml) was also present.

The phytolith sample was based on a sum of 360 and was dominated by crenate (59.17%) forms and secondarily by rhomboidal (16.11%). Smaller percentages of keeled (1.11%), saddle (5.83%), simple lobate (3.33%), square (5.83%), irregular (7.78%), hair bases (0.56%), and cross (0.29%) were also present.

Sample 1228-b was taken from the 66-67 cmbs level and contained only 765 grains/ml total pollen concentration values and was based on a pollen sum of only 17 grains. *Pinus* (45 grains/ml) was present in trace amounts only but with high amounts of *Carya* (135 grains/ml). Cheno-am (225 grains/ml) was very low but dominated the assemblage and there were a large number of Cheno-am pollen clumps (45/ml). Both high and low spine (45 grains/ml each) Asteraceae were present in low to moderate amounts.

The phytolith sample was based on a sum of 319 and was dominated by crenate (57.05%) forms and secondarily by rhomboidal (14.11%) and square (10.03%). Smaller percentages of conical (1.57%), saddle (7.21%), simple lobate (6.27%), irregular (0.94%), and hair bases (2.82%) were also present.

Sample 1229-b was taken from the 71-72 cmbs level and contained only 784 grains/ml total pollen concentration values and was based on a pollen sum of only 27 grains. *Pinus* (29 grains/ml) was present in trace amounts only with a small amount of *Carya* (29 grains/ml) pollen. Cheno-am (116 grains/ml) was very low with high amounts of both high (174 grains/ml) and low spine (261 grains/ml) Asteraceae. Cactaceae (29 grains/ml) was low but was represented by only a single grain. Apiaceae pollen (6.43 grains/ml) was present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 310 and was dominated by crenate (49.35%) forms and secondarily by rhomboidal (21.29%) and square (14.52%). Smaller percentages of conical (0.65%), saddle (3.55%), simple lobate (1.29%), and irregular (9.35%), were also present.

Sample 1230-b was taken from the 76-77 cmbs level and contained only 581 grains/ml total pollen concentration values and was based on a pollen sum of only 20 grains. *Quercus* and *Celtis* (29 grains/ml each) were present in small amounts only. Poaceae (87 grains/ml) was high with low amounts of Cheno-am (145 grains/ml) and moderate to low amounts of both high (58 grains/ml) and low spine (29 grains/ml) Asteraceae. Trilete spores (4.47/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 362 and was dominated by crenate (35.64%) forms and secondarily by rhomboidal (23.48%), irregular (25.41%), and square (10.22%). Smaller percentages of saddle (3.59%), simple lobate (0.83%), hair bases (0.28%), and Sabal (0.55%) were also present.

E.2.1.4 Early Archaic (ca. 5200-6300 years B.P.)

Sample 1231-b was taken from the 81-82 cmbs level and contained 1276 grains/ml total pollen concentration values and was based on a pollen sum of only 26 grains. A small amount of *Quercus* (46 grains/ml) was present. Poaceae (98 grains/ml) was high with low amounts of Cheno-am (344 grains/ml), and high amounts of both high (98 grains/ml) and low spine (442 grains/ml) Asteraceae.

The phytolith sample was based on a sum of 371 and was dominated by rhomboidal (53.37%) and secondarily by crenate

(19.41%) and irregular (11.59%). Smaller percentages of conical (1.62%), saddle (3.77%), simple lobate (3.23%), square (6.47%), and hair bases (0.54%), were also present.

Sample 1232-b was taken from the 86-87 cm level. The phytolith sample was based on a sum of 244 and the pollen sample from this level was not extracted. The phytolith sample from this level was dominated by irregular (46.31%) forms and secondarily by crennate (25.41%) and rhomboidal (15.16%). Smaller percentages of saddle and square (6.56% each) were also present.

Sample 1233-b was taken from the 90-91 cm level. The phytolith sample was based on a sum of 286 and the pollen sample from this level was not extracted. The sample was dominated by crennate (55.24%) forms and secondarily by irregular (14.34%) and rhomboidal (20.98%). Smaller percentages of conical (0.35%), saddle (2.80%), square (5.24%), simple lobate (0.70%), and hair bases (0.35%) were also present.

Sample 1234-b was taken from the 95-96 cm level and contained only 800 grains/ml total pollen concentration values and was based on a pollen sum of only 16 grains. A small amount of *Carya* (50 grains/ml) was present. *Cheno-am* (250 grains/ml) was present in very low amounts along with high amounts of low spine (150 grains/ml) *Asteraceae*. Trilete spores (12.24/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 372. The sample was dominated by Rhomboidal (34.14%), crennate (26.08%), and irregular (23.66%) forms. Smaller percentages of conical (1.08%), saddle (5.11%), square (8.87%), and hair bases (1.08%) were also present.

Sample 1235-b was taken from the 100-101 cm level. The phytolith sample was based on a sum of 320 and the pollen sample from this level was not extracted. The sample was dominated by crennate (55.63%) forms and secondarily by irregular (10.31%) and rhomboidal (21.56%). Smaller percentages of saddle (1.88%), square (9.38%), simple lobate (0.31%), and hair bases (0.94%) were also present.

Sample 1236-b was taken from the 104-106 cm level. The phytolith sample was based on a sum of 389 and the pollen sample from this level was not extracted. The sample was dominated by crennate (54.24%) forms and secondarily by rhomboidal (21.34%). Smaller percentages of conical (1.29%), saddle (4.63%), square (9.25%), simple lobate (2.31%), irregular (5.91%), and hair bases (1.03%) were also present.

E.2.2 Dated Sections

Two sediment samples were submitted from BT1. Sample 1208-4-d was taken from unit 3, from the 2Ab deposit, which dated to the late Archaic, approximately 1870 years B.P. The assemblage contained 2333 grains/ml total pollen concentration values and was based on a pollen sum of 70 grains. *Pinus* (100 grains/ml) was very low with high amounts of *Quercus* (167 grains/ml). *Cheno-am* (1433 grains/ml) was moderate to high with high amounts of both high (133 grains/ml) and low spine (167 grains/ml) *Asteraceae*. *Solanaceae* and *Ephedra* (33 grains/ml each) were also present.

The phytolith sample was based on a sum of 370. The sample was dominated by crennate (57.57%) and secondarily by Rhomboidal (17.84%) forms. Smaller percentages of conical (0.27%), saddle (9.46%), simple lobate (9.19%), square (3.78%), irregular (1.35%), hair bases and *Sabal* (0.27% each) were also present.

Sample 1207-4-d was taken from unit 4, from the 2Bw deposit, which dated to the Early Archaic, approximately 6279 years B.P. *Pinus* (90 grains/ml) was very low along with low to moderate amounts of *Quercus* (30 grains/ml) and *Carya* (60 grains/ml) pollen. Chen-am (120 grains/ml) was very low with low amounts of high spine (30 grains/ml) and high amounts of low spine (90 grains/ml) Asteraceae. *Ephedra* (30 grains/ml) was also present. Poaceae (4.53 grains/ml) pollen was present in the low magnification scan of the slide. The phytolith sample from this level was not countable.

An additional 3 sediment samples were submitted from BT 7. Sample 1211-4-d was taken from cultural strata 15-20 cmbs and dated to the late Archaic, approximately 1900 years B.P. The assemblage contained 900 grains/ml total pollen concentration values and was based on a pollen sum of 28 grains. *Pinus* (32 grains/ml) was present in trace amounts only. A small amount of *Quercus* (32 grains/ml) pollen was present. Poaceae (32 grains/ml) was low with low amounts of Chen-am (482 grains/ml) and high spine Asteraceae (32 grains/ml) and a high amount of low spine Asteraceae (96 grains/ml).

The phytolith sample was based on a sum of 424. The sample was dominated by crennate (68.40%) and secondarily by Rhomboidal (10.85%) forms. Smaller percentages of saddle (6.13%), simple lobate (1.18%), square (7.55%), irregular (4.01%), hair bases (1.65%), and Sabal (0.24%) were also present.

Sample 1210-4-d was taken from the 2Bk deposit (80-85 cmbs), which dated to the Early Archaic, approximately 4820 years B.P. The assemblage contained 886

grains/ml total pollen concentration values and was based on a pollen sum of 249 grains. *Pinus* (25 grains/ml) was present in trace amounts only with small amounts of *Quercus* (36 grains/ml) and *Carya* (43 grains/ml) pollen. Poaceae (25 grains/ml) was low with low amounts of Chen-am (277 grains/ml) pollen. Both high (142 grains/ml) and low spine (160 grains/ml) Asteraceae were present in high amounts. A trace of Liguliflorae and *Ephedra* pollen (4 grains/ml each) were also present, in addition to a small, unknown triporate type grain. Malvaceae and trilete spores (1.71 grains/ml) were present in the low magnification scan of the slide. The phytolith sample from this level was not countable.

Sample 1209-4-d was taken from the 115-120 cmbs level of the Bk2 deposit, which dated to the Early Archaic, approximately 5230 years B.P. The assemblage contained only 374 grains/ml total pollen concentration values and was based on a pollen sum of 31 grains. *Pinus* and *Quercus* (12 grains/ml each) were present in trace amounts and *Carya* (24 grains/ml) was present in low amounts. Poaceae (36 grains/ml) was low with a trace (12 grains/ml) of Chen-am pollen along with moderate amounts of high spine (60 grains/ml) and moderate to high amounts of low spine (85 grains/ml) Asteraceae. *Artemisia* and Apiaceae (24 grains/ml each) were present in small amounts. Trilete spores (3.22/ml) were present in the low magnification scan of the slide.

The phytolith sample was based on a sum of 217. The sample was dominated by crennate (70.51%) and secondarily by Rhomboidal (10.14%) and irregular (10.60%) forms. Smaller percentages of saddle (2.30%), square (4.61%), irregular

(4.02%), and hair bases (1.84%) were also present.

E.3 DISCUSSION

E.3.1 Pollen Data

The pollen data was very poorly preserved throughout the column. The samples from the youngest period (Toyah component) were better preserved than from other periods. The total pollen concentration values are generally higher from the Toyah component and then decrease throughout the Late Archaic to very low levels where they remain throughout both the Middle and Early Archaic time periods (Figures E-1 and E-2). The concentration values of indeterminate grains also tend to increase with depth of the column although these are generally high throughout the column. While the number of pollen taxa recovered from individual samples is generally low (5-12 with a mean of 7.75), the samples from the Toyah component contained higher numbers of taxa with the taxa decreasing by age of the column (Table E-6). This reveals a highly weathered column with poor preservation.

Pinus pollen is present in very low amounts throughout the column and probably represents the results of long distance transport. Although *Pinus* is present in the mesic forests presently located along the streams, it is probably not very dominant. Although, the low pollen concentration values may be accounted for by preservation, I suspect that the number of pines in the area are low. In the earlier sediments (Middle to Early Archaic) *Pinus* pollen concentration values decrease to trace amounts. This is likely due to preservation and I suspect pines have been locally present, although not abundant, throughout

most of the time periods represented by these samples.

Juniperus pollen is absent from the pollen assemblages although it was an important constituent of the modern vegetation. This is likely due to factors of preservation. *Juniperus* pollen is thin walled and contains a smaller percentage of the compound sporopollenin in the exine. The percentage of this compound has been demonstrated to positively correlate with the degree to which a pollen grain is resistant to weathering (Brooks 1971, 1978). Further, in a series of controlled laboratory experiments Holloway (1981, 1989) demonstrated that more than 80% of the fresh *Juniperus* pollen was deteriorated after only 25 alternating cycles of either freezing/thawing temperatures, or wet/dry conditions. Thus, it is not unexpected for *Juniperus* pollen to be absent from assemblages, even when it is known to be present in the plant community.

In order to evaluate the degree of variation of the data, both the pollen and phytolith data sets were analyzed using Principal Components Analysis. The calculations were performed using MVSP (Kovach 1998), a computer program specifically designed for use with Pollen and microfossil data. With only a few exceptions, the vast majority of the samples clustered around a single axis and thus no real separation was obtained. Because of this lack of separation, the data are not included in this report but are available from the author.

E.3.1.1 Toyah Component ca. 300-650 B.P.

Quercus pollen was fairly high throughout this period and was present in all samples. Additionally, *Carya* pollen was present in all samples from this period and both *Celtis* and *Juglans* pollen were recovered from the lowest sample from this period. This is

consistent with the modern vegetation of the area described earlier.

The uppermost sample from the column (1217-b) contained a fairly large concentration value of Apiaceae pollen, which undoubtedly reflects a more riparian habitat within the area. Chen-am pollen is very high and the upper sample (1217-b) also contained a high number of Chen-am pollen clumps (67/ml), which is suggestive of these plants being extremely common in the vicinity. High and low spine Asteraceae pollen concentration values were very large, particularly in the lowest level of this period (1220-b). The high levels of the Asteraceae, *Artemisia*, Chen-am and Poaceae suggest a mosaic pattern with the arboreal cover interspersed with shrubby grassland components. Small amounts of *Opuntia* pollen are present only in the upper level of the column and probably reflect the local presence of this taxon in the plant community. However, this was based on the presence of a single pollen grain and may not be indicative of current conditions. No other *Opuntia* grains were observed from this suite of samples.

E.3.1.2 Late Archaic Period ca. 1700-2300 B.P.

A total of 3 samples were submitted from this time period and represented the section of the column between 28-41 cm. The pollen concentration values show a trend to decreasing values during this period. *Pinus* pollen decreases to trace amounts remains at these low levels or is absent from the remainder of the column. *Quercus* is present only in the upper level of this period and no other arboreal taxa are present. Chen-am, Asteraceae and *Artemisia* pollen show gradual decreases but are still fairly abundant. Generally, the pollen assemblages reflect the same taxa as present during the later Toyah component. The

pollen assemblages contain lowered pollen concentration values but this is likely due to increased deterioration of the assemblages.

Two dated sections were also affiliated with this time period. Sample 1208-4-d was taken from BT-M (90 cmbs level). This assemblage contained very low concentration values of *Pinus* (100 grains/ml) and fairly high concentration values of *Quercus* (167 grains/ml). Chen-am pollen was moderate to high (1433 grains/ml) with high amounts of both high (133 grains/ml) and low spine (167 grains/ml) Asteraceae, which compares fairly close to the upper levels of the Late Archaic samples from the column. Small amounts of Solanaceae and *Ephedra* pollen (33 grains/ml each) were also present.

Sample 1211-4-d was taken from a cultural level from BT 7 from the 15-20 cmbs level. This assemblage contained small concentration values for *Pinus* and *Quercus* along with Poaceae. The Chen-am pollen concentration values were very low (482 grains/ml) and both types of Asteraceae were lower than from sample 1208-4-d. Thus the higher concentration values from 1208-4-d are likely from locally present *Chenopodium* type plants. Although physically closer to the surface, this sample corresponds closer to the deeper Late Archaic sediments from the column but this may be due to more extensive weathering of this cultural layer.

E.3.1.3 Middle Archaic Period ca. 3900-4800 B.P.

Quercus pollen is present in small quantities in the lowest sample of this time period. A small amount of *Celtis* pollen is present from a single level but *Carya* pollen is present in 5 of the 7 samples. While the ubiquity of these arboreal taxa is drastically lowered, this is most likely a function of

preservation. The arboreal component, in terms of the taxa present, is very similar to the better-preserved levels of the column. Low spine Asteraceae tends to increase in concentration values during this period while all other taxa show decreases. This is also possibly a function of preservation since the Asteraceae are among the better-preserved taxa (Holloway 1981, 1989). Alternatively, this could suggest an actual increase in these types of plants. This is supported by the occurrence of non-*Opuntia* Cactaceae and *Ephedra* in single samples. Again, both the Cactaceae and *Ephedra* were based on the occurrence of single grains and I hesitate to place a great deal of weight to their presence. Alternatively, these are indicators of drier environments and their presence within this period may suggest slightly drier conditions were present in the local area. Given the poor preservation from these assemblages however, additional data would be required prior to hypothesizing an environmental change.

E.3.1.4 Early Archaic Period ca. 5200-6300 B.P.

Only 2 pollen samples from this period were analyzed. The remaining pollen samples were not extracted given the low potential for pollen recovery. Given the generally poor condition of the samples from this time period, this was an accurate assessment.

Small amounts of both *Quercus* and *Carya* pollen were present and were based on single grain occurrences. The assemblages were dominated by both high and low spine Asteraceae but again these taxa are most resistant to deterioration, and high concentration values for these would be expected. In both the Middle and Early Archaic Periods, while Cheno-am pollen had high numbers, the concentration values were very low for this taxon. This again supports

and interpretation of a significantly weathered assemblage. The data from this early period is so sporadic and the pollen concentration values so low that I hesitate to infer any interpretations from this period. Interestingly, the same taxa (*Quercus* and *Carya*) are present in these assemblages.

Three additional pollen samples were submitted from dated sections affiliated with this earlier time period. Two of these samples (1207-4-d -BT-M, and 1209-4-d BT-7) contained very little pollen. The concentration values were based on pollen sums of only 16 and 31 respectively. Both samples contained small amounts of *Pinus*, *Quercus*, and *Carya* pollen while 1209-4-d contained small quantities of Apiaceae and Poaceae pollen. Both High and low spine Asteraceae were low in both samples. While Cheno-am pollen was also very low in both samples, sample 1207 (120 grains/ml) contained 10 times more Cheno-am pollen than did 1209 (12 grains/ml). The low pollen concentration values are consistent with the Early Archaic and the presence of the arboreal taxa *Pinus*, *Quercus*, and *Carya*, indicate that these taxa were present throughout the time periods represented, even if absent from individual samples.

Sample 1210-4-d contained sufficient pollen for a full count. Small amounts of *Pinus*, *Quercus*, and *Carya* pollen were present along with very small amounts of Cheno-am and Poaceae pollen. Both high and low spine Asteraceae pollen were fairly high and this sample did contain a trace of Liguliflorae pollen. The low arboreal pollen concentration values might suggest a decrease in the arboreal cover during this early time period with a concomitant expansion of meadow like components. Liguliflorae pollen is generally rare in assemblages because this type of pollen is

restricted to the Chichoreae tribe of the Asteraceae, which include taxa such as *Taraxacum*, *Lactuca*, *Liatris* etc., which are generally associated with grassland meadows. These plants also produce very low amounts of pollen so that even a small concentration value suggests a much higher composition of these plants within the local plant communities.

Given the presence of the *Quercus* and *Carya* throughout the column, I suspect that similar vegetation communities existed in this area throughout the time periods represented. The changes observed within the pollen assemblages are likely due to a function of preservation, although the earliest levels do suggest a possible larger component of meadows within the local vegetation.

Based on the pollen taxa recovered, the question always arises are economic taxa absent from these assemblages because they are truly not present, or, are they present in such small amounts to have been missed during sampling. In order to assess the likelihood of there being missed, the estimated maximum potential concentration values (Dean 1998) of target taxa were computed. Since the entire slide was examined (either by count or low magnification scan of the slide) the estimated number of marker grains per slide was computed by averaging the number of marker grains per transect and multiplying this by the total number of transects examined. Assuming, that the first grain observed on an hypothetical second slide was one of the target taxa, the maximum potential concentration value can be computed. Thus, the number of the fossil grains is one, and the number of marker grains per slide is substituted for the number of marker grains counted in the pollen concentration formula. These data are

presented in Table E-3 and indicate that the estimated potential pollen concentration values fall between 1.61 and 27.16 grains/g. Without examining the total of the pollen residues we can never be absolutely sure that target taxa are indeed absent from the assemblage. Given the low estimated potential pollen concentration values however, I conclude that it is more likely that the missing taxa were indeed absent from these assemblages.

E.3.2 Phytolith Data

A preliminary assessment 5 of the column phytolith assemblages was conducted by Dr. John Jones of Texas A&M University. He noted that “phytoliths were noted in all samples and the preservation appeared quite good throughout the column.” He also noted that dominant forms included Chloridoids, Panicoids, and a small number of Festucoid types. A small amount of Sabal-type palm phytoliths were also present but Jones interpreted these as reflecting probable Cretaceous or Tertiary aged re-worked phytoliths. Jones interpreted these as being derived from lignites and/or shales. Very few of these types were present in the assemblages and his interpretation of these being re-worked deposits is very likely accurate.

After completion of the analysis, the relative frequencies of the phytolith types were plotted by depth in Figure E-3 from the column samples. The data from the dated sections was not sufficiently consistent to plot separately.

E.3.2.1 Early Archaic Period ca. 5200-6300 B.P.

The assemblages from this earliest time period are dominated by Crenate, Rhomboidal, and Irregular forms with a fairly consistent presence of square shaped

phytoliths. Saddle and conical forms are present in very small percentages and simple lobate forms are present but in trace percentages. Crennate forms are commonly produced by the Pooideae grasses (Fredlund and Tieszen 1994), as are the very small percentages of the conical forms. The dominant forms from this interval contained the Rhomboidal, which are rectangular with smooth walls, and generally smaller, and the square forms, also with smooth walls.

Two of the dated column sections from the Early Archaic Period were essentially not countable. Very few phytoliths were present on the slides. Sample 1209-4-d from strata Bk2 taken from backhoe trench 7 did provide a countable assemblage. Crennate forms were clearly dominant (70%) and the remainder consisted primarily of Rhomboidal, Irregular, and square types which is consistent with the column samples from this time period. Small, almost trace amounts of saddle forms and a few hair bases were also present.

E.3.2.2 Middle Archaic Period ca. 3900-4800 B.P.

This period appears to be a transition period between forms. The samples from the lower levels of this period are quite similar to the Early Archaic assemblages. These lower samples are clearly dominated by Crennate forms, and the Rhomboidal, Irregular, and Square forms. The crennate forms show a gradual increase during this period, the Rhomboidal, Irregular, and Square forms show a concomitant decrease with both the Irregular and Rhomboidal disappearing in the upper section of the Middle Archaic. This section also shows gradual increases in both the saddle forms and the simple lobate forms. Conical forms are intermittent and are extremely rare. A keeled form was present in a single sample during this period and was the only sample in the column in

which this form was present. The dominant crennate forms and the keeled and conical forms are associated with the Pooideae. The gradual increases in both Saddle and simple lobate forms may suggest an increase in both the Chlorideae and Panicoideae grasses, but this is preliminary.

Stipa-type phytoliths begin to occur in the upper levels of the Middle Archaic Period and cross-shaped phytoliths begin to occur about the middle levels of the period. The cross-shaped varieties are generally associated with the Panicoideae and C₄ type grasses (Fredlund and Tieszen 1994). The cross-shaped forms also appear about the level that the Rhomboidal and Irregular forms disappear from the record. Whether this is coincidence or not remains to be seen.

E.3.2.3 Late Archaic Period ca. 1700-2300 B.P.

The Late Archaic Period was represented by only 3 samples. Irregular forms are present but in trace percentages. Both rhomboidal and Square forms are present, but in much smaller percentages than were present in the earlier periods. *Stipa*-type remain in low percentages at both the top and basal sample of this section. Cross-shaped forms and a single form that compares favorably to *Zea mays* are also present but in low percentages. In fact, the specimen comparing favorably to *Zea mays* was present from only a single sample from the Late Archaic. Panicoid forms are present in the middle samples but are quite high in percentages. Crennate forms still dominate the assemblage but there are gradual increases in the percentages of both Saddle and Simple Lobate forms. Conical forms show a tendency to decrease.

Two dated sections also dated to this Late Archaic Period. The section from BT-M, which dated to 1870 B.P. was dominated by

crenate forms. Rhomboidal, Irregular, and square forms were present, but in much smaller quantities than from the earlier periods. Saddle and simple lobate forms were present. The assemblage is fairly consistent with the assemblages from the column samples.

The other dated section was from backhoe trench 7 and dated to the 1900 B.P. level. This sample also was dominated by crenate forms and with smaller percentages of rhomboidal, irregular, and square forms. Saddle and simple lobate forms were present but in smaller percentages than from 1208-4-d. Again, despite some variations, this assemblage is consistent with those from the Late Archaic age from the column.

Thus, this period shows a mix between the C₃ grasses, dominated by the Pooideae in the crenate, and conical forms and *Stipa* sp., and the C₄ grasses showing increasing contributions of Saddle, Simple lobate, cross-shape, a possible *Zea mays*, and Panicoid type forms which are generally affiliated with both the Panicoideae and Chloridaceae (Fredlund and Tieszen 1994).

E.3.2.4 Toyah Component, ca. 300-650 B.P.

The Toyah component also appeared to be dominated by Crenate forms but to a lesser extent than from the other periods. There is a general trend to slightly decreasing frequencies of this form throughout the period. However, this may simply be a response to increased frequencies of other forms. *Stipa*-type shows a stable frequency throughout the period except in the upper most sample where it increases dramatically. Even at this level, the frequency is less than 8%. The upper most sample contains a small percentage of Pyramidal forms and a trace of conical forms are found lower in the column. Simple Lobate forms remain fairly

high although there is some fluctuation in the actual percentages. Saddle forms also tend to increase during this period. Square and Rhomboidal forms are present but in very low percentages. In the upper most sample, other lobate forms are present but again in relatively low frequencies. Cross-shaped forms also reach a maximum in the upper sample.

This period indicates a stable but perhaps decreasing, composition of C₃ (Pooideae) grasses as indicated by the Crenate, Conical, and Pyramidal forms. The Chloridaceae forms as indicated by Saddle types are increasing as are various genera of the Panicoideae as indicated by the *Stipa*-type, simple and other lobate forms, panicoid and cross-shaped forms. These generally are indicative of the C₄ grasses.

Members of the Poaceae, as many other higher plants, contain two photosynthetic pathways. The difference lies in the intermediate by-product of photosynthesis, which is either a 3 carbon molecule or a 4-carbon molecule, hence the grouping of these plants as either C₃ or C₄ plants. The C₃ plants are characterized by large, irregularly and loosely arranged Chlorenchymal cells with a double sheath of cells surrounding the vascular bundles within the leaves (Piperno 1988). These plants are generally adapted to cooler and moister environments.

The C₄ group, on the other hand, contains densely clustered chlorenchyma cells, which surround the single layer of bundle sheath cells surrounding the vascular bundles. This particular pathway tends to occur in grasses characteristic of warm, dry environments and were likely of more tropical origin (Piperno 1988).

Piperno (1988) further notes that members of the Pooideae, which generally produce

types such as Crennate, keeled, conical, and pyramidal are restricted to the C₃ pathway. Grasses of the Chlorideae and the Panicoideae which tend to produce saddles, bilobate and cross-shaped forms, tend to be associated with the C₄ pathway. This is not an absolute and Piperno (1988) also notes what she calls confuser genera that need to be sorted out. She cites as an example that within the Panicoideae, both C₃ and C₄ plants are present. Even within genera such as *Panicum*, Piperno (1988) notes that both C₃ and C₄ species are present. Thus, there is a great deal of overlap within the genera.

In general, the phytolith column suggests that during the Early to sometime in the Middle Archaic, the grass assemblage was clearly dominated by C₃ (possibly Pooideae) grasses. The data suggest that C₄ grasses began coming into the area sometime during the middle Archaic but don't really take off until the Late Archaic or even more recent periods. There is some suggestion that some C₄ grasses were likely in the area during the Early Archaic, but if so, were likely a minor constituent.

While the pollen data is rather deteriorated, the evidence indicates that the arboreal component remained rather stable over time consisting primarily of *Quercus*, *Carya*, and probably smaller numbers of *Celtis* and *Juglans*. The vegetation community was likely a mixture of arboreal and grassland meadow components. These grassland components revealed a slight change in composition (probably of component taxa) due to the immigration of some C₄ grasses.

Although there was likely an admixture of both C₃ and C₄ grasses throughout the Archaic period, the relative abundance shows a shift to the C₄ grasses, by the Late Archaic and Toyah component. While *Zea mays* phytoliths were only identified

positively from the Late Archaic period, the increased presence of C₄ grasses during the later period might suggest this as a function of the introduction of corn materials, although this is highly speculative for the moment.

E.4 CONCLUSIONS

The pollen assemblages from this site were generally poorly preserved. *Pinus* pollen, although present throughout the column, was present in very low concentration values. This suggests that the *Pinus* pollen was deposited through long distance transport. Although *Pinus* was noted in the modern vegetation the concentration values suggest that its presence was minimal. The absence of *Juniperus* pollen from these assemblages is thought to be a function of preservation. *Juniperus* is common in the modern vegetation of the area but this pollen grain is thin walled and is generally poorly preserved. Thus, its absence from locales containing abundant *Juniperus* plants is not unexpected.

Quercus, *Carya*, and *Juglans* pollen were present throughout the column, although *Juglans* pollen was restricted to the Toyah component and was quite rare. The presence of these taxa suggests similar vegetational composition from the early Archaic through the more recent Toyah component. The variations in the pollen concentration values are likely a function of the weathering of the assemblages.

The upper levels of the column, representing the Toyah component (300-650 B.P.) and extending possibly to the upper level of the Late Archaic (1700-2300 B.P.) are characterized by high concentration values of Chenopodiaceae, Asteraceae, and Poaceae indicate a mosaic pattern of grassland components interspersed with the arboreal

components. The slight increase in Poaceae pollen concentration values from the Early Archaic period may indicate an increase in grasses during this early time period but is also suggestive of the effects of weathering. In particular, the decrease in Chenopodiaceae and Asteraceae pollen concentration values during the Early Archaic period is probably indicative of preservation.

There is also some indication of the presence of more riparian communities within the area throughout the time periods represented. Particularly, this is indicated by the presence of—Apiaceae pollen concentration values from both the Toyah component and the Early Archaic period, although the evidence from the Early Archaic was present in the low magnification scan of the slide only. Members of the Apiaceae Family are generally found in more moist conditions, possibly along the banks of Hackberry Creek. *Juglans* pollen was present in the Toyah component only and *Carya* pollen was present from the Toyah component as well as from the Early, Middle, and Late Archaic deposits. Interestingly, *Carya* pollen is restricted to the Early Archaic deposits from the dated section samples. *Carya* and *Juglans* generally require a more dependable water source and are thus often indicators of more riparian conditions. The presence of Hackberry Creek in close proximity to the site, although intermittent, probably provided the necessary moisture requirements for these taxa, throughout both the Archaic and the Toyah component.

The phytolith assemblages show a dominance of Pooideae grasses (C₃) during the Early to Middle Archaic periods. There is some indication that some C₄ type grasses were indeed present in the area during this early period but contributed only small amounts to the assemblages. There is a

gradual increase in the proportions of C₄ phytoliths during the Middle Archaic but the dominance of these types does not really appear until much later during the later portion of the Late Archaic or into the Toyah component.

The Panicoideae and Chloridaceae grasses appear dominant in the Late Archaic and Toyah component periods. These forms, often consisting of Saddle, Simple Lobate, Other Lobate, and Cross morphotypes, are generally associated with C₄ type grasses. The cross type specifically occurs in a large number of the Panicoid grasses. A possible *Zea mays* phytolith was present only from the Late Archaic period, and this could not be positively associated with *Zea mays*. Based on this single occurrence and lack of a positive identification, it is likely that at best, *Zea mays* was only minimally present and likely from the Late Archaic or later Toyah component. The other cross shaped varieties continued through the later Toyah component and are more likely related to the presence of Panicoid (C₄) grasses in the area. Certainly, the higher percentages of C₄ grass material suggests the introduction of these plants, including possibly corn, into the area during the Late Archaic and Toyah component periods.

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Table E-1. Scientific and Common Names of Plant Taxa used in this Report

Family	Scientific Name	Common Name
Agavaceae		Yucca Family
	<i>Agave lechuguilla</i>	Lechuguilla
	<i>Dasyllirion wheeleri</i>	Sotol
	<i>Nolina</i> sp.	Bear grass
	<i>Yucca</i> sp.	Yucca
Amaranthaceae	<i>Amaranthus</i>	Pigweed
Apiaceae		Umbell or Carrot Family
Asteraceae		Composite Family
	<i>Ambrosia</i>	Bursage
	<i>Artemisia</i>	Sagebrush
	<i>Lactuca</i>	Lettuce
	<i>Liatris punctata</i>	Dotted Blazingstar
	<i>Taraxacum</i>	Dandelion
	Chichoreae	Tribe of Asteraceae, heads comprised entirely of ligulate flowers
	Liguliflorae	Pollen morphological group, Fenestrate type pollen
	Low Spine	Pollen morphological group, spines <2.5 height
Cactaceae	High Spine	Pollen morphological group, spines >2.5 height
		Cactus Family
	<i>Opuntia</i>	Prickly Pear or Cholla Cactus
	<i>Cylindropuntia</i>	Sub-genus of Opuntia, Cholla Cactus
	<i>Platyopuntia</i>	Sub-genus of Opuntia, Prickly Pear Cactus
Chenopodiaceae		Goosefoot Family
	<i>Atriplex canescens</i>	Saltbush
	<i>Chenopodium</i>	Goosefoot, Lambs quarters
	Cheno-am	Pollen morphological group, members of the family Chenopodiaceae and the genus Amaranthus
Cupressaceae	<i>Juniperus</i>	Juniper
Ephedraceae		Joint Fir Family
	<i>Ephedra</i>	Mormon Tea
Fabaceae		Bean Family
Fagaceae		Oak Family
	<i>Quercus</i> sp.	Oak
	<i>Quercus virginiana</i>	Live Oak
Juglandaceae		Walnut Family
	<i>Carya</i>	Hickory, Pecan
	<i>Juglans</i> sp.	Walnut
Lycopodiaceae		Club-Moss Family
	<i>Lycopodium</i>	Club-moss
Malvaceae		Cotton Family
Nyctaginaceae		
Onagraceae		Evening Primrose Family
Palmae		Palm Family
	<i>Sabal</i> sp.	Sabal Palm
Pinaceae		Pine Family
	<i>Pinus</i>	Pine
Poaceae		Grass Family
	<i>Andropogon</i> sp.	Bluestem
	<i>Andropogon scoparius</i>	Little Bluestem
	<i>Bouteloua barbata</i>	Six Weeks Fescue grass
	<i>Bouteloua curtipendula</i>	Side-oats Grama
	<i>Bouteloua eriopoda</i>	Black grama
	<i>Bouteloua gracilis</i>	Blue Grama
	<i>Panicum</i> sp.	Switch grass
	<i>Stipa</i> sp.	needlegrass
	<i>Zea mays</i>	Corn
Solanaceae		Nightshade Family
Ulmaceae		Elm Family
	<i>Celtis</i> sp.	Desert Hackberry
	<i>Ulmus</i>	Elm

Table E-2a. Raw Pollen Counts from 41ED28, Edwards County, Texas											
CAT#	Unit	Strat	Level	Period	Age	Pinus	Quercus	Carya	Celtis	Solanaceae	Poaceae
1217-b			3-6 cmbs	Toyah component	BP 300-650	7	8	1		3	2
1218-b			13-15 cmbs	Toyah component	BP 300-650	4	4	1			
1219-b			19-20 cmbs	Toyah component	BP 300-650	4	1	2			1
1220-b			23-24 cmbs	Toyah component	BP 300-650	7	3		1		1
1221-b			28-29 cmbs	Archaic:Late	BP 1700-2300	7	1	1			1
1222-b			33-34 cmbs	Archaic:Late	BP 1700-2300	1	2				2
1223-b			40-41 cmbs	Archaic:Late	BP 1700-2300	1					1
1224-b			46-47 cmbs	Archaic:Middle	BP 3900-4800	2					
1225-b			50-51 cmbs	Archaic:Middle	BP 3900-4800	2		1			1
1226-b			55-56 cmbs	Archaic:Middle	BP 3900-4800	3					1
1227-b			60-61 cmbs	Archaic:Middle	BP 3900-4800	1		2	1		1
1228-b			66-67 cmbs	Archaic:Middle	BP 3900-4800	1		3			
1229-b			71-72 cmbs	Archaic:Middle	BP 3900-4800	1		1			
1230-b			76-77 cmbs	Archaic:Middle	BP 3900-4800		1	1			3
1231-b			81-82 cmbs	Archaic:Early	BP 5200-6300		1				2
1232-b			86-87 cmbs	Archaic:Early	BP 5200-6300						
1233-b			90-91 cmbs	Archaic:Early	BP 5200-6300						
1234-b			95-96 cmbs	Archaic:Early	BP 5200-6300			1			
1235-b			100-101 cmbs	Archaic:Early	BP 5200-6300						
1236-b			104-106 cmbs	Archaic:Early	BP 5200-6300						
1208-4-d	Unit 3	2Ab	90 cmbs	Archaic:Late	BP 1870	3	5			1	
1207-4-d	Unit 4	2Bw	100 cmbs	Archaic:Early	BP 6279	3	1	2			
1211-4-d		Cultural	15-20 cmbs	Archaic:Late	BP 1900	1	1				1
1210-4-d		2Bk	80-85 cmbs	Archaic:Early	BP 4820	7	10	12			7
1209-4-d		Bk2	115-120 cmbs	Archaic:Early	BP 5230	1	1	2		2	3

Table E-2b.

CAT#	Cheno-am	Cheno-am clumps	Asteraceae hs.	Asteraceae ls	Artemisia	Liguliflorae	Cactaceae	Opuntia	Ephedra	Nyctaginaceae
1217-b	160	2	20	14	1			1		
1218-b	71		3	12						
1219-b	119		3	3						
1220-b	132		87	9	4					
1221-b	66		10	13	3					
1222-b	35		18	11	1					
1223-b	25			2	1					
1224-b	31		3	2	1					
1225-b	14		3	8						
1226-b	36		8	13						
1227-b	9		3	10					1	
1228-b	5	1	1	1						
1229-b	4		6	9			1			
1230-b	5		2	1						
1231-b	7		2	9						
1232-b										
1233-b										
1234-b	5			3						
1235-b										
1236-b										
1208-4-d	43		4	5					1	
1207-4-d	4		1	3					1	
1211-4-d	15		1	3						
1210-4-d	78		40	45		1			1	1
1209-4-d	1		5	7	2					

Table E-2c.										
CAT#	Indeterminate	sm unk triporate	lg grass	Sum	% Indeterminate	Based on Counts and Low Magnification Scan of Slide				
						<i>Opuntia</i>	cheno-am clumps	Apiaceae	Malvaceae	Unknown
1217-b	10			229	4.37	2				
1218-b	6			101	5.94		1			
1219-b	7			140	5.00					
1220-b	8			252	3.17					1
1221-b	10			112	8.93					
1222-b	6			76	7.89					
1223-b	7			37	18.92					
1224-b	7			46	15.22					
1225-b	8			37	21.62					
1226-b	6		1	68	8.82					
1227-b	4			32	12.50					
1228-b	5			17	29.41			1		
1229-b	5			27	18.52					
1230-b	7			20	35.00					
1231-b	5			26	19.23					
1232-b										
1233-b										
1234-b	7			16	43.75					
1235-b										
1236-b										
1208-4-d	8			70	11.43					
1207-4-d	1			16	6.25					
1211-4-d	6			28	21.43					
1210-4-d	35	12		249	14.06				1	
1209-4-d	7			31	22.58					4

Table E-2d.								
Based on Counts and Low Magnification Scan of Slide								
CAT#	<i>Juglans</i>	<i>Carya</i>	Poaceae	<i>Pinus</i>	<i>Quercus</i>	hs aster clump	Max. Potential Concentration	Trilete Spores
1217-b								1
1218-b								2
1219-b								1
1220-b	1			1		10		1
1221-b				1				1
1222-b								
1223-b								
1224-b								1
1225-b								
1226-b								
1227-b		3		2				
1228-b		7		1		4		
1229-b								
1230-b								1
1231-b								
1232-b								
1233-b								
1234-b								1
1235-b								
1236-b								
1208-4-d								
1207-4-d			1	6				1
1211-4-d								
1210-4-d		16		8	14			1
1209-4-d		5		2	3	11		2

Table E-3. Pollen Concentration Values, 41ED28, Edwards County, Texas												
CAT#	Unit	Strat	Level	Period	Age	Pinus	Quercus	Carya	Celtis	Solanaceae	Apiaceae	Poaceae
1217-b			3-6 cmbs	Toyah component	BP 300-650	233	267	33	0	0	100	67
1218-b			13-15 cmbs	Toyah component	BP 300-650	136	136	34	0	0	0	0
1219-b			19-20 cmbs	Toyah component	BP 300-650	124	31	62	0	0	0	31
1220-b			23-24 cmbs	Toyah component	BP 300-650	233	100	0	33	0	0	33
1221-b			28-29 cmbs	Archaic: Late	BP 1700-2300	229	33	33	0	0	0	33
1222-b			33-34 cmbs	Archaic: Late	BP 1700-2300	35	71	0	0	0	0	71
1223-b			40-41 cmbs	Archaic: Late	BP 1700-2300	33	0	0	0	0	0	33
1224-b			46-47 cmbs	Archaic: Middle	BP 3900-4800	71	0	0	0	0	0	0
1225-b			50-51 cmbs	Archaic: Middle	BP 3900-4800	71	0	35	0	0	0	35
1226-b			55-56 cmbs	Archaic: Middle	BP 3900-4800	96	0	0	0	0	0	32
1227-b			60-61 cmbs	Archaic: Middle	BP 3900-4800	35	0	71	35	0	0	35
1228-b			66-67 cmbs	Archaic: Middle	BP 3900-4800	45	0	135	0	0	0	0
1229-b			71-72 cmbs	Archaic: Middle	BP 3900-4800	29	0	29	0	0	0	0
1230-b			76-77 cmbs	Archaic: Middle	BP 3900-4800	0	29	29	0	0	0	87
1231-b			81-82 cmbs	Archaic: Early	BP 5200-6300	0	49	0	0	0	0	98
1232-b			86-87 cmbs	Archaic: Early	BP 5200-6300	Not Extracted						
1233-b			90-91 cmbs	Archaic: Early	BP 5200-6300	Not Extracted						
1234-b			95-96 cmbs	Archaic: Early	BP 5200-6300	0	0	50	0	0	0	0
1235-b			100-101 cmbs	Archaic: Early	BP 5200-6300	Not Extracted						
1236-b			104-106 cmbs	Archaic: Early	BP 5200-6300	Not Extracted						
1208-4-d	Unit 3	2Ab	90	Archaic: Late	BP 1870	100	167	0	0	33	0	0
1207-4-d	Unit 4	2Bw	100	Archaic: Early	BP 6279	90	30	60	0	0	0	0
1211-4-d		Cultural	15-20	Archaic: Late	BP 1900	32	32	0	0	0	0	32
1210-4-d		2Bk	80-85	Archaic: Early	BP 4820	25	36	43	0	0	0	25
1209-4-d		Bk2	115-120	Archaic: Early	BP 5230	12	12	24	0	0	24	36

Table E-3b.										
CAT#	Cheno-am	Cheno-am clumps	Asteraceae hs.	Asteraceae ls	Artemisia	Liguliflorae	Cactaceae	Opuntia	Ephedra	Nyctaginaceae
1217-b	5333	67	667	467	33	0	0	33	0	0
1218-b	2411	0	102	408	0	0	0	0	0	0
1219-b	3693	0	93	93	0	0	0	0	0	0
1220-b	4400	0	2900	300	133	0	0	0	0	0
1221-b	2160	0	327	425	98	0	0	0	0	0
1222-b	1235	0	635	388	35	0	0	0	0	0
1223-b	833	0	0	67	33	0	0	0	0	0
1224-b	1094	0	106	71	35	0	0	0	0	0
1225-b	494	0	106	282	0	0	0	0	0	0
1226-b	1157	0	257	418	0	0	0	0	0	0
1227-b	318	0	106	353	0	0	0	0	35	0
1228-b	225	45	45	45	0	0	0	0	0	0
1229-b	116	0	174	261	0	0	29	0	0	0
1230-b	145	0	58	29	0	0	0	0	0	0
1231-b	344	0	98	442	0	0	0	0	0	0
1232-b										
1233-b										
1234-b	250	0	0	150	0	0	0	0	0	0
1235-b										
1236-b										
1208-4-d	1433	0	133	167	0	0	0	0	33	0
1207-4-d	120	0	30	90	0	0	0	0	30	0
1211-4-d	482	0	32	96	0	0	0	0	0	0
1210-4-d	277	0	142	160	0	4	0	0	4	0
1209-4-d	12	0	60	85	24	0	0	0	0	0

Table E-3c.												
										Based on Counts and Low Magnification Scan of Slide		
CAT#	Indeterminate	sm unk triplicate	lg grass	Sum	Total	marker	trans	tot trans	mark/slide	<i>Lycopodium</i> added	volume	cheno-am clumps
1217-b	333	0	0	229	7633	54	12	28	126.00	27000	15	0.00
1218-b	204	0	0	101	3430	53	11	27	130.09	27000	15	13.84
1219-b	217	0	0	140	4345	58	6	26	251.33	27000	15	0.00
1220-b	267	0	0	252	8400	54	8	26	175.50	27000	15	0.00
1221-b	327	0	0	112	3665	55	6	26	238.33	27000	15	0.00
1222-b	212	0	0	76	2682	51	10	30	153.00	27000	15	0.00
1223-b	233	0	0	37	1233	54	22	27	66.27	27000	15	0.00
1224-b	247	0	0	46	1624	51	6	28	238.00	27000	15	0.00
1225-b	282	0	0	37	1306	51	10	27	137.70	27000	15	0.00
1226-b	193	0	32	68	2186	56	8	26	182.00	27000	15	0.00
1227-b	141	0	0	32	1129	51	8	27	172.13	27000	15	0.00
1228-b	225	0	0	17	765	60	4	28	420.00	27000	10	0.00
1229-b	145	0	0	27	784	62	8	25	193.75	27000	15	0.00
1230-b	203	0	0	20	581	62	4	26	403.00	27000	15	0.00
1231-b	245	0	0	26	1276	55	8	26	178.75	27000	10	0.00
1232-b									Not Extracted			
1233-b												
1234-b	350	0	0	16	800	54	6	24.5	220.50	27000	10	0.00
1235-b									Not Extracted			
1236-b												
1208-4-d	267	0	0	70	2333	54	8	27	182.25	27000	15	0.00
1207-4-d	30	0	0	16	480	60	4	26.5	397.50	27000	15	0.00
1211-4-d	193	0	0	28	900	56	12	28	130.67	27000	15	0.00
1210-4-d	125	43	0	249	886	506	12	25	1054.17	27000	15	0.00
1209-4-d	85	0	0	31	374	149	4	30	1117.50	27000	15	0.00

Table E-3d.											
Based on Counts and Low Magnification Scan of Slide											
CAT#	Apiaceae	Malvaceae	Unknown	Juglans	Carya	Poaceae	Pinus	Quercus	hs Aster clump	Max. Potential Concentration	Trilete Spores
1217-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29	14.29
1218-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.84	27.67
1219-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.16	7.16
1220-b	0.00	0.00	0.00	10.26	0.00	0.00	10.26	0.00	102.56	10.26	10.26
1221-b	0.00	0.00	0.00	0.00	0.00	0.00	7.55	0.00	0.00	7.55	7.55
1222-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.76	0.00
1223-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.16	0.00
1224-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.56	7.56
1225-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.07	0.00
1226-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.89	0.00
1227-b	0.00	0.00	0.00	0.00	31.37	0.00	20.92	0.00	0.00	10.46	0.00
1228-b	6.43	0.00	0.00	0.00	45.00	0.00	6.43	0.00	25.71	6.43	0.00
1229-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.29	0.00
1230-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.47	4.47
1231-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.10	0.00
1232-b	Not Extracted										
1233-b	Not Extracted										
1234-b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.24	12.24
1235-b	Not Extracted										
1236-b	Not Extracted										
1208-4-d	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.88	0.00
1207-4-d	0.00	0.00	0.00	0.00	0.00	4.53	27.17	0.00	0.00	4.53	4.53
1211-4-d	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.78	0.00
1210-4-d	0.00	1.71	0.00	0.00	27.32	0.00	13.66	23.91	0.00	1.71	1.71
1209-4-d	0.00	0.00	6.44	0.00	8.05	0.00	3.22	4.83	17.72	1.61	3.22

Table E-4. Phytolith Raw Counts, 41ED28, Edwards County, Texas												
Bag #	CAT#	Unit	Strat	Level	Type	Period	Age	keeled	Conical	Pyramidal	Crenate	Saddle
1	1217-b			3-6 cmbs	column	Toyah component	BP 300-650			1	237	111
2	1218-b			13-15 cmbs	column	Toyah component	BP 300-650		1		299	33
3	1219-b			19-20 cmbs	column	Toyah component	BP 300-650				270	12
4	1220-b			23-24 cmbs	column	Toyah component	BP 300-650				204	34
5	1221-b			28-29 cmbs	column	Archaic:Late	BP 1700-2300		2		226	36
6	1222-b			33-34 cmbs	column	Archaic:Late	BP 1700-2300				109	1
7	1223-b			40-41 cmbs	column	Archaic:Late	BP 1700-2300		3		220	18
8	1224-b			46-47 cmbs	column	Archaic:Middle	BP 3900-4800		3		220	27
9	1225-b			50-51 cmbs	column	Archaic:Middle	BP 3900-4800		4		185	33
10	1226-b			55-56 cmbs	column	Archaic:Middle	BP 3900-4800	Not Countable				
11	1227-b			60-61 cmbs	column	Archaic:Middle	BP 3900-4800	4			213	21
12	1228-b			66-67 cmbs	column	Archaic:Middle	BP 3900-4800		5		182	23
13	1229-b			71-72 cmbs	column	Archaic:Middle	BP 3900-4800		2		153	11
14	1230-b			76-77 cmbs	column	Archaic:Middle	BP 3900-4800				129	13
15	1231-b			81-82 cmbs	column	Archaic:Early	BP 5200-6300		6		72	14
16	1232-b			86-87 cmbs	column	Archaic:Early	BP 5200-6300				62	16
17	1233-b			90-91 cmbs	column	Archaic:Early	BP 5200-6300		1		158	8
18	1234-b			95-96 cmbs	column	Archaic:Early	BP 5200-6300		4		97	19
19	1235-b			100-101 cmbs	column	Archaic:Early	BP 5200-6300				178	6
20	1236-b			104-106 cmbs	column	Archaic:Early	BP 5200-6300		5		211	18
	1208-4-d	Unit 3	2Ab	90	BT-M-1	Archaic:Late	1870		1		213	35
	1207-4-d	Unit 4	2Bw	100	BT-M-1	Archaic:Early	6279	Not Countable				
	1211-4-d		Cultural	15-20	BT 7	Archaic:Late	1900				290	26
	1210-4-d		2Bk	80-85	BT 7	Archaic:Early	4820	Not Countable				
	1209-4-d		Bk2	115-120	BT 7	Archaic:Early	5230				153	5

Bag #	CAT#	Simple Lobate	Panicoid	Stipa-type	Other lobate	cf. <i>Zea mays</i>	cross	Square	Irregular	Rhomboidal	Hair base	Sabal	Sum
1	1217-b	53	2	45	42		7	1		55		3	557
2	1218-b	60		4				11	1	47	2		458
3	1219-b	146		5			2	6		47		1	489
4	1220-b	58	2					10		47	1	1	357
5	1221-b	55		3					8	43	3		376
6	1222-b		91					37	4	80	6		328
7	1223-b	41		3		2	1	14		26	4		332
8	1224-b	37		2			1	29	3	21	1		344
9	1225-b	34		1			1	11		23			292
10	1226-b							Not Countable					
11	1227-b	12					1	21	28	58	2		360
12	1228-b	20						32	3	45	9		319
13	1229-b	4						45	29	66			310
14	1230-b	3						37	92	85	1	2	362
15	1231-b	12						24	43	198	2		371
16	1232-b							16	113	37			244
17	1233-b	2						15	41	60	1		286
18	1234-b							33	88	127	4		372
19	1235-b	1						30	33	69	3		320
20	1236-b	9						36	23	83	4		389
	1208-4-d	34						14	5	66	1	1	370
	1207-4-d							Not Countable					
	1211-4-d	5						32	17	46	7	1	424
	1210-4-d							Not Countable					
	1209-4-d							10	23	22	4		217

Table E-5. Relative Phytolith Frequencies, 41ED28, Edwards County, Texas										
CAT#	Strat	Level	Period	Age	keeled	Conical	Pyramidal	Crenate	Saddle	Simple Lobate
1217-b		3-6 cmbs	Toyah component	BP 30-650	0.00	0.00	0.18	42.55	19.93	9.52
1218-b		13-15 cmbs	Toyah component	BP 30-650	0.00	0.22	0.00	65.28	7.21	13.10
1219-b		19-20 cmbs	Toyah component	BP 30-650	0.00	0.00	0.00	55.21	2.45	29.86
1220-b		23-24 cmbs	Toyah component	BP 30-650	0.00	0.00	0.00	57.14	9.52	16.25
1221-b		28-29 cmbs	Archaic:Late	BP 1700-2300	0.00	0.53	0.00	60.11	9.57	14.63
1222-b		33-34 cmbs	Archaic:Late	BP 1700-2300	0.00	0.00	0.00	33.23	0.30	0.00
1223-b		40-41 cmbs	Archaic:Late	BP 1700-2300	0.00	0.90	0.00	66.27	5.42	12.35
1224-b		46-47 cmbs	Archaic:Middle	BP 3900-4800	0.00	0.87	0.00	63.95	7.85	10.76
1225-b		50-51 cmbs	Archaic:Middle	BP 3900-4800	0.00	1.37	0.00	63.36	11.30	11.64
1226-b		55-56 cmbs	Archaic:Middle	BP 3900-4800	Not Countable					
1227-b		60-61 cmbs	Archaic:Middle	BP 3900-4800	1.11	0.00	0.00	59.17	5.83	3.33
1228-b		66-67 cmbs	Archaic:Middle	BP 3900-4800	0.00	1.57	0.00	57.05	7.21	6.27
1229-b		71-72 cmbs	Archaic:Middle	BP 3900-4800	0.00	0.65	0.00	49.35	3.55	1.29
1230-b		76-77 cmbs	Archaic:Middle	BP 3900-4800	0.00	0.00	0.00	35.64	3.59	0.83
1231-b		81-82 cmbs	Archaic:Early	BP 5200-6300	0.00	1.62	0.00	19.41	3.77	3.23
1232-b		86-87 cmbs	Archaic:Early	BP 5200-6300	0.00	0.00	0.00	25.41	6.56	0.00
1233-b		90-91 cmbs	Archaic:Early	BP 5200-6300	0.00	0.35	0.00	55.24	2.80	0.70
1234-b		95-96 cmbs	Archaic:Early	BP 5200-6300	0.00	1.08	0.00	26.08	5.11	0.00
1235-b		100-101 cmbs	Archaic:Early	BP 5200-6300	0.00	0.00	0.00	55.63	1.88	0.31
1236-b		104-106 cmbs	Archaic:Early	BP 5200-6300	0.00	1.29	0.00	54.24	4.63	2.31
1208-4-d	2Ab	90	Archaic:Late	1870	0.00	0.27	0.00	57.57	9.46	9.19
1207-4-d	2Bw	100	Archaic:Early	6279	Not Countable					
1211-4-d	Cultural	15-20	Archaic:Late	1900	0.00	0.00	0.00	68.40	6.13	1.18
1210-4-d	2Bk	80-85	Archaic:Early	4820	Not Countable					
1209-4-d	Bk2	115-120	Archaic:Early	5230	0.00	0.00	0.00	70.51	2.30	0.00

Table E-5. Continued										
CAT#	Panicoid	Stipa-type	Other lobate	Zea mays	Cross-shape	Square	Irregular	Rhomboidal	Hair base	Sum
1217-b	0.36	8.08	7.54	0.00	1.26	0.18	0.00	9.87	0.00	100.00
1218-b	0.00	0.87	0.00	0.00	0.00	2.40	0.22	10.26	0.44	100.00
1219-b	0.00	1.02	0.00	0.00	0.41	1.23	0.00	9.61	0.00	100.00
1220-b	0.56	0.00	0.00	0.00	0.00	2.80	0.00	13.17	0.28	100.00
1221-b	0.00	0.80	0.00	0.00	0.00	0.00	2.13	11.44	0.80	100.00
1222-b	27.74	0.00	0.00	0.00	0.00	11.28	1.22	24.39	1.83	100.00
1223-b	0.00	0.90	0.00	0.60	0.30	4.22	0.00	7.83	1.20	100.00
1224-b	0.00	0.58	0.00	0.00	0.29	8.43	0.87	6.10	0.29	100.00
1225-b	0.00	0.34	0.00	0.00	0.34	3.77	0.00	7.88	0.00	100.00
1226-b	Not Countable									
1227-b	0.00	0.00	0.00	0.00	0.28	5.83	7.78	16.11	0.56	0
1228-b	0.00	0.00	0.00	0.00	0.00	10.03	0.94	14.11	2.82	0.00
1229-b	0.00	0.00	0.00	0.00	0.00	14.52	9.35	21.29	0.00	0.00
1230-b	0.00	0.00	0.00	0.00	0.00	10.22	25.41	23.48	0.28	0.55
1231-b	0.00	0.00	0.00	0.00	0.00	6.47	11.59	53.37	0.54	0.00
1232-b	0.00	0.00	0.00	0.00	0.00	6.56	46.31	15.16	0.00	0.00
1233-b	0.00	0.00	0.00	0.00	0.00	5.24	14.34	20.98	0.35	0.00
1234-b	0.00	0.00	0.00	0.00	0.00	8.87	23.66	34.14	1.08	0.00
1235-b	0.00	0.00	0.00	0.00	0.00	9.38	10.31	21.56	0.94	0.00
1236-b	0.00	0.00	0.00	0.00	0.00	9.25	5.91	21.34	1.03	0.00
1208-4-d	0.00	0.00	0.00	0.00	0.00	3.78	1.35	17.84	0.27	0.27
1207-4-d	Not Countable									
1211-4-d	0.00	0.00	0	0	0	7.55	4.01	10.85	1.65	0.24
1210-4-d	Not Countable									
1209-4-d	0.00	0.00	0.00	0.00	0.00	4.61	10.60	10.14	1.84	0
										100

Table E-6. Number of Pollen Taxa by Period, 41ED29, Edwards County, Texas	
Period	Number of Taxa (Mean)
Toyah component 300-650 B.P.	8-12, (9.75) $n=4$
Late Archaic 1700-2300 B.P.	6-8, (8) $n=3$
Middle Archaic 3900-4800 B.P.	6-9, (7) $n=7$
Early Archaic 5200-6300 B.P.	5-6, (5.5) $n=2$

Figure E-1. Arboreal Pollen Concentration Values, 41ED28, Column Samples

Figure E-2. Non-Arboreal Pollen Concentration Values, 41ED28, Column Samples

Figure E-3. Phytolith Relative Frequencies, 41ED28, Column Samples

APPENDIX F:

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF CHERT FROM THE VARGA SITE (41ED28) IN SOUTHWEST TEXAS

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF CHERT FROM THE VARGA SITE (41ED28) IN SOUTHWEST TEXAS

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F.1 INTRODUCTION

Instrumental neutron activation analysis (INAA) was performed on 154 chert artifacts from the Varga Site (41ED28) in Edwards County, Texas, and 107 natural (i.e., culturally unmodified) source specimens from various locations in the Edwards Formation in across Southwest and Central Texas. Data on the source specimens were examined for possible differences within the Edwards Formation and data on the artifacts were examined to calculate probabilities of membership with the various Edwards Formation chert sub-types. INAA data from previous samples of Edwards Formation chert from the Texas Hill Country conducted for Charles Frederick (i.e., Fort Hood) and Chris Turnbull (i.e., Segovia Formation) were also used for comparison.

F.2 CHERT SAMPLE PREPARATION

Following their arrival at the University of Missouri Research Reactor Center (MURR), the source samples and artifacts were washed in deionized water to remove dirt and other loose materials from the surface. Samples for INAA were prepared by placing the source specimens between two tool-steel plates and crushing them with a Carver Press to obtain a number of small, 50- to 100-mg fragments. The fragments were examined with a magnifier to eliminate those with metallic streaks or crush fractures that could possibly contain contamination. Several grams of clean fragments were obtained from each sample and stored temporarily in plastic bags.

Two analytical samples were prepared from each source specimen. The first sample, used for short irradiations, was made by placing about 200 mg of fragments into clean, high-density polyethylene vials. A second sample, used for long irradiation and weighing about 800 mg, was placed in clean, high-purity quartz vials.

Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both irradiation vials were sealed prior to irradiation. Standards made from the National Institute of Standards and Technology (NIST) certified standard reference materials SRM-1633a (Coal Fly Ash), SRM-278 (Obsidian Rock), and SRM-688 (Basalt Rock) were similarly prepared.

F.3 IRRADIATION AND GAMMA-RAY SPECTROSCOPY

INAA of archaeological materials at MURR, which consists of two irradiations and a total of three measurements of emitted gamma rays, constitutes a superset of the procedures employed at most other INAA laboratories. As discussed in detail in Glascock (1992), a short irradiation is carried out through the pneumatic-tube irradiation system at MURR. Samples and standards in polyethylene vials are sequentially irradiated, two at a time, for five seconds by a thermal neutron flux of $8 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$. Following irradiation, the samples are allowed to decay for 25 minutes so that radioactivity from the short-lived radioisotope ^{28}Al (half-life = 2.24 minutes) can decline to acceptable levels. Sample vials are mounted in sample holders at a distance of 10 cm from the face of separate high-purity germanium (HPGe) detectors. The sample holders are designed to continuously rotate the samples during a 12-minute counting period to compensate for slight differences between individual sample shapes. The short-count, gamma-ray spectra are stored and subsequently analyzed in batches to determine the concentrations of elements in the unknown archaeological samples relative to the known concentrations in the standard reference materials. The short-lived elements measured in chert characterization studies are usually aluminum (Al), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V).

The long-irradiation samples and standards in high-purity quartz vials are wrapped in bundles of approximately 32 unknowns and six standards each. Two sample bundles are placed inside an aluminum can and irradiated for a total of 70 hours by a thermal neutron flux of $5 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$. Following irradiation, the sample bundles are unwrapped and the quartz vials are washed in aqua regia to remove possible surface contamination. Two gamma measurements are performed on the individual samples from each bundle using a pair of HPGe detectors coupled to automatic sample changers with rotating sample holders. The first count for 2,000 seconds each (i.e., the “middle count”) is usually made about one week after the end of irradiation to allow ^{24}Na (half-life = 15 hours) to decay to a safe handling level. The middle count yields data for the determination of several medium half-life elements, including arsenic (As), barium (Ba), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three or four weeks of decay, a final measurement of approximately three hours on each sample (i.e., the “long count”) is carried out. The latter measurement yields the data for several long-lived elements, including cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), and zinc (Zn). Additional details about gamma-ray spectroscopy, neutron activation analysis, and standardization can be found in Glascock (1998).

The element concentration data from the three measurements are tabulated in parts per million using the Microsoft Excel spreadsheet program. Descriptive data for the archaeological samples are appended to the concentration spreadsheet and the data are also stored in a dBase/Foxpro database file useful for organizing, sorting, and extracting sample information. Table F-1

following this appendix presents the sample database.

F.4 INTERPRETING THE COMPOSITIONAL DATA

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and is only summarized here. The main goal of data analysis is to identify distinct, homogeneous groups within the analytical database. Based on the provenance postulate of Weigand et al. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits, and the compositional data obtained from the samples are used to define the source localities or boundaries. In contrast, the locations of ceramic raw materials are often inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples), by indirect methods such as the “criterion of abundance” (Bishop et al. 1992), or by arguments based on geological and sedimentological characteristics (Steponaitis et al. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential “sources” intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous, in the case of obsidian, or compositionally heterogeneous, as is the case for most cherts.

Compositional groups are viewed as “centers of mass” in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of

their centroids and the unique relationships (i.e., correlations) among the elements. Decisions about whether or not to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Potential compositional groups can be hypothesized initially by using non-compositional information (e.g., archaeological context, visual attributes) or by application of one or more different pattern recognition techniques to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal component analysis (PCA), and discriminant analysis (DA). Each of the techniques has its own advantages and disadvantages for data interpretation that may depend upon the types and quantity of data available.

The variables (measured elements) in archaeological and geological data sets are often correlated and are frequently large in number. This makes handling and interpreting patterns within the data set more challenging. As a result, it is often advantageous to transform the original variables in the data set into a smaller set of uncorrelated variables to make data interpretation easier. Of the abovementioned pattern recognition techniques, PCA is the technique that most readily transforms the data from the original, correlated variables into uncorrelated variables.

PCA uses all of the variables measured in the sample (in this case, element concentrations) and calculates the variation among those variables. The individual principal components (PCs) are measures of the magnitude of variation, each describing a decreasing amount of variance. The first PC subsumes the greatest amount of variance in the data set and is aligned along the

direction of greatest variation. The second PC is orthogonal to the first PC and, like the first PC, is a linear summary of the variables analyzed. The second PC subsumes the greatest amount of variation after removal of the variation accounted for by the first PC and is aligned along the direction of greatest remaining variation. The third PC is orthogonal to the first two PCs and subsumes the greatest amount of remaining variation after removing the first two PCs, and so forth. The number of PCs calculated equals the number of original variables measured.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode (i.e., to search for subgroups in an undifferentiated data set) or in a more evaluative mode (i.e., to assess the coherence of hypothetical groups suggested by other criteria). Generally, compositional differences among specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale-dependent (Mardia et al. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are found in most statistical packages. A common approach is to transform the data into logarithms (to base 10). As an initial step in the PCA of most chemical data at MURR, the data are transformed into log concentrations to equalize the differences in variance between the major elements such as Al, Ca, and Fe on one

hand and to trace elements, such as the rare-earth elements (REEs), on the other hand. An additional advantage of the transformation is that it appears to produce more normal distributions for the trace elements.

A frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2000), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of PC reference axes. A plot using the first two PCs as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space. Displaying both objects and variables on the same plot makes it possible to examine the contribution of individual elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a “biplot” in reference to the simultaneous plotting of objects and variables. The variable relationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots. (Note that a bivariate plot of elemental concentrations is not a biplot.)

Whether or not a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance)

makes it possible to describe the separation among groups or among individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber et al. 1976, Bishop and Neff 1989) is defined by:

$$D_{y,X}^2 = [y - \bar{X}]' I_x [y - \bar{X}]$$

where y is the $1 \times m$ array of logged elemental concentrations for the specimen of interest, X is the $n \times m$ data matrix of logged concentrations for the group to which the point is being compared, with $\bar{X}$ being its $1 \times m$ centroid, and I_x is the inverse of the $m \times m$ variance-covariance matrix of group X . Because Mahalanobis distance takes into account variances and covariances in the multivariate group, it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2 , which is the multivariate extension of the univariate Student's t .

If group sizes are small, Mahalanobis-distance-based probabilities can fluctuate dramatically depending on whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon “stretchability” in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that sometimes excludes “true” group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distances. It is generally true that the probability of individual samples having membership in a group is most reliable if the total number of samples in a group is two or three times the number of elements being used to calculate the probability. When there are more elements than samples, the group variance-covariance matrix is singular, thus rendering calculation of I_x (and D^2 itself) impossible. Therefore, the dimensionality of small groups must be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this tactic is that the investigator's preconceptions about which elements should be discriminating may not be valid. It also diminishes the main advantage of multielemental analysis, namely the capability of measuring a large number of elements. An alternative approach is to calculate Mahalanobis distances using PC scores from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using a sufficient number of components to subsume 90 percent or more of the total variance can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Finally, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from

consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens that are missing a single concentration value can still be used in group calculations.

F.5 RESULTS AND CONCLUSIONS

The INAA results were tabulated using the Excel spreadsheet program and combined with the descriptive data to create a database for sorting and extraction of subsets. Table F-1 lists the sample descriptions for all samples, and Table F-2 lists the measured concentrations.

To determine if possible subgroups could be found within the database, the source sample and artifact concentration data were transformed into base-10 logarithms. Because our missing value replacement program requires the number of missing values to be fewer than 50 percent for any subgroup, it was necessary to eliminate seven elements, including Lu, Yb, Ni, Ta, Tb, Dy and Ti. After missing value replacement, a PCA was performed on the variance-covariance matrix for the 261-sample database. The eigenvalues and percentage of variance explained by individual PCs are shown in Table F-3. We also note that a minimum of 10 PCs are required to explain 90 percent of the variance in the data set.

Through examination of bivariate plots of the PCs, one finds a very subtle structure within the source specimen database primarily involving the smaller chert source groups. The groups with larger sample numbers seem to overlap significantly. Source sample TRC107 (i.e., Cretaceous volcanic from Brewster County) is not shown on the plots because many of its trace-element concentrations are one to two orders of magnitude greater than all other source specimens, which suggests that the specimen is an outlier.

RQ-mode biplots of PC-1 versus PC-2 and PC-2 versus PC-3 are shown in Figures F-1 and F-2, respectively. Examination of these plots reveals that the smaller groups from Hackberry Creek, Glen Rose, Georgetown, Varga mixture, and Devils River Formation show differences. The vectors shown on the plots indicate the contributions of individual elements to explaining differences between the groups. Table F-4 summarizes these observations.

On the other hand, the subgroups with larger numbers of specimens from the Segovia Member, Terrett Member, and Camp Wood fail to exhibit any particular patterning on the plots. A test of membership for groups with at least 15 samples (i.e., Hackberry Creek, Segovia Member, Terrett Member, and Camp Wood) using Mahalanobis distance-based probabilities and posterior classification is presented in Table F-5. As shown, approximately 45 percent of the source specimens would move from their original group to a new group. Based on the source samples collected in the investigation, it appears that the larger groups are not significantly different from one another.

The results from previous studies of Edwards Formation chert conducted by Charles Frederick and Chris Turnbull were also available for comparison. Frederick's source sample collections involved 118 samples from outcrops in the Fort Hood region analyzed earlier as part of a patination dating study reported in Frederick et al. (1994) along with an additional 59 chert samples collected from a wide range of locations throughout the Texas Hill Country. The Fort Hood samples were chemically subdivided into six subgroups associated with recognizably different visual characteristics, including Owl Creek, Gray-Brown-Green, Tan, Texas Novaculite, Heiner Lake Tan, and Fort Hood Gray. Turnbull's chert samples consist of 15 specimens collected from a Segovia

Formation outcrop in Howard County in Northwest Texas.

Before the comparisons could be made, five additional elements (As, Nd, Ca, K, and V) not observed in a majority of the Frederick and Turnbull samples were removed from further consideration. The source sample database (excluding samples TRC107 and TRC255) was then combined with the Frederick and Turnbull samples to create a 451-specimen database. After transformation to log base-10 and replacement of missing values within each of the identified sample subgroups, a new PCA was performed on the data. Table F-6 lists the eigenvalues and percentage of variance explained by the new PCA. More than 90 percent of the variance in the combined database is explained by the first nine PCs.

A biplot of the source samples and element vectors based on the first two PCs is shown in Figure F-3. Figure F-4 shows the same data without the element vectors but includes Sample IDs for the new Edwards Formation samples. Inspection of both plots indicates that the source samples analyzed in this study are chemically different from the Fort Hood source groups but quite similar to the mixture of Edwards Formation samples collected by Frederick and somewhat similar to the Howard County Segovia Formation samples collected by Turnbull. As shown in the biplot, the differences are based on higher concentrations of Cs, Ba, Sr, and Sb along with low concentrations of the REEs (La, Sm, and Ce). Further support is presented in Table F-7, in which calculations of the Mahalanobis distance-based probabilities and posterior classification of the Edwards Formation source samples in this study are used to compare to the eight earlier chert groups. The calculation used the first nine PCs, subsuming more than 91 percent of the variance. The results show that the source (i.e., non-Varga Site) samples from the current study

have extremely low probabilities of membership in the Fort Hood groups, relatively low probabilities of membership in the Howard County Segovia Formation group, and high probabilities of membership in Frederick's mixed collection.

The bivariate plot in Figure F-5 to F-9 presents data for the first two PCs using the Varga site artifacts projected against the Edwards Formation source samples collected by Frederick and the new Edwards Formation specimens in this study. The artifacts show a close relationship to both collections of Edwards Formation source specimens. Table F-8 presents the Mahalanobis distance-based probabilities and posterior classifications of the artifacts when compared to all of the Texas source groups. The results show very low probability of the artifacts coming from the Fort Hood subgroups or the Howard County Segovia Formation, but very high probabilities of membership in the two collections of Edwards Formation source specimens.

F.6 CONCLUSIONS

A total of 261 lithic samples (i.e., chert source specimens and artifacts) from the Varga Site (41ED28) in Edwards County, Texas, were analyzed by INAA to investigate possible movement of lithic materials in Texas. The new source samples show very subtle differences between most of the collection sites for raw materials due to the fact that compositional variation within individual outcrops is large and differences among outcrops are relatively small.

Comparisons between the new source samples and previous analyses indicate that the new source samples are significantly different from the varieties of chert collected near Fort Hood but they overlap with an earlier collection of Edwards Formation chert made by Charles Frederick from throughout the Formation.

Analyses of the Varga Site artifacts find that they are compositionally different from the Fort Hood varieties; however, the Varga Site artifacts are similar to both collections of Edwards Formation source specimens. Our primary conclusion is that none of the Varga Site artifacts came from Fort Hood. We can say little about other outcrops within the Edwards Formation.

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Figure F-3. Biplot of First and Second Principal Components for Chert Source Samples With Element Vectors

Confidence ellipses are shown at the 90 percent confidence level.

Figure F-4. Bivariate Plot of First and Second Principal Components for Chert Source Samples Without Element Vectors

Confidence ellipses are shown at the 90% confidence level.
Source specimens collected in this study are labeled.

Figure F-5. Bivariate Plot of First and Second Principal Components for Edwards Formation Chert and Varga Site artifacts (Numbered)

Samples collected by Frederick et al. (1994), Edwards Formation chert collected in this study, and Varga Site artifacts from this study.

Figure F-6. Bivariate Plot of First and Second Principal Components for Edwards Formation Chert and Middle Archaic Artifacts (Numbered)

Samples collected by Frederick et al. (1994), Edwards Formation chert collected in this study, and Varga Site Middle Archaic artifacts from this study.

Figure F-7. Bivariate Plot of First and Second Principal Components for Edwards Formation Chert and Early Archaic Artifacts (Numbered)

Samples collected by Frederick et al. (1994), Edwards Formation chert collected in this study, and Varga Site Early Archaic artifacts from this study.

Figure F-8. Bivariate Plot of First and Second Principal Components for Edwards Formation Chert and Late Archaic Artifacts (Numbered)

Samples collected by Frederick et al. (1994), Edwards Formation chert collected in this study, and Varga Site Late Archaic artifacts from this study.

Figure F-9. Bivariate Plot of First and Second Principal Components for Edwards Formation Chert and Toyah Artifacts (Numbered)

Samples collected by Frederick et al. (1994), Edwards Formation chert collected in this study, and Varga Site Toyah artifacts from this study.

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC001	MQ-1-1	source	Edwards County	Devils River Member
TRC002	MQ-1-2	source	Edwards County	Devils River Member
TRC003	MQ-1-3	source	Edwards County	Devils River Member
TRC004	MQ-1-4	source	Edwards County	Devils River Member
TRC005	MQ-1-5	source	Edwards County	Devils River Member
TRC006	MQ-1-6	source	Edwards County	Devils River Member
TRC007	41ED58-1	source	Edwards County	Segovia Member
TRC008	41ED58-2	source	Edwards County	Segovia Member
TRC009	41ED58-7-2	source	Edwards County	Segovia Member
TRC010	41ED58-7-3	source	Edwards County	Segovia Member
TRC011	41ED58-7-4	source	Edwards County	Segovia Member
TRC012	41ED58-7-5	source	Edwards County	Segovia Member
TRC013	41ED54-5	source	Edwards County	Segovia Member
TRC014	41ED54-6	source	Edwards County	Segovia Member
TRC015	41ED141-4	source	Edwards County	Segovia Member
TRC016	41ED58-7-1	source	Edwards County	Segovia Member
TRC017	1274-1	source	Varga, Edwards County	mixture
TRC018	1274-2	source	Varga, Edwards County	mixture
TRC019	1274-3	source	Varga, Edwards County	mixture
TRC020	1274-4	source	Varga, Edwards County	mixture
TRC021	1274-5	source	Varga, Edwards County	mixture
TRC022	1274-6	source	Varga, Edwards County	mixture
TRC023	1274-7	source	Varga, Edwards County	mixture
TRC024	1274-8	source	Varga, Edwards County	mixture
TRC025	1274-9	source	Varga, Edwards County	mixture
TRC026	1274-10	source	Varga, Edwards County	mixture
TRC027	1253-0	source	Camp Wood, Real County	mixture
TRC028	1253-2	source	Camp Wood, Real County	mixture
TRC029	1253-5	source	Camp Wood, Real County	mixture
TRC030	1253-6	source	Camp Wood, Real County	mixture
TRC031	1253-15	source	Camp Wood, Real County	mixture
TRC032	1253-24a	source	Camp Wood, Real County	mixture
TRC033	1253-25a	source	Camp Wood, Real County	mixture
TRC034	1253-27	source	Camp Wood, Real County	mixture
TRC035	1253-28	source	Camp Wood, Real County	mixture
TRC036	1253-29	source	Camp Wood, Real County	mixture

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC037	1253-30a	source	Camp Wood, Real County	mixture
TRC038	1253-31g	source	Camp Wood, Real County	mixture
TRC039	1253-34a	source	Camp Wood, Real County	mixture
TRC040	1253-38a	source	Camp Wood, Real County	mixture
TRC041	1253-39d	source	Camp Wood, Real County	mixture
TRC042	1253-66	source	Camp Wood, Real County	mixture
TRC043	1253-256	source	Camp Wood, Real County	mixture
TRC044	1253-306	source	Camp Wood, Real County	mixture
TRC045	1253-376	source	Camp Wood, Real County	mixture
TRC046	1253-35a	source	Camp Wood, Real County	mixture
TRC047	CF-7-1	source	Kerr County	Terrett Member
TRC048	CF-7-2	source	Kerr County	Terrett Member
TRC049	CF-7-3	source	Kerr County	Terrett Member
TRC050	CF-7-4	source	Kerr County	Terrett Member
TRC051	CF-7-5	source	Kerr County	Terrett Member
TRC052	CF-9-1	source	Real County	Segovia Member
TRC053	CF-9-2	source	Real County	Segovia Member
TRC054	CF-9-3	source	Real County	Segovia Member
TRC055	CF-9-4	source	Real County	Segovia Member
TRC056	CF-10-1	source	Edwards County	Segovia Member
TRC057	CF-10-2	source	Edwards County	Segovia Member
TRC058	CF-10-3	source	Edwards County	Segovia Member
TRC059	CF-10-4	source	Edwards County	Segovia Member
TRC060	CF-10-5	source	Edwards County	Segovia Member
TRC061	CF-6-1	source	Kerr County	Glen Rose
TRC062	CF-6-2	source	Kerr County	Glen Rose
TRC063	CF-6-3	source	Kerr County	Glen Rose
TRC064	CF-6-4	source	Kerr County	Glen Rose
TRC065	CF-6-5	source	Kerr County	Glen Rose
TRC066	CF-11-1	source	Kerr County	Terrett Member
TRC067	CF-11-2	source	Kerr County	Terrett Member
TRC068	CF-11-3	source	Kerr County	Terrett Member
TRC069	CF-11-4	source	Kerr County	Terrett Member
TRC070	CFC-11-5	source	Kerr County	Terrett Member
TRC071	CFC-11-6	source	Kerr County	Terrett Member
TRC072	CF-12-1	source	Val Verde County	Segovia Member

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC073	CF-12-2	source	Val Verde County	Segovia Member
TRC074	CF-12-3	source	Val Verde County	Segovia Member
TRC075	CF-16a-1	source	Pecos County	Terrett Member
TRC076	CF-16a-2	source	Pecos County	Terrett Member
TRC077	CF-16b-1	source	Pecos County	Terrett Member
TRC078	CF-16c-1	source	Pecos County	Terrett Member
TRC079	CF-17-1	source	Pecos County	Segovia Member
TRC080	CF-17-2	source	Pecos County	Segovia Member
TRC081	CF-17-3	source	Pecos County	Segovia Member
TRC082	CF-19-1	source	Sutton County	Segovia Member
TRC083	1252-0	source	Hackberry Creek, Edwards County	mixture
TRC084	1252-1	source	Hackberry Creek, Edwards County	mixture
TRC085	1252-2	source	Hackberry Creek, Edwards County	mixture
TRC086	1252-3	source	Hackberry Creek, Edwards County	mixture
TRC087	1252-4	source	Hackberry Creek, Edwards County	mixture
TRC088	1252-5	source	Hackberry Creek, Edwards County	mixture
TRC089	1252-6	source	Hackberry Creek, Edwards County	mixture
TRC090	1252-9	source	Hackberry Creek, Edwards County	mixture
TRC091	1252-10	source	Hackberry Creek, Edwards County	mixture
TRC092	1252-15	source	Hackberry Creek, Edwards County	mixture
TRC093	1252-17	source	Hackberry Creek, Edwards County	mixture
TRC094	1252-19	source	Hackberry Creek, Edwards County	mixture
TRC095	1252-21	source	Hackberry Creek, Edwards County	mixture
TRC096	1252-22	source	Hackberry Creek, Edwards County	mixture
TRC097	1252-23	source	Hackberry Creek, Edwards County	mixture
TRC098	1252-24	source	Hackberry Creek, Edwards County	mixture
TRC099	1252-25	source	Hackberry Creek, Edwards County	mixture
TRC100	1252-26	source	Hackberry Creek, Edwards County	mixture
TRC101	1252-28	source	Hackberry Creek, Edwards County	mixture
TRC102	1252-31	source	Hackberry Creek, Edwards County	mixture
TRC103	1252-32	source	Hackberry Creek, Edwards County	mixture
TRC104	Georgetown-M	source	Williamson County	Lower Cretaceous
TRC105	Georgetown-DK	source	Williamson County	Lower Cretaceous
TRC106	Georgetown-LY	source	Williamson County	Lower Cretaceous
TRC107	Burro Mesa-Y	source	Brewster County	Cretaceous Volcanic
TRC108	662-10	artifact	Varga, Edwards County	unknown

906 Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC109	100-11	artifact	Varga, Edwards County	unknown
TRC110	149-10	artifact	Varga, Edwards County	unknown
TRC111	191-11	artifact	Varga, Edwards County	unknown
TRC112	397-13	artifact	Varga, Edwards County	unknown
TRC113	397-10	artifact	Varga, Edwards County	unknown
TRC114	417-10	artifact	Varga, Edwards County	unknown
TRC115	417-13	artifact	Varga, Edwards County	unknown
TRC116	418-28	artifact	Varga, Edwards County	unknown
TRC117	419-12	artifact	Varga, Edwards County	unknown
TRC118	484-16	artifact	Varga, Edwards County	unknown
TRC119	484-17	artifact	Varga, Edwards County	unknown
TRC120	537-16	artifact	Varga, Edwards County	unknown
TRC121	213-12	artifact	Varga, Edwards County	unknown
TRC122	537-17	artifact	Varga, Edwards County	unknown
TRC123	544-12	artifact	Varga, Edwards County	unknown
TRC124	649-11	artifact	Varga, Edwards County	unknown
TRC125	28-11	artifact	Varga, Edwards County	unknown
TRC126	29-12	artifact	Varga, Edwards County	unknown
TRC127	39-15	artifact	Varga, Edwards County	unknown
TRC128	40-12	artifact	Varga, Edwards County	unknown
TRC129	49-12	artifact	Varga, Edwards County	unknown
TRC130	63-16	artifact	Varga, Edwards County	unknown
TRC131	77-13	artifact	Varga, Edwards County	unknown
TRC132	86-20	artifact	Varga, Edwards County	unknown
TRC133	116-20	artifact	Varga, Edwards County	unknown
TRC134	117-21	artifact	Varga, Edwards County	unknown
TRC135	142-11	artifact	Varga, Edwards County	unknown
TRC136	153-31	artifact	Varga, Edwards County	unknown
TRC137	157-11	artifact	Varga, Edwards County	unknown
TRC138	183-21	artifact	Varga, Edwards County	unknown
TRC139	192-11	artifact	Varga, Edwards County	unknown
TRC140	205-10	artifact	Varga, Edwards County	unknown
TRC141	215-21	artifact	Varga, Edwards County	unknown
TRC142	255-11	artifact	Varga, Edwards County	unknown
TRC143	260-14	artifact	Varga, Edwards County	unknown
TRC144	268-21	artifact	Varga, Edwards County	unknown

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC145	299-14	artifact	Varga, Edwards County	unknown
TRC146	311-13	artifact	Varga, Edwards County	unknown
TRC147	312-19	artifact	Varga, Edwards County	unknown
TRC148	323-20	artifact	Varga, Edwards County	unknown
TRC149	324-16	artifact	Varga, Edwards County	unknown
TRC150	333-22	artifact	Varga, Edwards County	unknown
TRC151	345-28	artifact	Varga, Edwards County	unknown
TRC152	346-11	artifact	Varga, Edwards County	unknown
TRC153	346-25	artifact	Varga, Edwards County	unknown
TRC154	347-13	artifact	Varga, Edwards County	unknown
TRC155	366-13	artifact	Varga, Edwards County	unknown
TRC156	391-10	artifact	Varga, Edwards County	unknown
TRC157	400-10	artifact	Varga, Edwards County	unknown
TRC158	400-11	artifact	Varga, Edwards County	unknown
TRC159	401-36	artifact	Varga, Edwards County	unknown
TRC160	402-11	artifact	Varga, Edwards County	unknown
TRC161	411-17	artifact	Varga, Edwards County	unknown
TRC162	412-10	artifact	Varga, Edwards County	unknown
TRC163	412-11	artifact	Varga, Edwards County	unknown
TRC164	422-19	artifact	Varga, Edwards County	unknown
TRC165	449-10	artifact	Varga, Edwards County	unknown
TRC166	462-15	artifact	Varga, Edwards County	unknown
TRC167	465-10	artifact	Varga, Edwards County	unknown
TRC168	539-12	artifact	Varga, Edwards County	unknown
TRC169	546-14	artifact	Varga, Edwards County	unknown
TRC170	563-19	artifact	Varga, Edwards County	unknown
TRC171	578-15	artifact	Varga, Edwards County	unknown
TRC172	592-11	artifact	Varga, Edwards County	unknown
TRC173	598-13	artifact	Varga, Edwards County	unknown
TRC174	615-20	artifact	Varga, Edwards County	unknown
TRC175	621-10	artifact	Varga, Edwards County	unknown
TRC176	627-13	artifact	Varga, Edwards County	unknown
TRC177	628-11	artifact	Varga, Edwards County	unknown
TRC178	670-5-12	artifact	Varga, Edwards County	unknown
TRC179	670-13	artifact	Varga, Edwards County	unknown
TRC180	671-11	artifact	Varga, Edwards County	unknown

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC181	699-20	artifact	Varga, Edwards County	unknown
TRC182	718-15	artifact	Varga, Edwards County	unknown
TRC183	719-10	artifact	Varga, Edwards County	unknown
TRC184	724-13	artifact	Varga, Edwards County	unknown
TRC185	725-14	artifact	Varga, Edwards County	unknown
TRC186	729-10	artifact	Varga, Edwards County	unknown
TRC187	735-12	artifact	Varga, Edwards County	unknown
TRC188	854-10	artifact	Varga, Edwards County	unknown
TRC189	1203-10	artifact	Varga, Edwards County	unknown
TRC190	1213-10	artifact	Varga, Edwards County	unknown
TRC191	2-1	artifact	Varga, Edwards County	unknown
TRC192	2-11	artifact	Varga, Edwards County	unknown
TRC193	2-12	artifact	Varga, Edwards County	unknown
TRC194	3-10	artifact	Varga, Edwards County	unknown
TRC195	11-5-11	artifact	Varga, Edwards County	unknown
TRC196	22-15	artifact	Varga, Edwards County	unknown
TRC197	42-10	artifact	Varga, Edwards County	unknown
TRC198	89-10	artifact	Varga, Edwards County	unknown
TRC199	98-12	artifact	Varga, Edwards County	unknown
TRC200	187-10	artifact	Varga, Edwards County	unknown
TRC201	197-16	artifact	Varga, Edwards County	unknown
TRC202	197-17	artifact	Varga, Edwards County	unknown
TRC203	208-10	artifact	Varga, Edwards County	unknown
TRC204	233-10	artifact	Varga, Edwards County	unknown
TRC205	263-10	artifact	Varga, Edwards County	unknown
TRC206	274-5-11	artifact	Varga, Edwards County	unknown
TRC207	283-12	artifact	Varga, Edwards County	unknown
TRC208	293-5-12	artifact	Varga, Edwards County	unknown
TRC209	293-5-13	artifact	Varga, Edwards County	unknown
TRC210	459-11	artifact	Varga, Edwards County	unknown
TRC211	525-5-13	artifact	Varga, Edwards County	unknown
TRC212	543-12	artifact	Varga, Edwards County	unknown
TRC213	691-11	artifact	Varga, Edwards County	unknown
TRC214	159-5-27	artifact	Varga, Edwards County	unknown
TRC215	159-5-28	artifact	Varga, Edwards County	unknown
TRC216	207-11	artifact	Varga, Edwards County	unknown

Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC217	220-13	artifact	Varga, Edwards County	unknown
TRC218	220-15	artifact	Varga, Edwards County	unknown
TRC219	262-20	artifact	Varga, Edwards County	unknown
TRC220	282-17	artifact	Varga, Edwards County	unknown
TRC221	291-14	artifact	Varga, Edwards County	unknown
TRC222	302-21	artifact	Varga, Edwards County	unknown
TRC223	349-13	artifact	Varga, Edwards County	unknown
TRC224	474-10	artifact	Varga, Edwards County	unknown
TRC225	482-10	artifact	Varga, Edwards County	unknown
TRC226	525-10	artifact	Varga, Edwards County	unknown
TRC227	526-10	artifact	Varga, Edwards County	unknown
TRC228	562-10	artifact	Varga, Edwards County	unknown
TRC229	572-15	artifact	Varga, Edwards County	unknown
TRC230	781-10	artifact	Varga, Edwards County	unknown
TRC231	800-11	artifact	Varga, Edwards County	unknown
TRC232	806-17	artifact	Varga, Edwards County	unknown
TRC233	825-10	artifact	Varga, Edwards County	unknown
TRC234	836-10	artifact	Varga, Edwards County	unknown
TRC235	841-13	artifact	Varga, Edwards County	unknown
TRC236	842-10	artifact	Varga, Edwards County	unknown
TRC237	845-10	artifact	Varga, Edwards County	unknown
TRC238	881-17	artifact	Varga, Edwards County	unknown
TRC239	888-14	artifact	Varga, Edwards County	unknown
TRC240	889-13	artifact	Varga, Edwards County	unknown
TRC241	895-12	artifact	Varga, Edwards County	unknown
TRC242	903-12	artifact	Varga, Edwards County	unknown
TRC243	903-22	artifact	Varga, Edwards County	unknown
TRC244	903-24	artifact	Varga, Edwards County	unknown
TRC245	913-17	artifact	Varga, Edwards County	unknown
TRC246	934-19	artifact	Varga, Edwards County	unknown
TRC247	974-11	artifact	Varga, Edwards County	unknown
TRC248	967-24	artifact	Varga, Edwards County	unknown
TRC249	1002-13	artifact	Varga, Edwards County	unknown
TRC250	1029-5-11	artifact	Varga, Edwards County	unknown
TRC251	1031-13	artifact	Varga, Edwards County	unknown
TRC252	1038-12	artifact	Varga, Edwards County	unknown

016 Table 1. Descriptions of the chert samples in this study.

ANID	Field ID	Sample type	Site name	Description
TRC253	1041-14	artifact	Varga, Edwards County	unknown
TRC254	1054-16	artifact	Varga, Edwards County	unknown
TRC255	1074-12	artifact	Varga, Edwards County	unknown
TRC256	1088-13	artifact	Varga, Edwards County	unknown
TRC257	1092-15	artifact	Varga, Edwards County	unknown
TRC258	1101-13	artifact	Varga, Edwards County	unknown
TRC259	1132-10	artifact	Varga, Edwards County	unknown
TRC260	1162-11	artifact	Varga, Edwards County	unknown
TRC261	1256-5-11	artifact	Varga, Edwards County	unknown

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC001	0.1441	230.88	0.0978	0.0050	0.6861	0.0715	0.7979	0.0000	0.2374	0.0136	0.1113
TRC002	0.1812	29.74	0.0905	0.0050	0.1964	0.0646	0.7177	0.0000	0.2254	0.0148	0.3588
TRC003	0.1705	37.43	0.1513	0.0082	0.2044	0.0908	0.8442	0.0055	0.3911	0.0183	0.0950
TRC004	0.0000	39.22	0.0827	0.0052	0.1446	0.0730	0.7871	0.0000	0.2252	0.0092	0.1173
TRC005	0.2762	45.03	0.1133	0.0071	0.2454	0.0906	1.0240	0.0000	0.2828	0.0160	0.1044
TRC006	0.0000	58.57	0.1083	0.0065	0.2566	0.0844	0.9479	0.0000	0.2683	0.0090	0.1035
TRC007	0.2353	20.46	0.1313	0.0076	0.5541	0.1019	1.0788	0.0000	0.3440	0.0326	0.3258
TRC008	0.0000	28.22	0.4309	0.0224	0.9381	0.3099	3.4348	0.0025	0.9790	0.0787	0.5933
TRC009	0.9205	20.55	0.1888	0.0098	0.3845	0.1352	1.4812	0.0000	0.4304	0.0312	0.3848
TRC010	0.0888	10.89	0.1967	0.0105	0.3741	0.1348	1.4834	0.0057	0.4134	0.0333	0.5028
TRC011	0.1198	11.40	0.1268	0.0000	0.4325	0.1531	1.6941	0.0000	0.5092	0.0118	0.3342
TRC012	0.1420	16.44	0.1078	0.0000	0.1988	0.1141	1.2195	0.0000	0.3653	0.0218	0.3017
TRC013	0.1004	71.19	0.0523	0.0033	0.0000	0.0355	0.3328	0.0000	0.1570	0.0145	0.4354
TRC014	0.2954	29.94	0.2995	0.0000	1.8278	0.3904	4.2566	0.0000	1.2231	0.0122	0.2173
TRC015	0.4329	34.05	0.1326	0.0000	0.4284	0.1525	1.6197	0.0000	0.4874	0.1332	0.1364
TRC016	0.1913	13.51	0.1312	0.0000	0.2210	0.1384	1.4344	0.0053	0.4780	0.0109	0.2357
TRC017	0.3865	39.82	0.1013	0.0000	0.5338	0.1117	1.1737	0.0000	0.3475	0.0224	0.2113
TRC018	0.1870	17.25	0.0708	0.0000	0.0000	0.0763	0.7863	0.0000	0.2376	0.0122	0.9637
TRC019	0.0863	19.01	0.1321	0.0032	0.0000	0.0499	0.3717	0.0000	0.1289	0.0078	0.1027
TRC020	0.1172	30.76	0.1109	0.0066	0.1182	0.0700	0.6327	0.0032	0.2515	0.0378	0.1370
TRC021	0.0579	19.18	0.0949	0.0048	0.0000	0.0522	0.4747	0.0000	0.1931	0.0120	0.2367
TRC022	0.0000	18.42	0.1849	0.0018	0.0000	0.0397	0.2422	0.0050	0.1455	0.0090	0.1037
TRC023	0.1669	24.61	0.2112	0.0000	0.7292	0.2188	2.3518	0.0000	0.7007	0.0234	0.0837
TRC024	0.1791	24.87	0.1893	0.0000	0.7831	0.2044	2.1266	0.0000	0.6423	0.0243	0.0908
TRC025	0.1038	25.63	0.0869	0.0000	0.0000	0.0691	0.6855	0.0031	0.2461	0.0105	0.1262
TRC026	0.0710	20.73	0.0763	0.0000	0.0000	0.0649	0.6369	0.0000	0.2231	0.0099	0.1037
TRC027	0.1022	26.53	0.2147	0.0000	0.6783	0.2499	2.6595	0.0000	0.7498	0.0060	0.2943
TRC028	0.2094	69.34	0.0905	0.0000	0.0000	0.0867	0.8941	0.0000	0.2879	0.0252	0.1883
TRC029	0.2291	127.34	0.0462	0.0000	0.2426	0.0403	0.4166	0.0000	0.1130	0.0220	0.1475
TRC030	0.1587	78.30	0.2520	0.0000	0.9752	0.2867	3.0221	0.0000	0.8719	0.0182	0.8794
TRC031	1.2333	51.75	0.1090	0.0092	0.0000	0.0909	0.8348	0.0081	0.2414	0.1889	0.5279
TRC032	0.0790	22.17	0.1452	0.0000	0.5707	0.1555	1.6006	0.0000	0.4671	0.0205	0.2379
TRC033	0.1464	34.28	0.1571	0.0000	0.3257	0.1610	1.6489	0.0000	0.4990	0.0127	0.5005
TRC034	0.1462	17.45	0.3167	0.0000	0.4855	0.1863	1.9701	0.0000	0.8879	0.0078	0.3181
TRC035	0.1333	110.14	0.0857	0.0000	0.0000	0.0867	0.9061	0.0000	0.2673	0.0078	0.1530
TRC036	0.1443	104.73	0.2459	0.0000	0.7078	0.2662	2.7767	0.0000	0.8040	0.0106	0.7925

912 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC037	0.5288	21.01	0.1476	0.0000	0.4838	0.1348	1.3419	0.0000	0.4813	0.0253	1.2717
TRC038	0.1587	37.70	0.2741	0.0000	0.8611	0.2943	3.0487	0.0000	0.8914	0.0101	0.1993
TRC039	0.1929	61.61	0.0752	0.0000	0.0000	0.0644	0.6174	0.0000	0.2235	0.0226	4.9581
TRC040	0.2943	16.61	0.0598	0.0038	0.0000	0.0448	0.4171	0.0000	0.1749	0.0089	0.4009
TRC041	0.3979	41.94	0.1078	0.0000	0.0000	0.1109	1.2997	0.0000	0.4149	0.0271	1.1556
TRC042	0.3007	78.47	0.2944	0.0000	1.4279	0.3368	3.7912	0.0000	1.1559	0.0583	0.4069
TRC043	0.0713	33.49	0.1197	0.0000	0.4340	0.1475	1.7854	0.0000	0.5195	0.0143	0.0982
TRC044	0.2890	21.28	0.1156	0.0000	0.0000	0.1135	1.3377	0.0000	0.4912	0.0317	0.2715
TRC045	0.1988	27.04	0.2378	0.0000	1.0833	0.2973	3.6322	0.0000	1.0168	0.0305	0.3467
TRC046	0.0861	41.53	0.1132	0.0000	0.6726	0.1348	1.6319	0.0000	0.5074	0.0215	0.1314
TRC047	0.1501	24.04	0.1476	0.0000	0.8647	0.1703	1.9430	0.0000	0.5970	0.0162	0.3825
TRC048	0.3058	85.32	0.2211	0.0000	1.2024	0.2687	3.1862	0.0000	0.9562	0.0266	0.5176
TRC049	0.3153	46.68	0.1793	0.0000	0.6276	0.1950	2.3503	0.0000	0.7298	0.0354	0.4161
TRC050	0.0824	24.14	0.2062	0.0000	0.8271	0.2506	2.9984	0.0000	0.8928	0.0147	0.4640
TRC051	0.2887	37.52	0.1562	0.0000	0.7251	0.1239	1.2927	0.0150	0.5240	0.0254	0.2169
TRC052	0.1373	34.42	0.2607	0.0000	1.2093	0.3011	3.6899	0.0000	1.0557	0.0096	0.4688
TRC053	0.2029	97.67	0.2010	0.0000	0.9563	0.2271	2.6933	0.0000	0.7804	0.0131	0.2642
TRC054	0.0000	81.14	0.1435	0.0000	0.5364	0.1597	1.9092	0.0000	0.5792	0.0129	0.1523
TRC055	0.0000	53.46	0.1854	0.0000	1.0234	0.2077	2.5046	0.0000	0.7393	0.0089	0.1644
TRC056	0.0531	41.08	0.0420	0.0000	0.0000	0.0288	0.3534	0.0000	0.1011	0.0129	0.5332
TRC057	0.0000	71.96	0.0898	0.0000	0.7167	0.0992	1.1871	0.0000	0.3689	0.0097	1.2985
TRC058	0.0000	58.91	0.0875	0.0000	0.0000	0.0958	1.1527	0.0000	0.3536	0.0083	0.4071
TRC059	0.0000	31.62	0.0877	0.0000	0.0000	0.0898	1.0637	0.0000	0.3162	0.0105	0.3325
TRC060	0.0986	64.43	0.0924	0.0000	0.0000	0.0681	0.7664	0.0000	0.2510	0.0122	0.4188
TRC061	0.3935	38.07	0.1679	0.0000	0.2897	0.1416	1.3851	0.0000	0.4731	0.0397	1.0154
TRC062	0.6106	38.00	0.2016	0.0134	0.4272	0.1715	1.5923	0.0057	0.5612	0.0545	1.4892
TRC063	0.3534	61.94	0.1738	0.0000	0.7239	0.1749	2.0994	0.0000	0.6280	0.0472	0.7320
TRC064	0.5470	76.85	0.1854	0.0000	0.3606	0.1835	2.1714	0.0000	0.6612	0.0573	0.6554
TRC065	0.5333	67.79	0.1995	0.0000	0.9025	0.1841	2.0276	0.0000	0.6384	0.0707	1.0639
TRC066	0.5774	28.71	0.0990	0.0000	0.0000	0.0590	0.6339	0.0071	0.2878	0.1546	0.2719
TRC067	0.2448	44.34	0.0764	0.0000	0.0000	0.0779	0.8818	0.0000	0.2937	0.0320	0.1590
TRC068	0.0000	22.36	0.0458	0.0000	0.0000	0.0461	0.5322	0.0000	0.1618	0.0091	0.0977
TRC069	0.3089	23.50	0.0754	0.0000	0.0000	0.0606	0.6550	0.0000	0.2353	0.0622	0.2827
TRC070	0.1727	22.43	0.1197	0.0041	0.0000	0.0355	0.3429	0.0000	0.1604	0.0382	0.7541
TRC071	0.1593	90.69	0.2120	0.0000	0.0000	0.0835	0.9621	0.0070	0.3436	0.0268	0.4021
TRC072	0.5694	84.15	0.2042	0.0000	0.0000	0.0894	1.0311	0.0000	0.3496	0.0313	0.1533

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC073	1.7010	403.79	0.1944	0.0000	0.0000	0.0659	0.6732	0.0146	0.2826	0.0540	0.3549
TRC074	1.8670	213.23	0.2122	0.0000	0.0000	0.0707	0.7485	0.0129	0.3272	0.0929	0.2389
TRC075	0.6009	23.23	0.2623	0.0367	0.9827	0.3066	3.7248	0.0070	1.0720	0.0127	0.2215
TRC076	0.2176	66.98	0.1770	0.0268	0.5741	0.2205	2.7296	0.0000	0.7638	0.0125	0.5235
TRC077	0.3708	25.10	0.3227	0.0014	1.3313	0.4085	5.0234	0.0000	1.3898	0.0163	0.1317
TRC078	3.9448	23.98	0.3055	0.0013	1.0391	0.3683	4.5061	0.0000	1.2501	0.1195	0.3997
TRC079	0.2961	44.58	0.1455	0.0006	0.4398	0.1691	2.0017	0.0000	0.6503	0.0965	0.8119
TRC080	0.2884	641.30	0.2671	0.0341	0.8944	0.3005	3.5981	0.0000	1.0107	0.0043	0.5925
TRC081	0.1384	34.14	0.1706	0.0009	0.4868	0.2133	2.5547	0.0000	0.7185	0.0045	0.2352
TRC082	0.5433	25.08	0.1355	0.0024	0.1360	0.0500	0.3032	0.0115	0.3639	0.0211	0.4633
TRC083	0.1053	89.28	0.2818	0.0369	1.0220	0.3257	3.9830	0.0000	1.1128	0.0066	0.1073
TRC084	0.0812	66.95	0.2383	0.0352	0.7832	0.3041	3.6802	0.0000	1.0165	0.0000	0.1259
TRC085	0.3683	53.64	0.0912	0.0006	0.2354	0.0686	0.8044	0.0045	0.2656	0.0256	2.0682
TRC086	0.0507	47.34	0.0858	0.0104	0.2761	0.0951	1.1218	0.0000	0.3131	0.0022	0.0898
TRC087	0.1209	91.04	0.2424	0.0323	0.9948	0.2941	3.5344	0.0000	0.9714	0.0082	0.1811
TRC088	0.3514	16.14	0.0776	0.0005	0.1647	0.0807	0.9220	0.0000	0.2512	0.0081	0.1120
TRC089	0.1016	21.93	0.1304	0.0109	0.2972	0.1068	1.2526	0.0000	0.3948	0.0070	0.2923
TRC090	0.3130	95.26	0.1071	0.0007	0.2087	0.0612	0.6254	0.0000	0.2301	0.0056	0.1109
TRC091	0.1129	33.16	0.0789	0.0080	0.1207	0.0712	0.8214	0.0000	0.2249	0.0059	0.2863
TRC092	0.7427	174.38	0.2135	0.0012	0.4642	0.1758	1.9950	0.0000	0.6867	0.0488	0.4871
TRC093	0.1801	57.64	0.1344	0.0108	0.2663	0.1064	1.2008	0.0055	0.3879	0.0062	0.1487
TRC094	0.2024	19.88	0.0878	0.0005	0.2733	0.0644	0.7039	0.0000	0.2212	0.0070	0.2763
TRC095	0.3095	76.15	0.1527	0.0150	0.4840	0.1463	1.7212	0.0000	0.4907	0.0070	0.5894
TRC096	0.2320	68.44	0.1780	0.0147	0.5378	0.1452	1.5345	0.0069	0.5175	0.0132	0.2802
TRC097	0.1105	42.65	0.1814	0.0162	0.5926	0.1591	1.8233	0.0000	0.5269	0.0066	0.2124
TRC098	0.0000	45.70	0.1440	0.0145	0.5521	0.1479	1.7273	0.0000	0.5107	0.0054	0.2016
TRC099	0.2210	67.20	0.1235	0.0130	0.2853	0.1273	1.5101	0.0000	0.4233	0.0043	0.1356
TRC100	0.8031	41.77	0.1105	0.0097	0.6376	0.0898	1.0614	0.0000	0.3438	0.0073	0.2081
TRC101	0.1648	17.55	0.1109	0.0094	0.2196	0.0941	1.0863	0.0000	0.2999	0.0034	0.2102
TRC102	0.0698	56.19	0.1340	0.0123	0.3299	0.1238	1.4094	0.0000	0.4232	0.0041	0.1088
TRC103	0.1322	21.92	0.2459	0.0227	0.8092	0.2322	2.6714	0.0059	0.8326	0.0107	0.1915
TRC104	0.1720	56.83	0.6148	0.0644	1.6784	0.6574	7.6883	0.0000	2.0626	0.0096	0.1661
TRC105	0.2353	30.33	0.4154	0.0431	0.9785	0.4365	5.0813	0.0000	1.3855	0.0047	0.4888
TRC106	0.1260	76.89	0.7004	0.0000	1.7036	0.7118	8.1010	0.0000	2.2223	0.0094	0.0918
TRC107	3.1744	216.40	8.8710	0.1392	13.4584	5.2995	37.5021	0.9702	24.8490	0.0333	1.1564
TRC108	0.2207	17.28	0.0871	0.0008	0.1787	0.0573	0.6043	0.0029	0.2366	0.0098	0.4844

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC109	0.5731	25.53	0.4762	0.0046	0.6968	0.1945	1.5800	0.0290	1.4583	0.1457	0.8337
TRC110	0.6371	46.48	0.4282	0.0000	1.4799	0.4005	4.5649	0.0000	1.2878	0.0125	0.7015
TRC111	0.0000	47.41	0.1064	0.0090	0.2824	0.0998	1.1168	0.0039	0.3225	0.0068	0.6623
TRC112	0.1781	27.38	0.3384	0.0033	0.5330	0.1350	0.9428	0.0265	0.5074	0.0527	0.3526
TRC113	0.0836	19.61	0.1984	0.0184	0.5846	0.1980	2.2504	0.0000	0.6192	0.0092	0.2299
TRC114	0.2395	17.52	0.1986	0.0020	0.4057	0.0731	0.5134	0.0204	0.5475	0.0476	1.4080
TRC115	0.1113	61.69	0.2342	0.0028	0.4822	0.1977	2.2087	0.0000	0.6393	0.0121	0.2693
TRC116	0.0000	57.38	0.1578	0.0147	0.4476	0.1612	1.8677	0.0000	0.4889	0.0031	0.2544
TRC117	0.1670	26.23	0.0677	0.0000	0.2121	0.0555	0.6127	0.0031	0.2052	0.0111	0.1400
TRC118	0.4216	64.28	0.1995	0.0028	0.3655	0.0778	0.5462	0.0132	0.3738	0.0443	0.5462
TRC119	0.4198	39.86	0.3672	0.0036	0.5660	0.2098	2.0254	0.0109	0.9288	0.0637	0.6529
TRC120	0.2329	34.88	0.2427	0.0005	0.5207	0.1738	1.8792	0.0056	0.6145	0.0168	0.2234
TRC121	0.1566	33.53	0.3777	0.0000	0.8343	0.3321	3.6853	0.0000	1.0648	0.0160	0.2783
TRC122	0.1710	47.57	0.1013	0.0000	0.2664	0.0737	0.8125	0.0000	0.2694	0.0077	0.2528
TRC123	0.1058	49.50	0.2837	0.0000	0.4954	0.1744	1.7704	0.0063	0.6796	0.0204	0.3242
TRC124	0.2297	50.30	0.1650	0.0019	0.1963	0.0639	0.4134	0.0133	0.3546	0.0213	0.7074
TRC125	0.2930	96.28	0.0875	0.0000	0.0000	0.0372	0.3586	0.0000	0.2103	0.0155	0.2392
TRC126	0.0883	40.64	0.3192	0.0015	0.8545	0.2532	2.7822	0.0000	0.8523	0.0068	0.1943
TRC127	0.7676	73.55	0.1951	0.0010	0.4598	0.1169	1.2306	0.0178	0.4741	0.0731	0.6839
TRC128	0.2045	25.35	0.1328	0.0011	0.1490	0.0624	0.5637	0.0046	0.2655	0.0141	0.2464
TRC129	0.2112	75.21	0.3223	0.0000	0.9432	0.2751	3.0456	0.0000	0.8774	0.0074	0.1896
TRC130	0.2158	174.81	0.3636	0.0037	0.5057	0.2211	2.2413	0.0170	0.8296	0.0352	0.5961
TRC131	0.1252	37.94	0.2115	0.0012	0.4572	0.1696	1.8691	0.0000	0.5491	0.0034	0.1937
TRC132	0.0000	30.63	0.1136	0.0000	0.3921	0.0845	0.8773	0.0000	0.2809	0.0089	0.1847
TRC133	0.1397	14.53	0.1580	0.0012	0.3050	0.1172	1.2646	0.0000	0.4344	0.0470	0.4684
TRC134	0.0000	73.48	0.2573	0.0000	0.5710	0.1933	2.1182	0.0000	0.6286	0.0061	0.1422
TRC135	0.2539	19.76	0.4651	0.0000	0.8474	0.2932	3.1944	0.0000	1.4264	0.0246	5.2229
TRC136	0.3362	240.13	0.3385	0.0000	0.7323	0.2625	2.8146	0.0000	0.8971	0.0252	2.0514
TRC137	0.0000	18.21	0.4128	0.0000	0.8204	0.3078	3.3892	0.0000	0.9573	0.0147	0.8271
TRC138	0.3178	26.30	0.2375	0.0000	0.5586	0.1655	1.7924	0.0000	0.5746	0.0182	0.8903
TRC139	0.2457	72.69	0.3768	0.0027	0.7656	0.2380	2.3536	0.0157	0.8880	0.0415	0.2698
TRC140	0.4349	20.55	1.1075	0.0083	0.9842	0.2477	1.5056	0.0586	2.1846	0.1952	3.6306
TRC141	0.3756	95.74	0.1643	0.0206	0.5855	0.1812	2.1691	0.0000	0.6376	0.0264	1.2517
TRC142	0.0555	32.17	0.2502	0.0010	0.6762	0.2744	3.2739	0.0055	0.9499	0.0132	0.2220
TRC143	0.2333	20.02	0.2071	0.0303	0.8145	0.2665	3.2454	0.0000	0.8706	0.0092	0.2751
TRC144	0.3058	292.38	0.2940	0.0033	0.5883	0.1374	1.2667	0.0261	0.7480	0.3834	1.9895

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC145	0.1912	37.62	0.0551	0.0008	0.2031	0.0561	0.5953	0.0080	0.1869	0.0142	0.2236
TRC146	0.0595	70.78	0.3011	0.0344	1.0057	0.3258	3.7334	0.0062	1.0784	0.0137	0.2022
TRC147	0.2226	39.66	0.2824	0.0011	1.1676	0.3190	3.8354	0.0000	1.0258	0.0138	0.3259
TRC148	0.2585	41.72	0.1334	0.0162	0.6772	0.1531	1.8275	0.0000	0.5062	0.0136	0.3483
TRC149	0.3088	20.40	0.0730	0.0008	0.0000	0.0614	0.7240	0.0000	0.2427	0.0119	0.5369
TRC150	0.1507	20.12	0.2999	0.0400	1.3453	0.3727	4.4974	0.0000	1.1792	0.0086	0.6226
TRC151	0.0000	141.73	0.1862	0.0009	0.6472	0.1367	1.3824	0.0000	0.4642	0.0095	0.4140
TRC152	0.5138	34.29	0.2835	0.0000	0.3996	0.1546	1.5757	0.0000	0.5380	0.0574	0.1511
TRC153	0.0000	46.66	0.2353	0.0126	0.3457	0.1491	1.5365	0.0116	0.5675	0.0284	0.2564
TRC154	1.2358	87.00	0.2653	0.0011	1.0082	0.1734	1.8929	0.0000	0.6178	0.0580	0.3613
TRC155	0.5093	20.25	0.3890	0.0141	0.5303	0.1599	1.1944	0.0176	0.5998	0.0431	0.6721
TRC156	0.1609	20.31	0.1510	0.0009	0.2559	0.0995	1.0312	0.0000	0.3548	0.0080	0.8296
TRC157	0.2546	37.98	0.1668	0.0009	0.2461	0.1003	1.0432	0.0000	0.3275	0.0106	0.3473
TRC158	2.1529	127.87	0.1883	0.0000	0.0000	0.0479	0.3126	0.0099	0.3185	0.1375	0.7926
TRC159	0.2672	21.02	0.2247	0.0024	0.2536	0.0975	0.8127	0.0128	0.4243	0.0283	0.6822
TRC160	0.7894	41.58	0.1789	0.0126	0.3535	0.1419	1.5853	0.0063	0.4919	0.0158	0.9726
TRC161	0.2602	37.06	0.1148	0.0089	0.4000	0.0830	0.8925	0.0000	0.3000	0.0265	0.3497
TRC162	0.2605	21.80	0.2623	0.0215	0.6926	0.2463	2.7244	0.0056	0.7650	0.0201	0.3259
TRC163	0.2020	282.62	0.2582	0.0207	0.7775	0.2415	2.6817	0.0057	0.7467	0.0163	0.3590
TRC164	0.2642	213.72	0.2260	0.0139	0.5496	0.1607	1.6255	0.0059	0.5488	0.0379	0.5798
TRC165	0.1054	24.51	0.3151	0.0254	0.8323	0.2943	3.3050	0.0000	0.9366	0.0176	0.2915
TRC166	0.9622	89.85	0.1841	0.0012	0.2197	0.0984	0.9572	0.0093	0.3976	0.0499	0.9310
TRC167	0.1917	15.12	0.1690	0.0017	0.2876	0.0774	0.6178	0.0149	0.4174	0.0353	0.7014
TRC168	0.5499	92.26	0.2905	0.0167	0.8855	0.2117	2.1730	0.0000	0.7235	0.0696	0.5295
TRC169	0.4696	38.08	0.1978	0.0018	0.4253	0.1092	0.9715	0.0116	0.4544	0.0380	0.2481
TRC170	0.4607	43.34	0.3532	0.0233	0.8979	0.2515	2.5674	0.0130	1.0939	0.0502	0.3363
TRC171	0.2068	22.44	0.1564	0.0102	0.3069	0.1207	1.2413	0.0057	0.4312	0.0218	0.6114
TRC172	0.6730	19.89	0.1706	0.0013	0.4646	0.1062	1.0032	0.0129	0.3839	0.0768	0.2082
TRC173	0.2099	40.64	0.2362	0.0174	0.6556	0.2182	2.4182	0.0037	0.6570	0.0051	0.2065
TRC174	0.1776	25.36	0.2364	0.0156	0.5925	0.1828	1.9701	0.0000	0.5662	0.0152	0.4254
TRC175	0.0000	49.39	0.3734	0.0229	0.7636	0.2883	3.2202	0.0000	0.8461	0.0036	0.0671
TRC176	1.0467	34.35	0.4000	0.0103	0.4330	0.1201	0.6526	0.0378	1.0021	0.1700	1.7549
TRC177	0.0000	24.98	0.2959	0.0205	0.8715	0.2355	2.5413	0.0000	0.7754	0.0270	0.3924
TRC178	0.3999	34.22	0.1329	0.0015	0.1152	0.0686	0.6069	0.0089	0.3334	0.0227	0.9130
TRC179	0.1747	12.41	0.2000	0.0011	0.2704	0.1026	1.0303	0.0000	0.4062	0.0147	0.6540
TRC180	0.1497	11.00	0.2073	0.0057	0.0000	0.0639	0.7838	0.0000	0.4840	0.0253	0.5378

916 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC181	0.0000	14.95	0.3236	0.0171	0.6894	0.2421	2.5968	0.0000	0.7131	0.0134	0.3519
TRC182	0.1193	35.08	0.4048	0.0233	0.8211	0.3271	3.5357	0.0000	0.9374	0.0117	0.1588
TRC183	0.3403	28.18	0.1994	0.0082	0.2930	0.1231	1.2141	0.0049	0.4171	0.0126	0.5508
TRC184	0.0000	69.58	0.7440	0.0028	1.6285	0.4950	5.1689	0.0112	1.5866	0.0453	0.3087
TRC185	0.6238	23.41	0.4174	0.0014	0.7481	0.2666	2.6640	0.0000	0.8386	0.1104	0.4425
TRC186	0.6462	57.92	0.2293	0.0018	0.4263	0.1263	1.1359	0.0121	0.4510	0.0523	0.5904
TRC187	0.0000	147.50	0.1955	0.0083	0.4361	0.1270	1.3324	0.0000	0.4022	0.0158	0.4204
TRC188	0.0000	41.54	0.3495	0.0172	0.4882	0.2433	2.6135	0.0000	0.6963	0.0081	0.1868
TRC189	0.0000	8.68	0.0978	0.0014	0.0997	0.0449	0.3712	0.0062	0.1715	0.0088	0.6219
TRC190	0.3596	44.20	0.4017	0.0009	0.6292	0.2837	3.0099	0.0000	0.8407	0.0291	0.3632
TRC191	0.2325	32.06	0.0868	0.0011	0.0983	0.0577	0.6326	0.0036	0.2489	0.0286	0.2076
TRC192	0.5244	29.33	0.0945	0.0014	0.1638	0.0538	0.5445	0.0097	0.2293	0.0339	2.2838
TRC193	0.3612	71.41	0.3144	0.0014	0.8207	0.1219	1.1795	0.0181	0.5731	0.0287	5.5686
TRC194	0.3708	34.74	0.1059	0.0010	0.1599	0.0688	0.7102	0.0076	0.2948	0.0147	0.8123
TRC195	0.6837	22.79	0.1301	0.0082	0.2984	0.0594	0.5740	0.0080	0.3064	0.0619	0.4124
TRC196	0.4635	19.08	0.1957	0.0000	0.5412	0.1705	1.9961	0.0000	0.6084	0.0108	0.5506
TRC197	0.2240	32.04	0.1848	0.0011	0.3427	0.1161	1.2176	0.0124	0.4962	0.0384	0.4334
TRC198	0.2595	28.16	0.3678	0.0020	0.9998	0.2440	2.5867	0.0178	1.0481	0.0448	0.5996
TRC199	0.0000	15.50	0.0945	0.0008	0.1741	0.0562	0.5675	0.0064	0.2429	0.0143	0.2617
TRC200	1.1844	109.89	0.7021	0.0000	1.4961	0.3883	4.4237	0.0140	1.8777	0.2624	0.6522
TRC201	0.1337	22.39	0.1395	0.0010	0.2093	0.0970	1.0589	0.0032	0.3759	0.0070	0.3750
TRC202	0.8128	21.08	0.0856	0.0051	0.1649	0.0511	0.4924	0.0000	0.2378	0.0237	0.7016
TRC203	0.3416	16.56	0.1526	0.0112	0.4752	0.1229	1.3772	0.0048	0.4615	0.0138	0.6678
TRC204	0.2416	36.17	0.2207	0.0000	0.4695	0.1927	2.1988	0.0000	0.6192	0.0058	0.1629
TRC205	0.1617	15.87	0.2226	0.0000	0.5575	0.2247	2.6180	0.0000	0.7152	0.0042	0.1697
TRC206	0.6505	47.45	0.1473	0.0011	0.7089	0.0798	0.8561	0.0030	0.3478	0.0179	0.5376
TRC207	0.1524	20.57	0.1902	0.0019	0.2754	0.1087	1.0314	0.0101	0.5281	0.0110	0.3681
TRC208	0.1741	30.39	0.1152	0.0010	0.1687	0.0890	1.0133	0.0000	0.3001	0.0070	0.1745
TRC209	0.0000	11.05	0.1007	0.0006	0.1821	0.0601	0.6376	0.0000	0.2231	0.0051	0.2172
TRC210	0.2671	34.00	0.3969	0.0000	1.0666	0.3618	4.2210	0.0000	1.1410	0.0114	0.1061
TRC211	0.1804	43.26	0.2227	0.0128	0.3263	0.1457	1.5994	0.0000	0.4924	0.0122	0.2165
TRC212	0.0933	74.57	0.2855	0.0011	0.9040	0.3118	3.6721	0.0000	1.0098	0.0198	0.4294
TRC213	0.3337	23.45	0.0846	0.0048	0.1682	0.0577	0.6567	0.0000	0.2120	0.0110	0.2304
TRC214	0.1286	35.35	0.0857	0.0092	0.3628	0.0905	1.0825	0.0000	0.2979	0.0060	0.1710
TRC215	0.4419	55.55	0.2915	0.0024	0.8168	0.2613	2.7866	0.0087	0.9835	0.0523	0.5434
TRC216	0.5748	174.53	0.1088	0.0077	0.5793	0.0825	0.8880	0.0094	0.3286	0.0490	0.7581

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC217	0.2891	38.77	0.1756	0.0007	0.4591	0.0752	0.6373	0.0102	0.2861	0.0231	0.4044
TRC218	0.3547	37.14	0.7676	0.0028	1.9418	0.6000	6.7603	0.0119	2.1483	0.0656	0.8265
TRC219	0.2993	45.50	0.2057	0.0000	0.6016	0.1579	1.7313	0.0000	0.5424	0.0289	0.0917
TRC220	0.3569	36.22	0.4261	0.0000	0.9389	0.3648	4.2354	0.0000	1.1961	0.0144	0.2574
TRC221	0.3625	79.70	0.1505	0.0000	0.0000	0.0803	0.8021	0.0000	0.3400	0.0141	0.8396
TRC222	0.2041	31.44	0.2446	0.0000	0.5620	0.1874	2.1681	0.0000	0.6280	0.0059	0.2064
TRC223	0.1083	15.57	0.2284	0.0000	0.5442	0.1644	1.8268	0.0000	0.5631	0.0102	0.2920
TRC224	0.3850	58.97	0.2427	0.0000	0.4784	0.1647	1.8100	0.0000	0.6113	0.0089	0.1317
TRC225	0.3881	135.18	0.1552	0.0024	0.0000	0.0925	0.9206	0.0000	0.4094	0.0134	0.8621
TRC226	0.2232	35.63	0.1203	0.0048	0.0000	0.0581	0.5076	0.0072	0.2762	0.0321	0.2181
TRC227	0.0000	15.00	0.0999	0.0050	0.0000	0.0501	0.5064	0.0075	0.2272	0.0167	0.2925
TRC228	0.2975	17.23	0.1699	0.0000	0.3864	0.1158	1.3015	0.0049	0.4408	0.0434	2.0460
TRC229	0.5019	591.24	0.1668	0.0019	0.6573	0.0756	0.7435	0.0000	0.3521	0.0205	0.8440
TRC230	0.1297	54.60	0.1689	0.0000	0.3394	0.1177	1.3088	0.0000	0.4466	0.0101	0.1824
TRC231	0.0000	15.81	0.4475	0.0000	0.4813	0.1508	0.9425	0.0287	0.7881	0.0259	0.8310
TRC232	0.0000	29.64	0.2443	0.0186	0.8716	0.2150	2.5223	0.0000	0.7211	0.0098	0.1893
TRC233	0.3995	104.73	0.1765	0.0179	0.0000	0.1672	1.8924	0.0000	0.5951	0.0124	0.1473
TRC234	0.8687	39.30	0.3679	0.0345	1.6150	0.3707	4.3329	0.0000	1.2425	0.0327	0.4568
TRC235	0.2678	22.53	0.2767	0.0087	0.0000	0.0801	0.8884	0.0000	0.3754	0.0177	0.2804
TRC236	0.3109	111.04	0.1969	0.0091	0.0000	0.1053	1.1568	0.0000	0.5052	0.0219	0.9254
TRC237	0.4114	34.05	0.2578	0.0023	0.0000	0.1486	1.6555	0.0000	0.6753	0.0282	0.6944
TRC238	0.7247	71.71	0.5590	0.0547	2.1014	0.5611	6.5665	0.0000	1.8942	0.0383	0.2819
TRC239	0.0000	16.64	0.0939	0.0030	0.0000	0.0259	0.2727	0.0000	0.1943	0.0133	0.2223
TRC240	0.0000	23.44	0.2430	0.0202	0.6010	0.2421	2.8361	0.0000	0.7870	0.0081	0.2232
TRC241	0.0000	19.00	0.1768	0.0086	0.4048	0.1066	1.1550	0.0000	0.3857	0.0175	1.8619
TRC242	0.4277	31.70	0.2046	0.0014	0.5603	0.1792	2.0151	0.0156	0.5594	0.0565	0.1649
TRC243	0.0000	31.63	0.5002	0.0012	0.7216	0.0959	0.9652	0.0068	1.2600	0.0374	0.4264
TRC244	0.5044	36.39	0.2158	0.0141	0.4200	0.1588	1.5842	0.0000	0.5792	0.0433	0.4851
TRC245	0.0000	31.76	0.2353	0.0162	1.3683	0.1923	2.3210	0.0000	0.6143	0.0102	0.0910
TRC246	0.2222	77.00	0.3710	0.0319	1.7760	0.3636	4.2299	0.0000	1.1059	0.0059	0.2214
TRC247	0.0000	123.92	0.6160	0.0034	2.0235	0.6200	7.3256	0.0000	1.9044	0.0235	0.0802
TRC248	0.2534	22.98	0.3774	0.0300	1.2340	0.3498	4.0399	0.0000	1.1831	0.0320	3.0890
TRC249	0.4173	92.88	0.3299	0.0200	1.7738	0.2404	2.8195	0.0000	0.8815	0.0137	0.2876
TRC250	0.0000	33.90	0.2344	0.0175	0.7110	0.2106	2.4095	0.0000	0.6563	0.0204	0.5080
TRC251	0.4423	30.28	0.4089	0.0563	1.6502	0.5318	6.4823	0.0000	1.6602	0.0203	0.2849
TRC252	0.1851	24.03	0.0924	0.0103	0.4107	0.0969	1.1507	0.0000	0.3306	0.0235	0.7481

816 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	As (ppm)	Ba (ppm)	La (ppm)	Lu (ppm)	Nd (ppm)	Sm (ppm)	U (ppm)	Yb (ppm)	Ce (ppm)	Co (ppm)	Cr (ppm)
TRC253	0.4644	32.41	0.1022	0.0016	0.3334	0.0828	0.9149	0.0057	0.3329	0.0125	0.8624
TRC254	0.4344	46.01	0.1127	0.0027	0.1950	0.0781	0.6482	0.0165	0.2608	0.0466	0.8092
TRC255	0.5556	282.04	32.9773	0.2678	29.0397	5.8433	3.4357	2.0616	68.4576	0.0642	0.6858
TRC256	0.3847	16.30	0.1119	0.0018	0.2804	0.0702	0.7052	0.0149	0.3124	0.0437	0.6166
TRC257	0.5411	14.82	0.0932	0.0014	0.3775	0.0659	0.6084	0.0147	0.2502	0.0435	0.8294
TRC258	0.4172	20.76	0.1173	0.0030	0.2790	0.0967	1.0258	0.0073	0.3430	0.0207	0.7909
TRC259	0.4525	171.51	0.2096	0.0017	0.6558	0.2121	2.4269	0.0096	0.7293	0.0814	0.4492
TRC260	0.1857	52.79	0.2664	0.0008	0.9645	0.2554	2.9491	0.0061	0.9019	0.0217	0.2622
TRC261	0.4587	176.62	0.1870	0.0012	0.5367	0.1786	2.0097	0.0069	0.6098	0.1246	1.1224

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC001	0.0403	0.0017	40.2	0.0284	0.00	0.16	0.0404	0.0061	540.27	0.0000	0.0000
TRC002	0.0190	0.0000	30.2	0.0080	0.00	0.15	0.0323	0.0070	13.46	0.0000	0.0000
TRC003	0.0663	0.0030	21.0	0.0245	0.00	0.21	0.0390	0.0077	9.06	0.0000	0.0010
TRC004	0.0891	0.0009	23.0	0.0262	0.00	0.48	0.0241	0.0040	18.20	0.0011	0.0000
TRC005	0.0752	0.0000	33.8	0.0111	0.00	0.19	0.0528	0.0046	8.99	0.0000	0.0000
TRC006	0.0450	0.0000	19.3	0.0199	0.00	0.11	0.0166	0.0048	115.27	0.0000	0.0000
TRC007	0.0186	0.0024	155.2	0.0194	0.00	0.27	0.0662	0.0299	6.82	0.0029	0.0000
TRC008	0.0109	0.0013	26.2	0.0163	0.00	0.09	0.0401	0.0066	5.12	0.0000	0.0000
TRC009	0.0319	0.0010	282.0	0.0243	1.44	0.24	0.0827	0.0282	3.66	0.0021	0.0000
TRC010	0.0097	0.0011	55.1	0.0089	0.00	0.15	0.0518	0.0167	1.11	0.0000	0.0000
TRC011	0.0172	0.0022	45.5	0.0129	0.00	0.18	0.0400	0.0159	0.00	0.0000	0.0000
TRC012	0.0157	0.0000	55.5	0.0104	0.00	0.18	0.0250	0.0201	2.68	0.0000	0.0000
TRC013	0.0157	0.0025	47.6	0.0132	0.00	0.00	0.0062	0.0120	36.95	0.0000	0.0000
TRC014	0.0332	0.0022	99.6	0.0326	0.00	0.22	0.0328	0.0237	6.98	0.0000	0.0000
TRC015	0.0505	0.0018	169.4	0.0525	0.00	0.18	0.0465	0.0188	5.85	0.0024	0.0000
TRC016	0.0169	0.0028	62.1	0.0105	0.00	0.11	0.0583	0.0148	1.98	0.0000	0.0000
TRC017	0.0385	0.0016	59.8	0.0383	0.00	0.19	0.0839	0.0077	6.59	0.0000	0.0000
TRC018	0.0300	0.0014	52.9	0.0142	0.00	0.27	0.0420	0.0073	5.56	0.0000	0.0000
TRC019	0.0473	0.0034	34.1	0.0681	0.00	0.27	0.0083	0.0110	13.75	0.0000	0.0000
TRC020	0.0478	0.0029	62.6	0.0436	0.00	0.35	0.0112	0.0147	19.49	0.0000	0.0016
TRC021	0.0449	0.0025	48.1	0.0333	0.00	0.33	0.0114	0.0120	6.71	0.0000	0.0000
TRC022	0.0396	0.0053	37.3	0.0436	0.00	0.21	0.0066	0.0219	20.22	0.0000	0.0030
TRC023	0.0482	0.0034	89.5	0.0717	0.00	0.29	0.0226	0.0094	5.66	0.0000	0.0000
TRC024	0.0618	0.0029	96.7	0.0880	0.00	0.37	0.0208	0.0098	6.27	0.0000	0.0000
TRC025	0.0491	0.0027	50.7	0.0373	0.00	0.26	0.0083	0.0114	15.40	0.0000	0.0000
TRC026	0.0523	0.0025	35.5	0.0522	0.00	0.23	0.0111	0.0098	12.46	0.0000	0.0000
TRC027	0.0665	0.0015	74.7	0.0466	0.00	0.21	0.0241	0.0096	7.67	0.0000	0.0000
TRC028	0.0665	0.0023	152.8	0.0488	0.00	0.25	0.0196	0.0098	12.55	0.0000	0.0000
TRC029	0.0352	0.0022	112.3	0.0228	0.00	0.26	0.0094	0.0087	597.37	0.0000	0.0000
TRC030	0.0476	0.0021	79.8	0.0378	0.00	0.23	0.0105	0.0094	12.98	0.0000	0.0000
TRC031	0.0616	0.0049	869.2	0.0740	0.00	0.43	0.1031	0.0216	8.06	0.0016	0.0000
TRC032	0.0509	0.0015	59.9	0.0341	0.00	0.26	0.0119	0.0081	6.91	0.0000	0.0000
TRC033	0.0356	0.0019	76.3	0.0104	0.00	0.07	0.0074	0.0046	16.07	0.0000	0.0000
TRC034	0.0409	0.0014	75.3	0.0076	0.00	0.19	0.0147	0.0114	5.21	0.0000	0.0000
TRC035	0.0123	0.0025	47.8	0.0084	0.00	0.11	0.0168	0.0133	18.23	0.0000	0.0000
TRC036	0.0643	0.0017	59.8	0.0657	0.00	0.20	0.0098	0.0080	11.62	0.0000	0.0000

920 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC037	0.0584	0.0023	224.1	0.0355	0.00	0.29	0.0297	0.0323	7.77	0.0033	0.0000
TRC038	0.0387	0.0014	69.2	0.0107	0.00	0.18	0.0184	0.0085	10.62	0.0000	0.0000
TRC039	0.0524	0.0025	129.9	0.0633	0.00	0.21	0.0105	0.0101	7.95	0.0022	0.0000
TRC040	0.0253	0.0022	72.6	0.0147	0.00	0.15	0.0144	0.0204	15.06	0.0000	0.0000
TRC041	0.0532	0.0021	185.1	0.0420	0.00	0.22	0.0212	0.0126	11.54	0.0016	0.0000
TRC042	0.0879	0.0023	278.0	0.0886	0.00	0.48	0.0298	0.0137	21.74	0.0000	0.0000
TRC043	0.0298	0.0007	82.2	0.0100	0.00	0.12	0.0127	0.0066	21.79	0.0000	0.0000
TRC044	0.0747	0.0025	179.2	0.0469	0.00	0.40	0.0272	0.0341	9.68	0.0043	0.0000
TRC045	0.0449	0.0024	154.4	0.0212	0.00	0.12	0.0267	0.0123	6.87	0.0000	0.0000
TRC046	0.0856	0.0021	89.6	0.0498	0.00	0.29	0.0124	0.0057	8.78	0.0000	0.0000
TRC047	0.0000	0.0031	94.3	0.0060	0.00	0.10	0.0267	0.0352	4.88	0.0000	0.0000
TRC048	0.0265	0.0023	125.8	0.0394	0.88	0.27	0.0263	0.0173	2.94	0.0000	0.0000
TRC049	0.0334	0.0032	171.0	0.0332	0.00	0.45	0.0386	0.0316	7.17	0.0052	0.0000
TRC050	0.0120	0.0026	79.5	0.0056	0.00	0.19	0.0297	0.0156	0.00	0.0000	0.0000
TRC051	0.0080	0.0061	155.8	0.0243	0.00	0.21	0.0589	0.0345	14.97	0.0045	0.0044
TRC052	0.0060	0.0020	92.8	0.0069	0.00	0.00	0.0268	0.0219	3.94	0.0000	0.0000
TRC053	0.0263	0.0021	92.8	0.0184	0.00	0.25	0.0217	0.0114	12.15	0.0000	0.0000
TRC054	0.0464	0.0016	67.2	0.0289	0.00	0.33	0.0129	0.0072	15.38	0.0000	0.0000
TRC055	0.0543	0.0032	74.9	0.0521	0.00	0.29	0.0191	0.0109	11.04	0.0000	0.0000
TRC056	0.0339	0.0028	78.5	0.0249	0.00	0.22	0.0183	0.0116	5.71	0.0000	0.0000
TRC057	0.0549	0.0024	77.9	0.0120	0.00	0.30	0.0140	0.0102	8.20	0.0000	0.0000
TRC058	0.0290	0.0019	83.6	0.0112	0.00	0.21	0.0192	0.0115	8.38	0.0021	0.0000
TRC059	0.0337	0.0026	72.8	0.0096	0.00	0.20	0.0203	0.0108	5.79	0.0000	0.0000
TRC060	0.0368	0.0022	105.3	0.0118	0.00	0.29	0.0182	0.0118	8.10	0.0000	0.0000
TRC061	0.0192	0.0034	110.2	0.0788	0.00	0.25	0.0245	0.0271	35.41	0.0000	0.0000
TRC062	0.0125	0.0049	173.3	0.0376	0.00	0.00	0.0433	0.0480	71.55	0.0000	0.0000
TRC063	0.0178	0.0025	146.8	0.0848	0.00	0.10	0.0307	0.0276	12.42	0.0018	0.0000
TRC064	0.0295	0.0027	220.2	0.0655	0.00	0.33	0.0471	0.0277	13.01	0.0022	0.0000
TRC065	0.0213	0.0037	224.3	0.0658	0.00	0.44	0.0477	0.0419	32.05	0.0000	0.0033
TRC066	0.1555	0.0036	542.1	0.1448	0.00	1.01	0.0562	0.0345	12.90	0.0110	0.0000
TRC067	0.0636	0.0024	131.7	0.0289	0.00	0.29	0.0285	0.0150	25.31	0.0033	0.0000
TRC068	0.0897	0.0019	53.3	0.0861	0.00	0.29	0.0117	0.0078	10.74	0.0000	0.0000
TRC069	0.0990	0.0025	268.6	0.0993	0.00	0.48	0.0435	0.0133	7.09	0.0043	0.0000
TRC070	0.0991	0.0031	115.9	0.1185	0.00	0.47	0.0271	0.0117	11.87	0.0054	0.0014
TRC071	0.1301	0.0027	227.2	0.1396	0.00	0.71	0.0234	0.0163	14.79	0.0050	0.0000
TRC072	0.1355	0.0026	158.3	0.1108	0.00	0.54	0.0414	0.0095	53.80	0.0031	0.0000

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

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TRC073	0.1348	0.0040	407.7	0.1258	0.00	0.42	0.1065	0.0115	51.01	0.0026	0.0000
TRC074	0.1397	0.0030	260.1	0.1385	0.00	0.75	0.0935	0.0132	18.95	0.0063	0.0000
TRC075	0.0929	0.0025	334.5	0.1507	0.00	0.65	0.0545	0.0158	6.60	0.0057	0.0020
TRC076	0.0756	0.0000	59.0	0.1357	0.00	0.35	0.0201	0.0023	12.49	0.0000	0.0000
TRC077	0.0823	0.0000	91.3	0.1204	0.00	0.51	0.0846	0.0036	3.48	0.0000	0.0000
TRC078	0.1031	0.0000	2087.2	0.1468	5.68	0.86	0.3827	0.0119	13.71	0.0078	0.0000
TRC079	0.0986	0.0017	154.9	0.1142	0.00	0.51	0.0113	0.0192	20.93	0.0038	0.0000
TRC080	0.0967	0.0011	114.3	0.1035	0.00	0.48	0.0234	0.0129	50.16	0.0073	0.0000
TRC081	0.1124	0.0000	57.0	0.0960	0.00	0.59	0.0202	0.0046	27.58	0.0019	0.0000
TRC082	0.0947	0.0059	332.9	0.0510	0.00	0.56	0.0298	0.0400	13.73	0.0062	0.0038
TRC083	0.0436	0.0000	63.9	0.0454	0.00	0.25	0.0121	0.0121	5.37	0.0000	0.0000
TRC084	0.0467	0.0000	16.3	0.0651	0.00	0.18	0.0000	0.0060	2.77	0.0000	0.0000
TRC085	0.0440	0.0020	135.8	0.0430	0.00	0.20	0.0255	0.0155	4.58	0.0014	0.0000
TRC086	0.0531	0.0000	19.7	0.0471	0.00	0.22	0.0056	0.0051	4.82	0.0000	0.0000
TRC087	0.0397	0.0000	36.1	0.0441	0.00	0.18	0.0103	0.0053	5.01	0.0000	0.0000
TRC088	0.0444	0.0000	36.5	0.0300	0.00	0.23	0.0881	0.0046	2.77	0.0000	0.0000
TRC089	0.0303	0.0014	28.0	0.0277	0.00	0.00	0.0043	0.0145	22.27	0.0000	0.0000
TRC090	0.0633	0.0021	75.1	0.0518	0.00	0.31	0.0218	0.0126	3.96	0.0000	0.0000
TRC091	0.0665	0.0000	37.0	0.0573	0.00	0.29	0.0114	0.0058	5.23	0.0031	0.0000
TRC092	0.0300	0.0019	214.2	0.0361	0.00	0.38	0.0566	0.0555	8.00	0.0036	0.0000
TRC093	0.0743	0.0024	72.8	0.0799	0.00	0.34	0.0112	0.0106	7.37	0.0051	0.0000
TRC094	0.0278	0.0009	134.1	0.0144	0.00	0.21	0.0205	0.0315	5.56	0.0027	0.0000
TRC095	0.0387	0.0018	60.1	0.0345	0.00	0.17	0.0253	0.0076	3.31	0.0000	0.0000
TRC096	0.0558	0.0037	163.8	0.0779	0.00	0.29	0.0280	0.0141	5.09	0.0019	0.0051
TRC097	0.0487	0.0011	28.5	0.0640	0.00	0.33	0.0147	0.0079	9.82	0.0000	0.0016
TRC098	0.0529	0.0005	22.6	0.0645	0.00	0.29	0.0089	0.0039	7.68	0.0000	0.0000
TRC099	0.0197	0.0000	41.4	0.0094	0.00	0.17	0.0265	0.0075	2.98	0.0000	0.0000
TRC100	0.0474	0.0000	33.5	0.0313	0.00	0.21	0.0923	0.0062	6.17	0.0000	0.0000
TRC101	0.0146	0.0013	45.9	0.0068	0.00	0.20	0.0331	0.0108	1.29	0.0000	0.0000
TRC102	0.1022	0.0000	21.5	0.1077	0.00	0.42	0.0126	0.0062	4.46	0.0037	0.0000
TRC103	0.0113	0.0000	54.7	0.0154	0.00	0.19	0.0140	0.0274	4.14	0.0030	0.0000
TRC104	0.0657	0.0000	72.5	0.0759	0.00	0.59	0.0141	0.0122	5.41	0.0000	0.0000
TRC105	0.0119	0.0010	59.5	0.0127	0.00	0.00	0.0198	0.0262	2.15	0.0000	0.0000
TRC106	0.0759	0.0000	29.5	0.0989	0.00	0.58	0.0103	0.0079	5.88	0.0000	0.0000
TRC107	0.1923	0.2812	1687.9	20.6346	0.00	1.61	0.9785	0.9888	0.00	7.2111	0.4235
TRC108	0.0291	0.0019	137.6	0.0161	2.62	0.17	0.0381	0.0381	4.82	0.0028	0.0000

922 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC109	0.0973	0.0114	495.6	0.0902	0.00	1.11	0.0416	0.0907	5.20	0.0104	0.0077
TRC110	0.0432	0.0000	250.2	0.0421	0.00	0.36	0.0911	0.0569	7.42	0.0071	0.0000
TRC111	0.0345	0.0013	20.6	0.0383	0.00	0.24	0.0195	0.0134	6.51	0.0000	0.0000
TRC112	0.1095	0.0118	139.4	0.1143	0.00	0.69	0.0980	0.0388	11.32	0.0075	0.0091
TRC113	0.0119	0.0010	93.2	0.0099	1.56	0.15	0.0400	0.0201	1.91	0.0000	0.0000
TRC114	0.0727	0.0057	192.7	0.0471	0.00	0.54	0.1014	0.0579	5.23	0.0067	0.0000
TRC115	0.0659	0.0030	64.7	0.0876	1.75	0.37	0.4882	0.0166	14.32	0.0000	0.0000
TRC116	0.0533	0.0005	11.3	0.0962	0.00	0.31	0.0059	0.0087	9.26	0.0021	0.0000
TRC117	0.0227	0.0012	54.5	0.0142	0.00	0.12	0.0131	0.0095	6.35	0.0000	0.0000
TRC118	0.0481	0.0055	267.0	0.0289	0.00	0.42	0.0232	0.0563	98.56	0.0046	0.0051
TRC119	0.1184	0.0070	258.1	0.1361	0.00	0.80	0.0298	0.0719	5.51	0.0098	0.0057
TRC120	0.0684	0.0000	133.8	0.0307	0.00	0.36	0.0741	0.0195	9.74	0.0029	0.0000
TRC121	0.0888	0.0029	83.3	0.1027	0.00	0.50	0.0223	0.0149	6.61	0.0046	0.0000
TRC122	0.0639	0.0000	50.7	0.0802	0.00	0.30	0.0114	0.0165	12.33	0.0028	0.0000
TRC123	0.0661	0.0054	110.2	0.0451	0.00	0.43	0.0604	0.0339	6.73	0.0000	0.0000
TRC124	0.0689	0.0062	221.8	0.0715	0.00	0.72	0.1474	0.0601	7.65	0.0075	0.0000
TRC125	0.0493	0.0012	197.2	0.0592	0.00	0.40	0.0469	0.0260	5.91	0.0043	0.0000
TRC126	0.0397	0.0000	59.0	0.0329	0.00	0.28	0.0178	0.0165	4.85	0.0000	0.0000
TRC127	0.0989	0.0018	356.3	0.0864	0.00	0.82	0.0670	0.0506	58.36	0.0076	0.0021
TRC128	0.0535	0.0027	130.8	0.0507	0.00	0.47	0.0248	0.0308	5.65	0.0036	0.0024
TRC129	0.0307	0.0019	66.1	0.0262	0.00	0.23	0.0134	0.0151	6.30	0.0013	0.0011
TRC130	0.0673	0.0063	188.7	0.0391	0.00	0.58	0.0288	0.0560	22.51	0.0043	0.0042
TRC131	0.0248	0.0020	21.6	0.0938	0.00	0.29	0.0261	0.0174	4.42	0.0000	0.0000
TRC132	0.0788	0.0000	59.8	0.0300	0.00	0.48	0.1456	0.0114	6.44	0.0000	0.0000
TRC133	0.0262	0.0000	68.5	0.1134	0.00	0.29	0.0295	0.0218	3.74	0.0022	0.0000
TRC134	0.0412	0.0000	44.1	0.0269	0.00	0.22	0.0296	0.0099	3.42	0.0000	0.0000
TRC135	0.0400	0.0044	181.0	0.0394	0.00	0.49	0.0869	0.0964	4.01	0.0091	0.0000
TRC136	0.0524	0.0033	195.6	0.0475	0.00	0.35	0.0242	0.0253	13.65	0.0000	0.0000
TRC137	0.0192	0.0025	60.2	0.0160	0.00	0.29	0.0948	0.0820	0.00	0.0000	0.0000
TRC138	0.0520	0.0022	140.8	0.0275	0.00	0.31	0.0324	0.0308	7.12	0.0000	0.0000
TRC139	0.0995	0.0059	118.7	0.1034	0.00	0.73	0.0343	0.0329	13.28	0.0000	0.0049
TRC140	0.1375	0.0225	975.3	0.1239	32.47	1.95	0.4638	0.2149	5.50	0.0234	0.0178
TRC141	0.0520	0.0016	141.0	0.0511	0.00	0.40	0.0202	0.0447	14.25	0.0036	0.0000
TRC142	0.0574	0.0035	76.5	0.0904	0.00	0.37	0.0208	0.0105	4.86	0.0000	0.0000
TRC143	0.0215	0.0000	131.0	0.0225	0.00	0.29	0.0467	0.0342	0.00	0.0000	0.0000
TRC144	0.0608	0.0067	448.7	0.1134	0.00	1.03	0.1365	0.1549	28.06	0.0153	0.0037

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC145	0.1642	0.0000	117.6	0.1148	0.00	0.66	0.0307	0.0082	8.92	0.0000	0.0000
TRC146	0.0330	0.0032	91.5	0.0840	0.00	0.45	0.1841	0.0188	10.34	0.0000	0.0000
TRC147	0.0168	0.0000	109.6	0.0147	0.00	0.27	0.0270	0.0276	3.11	0.0044	0.0000
TRC148	0.0340	0.0008	97.4	0.0221	0.00	0.16	0.0242	0.0346	14.04	0.0000	0.0000
TRC149	0.0532	0.0010	142.8	0.0363	0.00	0.44	0.0335	0.0307	15.22	0.0045	0.0000
TRC150	0.0120	0.0000	125.0	0.0178	0.00	0.18	0.0320	0.0324	2.02	0.0000	0.0000
TRC151	0.0595	0.0031	96.4	0.0525	0.00	0.51	0.0151	0.0426	18.07	0.0033	0.0042
TRC152	0.0710	0.0033	215.0	0.0451	0.00	0.36	0.0281	0.0206	3.41	0.0000	0.0032
TRC153	0.0705	0.0000	112.3	0.0975	0.00	0.45	0.0282	0.0354	8.01	0.0055	0.0000
TRC154	0.0973	0.0015	262.1	0.0911	0.00	0.78	0.2163	0.0308	10.34	0.0075	0.0000
TRC155	0.1457	0.0085	331.0	0.0709	0.00	1.02	0.0296	0.0709	8.61	0.0069	0.0051
TRC156	0.0580	0.0012	114.2	0.0221	0.00	0.26	0.2523	0.0502	5.57	0.0060	0.0000
TRC157	0.0298	0.0022	93.8	0.0203	0.00	0.17	0.0201	0.0209	8.43	0.0017	0.0000
TRC158	0.2981	0.0025	804.9	0.1225	0.00	1.80	0.1445	0.0612	14.45	0.0150	0.0000
TRC159	0.0678	0.0058	206.9	0.0516	0.00	0.67	0.0195	0.0594	13.76	0.0063	0.0000
TRC160	0.1236	0.0000	270.5	0.0726	0.00	0.68	0.1769	0.0249	9.55	0.0059	0.0000
TRC161	0.0329	0.0000	150.7	0.0697	0.00	0.30	0.0120	0.0244	6.48	0.0046	0.0000
TRC162	0.0544	0.0022	101.5	0.0213	0.00	0.31	0.0202	0.0310	12.29	0.0000	0.0000
TRC163	0.0544	0.0000	79.7	0.0476	0.00	0.32	0.0422	0.0140	20.81	0.0042	0.0000
TRC164	0.0580	0.0025	169.7	0.0494	0.00	0.45	0.0132	0.0379	13.27	0.0034	0.0000
TRC165	0.0387	0.0000	100.2	0.0553	1.18	0.35	0.1641	0.0230	4.91	0.0031	0.0000
TRC166	0.1944	0.0027	368.8	0.1479	0.00	1.46	0.0595	0.0469	14.24	0.0117	0.0000
TRC167	0.0613	0.0040	185.9	0.0369	0.00	0.49	0.0158	0.0452	11.05	0.0042	0.0067
TRC168	0.0507	0.0046	306.5	0.0919	0.00	0.38	0.5244	0.0466	17.32	0.0049	0.0029
TRC169	0.0857	0.0054	136.1	0.0685	0.00	0.51	0.0177	0.0355	8.25	0.0000	0.0000
TRC170	0.0667	0.0036	199.2	0.1183	0.00	0.80	0.0481	0.0484	5.62	0.0031	0.0032
TRC171	0.0378	0.0015	161.7	0.0252	0.00	0.41	0.0166	0.0652	3.75	0.0050	0.0000
TRC172	0.0226	0.0044	234.0	0.0173	0.00	0.00	0.0215	0.0187	6.12	0.0024	0.0043
TRC173	0.0363	0.0000	91.3	0.0628	0.00	0.28	0.0213	0.0112	4.46	0.0021	0.0000
TRC174	0.0234	0.0025	107.9	0.0202	0.00	0.22	0.0669	0.0279	1.93	0.0000	0.0000
TRC175	0.0585	0.0000	10.5	0.0803	0.00	0.27	0.0048	0.0044	6.96	0.0000	0.0000
TRC176	0.2259	0.0116	641.2	0.1297	0.00	1.65	0.0464	0.1007	14.44	0.0175	0.0137
TRC177	0.0410	0.0000	100.7	0.0575	0.00	0.44	0.0146	0.0301	6.90	0.0037	0.0000
TRC178	0.0775	0.0031	340.2	0.0728	0.00	0.43	0.0425	0.0337	7.32	0.0074	0.0000
TRC179	0.0558	0.0030	159.9	0.0706	0.00	0.32	0.0495	0.0337	4.33	0.0054	0.0000
TRC180	0.0497	0.0000	150.7	0.0357	1.75	0.46	0.4064	0.0322	10.22	0.0038	0.0000

924 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC181	0.0163	0.0000	97.5	0.0169	0.00	0.22	0.0381	0.0280	0.00	0.0000	0.0000
TRC182	0.0646	0.0000	82.0	0.1025	0.00	0.50	0.0376	0.0103	8.66	0.0000	0.0000
TRC183	0.0339	0.0013	128.6	0.0283	0.86	0.33	0.0230	0.0530	12.47	0.0038	0.0000
TRC184	0.0696	0.0035	156.8	0.0618	0.00	0.66	0.0150	0.0452	5.87	0.0045	0.0036
TRC185	0.0549	0.0037	275.0	0.0373	0.00	0.25	0.0832	0.0257	7.29	0.0000	0.0037
TRC186	0.1536	0.0043	269.9	0.2477	0.00	0.93	0.0801	0.0490	15.00	0.0188	0.0000
TRC187	0.0376	0.0014	88.6	0.0159	0.00	0.20	0.0148	0.0291	12.91	0.0000	0.0000
TRC188	0.0693	0.0005	100.4	0.0319	0.00	0.32	0.0752	0.0079	6.19	0.0000	0.0000
TRC189	0.0738	0.0031	46.3	0.0209	0.00	0.24	0.1235	0.0538	5.86	0.0021	0.0050
TRC190	0.0094	0.0000	134.9	0.0385	0.00	0.27	0.0133	0.0371	2.86	0.0043	0.0000
TRC191	0.0421	0.0021	126.9	0.0446	0.00	0.32	0.0274	0.0186	4.12	0.0033	0.0015
TRC192	0.1976	0.0020	288.4	0.1128	0.00	0.65	0.0560	0.0205	6.26	0.0067	0.0000
TRC193	0.0730	0.0063	221.2	0.0480	2.69	0.51	0.0306	0.0528	4.71	0.0099	0.0000
TRC194	0.0495	0.0025	191.0	0.0255	0.00	0.23	0.0184	0.0569	9.94	0.0044	0.0000
TRC195	0.0490	0.0017	416.7	0.0724	0.00	0.69	0.0552	0.0437	7.65	0.0081	0.0000
TRC196	0.0726	0.0000	171.8	0.0292	0.76	0.41	0.0615	0.0191	8.54	0.0025	0.0000
TRC197	0.1144	0.0000	170.4	0.0859	0.00	0.71	0.7784	0.0334	7.71	0.0039	0.0000
TRC198	0.0524	0.0041	269.4	0.0424	0.00	0.77	0.0346	0.0781	4.33	0.0066	0.0000
TRC199	0.0340	0.0021	59.3	0.0100	0.00	0.27	0.0172	0.0217	5.69	0.0012	0.0000
TRC200	0.1595	0.0035	510.8	0.1196	0.00	1.11	0.1699	0.0790	5.95	0.0123	0.0000
TRC201	0.0491	0.0024	122.9	0.0242	0.00	0.50	0.1254	0.0516	4.45	0.0045	0.0000
TRC202	0.0161	0.0021	328.3	0.0175	0.00	0.50	0.0599	0.0467	5.75	0.0021	0.0000
TRC203	0.0468	0.0026	207.5	0.0184	0.00	0.32	0.0261	0.0536	3.79	0.0014	0.0000
TRC204	0.0273	0.0008	89.8	0.0146	0.00	0.22	0.0253	0.0140	2.78	0.0000	0.0000
TRC205	0.0070	0.0000	78.3	0.0088	0.00	0.11	0.0426	0.0185	0.00	0.0000	0.0000
TRC206	0.0424	0.0000	177.9	0.0322	0.00	0.33	0.1053	0.0283	5.21	0.0053	0.0000
TRC207	0.0499	0.0053	109.1	0.1017	0.00	0.40	0.0232	0.0178	4.83	0.0008	0.0037
TRC208	0.0754	0.0000	96.4	0.0599	0.00	0.34	0.0252	0.0152	7.59	0.0045	0.0000
TRC209	0.0298	0.0021	53.7	0.0144	0.00	0.00	0.0101	0.0152	4.83	0.0000	0.0000
TRC210	0.0274	0.0017	55.8	0.0776	0.00	0.25	0.0126	0.0157	6.21	0.0000	0.0000
TRC211	0.0707	0.0025	118.6	0.0717	0.00	0.24	0.1332	0.0181	10.09	0.0000	0.0000
TRC212	0.0537	0.0010	77.2	0.0647	0.75	0.28	0.2278	0.0192	7.94	0.0000	0.0000
TRC213	0.0412	0.0000	96.1	0.0172	0.00	0.29	0.1236	0.0180	4.88	0.0000	0.0000
TRC214	0.0367	0.0000	67.3	0.0411	1.08	0.26	0.0754	0.0132	6.15	0.0000	0.0000
TRC215	0.1020	0.0039	290.6	0.0613	0.00	0.92	0.0362	0.0565	22.65	0.0073	0.0033
TRC216	0.0570	0.0018	197.0	0.0262	0.00	0.51	0.0347	0.0411	11.47	0.0000	0.0000

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ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC217	0.0533	0.0039	185.6	0.0426	0.00	0.39	0.0318	0.0305	10.16	0.0033	0.0000
TRC218	0.0491	0.0048	257.2	0.0471	0.00	0.72	0.0397	0.0667	0.00	0.0073	0.0037
TRC219	0.1190	0.0016	118.2	0.1329	0.00	0.67	0.0342	0.0172	4.86	0.0037	0.0000
TRC220	0.0308	0.0000	102.3	0.0193	0.00	0.24	0.0544	0.0179	3.42	0.0000	0.0000
TRC221	0.0492	0.0032	207.8	0.0435	0.00	0.51	0.0313	0.0871	5.40	0.0065	0.0000
TRC222	0.0420	0.0000	65.7	0.0513	0.00	0.25	0.0391	0.0119	5.58	0.0000	0.0000
TRC223	0.0302	0.0026	99.1	0.0134	0.00	0.17	0.0358	0.0348	6.16	0.0018	0.0000
TRC224	0.0686	0.0000	150.0	0.0668	0.00	0.42	0.0324	0.0306	5.27	0.0021	0.0000
TRC225	0.0593	0.0030	206.6	0.0428	0.00	0.46	0.0456	0.0588	12.77	0.0000	0.0000
TRC226	0.0706	0.0031	130.1	0.1416	0.00	0.53	0.0423	0.0148	15.00	0.0034	0.0000
TRC227	0.0538	0.0012	76.9	0.0668	0.00	0.40	0.0133	0.0185	10.27	0.0055	0.0000
TRC228	0.0451	0.0016	163.5	0.0280	0.00	0.37	0.0217	0.0465	10.52	0.0039	0.0000
TRC229	0.0528	0.0022	229.5	0.0419	0.00	0.43	0.0355	0.0711	18.14	0.0000	0.0000
TRC230	0.0560	0.0016	81.0	0.0199	0.00	0.19	0.0509	0.0149	5.49	0.0000	0.0000
TRC231	0.0454	0.0157	196.9	0.0350	0.00	0.00	0.0000	0.0574	0.00	0.0000	0.0086
TRC232	0.0436	0.0000	57.6	0.0802	0.00	0.29	0.0000	0.0193	4.86	0.0000	0.0000
TRC233	0.0599	0.0000	173.7	0.1211	0.00	0.56	0.0289	0.0251	19.99	0.0000	0.0000
TRC234	0.0538	0.0000	253.9	0.0306	0.00	0.33	0.4262	0.1063	0.00	0.0000	0.0000
TRC235	0.0252	0.0000	95.6	0.0449	0.00	0.24	0.1211	0.0234	0.00	0.0000	0.0000
TRC236	0.0583	0.0056	182.2	0.0348	0.00	0.00	0.0440	0.0683	9.07	0.0000	0.0000
TRC237	0.0420	0.0051	233.3	0.0384	0.00	0.00	0.0360	0.0860	12.87	0.0045	0.0000
TRC238	0.0189	0.0000	135.3	0.0147	0.00	0.00	0.0736	0.0454	4.70	0.0000	0.0000
TRC239	0.0919	0.0025	32.0	0.0192	0.00	0.38	0.0175	0.0094	11.93	0.0000	0.0000
TRC240	0.0488	0.0000	78.7	0.0078	4.49	0.33	0.1094	0.0118	3.89	0.0000	0.0000
TRC241	0.0727	0.0030	55.9	0.1311	0.00	0.40	0.0092	0.0150	7.61	0.0000	0.0000
TRC242	0.0315	0.0026	178.0	0.0302	0.00	0.18	0.0358	0.0123	3.81	0.0000	0.0000
TRC243	0.0992	0.0031	166.9	0.0345	0.00	0.76	0.0388	0.0266	9.62	0.0000	0.0000
TRC244	0.0943	0.0050	363.1	0.0843	0.00	0.60	0.0562	0.0291	9.93	0.0000	0.0000
TRC245	0.0906	0.0000	46.7	0.0467	0.00	0.27	0.0000	0.0119	5.87	0.0000	0.0000
TRC246	0.0918	0.0000	66.1	0.1211	0.00	0.31	0.0142	0.0102	7.35	0.0000	0.0000
TRC247	0.1109	0.0000	39.9	0.1118	0.00	0.60	0.0181	0.0086	20.96	0.0000	0.0000
TRC248	0.0203	0.0000	127.6	0.0135	0.00	0.51	0.0726	0.0281	0.00	0.0000	0.0000
TRC249	0.0798	0.0000	170.3	0.0760	1.98	0.38	0.1345	0.0329	0.00	0.0000	0.0000
TRC250	0.0479	0.0000	133.5	0.0657	0.00	0.30	0.3232	0.0148	11.95	0.0000	0.0000
TRC251	0.0131	0.0000	109.8	0.0123	0.00	0.15	0.0803	0.0436	0.00	0.0000	0.0000
TRC252	0.0607	0.0000	162.2	0.0908	0.00	0.58	0.0400	0.0094	9.76	0.0000	0.0000

926 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Cs (ppm)	Eu (ppm)	Fe (ppm)	Hf (ppm)	Ni (ppm)	Rb (ppm)	Sb (ppm)	Sc (ppm)	Sr (ppm)	Ta (ppm)	Tb (ppm)
TRC253	0.0522	0.0017	216.3	0.0382	0.00	0.44	0.0272	0.0721	3.96	0.0054	0.0000
TRC254	0.1025	0.0051	245.3	0.0566	0.00	0.43	0.0401	0.0284	6.89	0.0079	0.0085
TRC255	0.6454	0.3706	1036.9	3.4629	0.00	111.18	0.5469	0.7491	25.69	1.7130	0.7186
TRC256	0.0530	0.0023	212.7	0.0588	0.00	0.51	0.0216	0.0398	12.25	0.0063	0.0034
TRC257	0.1004	0.0040	240.4	0.0518	0.00	0.54	0.0554	0.0211	4.09	0.0052	0.0020
TRC258	0.0461	0.0023	192.6	0.0339	1.25	0.40	0.0303	0.0617	9.09	0.0057	0.0000
TRC259	0.0313	0.0034	328.2	0.0248	1.79	0.29	0.0446	0.0232	2.58	0.0000	0.0037
TRC260	0.1031	0.0027	105.5	0.1179	0.00	0.86	0.0300	0.0314	16.84	0.0054	0.0000
TRC261	0.0519	0.0018	194.8	0.0343	0.00	0.20	0.0228	0.0429	12.13	0.0059	0.0000

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC001	0.0064	0.28	1200.4	638.2	0.0000	0.0	0.32	161.5	0.0	1.96
TRC002	0.0059	0.38	1174.8	2011.4	0.0000	0.0	1.03	158.8	13.4	0.00
TRC003	0.0305	0.46	1059.2	1794.5	0.0000	0.0	0.74	154.4	0.0	1.07
TRC004	0.0051	0.23	1473.4	941.6	0.0000	535.3	0.71	211.8	0.0	0.80
TRC005	0.0042	0.26	1335.9	131.0	0.0000	201.5	0.19	264.6	0.0	1.30
TRC006	0.0060	0.18	1285.2	689.2	0.0000	0.0	1.26	208.2	0.0	0.67
TRC007	0.0225	1.19	1400.4	487.7	0.0000	233.8	0.35	224.0	0.0	4.76
TRC008	0.0058	0.62	1218.0	1989.4	0.0000	366.0	1.34	185.9	0.0	1.69
TRC009	0.0208	1.31	1262.6	209.0	0.0000	193.6	1.20	262.2	0.0	3.53
TRC010	0.0114	0.39	673.6	204.2	0.0000	281.9	0.25	225.2	0.0	0.00
TRC011	0.0082	0.85	884.6	0.0	0.0000	0.0	0.48	192.3	0.0	0.00
TRC012	0.0082	0.82	1239.8	112.4	0.0000	114.3	0.40	133.3	0.0	0.00
TRC013	0.0141	0.35	969.3	2352.0	0.0000	79.3	0.33	122.6	0.0	1.65
TRC014	0.0138	0.64	1249.0	235.5	0.0000	285.3	0.28	195.6	0.0	0.92
TRC015	0.0172	0.81	1557.2	299.8	0.0000	329.3	0.13	246.9	0.0	1.57
TRC016	0.0117	1.07	1129.9	621.6	0.0000	175.9	0.70	193.4	66.6	0.00
TRC017	0.0069	0.65	987.6	812.0	0.0000	0.0	1.21	155.9	0.0	0.00
TRC018	0.0057	0.58	1084.8	474.4	0.0000	164.2	0.27	166.6	0.0	1.29
TRC019	0.0105	0.51	1255.9	1723.9	0.0000	108.9	0.36	171.5	0.0	0.56
TRC020	0.0120	0.54	1269.2	926.7	0.0000	161.8	0.50	207.7	0.0	2.32
TRC021	0.0136	0.53	1428.0	1926.0	0.0000	267.3	2.49	213.9	57.7	1.10
TRC022	0.0104	0.79	1130.1	3743.9	0.0000	205.0	0.29	123.1	28.7	1.11
TRC023	0.0137	0.71	2125.2	683.8	0.0000	344.2	2.51	273.5	0.0	0.00
TRC024	0.0130	0.98	1772.2	751.9	0.0000	372.0	1.34	256.0	0.0	2.17
TRC025	0.0155	0.75	1361.9	541.4	0.0000	193.8	1.64	181.6	0.0	1.87
TRC026	0.0108	0.58	1269.6	942.0	0.0000	190.6	0.44	186.4	0.0	0.00
TRC027	0.0151	0.58	1241.8	503.6	0.0000	113.1	0.71	205.7	0.0	1.87
TRC028	0.0159	0.63	1492.0	922.5	0.0000	134.4	0.33	232.2	0.0	1.80
TRC029	0.0082	0.70	915.8	355.6	0.0000	176.8	0.41	198.0	0.0	0.00
TRC030	0.0357	0.70	1490.3	1632.8	0.0000	0.0	0.46	188.7	0.0	1.94
TRC031	0.0221	1.22	1650.9	672.0	0.0000	230.6	1.23	225.2	0.0	3.45
TRC032	0.0122	0.67	1286.2	736.4	0.0000	152.8	0.55	137.8	0.0	1.29
TRC033	0.0145	0.48	1092.3	1019.9	0.0000	0.0	0.59	150.3	0.0	0.00
TRC034	0.0093	0.51	1360.5	278.2	0.0000	105.1	0.51	241.4	11.0	2.11
TRC035	0.0104	0.57	1159.9	898.9	0.0000	118.8	0.39	111.8	0.0	0.76
TRC036	0.0120	0.59	1488.1	952.7	0.0000	350.9	0.38	236.4	0.0	1.90

928 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC037	0.0470	0.84	1499.4	505.1	0.0000	185.7	0.81	246.9	0.0	4.55
TRC038	0.0102	0.52	1421.8	370.2	0.0000	312.1	0.31	227.5	0.0	2.04
TRC039	0.0227	0.67	1630.4	644.6	0.0000	134.3	0.56	175.2	0.0	0.65
TRC040	0.0249	0.73	1139.1	290.1	0.0000	201.9	0.32	234.9	0.0	2.17
TRC041	0.0098	1.17	1309.3	5534.5	0.0000	149.9	7.24	174.6	0.0	2.84
TRC042	0.0326	1.50	1825.1	699.9	0.0000	302.2	1.41	255.2	0.0	2.63
TRC043	0.0081	1.02	1102.0	826.5	0.0000	88.8	0.52	159.1	0.0	1.29
TRC044	0.0422	1.29	1580.9	527.0	0.0000	339.5	0.92	281.7	0.0	1.86
TRC045	0.0103	1.15	1284.7	301.0	0.0000	189.5	0.99	210.8	0.0	1.88
TRC046	0.0030	1.13	1725.0	172.3	0.0000	154.4	0.51	180.8	0.0	0.00
TRC047	0.0206	1.26	1063.7	1622.5	0.0000	0.0	0.16	182.0	0.0	2.18
TRC048	0.0299	1.19	1406.4	647.9	0.0000	261.1	0.77	239.9	0.0	1.56
TRC049	0.0528	1.59	1463.2	1292.7	0.0000	348.8	0.32	276.6	0.0	2.08
TRC050	0.0141	0.64	1097.8	328.9	0.0000	285.3	0.24	216.4	0.0	1.02
TRC051	0.0479	1.45	898.8	2035.5	0.0000	0.0	14.43	123.4	0.0	4.08
TRC052	0.0080	1.21	959.9	193.3	0.0000	0.0	0.31	181.7	0.0	0.82
TRC053	0.0098	1.22	1139.4	502.5	0.0000	95.4	0.36	200.5	0.0	0.70
TRC054	0.0100	1.19	1192.4	616.3	0.0000	153.1	0.33	221.5	0.0	0.00
TRC055	0.0151	1.08	1193.9	558.5	0.0000	181.2	0.32	241.2	0.0	0.00
TRC056	0.0098	1.07	1027.7	553.3	0.0000	117.5	0.17	149.4	0.0	0.84
TRC057	0.0083	1.02	1304.3	148.6	0.0000	185.3	0.33	227.1	26.1	1.13
TRC058	0.0063	1.09	963.7	401.4	0.0000	153.0	0.19	217.5	0.0	1.19
TRC059	0.0084	1.10	1284.1	316.5	0.0000	184.1	0.40	209.6	0.0	0.99
TRC060	0.0265	1.29	993.7	821.9	0.0000	134.6	1.08	194.4	0.0	1.52
TRC061	0.0201	0.79	1677.4	39950.8	0.0000	406.3	2.43	543.9	0.0	3.45
TRC062	0.0271	0.90	1481.0	52445.3	0.0637	174.5	3.19	379.7	12.3	5.49
TRC063	0.0205	1.16	1477.9	58805.1	0.0000	0.0	3.65	395.6	0.0	3.96
TRC064	0.0202	1.39	1807.0	10085.7	0.0000	188.8	1.67	331.3	0.0	2.90
TRC065	0.0333	1.56	1354.9	18793.8	0.0000	182.5	1.79	409.2	0.0	2.58
TRC066	0.0242	2.11	2664.3	4516.1	0.0000	521.3	6.39	233.1	0.0	4.38
TRC067	0.0169	1.62	1310.0	921.7	0.0000	168.0	0.49	201.2	0.0	1.71
TRC068	0.0040	1.01	1566.2	480.8	0.0000	215.2	0.43	151.8	0.0	0.00
TRC069	0.0193	3.13	1673.6	174.8	0.0000	160.2	0.52	152.0	73.7	1.50
TRC070	0.0308	1.71	1770.9	923.9	0.0000	215.4	1.04	203.5	0.0	1.26
TRC071	0.0226	1.87	1616.2	1010.9	0.0000	372.2	0.53	204.8	0.0	2.13
TRC072	0.0107	1.50	1876.8	417.8	0.0000	0.0	21.29	203.9	74.0	3.11

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC073	0.0110	1.56	1842.6	351.7	0.0000	277.3	2.75	171.3	0.0	8.78
TRC074	0.0124	1.27	1316.8	143.8	0.0000	345.5	0.34	179.5	35.7	1.63
TRC075	0.0304	2.32	1723.9	1114.9	0.0000	285.1	1.01	174.2	0.0	0.00
TRC076	0.0082	0.43	1621.3	291.8	0.0000	185.5	0.35	213.1	0.0	1.44
TRC077	0.0118	0.73	1826.7	211.9	0.0000	0.0	0.38	403.2	0.0	0.00
TRC078	0.0181	13.38	2639.4	977.9	0.0000	300.2	0.74	459.3	0.0	6.86
TRC079	0.0205	0.48	2368.1	322.6	0.0000	306.4	3.20	333.8	0.0	2.19
TRC080	0.0233	0.62	2191.5	355.2	0.0000	363.1	0.21	377.2	0.0	1.99
TRC081	0.0151	0.28	1785.1	319.2	0.0000	304.7	0.28	226.6	0.0	1.90
TRC082	0.0533	0.73	1830.2	775.6	0.0000	273.8	2.46	234.7	0.0	2.04
TRC083	0.0148	0.25	1240.8	406.7	0.0301	0.0	0.59	205.9	0.0	1.78
TRC084	0.0069	0.16	1271.6	477.6	0.0000	0.0	0.21	181.6	0.0	0.00
TRC085	0.0268	0.43	1379.0	869.8	0.0000	195.1	0.47	176.9	0.0	2.09
TRC086	0.0084	0.17	1416.1	510.7	0.0000	254.4	0.41	191.1	0.0	0.00
TRC087	0.0109	0.12	1170.7	447.0	0.0000	246.7	0.35	221.9	0.0	0.61
TRC088	0.0099	0.15	1416.3	455.4	0.0000	221.2	0.50	177.7	36.4	0.55
TRC089	0.0089	0.28	1124.6	48192.4	0.0000	115.0	1.82	174.8	0.0	0.00
TRC090	0.0132	0.62	1583.7	736.9	0.0000	214.9	0.64	238.5	0.0	1.33
TRC091	0.0086	0.21	1426.6	3529.9	0.0000	214.3	0.65	182.4	0.0	1.30
TRC092	0.0407	1.09	1421.6	1116.5	0.0000	270.0	4.85	214.9	0.0	4.24
TRC093	0.0164	0.44	1847.0	495.4	0.0000	261.4	0.53	260.0	0.0	1.18
TRC094	0.0197	0.51	1170.9	252.8	0.0000	274.0	0.31	227.6	43.8	2.11
TRC095	0.0057	0.32	1134.2	238.9	0.0000	250.4	0.40	182.2	5.9	1.09
TRC096	0.0327	1.23	1715.3	521.5	0.0000	337.1	1.09	192.6	0.0	1.00
TRC097	0.0200	0.27	1286.7	1688.2	0.0000	308.8	0.76	175.7	0.0	1.62
TRC098	0.0057	0.12	1429.6	611.8	0.0000	233.9	0.28	174.8	0.0	0.64
TRC099	0.0063	0.19	1088.5	288.1	0.0000	0.0	0.27	188.6	0.0	1.04
TRC100	0.0093	0.35	1159.9	1874.1	0.0000	143.8	0.28	171.4	0.0	1.42
TRC101	0.0098	0.29	1017.1	281.1	0.0000	132.9	0.26	166.3	0.0	0.00
TRC102	0.0067	0.06	2067.7	543.4	0.0000	303.3	0.47	229.1	0.0	1.01
TRC103	0.0197	0.24	1129.7	297.3	0.0000	228.3	0.18	225.2	0.0	1.99
TRC104	0.0132	0.48	1416.0	478.4	0.0000	284.1	0.22	366.8	0.0	0.00
TRC105	0.0162	0.73	1003.0	233.1	0.0000	108.8	0.20	167.5	0.0	1.21
TRC106	0.0125	0.84	2187.5	733.0	0.0000	272.3	0.31	300.4	0.0	0.00
TRC107	7.5076	3.83	1390.2	420.0	2.7129	335.8	4.52	158.7	535.5	14.82
TRC108	0.0271	0.33	1331.8	419.9	0.0000	183.3	0.49	216.3	0.0	1.44

066 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC109	0.1492	0.85	2611.7	2339.3	0.0698	636.1	24.75	278.0	110.3	5.46
TRC110	0.0517	0.83	1364.3	1515.7	0.0000	304.8	0.92	257.1	37.8	3.08
TRC111	0.0108	0.53	1624.0	54.6	0.0000	346.3	0.58	192.0	0.0	0.00
TRC112	0.0550	0.63	1625.3	724.1	0.0000	425.3	0.65	229.4	5.5	0.00
TRC113	0.0212	0.00	1164.1	356.7	0.0000	224.9	0.64	194.9	0.0	1.79
TRC114	0.0590	1.32	1338.7	437.8	0.0000	161.8	2.66	218.0	48.9	1.92
TRC115	0.0164	0.74	1403.3	566.3	0.0000	368.7	0.39	250.9	0.0	2.15
TRC116	0.0080	0.00	1206.2	714.1	0.0000	358.8	0.45	234.5	0.0	0.00
TRC117	0.0104	0.37	1183.5	694.0	0.0000	117.1	0.25	98.9	0.0	0.88
TRC118	0.0603	1.14	1367.2	433.8	0.0000	240.4	8.53	254.3	0.0	2.57
TRC119	0.0784	0.86	1733.1	1065.6	0.0000	464.9	3.21	276.4	0.0	2.36
TRC120	0.0233	0.67	1549.0	1250.3	0.0000	357.6	0.71	239.3	0.0	2.64
TRC121	0.0243	0.58	1960.4	342.5	0.0000	571.7	1.15	248.6	0.0	0.75
TRC122	0.0188	0.20	1683.2	558.0	0.0708	338.5	0.45	327.1	0.0	0.00
TRC123	0.0483	0.80	1614.3	648.4	0.0000	470.7	0.69	246.5	0.0	1.23
TRC124	0.0774	1.23	1829.6	497.3	0.0000	445.3	2.79	188.9	32.5	0.63
TRC125	0.0415	0.59	1843.2	789.0	0.0000	398.1	0.17	247.0	0.0	2.41
TRC126	0.0228	0.29	1416.9	1500.3	0.0000	356.7	1.91	181.9	0.0	0.72
TRC127	0.0791	2.26	1800.1	425.5	0.0000	518.2	0.48	281.6	0.0	3.70
TRC128	0.0266	0.92	1394.3	1564.5	0.0000	258.6	0.52	138.7	60.2	1.46
TRC129	0.0288	0.34	1178.3	514.3	0.0000	258.7	0.49	188.3	0.0	1.29
TRC130	0.0525	0.79	1291.3	8896.5	0.0000	421.4	2.53	229.5	0.0	2.36
TRC131	0.0219	0.25	1397.7	287.8	0.0000	348.4	0.17	194.8	0.0	0.00
TRC132	0.0140	0.67	1620.0	803.3	0.0000	350.3	0.86	161.3	0.0	2.08
TRC133	0.0239	0.41	1441.9	115.1	0.0000	387.8	0.85	141.1	0.0	0.00
TRC134	0.0103	0.32	1366.4	448.1	0.0000	220.7	0.26	163.9	0.0	1.35
TRC135	0.0679	0.75	1609.2	152.5	0.0000	411.1	0.64	226.5	0.0	2.58
TRC136	0.0237	0.53	1511.9	191.2	0.0000	259.5	0.32	256.8	0.0	1.48
TRC137	0.0315	0.60	1086.2	130.1	0.0000	327.9	0.44	224.9	0.0	1.08
TRC138	0.0264	0.83	1220.7	422.3	0.0000	325.2	0.51	258.7	0.0	2.03
TRC139	0.0450	1.05	2446.1	6758.6	0.0000	512.7	5.60	215.4	0.0	0.00
TRC140	0.2166	19.70	1558.2	837.5	0.0000	444.3	2.84	223.5	1.2	3.42
TRC141	0.0336	0.00	4184.8	0.0	0.0000	0.0	1.34	644.1	0.0	0.00
TRC142	0.0141	2.17	2516.1	7379.8	0.0000	625.6	1.96	268.8	0.0	0.00
TRC143	0.0223	0.75	1060.5	233.4	0.0000	271.0	0.58	199.1	0.0	3.31
TRC144	0.1729	3.96	2447.5	4851.2	0.0000	895.1	2.79	464.6	52.6	2.91

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC145	0.0081	0.74	2065.3	382.2	0.0000	213.2	0.32	179.9	17.9	1.95
TRC146	0.0274	0.84	2186.3	819.6	0.0000	599.3	0.72	134.5	98.9	0.00
TRC147	0.0212	0.00	1590.5	867.7	0.0000	391.5	3.41	254.1	8.5	3.55
TRC148	0.0157	0.00	1172.7	590.5	0.0000	245.0	0.57	163.4	0.0	3.73
TRC149	0.0354	1.55	1796.4	546.9	0.0000	432.6	1.07	240.7	19.3	2.56
TRC150	0.0214	1.63	1936.2	0.0	0.0000	0.0	0.98	367.1	0.0	2.12
TRC151	0.0279	0.49	1574.3	610.7	0.0000	343.2	0.52	257.7	0.0	2.37
TRC152	0.0331	0.84	1836.6	454.2	0.0000	544.4	15.24	250.6	0.0	2.90
TRC153	0.0367	0.56	1821.4	1439.5	0.0000	369.6	2.02	207.8	0.0	2.31
TRC154	0.0286	1.77	1878.2	298.1	0.0000	562.0	0.37	297.5	0.0	4.77
TRC155	0.0705	0.59	2963.9	403.5	0.0440	418.4	6.46	323.3	120.5	4.37
TRC156	0.0314	0.75	1250.0	525.2	0.0000	323.7	0.52	239.5	0.0	2.67
TRC157	0.0221	0.62	1143.1	475.3	0.0000	0.0	0.59	180.9	115.6	2.07
TRC158	0.0491	1.92	3799.9	567.2	0.0000	873.7	1.18	430.4	83.1	10.92
TRC159	0.0562	0.62	1483.1	1190.0	0.0000	332.4	1.98	262.2	84.2	2.23
TRC160	0.0253	2.63	1861.1	1155.4	0.0000	311.6	0.97	245.1	0.0	1.77
TRC161	0.0323	0.63	1460.2	56.6	0.0000	361.7	0.45	226.5	0.0	2.88
TRC162	0.0255	0.52	1414.2	197.7	0.0000	130.7	0.45	219.1	0.0	1.89
TRC163	0.0182	0.79	1395.9	822.4	0.0000	391.2	2.35	261.4	0.0	2.10
TRC164	0.0407	0.82	1561.4	2696.3	0.0000	377.0	2.25	244.1	0.0	2.47
TRC165	0.0242	0.80	1322.6	326.9	0.0000	373.7	1.18	240.6	0.0	2.47
TRC166	0.0576	1.26	2916.3	584.9	0.0000	832.3	1.58	333.8	0.0	4.40
TRC167	0.0474	0.96	1134.9	1908.7	0.0000	233.0	2.37	160.0	84.3	2.11
TRC168	0.0596	3.56	1583.6	753.4	0.0000	283.1	0.52	217.1	0.0	3.78
TRC169	0.0401	0.52	1620.4	957.2	0.0000	381.5	1.62	200.1	0.0	0.00
TRC170	0.0518	0.58	1659.2	958.2	0.0000	425.8	2.09	179.6	67.1	2.61
TRC171	0.0424	0.83	1213.5	378.0	0.0000	371.7	0.90	243.6	0.0	1.58
TRC172	0.0223	0.34	1047.1	1095.8	0.0000	0.0	1.01	126.5	0.0	1.64
TRC173	0.0173	0.32	1182.7	100.3	0.0000	168.4	0.83	207.5	0.0	1.92
TRC174	0.0184	0.89	1211.6	0.0	0.0000	232.1	0.66	206.8	0.0	1.83
TRC175	0.0067	0.17	1506.9	991.4	0.0000	478.1	0.36	207.9	0.0	0.51
TRC176	0.1412	3.53	2563.2	790.6	0.0000	409.0	1.57	303.1	0.0	1.54
TRC177	0.0330	0.55	1424.5	536.6	0.0000	235.4	0.81	241.2	0.0	0.85
TRC178	0.0655	2.05	1888.8	435.3	0.0000	406.3	0.94	258.3	0.0	0.90
TRC179	0.0525	1.02	1592.0	352.7	0.0000	314.5	0.84	205.3	0.0	2.95
TRC180	0.0418	1.37	1566.3	519.5	0.0000	332.5	0.57	278.7	0.0	2.05

832 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC181	0.0235	0.55	1024.8	103.3	0.0000	334.1	1.50	216.6	0.0	1.76
TRC182	0.0118	0.51	1288.4	244.4	0.0000	473.2	0.41	205.0	0.0	2.03
TRC183	0.0358	0.97	1217.4	6681.6	0.0000	163.9	1.56	249.7	0.0	3.42
TRC184	0.0555	0.62	1312.8	557.7	0.0000	358.1	1.17	175.8	0.0	0.00
TRC185	0.0414	0.61	1524.4	3371.1	0.0246	479.3	4.98	269.6	0.0	5.88
TRC186	0.0401	1.29	2644.1	1046.0	0.0000	462.0	1.35	302.2	0.0	7.12
TRC187	0.0277	1.15	1304.3	2436.4	0.0000	266.4	0.79	251.5	0.0	2.60
TRC188	0.0169	0.42	1427.4	1006.6	0.0000	366.5	0.81	193.6	0.0	2.64
TRC189	0.0138	0.98	1151.9	573.5	0.0000	213.0	0.20	180.4	0.0	0.97
TRC190	0.0325	0.36	1152.2	570.0	0.0000	447.0	1.18	221.8	0.0	0.00
TRC191	0.0292	0.75	1357.9	641.6	0.0000	226.2	1.68	202.8	0.0	0.81
TRC192	0.0276	1.81	1978.9	962.9	0.0000	320.9	0.87	191.8	0.0	2.37
TRC193	0.0590	0.78	1535.3	500.8	0.0000	419.6	1.90	246.3	0.0	2.75
TRC194	0.0446	0.86	1611.9	5201.7	0.0000	225.4	2.23	247.4	0.0	2.52
TRC195	0.0403	1.02	2021.5	311.6	0.0000	454.5	1.61	267.0	66.5	2.32
TRC196	0.0252	1.10	1506.0	450.0	0.0000	243.8	2.36	219.1	0.0	1.81
TRC197	0.0368	1.62	1904.1	593.9	0.0000	598.2	6.18	219.7	0.0	4.00
TRC198	0.0689	0.87	1912.4	556.7	0.0000	221.9	6.58	210.4	0.0	2.70
TRC199	0.0169	0.37	1212.1	658.0	0.0000	245.2	1.65	178.3	0.0	0.00
TRC200	0.0580	1.54	2501.6	488.7	0.0000	479.9	1.77	344.6	0.0	4.22
TRC201	0.0289	0.48	1429.1	287.2	0.0000	452.6	0.69	257.8	0.0	3.15
TRC202	0.0363	0.82	1057.3	700.9	0.0000	166.7	1.24	112.1	0.0	4.36
TRC203	0.0289	0.62	1413.9	227.7	0.0000	282.6	2.43	226.0	0.0	3.74
TRC204	0.0167	0.30	1303.3	0.0	0.0000	341.0	0.85	211.5	0.0	1.43
TRC205	0.0177	0.32	1003.8	130.8	0.0389	184.5	0.44	194.1	0.0	1.44
TRC206	0.0314	1.09	1283.1	302.6	0.0000	262.6	0.58	271.8	0.0	1.22
TRC207	0.0361	0.66	2109.4	1291.0	0.0000	318.5	0.86	209.6	0.0	0.94
TRC208	0.0169	0.42	1768.5	458.9	0.0000	294.7	1.02	205.4	0.0	1.08
TRC209	0.0098	0.39	910.3	148.6	0.0000	269.4	0.34	187.9	0.0	0.00
TRC210	0.0177	0.21	1656.9	2352.5	0.0241	256.6	1.50	233.7	0.0	0.00
TRC211	0.0218	1.02	1838.3	779.9	0.0000	316.1	2.10	251.0	162.9	1.92
TRC212	0.0255	0.00	1471.6	364.3	0.0000	271.9	1.27	200.1	201.7	0.00
TRC213	0.0289	1.49	1555.1	277.6	0.0000	369.4	0.86	220.8	188.4	1.91
TRC214	0.0157	0.00	1490.6	486.1	0.0000	0.0	0.31	198.2	129.5	0.00
TRC215	0.0625	0.00	1954.6	544.2	0.0655	459.0	3.60	288.5	222.1	0.00
TRC216	0.0346	0.00	1631.0	350.2	0.0000	0.0	67.05	229.7	367.4	0.00

Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC217	0.0255	1.22	1425.8	1716.8	0.0000	564.2	1.35	202.6	167.0	2.16
TRC218	0.0713	0.76	1038.7	267.4	0.0000	389.7	3.63	215.1	0.0	3.50
TRC219	0.0185	0.98	2440.6	489.6	0.0000	379.4	0.99	281.0	0.0	0.00
TRC220	0.0207	0.69	1090.3	295.3	0.0000	202.5	1.37	251.2	0.0	0.00
TRC221	0.0691	0.56	1314.2	289.7	0.0000	584.1	1.24	329.4	0.0	2.82
TRC222	0.0143	2.12	1429.3	326.5	0.0000	356.2	0.88	185.7	69.2	0.81
TRC223	0.0138	0.46	1127.7	263.7	0.0000	230.6	0.51	225.5	0.0	2.00
TRC224	0.0290	1.13	1471.4	1150.0	0.0000	326.7	0.54	250.3	0.0	1.68
TRC225	0.0571	2.14	1471.8	440.1	0.0000	279.0	1.05	293.0	0.0	3.41
TRC226	0.0232	0.67	1937.5	401.9	0.0000	440.9	0.61	264.6	0.0	1.35
TRC227	0.0231	0.37	1462.6	303.1	0.0000	339.3	0.80	273.6	0.0	0.00
TRC228	0.0232	0.42	1412.7	1163.2	0.0000	0.0	0.97	228.9	0.0	3.37
TRC229	0.0644	1.16	1758.9	8516.8	0.0000	0.0	1.95	291.4	0.0	2.44
TRC230	0.0162	0.57	1511.4	254.4	0.0000	387.1	0.72	255.5	0.0	0.00
TRC231	0.0683	0.72	1741.4	409.9	0.0000	385.3	3.17	238.0	0.0	2.16
TRC232	0.0181	0.75	1614.8	253.3	0.0000	319.1	1.09	240.5	0.0	0.00
TRC233	0.0492	1.35	1810.5	503.0	0.0000	396.9	1.38	281.8	0.0	2.15
TRC234	0.0434	13.54	1430.2	329.0	0.0000	164.6	1.90	231.9	0.0	5.54
TRC235	0.0294	2.19	1425.3	679.3	0.0000	132.2	1.34	222.6	0.0	0.00
TRC236	0.0553	2.14	1880.1	113.2	0.0737	393.1	1.06	273.7	0.0	3.20
TRC237	0.0510	1.58	1240.1	387.1	0.0000	260.0	1.51	233.9	0.0	5.01
TRC238	0.0277	1.74	1484.0	1291.3	0.0000	142.3	2.25	186.9	0.0	3.12
TRC239	0.0107	9.83	1698.4	1023.2	0.0000	0.0	0.59	99.4	0.0	1.76
TRC240	0.0163	0.53	1175.4	385.7	0.0000	347.1	0.35	206.4	0.0	1.75
TRC241	0.0137	1.00	1596.7	760.5	0.0582	0.0	1.11	195.6	0.0	0.90
TRC242	0.0163	0.32	1279.4	613.3	0.0000	0.0	1.27	176.0	88.4	1.81
TRC243	0.0338	0.50	1439.5	643.5	0.0000	154.3	2.14	116.9	0.0	1.60
TRC244	0.0355	1.14	2199.5	828.5	0.0430	438.9	5.70	254.5	0.0	4.38
TRC245	0.0125	0.94	18103.7	5684.1	0.0000	2121.6	8.90	1611.1	0.0	0.00
TRC246	0.0138	0.53	1969.2	533.2	0.0000	215.5	1.22	227.1	0.0	0.00
TRC247	0.0000	0.69	2172.9	579.2	0.0000	349.1	0.99	246.7	0.0	0.00
TRC248	0.0334	1.51	1297.1	349.5	0.0000	180.6	2.68	197.4	0.0	0.00
TRC249	0.0309	1.73	1926.6	749.9	0.0000	335.4	0.86	263.3	0.0	1.97
TRC250	0.0350	2.95	1789.4	382.1	0.0000	262.3	1.89	225.7	0.0	2.35
TRC251	0.0219	0.65	1279.0	0.0	0.0000	252.9	0.66	216.9	238.6	0.00
TRC252	0.0103	0.88	2122.3	147.9	0.0000	373.0	0.74	177.1	0.0	1.45

934 Table 2. Concentrations of elements measured by INAA in the chert samples in this study.

ANID	Th (ppm)	Zn (ppm)	Al (ppm)	Ca (ppm)	Dy (ppm)	K (ppm)	Mn (ppm)	Na (ppm)	Ti (ppm)	V (ppm)
TRC253	0.0593	0.00	1689.3	104.0	0.0000	287.0	0.60	262.3	76.2	3.79
TRC254	0.0464	3.26	1683.7	106.4	0.0000	0.0	13.90	202.5	409.6	1.91
TRC255	10.5094	5.28	36559.9	912.1	14.6378	42428.2	15.65	3692.3	485.2	0.00
TRC256	0.0438	1.66	1891.1	1458.9	0.0000	726.6	1.38	288.8	0.0	1.08
TRC257	0.0437	1.70	2036.4	279.2	0.0000	410.3	9.12	236.8	334.2	1.79
TRC258	0.0540	1.58	1250.3	276.1	0.0412	475.6	1.27	267.9	474.5	4.03
TRC259	0.0322	0.72	1193.2	486.0	0.0000	336.2	3.24	212.7	232.0	3.52
TRC260	0.0294	0.00	2169.7	339.5	0.0000	365.9	2.01	251.5	112.0	1.05
TRC261	0.0505	1.22	1460.1	4604.9	0.0000	314.8	0.76	273.9	0.0	4.75

Table 3. Eigenvalues and percentage of variance explained by principal components analysis of 261 chert samples.

Note: This PCA was performed on the samples in this study which include a collection of Edwards Formation source specimens (TRC001-TRC107) and Varga site artifacts (TRC108-TRC261).

Simultaneous R-Q Factor Analysis Based on Variance-Covariance Matrix

Eigenvalues and Percentage of Variance Explained:

Eigenvalue	%Variance	Cum. %Var.	
	36.30	36.30	
	14.84	51.14	
	9.927	61.07	
1.015	7.850	68.92	
0.4150	5.378	74.30	
0.2776	4.235	78.53	
0.2195	3.814	82.35	
0.1504	2.753	85.10	
0.1184	2.611	87.71	
0.1066	2.194	89.91	← 10 PCs required to explain approximately 90% of variance
0.07698	1.854	91.76	
0.07299	1.699	93.46	
0.06135	1.508	94.97	
0.05184	0.9863	95.95	
0.04750	0.8191	96.77	
0.04216	0.6556	97.43	
0.02758	0.5734	98.00	
0.02290	0.4752	98.48	
0.01833	0.4126	98.89	
0.01603	0.3589	99.25	
0.01329	0.2715	99.52	
0.01154	0.2363	99.76	
0.01004	0.1362	99.89	
0.007592	0.07602	99.97	
0.006608	0.03249	100.0	
0.003808			
0.002126			
0.0009084			

Table 4. Basic characteristics observed for chert sub-types characterized in this study.

Source Specimen Group Name	Main Characteristics
Hackberry Creek	Low concentrations of As, Co, Fe, Hf & Zn
Glen Rose	High concentrations of Mn
Georgetown	Low concentrations of Ca and Sr
Varga area samples	Low concentrations of REEs
Devil River Formation	Low concentrations of REEs, As, Fe, Sb & Zn

Table 5. Mahalanobis distance-based probabilities and posterior classification of TRC specimens from the larger groups (n>12) against one another.

Groups are:

	PC-HC	Hackberry Creek
1.000	PC-SM	Segovia Formation mixture
2.000	PC-TM	Terrett Formation mixture
3.000	PC-CW	Camp Wood

The following variables explaining more than 90% of the variance were used in the calculations:

PC02	PC03	PC04	PC05
PC07	PC08	PC09	PC10

Probabilities are jackknifed for specimens included in each group.

PC06

The following specimens are in the file PC-HC

ID. NO.	PC-HC	PC-SM	PC-TM	PC-CW	From:	Into:
TRC083	95.515	40.967	86.372	18.801	1	1
TRC084	67.249	4.463	62.628	2.980	1	1
TRC085	7.290	11.367	9.700	71.658	1	4
TRC086	81.232	2.178	77.594	2.243	1	1
TRC087	95.590	17.078	84.787	3.631	1	1
TRC088	0.811	0.796	3.021	0.257	1	3
TRC089	0.918	1.414	4.468	1.848	1	3
TRC090	59.683	11.321	7.667	9.038	1	1
TRC091	94.205	1.793	42.713	3.975	1	1
TRC092	1.102	35.512	18.482	20.113	1	2
TRC093	92.362	50.303	74.535	27.400	1	1
TRC094	47.284	62.259	11.603	80.627	1	4
TRC095	65.927	17.976	11.789	11.660	1	1
TRC096	31.302	59.604	92.611	47.219	1	3
TRC097	99.839	23.450	87.523	6.046	1	1
TRC098	82.085	3.848	47.337	0.864	1	1
TRC099	69.156	5.503	5.115	8.222	1	1
TRC100	8.684	1.971	1.809	1.708	1	1
TRC101	13.399	11.728	7.717	25.232	1	4
TRC102	26.321	0.328	26.543	0.082	1	3
TRC103	24.810	36.542	63.393	43.093	1	3

The following specimens are in the file PC-SM

ID. NO.	PC-HC	PC-SM	PC-TM	PC-CW	From:	Into:
TRC007	11.267	72.283	49.408	66.258	2	2
TRC008	0.306	0.035	13.540	0.631	2	3
TRC009	14.937	87.454	17.190	60.108	2	2
TRC010	5.424	53.621	31.807	5.064	2	2
TRC011	3.513	99.327	89.978	89.472	2	2
TRC012	1.111	75.015	73.886	76.678	2	4
TRC013	1.352	0.237	48.374	64.845	2	4
TRC014	32.897	94.910	96.071	88.678	2	3
TRC015	0.200	26.711	39.127	10.522	2	3
TRC016	12.421	64.689	60.191	67.717	2	4
TRC052	5.413	46.291	63.583	5.621	2	3
TRC053	2.644	93.150	81.137	19.487	2	2
TRC054	1.084	91.910	71.474	70.561	2	2
TRC055	6.734	66.276	59.971	47.290	2	2
TRC056	3.231	20.806	54.874	23.012	2	3
TRC057	4.441	49.954	42.061	31.704	2	2
TRC058	7.656	98.291	27.684	24.327	2	2
TRC059	6.275	99.758	63.578	80.451	2	2
TRC060	23.743	96.992	84.014	49.483	2	2
TRC072	0.020	3.004	50.205	0.623	2	3
TRC073	0.167	38.926	1.448	2.785	2	2
TRC074	0.259	37.534	1.460	9.520	2	2
TRC079	0.456	1.606	29.775	2.948	2	3
TRC080	0.756	4.048	4.139	2.785	2	3
TRC081	26.701	19.267	70.813	19.762	2	3
TRC082	50.472	13.921	19.180	25.500	2	1

The following specimens are in the file PC-TM

ID. NO.	PC-HC	PC-SM	PC-TM	PC-CW	From:	Into:
TRC047	21.166	51.255	48.566	4.164	3	2
TRC048	58.025	39.770	90.708	87.385	3	3
TRC049	22.234	26.569	73.124	23.800	3	3
TRC050	1.459	17.836	4.940	45.963	3	4
TRC051	5.536	12.523	12.591	7.600	3	3
TRC066	0.446	2.170	35.519	18.618	3	3
TRC067	0.285	77.193	92.512	76.598	3	3
TRC068	0.365	33.133	67.703	37.182	3	3
TRC069	0.055	20.961	33.077	34.793	3	4

Probabilities:

TRC070	2.116	16.461	92.337	66.707	3	3
TRC071	7.617	24.271	82.824	42.628	3	3
TRC075	4.169	2.265	31.612	15.314	3	3
TRC076	4.497	34.622	47.820	24.818	3	3
TRC077	1.388	20.095	26.761	15.506	3	3
TRC078	0.007	0.023	7.571	0.193	3	3

The following specimens are in the file PC-CW

ID. NO.	PC-HC	PC-SM	PC-TM	PC-CW	From:	Into:
TRC027	38.095	88.444	83.952	82.563	4	2
TRC028	6.608	98.539	88.154	78.932	4	2
TRC029	0.000	0.035	7.961	0.167	4	3
TRC030	53.535	37.936	59.888	66.000	4	4
TRC031	1.098	28.321	14.549	3.876	4	2
TRC032	1.613	89.627	27.940	55.181	4	2
TRC033	2.141	94.502	54.871	87.047	4	2
TRC034	10.185	98.529	86.847	93.008	4	2
TRC035	3.289	30.030	32.148	21.042	4	3
TRC036	56.786	53.277	84.669	70.597	4	3
TRC037	75.765	56.318	51.211	92.907	4	4
TRC038	8.946	84.599	99.008	72.690	4	3
TRC039	14.275	1.932	33.964	4.982	4	3
TRC040	11.883	54.057	17.184	75.162	4	4
TRC041	4.063	2.562	21.098	0.344	4	3
TRC042	1.565	34.559	45.738	56.849	4	4
TRC043	0.044	36.338	17.603	44.410	4	4
TRC044	13.786	83.471	91.228	62.809	4	3
TRC045	0.256	88.222	36.690	83.062	4	2
TRC046	0.015	37.594	21.512	20.795	4	2

Summary of Classification Success:

		PC-SM	PC-TM	PC-CW	Total
From Group:					
PC-HC	12	1	5	3	21
PC-SM	1	13	9	3	26
PC-TM	0	1	12	2	15
PC-CW	0	8	7	5	20
Total	13	23	33	13	82

PC-HC

Classified Into Group:

Table 6. Eigenvalues and percentage of variance explained by principal components analysis of 451 chert specimens.

Note: This PCA was performed on the INAA data for source specimens and artifacts samples in this study combined with earlier source specimen data from the Fort Hood, Segovia Formation, and a mixed collection from the Edwards Formation.

Simultaneous R-Q Factor Analysis Based on Variance-Covariance Matrix

Eigenvalues and Percentage of Variance Explained:

Eigenvalue	%Variance	Cum. %Var.
	30.90	30.90
	21.32	52.21
0.7689	13.03	65.24
0.5305	7.745	72.99
0.3243	6.042	79.03
0.1928	4.487	83.52
0.1504	3.177	86.69
0.1117	2.371	89.06
0.07906	2.179	91.24
0.05900	2.145	93.39
0.05424	1.652	95.04
0.05337	1.313	96.35
0.04112	1.085	97.44
0.03269	0.6502	98.09
0.02700	0.6024	98.69
0.01618	0.4825	99.17
0.01499	0.3968	99.57
0.01201	0.1959	99.77
0.009875	0.1575	99.92
0.004875	0.07698	100.0
0.003919		
0.001916		

← 9 PCs were required to exceed 90% of the variance

Table 7. Mahalanobis distance-based probabilities and posterior classification of source specimens TRC001 thru TRC106.

Reference groups and numbers of specimens:

	PC-E1	19	Fort Hood: Owl Creel
	PC-E2	21	Fort Hood: Gray-brown-green
	PC-E3	20	Fort Hood: Tan
1	PC-E4	20	Fort Hood: Texas Novaculite
2	PC-E5	20	Fort Hood: Heiner Lake Tan
3	PC-E6	18	Fort Hood: Gray
4	PC-SF	15	Segovia Formation (Turnbull's collection)
5	PC-CF	59	Edwards Formation mixture (Frederick's collection)
6			

The following variables explaining more than 91% of the variance were used in this calculations:

8	PC02	PC03	PC04	PC05	PC06	PC07	PC08	PC09
---	------	------	------	------	------	------	------	------

The following specimens are in the file PC-TRCS

ID. NO.	PC-E1	PC-E2	PC-E3	PC-E4	PC-E5	PC-E6	PC-SF	PC-CF	BEST GRP.
TRC001	0.000	0.000	0.000	0.000	0.000	0.001	0.018	2.868	8
TRC002	0.000	0.000	0.000	0.002	0.000	0.013	0.041	31.286	8
TRC003	0.000	0.000	0.000	0.009	0.000	0.023	0.076	52.341	8
TRC004	0.000	0.000	0.000	0.002	0.000	0.003	0.065	38.130	8
TRC005	0.000	0.000	0.000	0.001	0.000	0.005	0.010	21.898	8
TRC006	0.000	0.000	0.000	0.001	0.000	0.006	0.066	27.562	8
TRC007	0.000	0.000	0.000	0.011	0.000	0.020	0.039	30.725	8
TRC008	0.000	0.000	0.000	0.008	0.000	0.004	0.014	28.571	8
TRC009	0.000	0.000	0.000	0.002	0.000	0.011	0.033	30.615	8
TRC010	0.000	0.000	0.000	0.050	0.000	0.008	0.047	18.231	8
TRC011	0.000	0.000	0.000	0.004	0.000	0.004	0.046	44.407	8
TRC012	0.000	0.000	0.000	0.024	0.000	0.022	0.050	33.026	8
TRC013	0.000	0.000	0.000	0.001	0.000	0.012	0.667	7.629	8
TRC014	0.000	0.000	0.000	0.018	0.000	0.050	0.146	91.745	8
TRC015	0.000	0.000	0.000	0.003	0.000	0.000	0.009	3.385	8
TRC016	0.000	0.000	0.000	0.004	0.000	0.002	0.030	20.183	8
TRC017	0.000	0.000	0.000	0.001	0.000	0.010	0.015	37.045	8
TRC018	0.000	0.000	0.000	0.002	0.000	0.001	0.039	27.309	8
TRC019	0.000	0.000	0.000	0.032	0.000	0.006	0.412	15.082	8
TRC020	0.000	0.000	0.000	0.016	0.000	0.013	0.114	24.625	8
TRC021	0.000	0.000	0.000	0.015	0.000	0.017	0.773	54.542	8
TRC022	0.000	0.000	0.000	0.034	0.000	0.010	0.215	0.392	8
TRC023	0.000	0.000	0.000	0.005	0.000	0.011	0.102	67.046	8
TRC024	0.000	0.000	0.000	0.003	0.000	0.007	0.068	69.413	8
TRC025	0.000	0.000	0.000	0.018	0.000	0.037	0.435	70.514	8
TRC026	0.000	0.000	0.000	0.014	0.000	0.011	0.190	50.905	8
TRC027	0.000	0.000	0.000	0.004	0.000	0.024	0.284	93.932	8

TRC028	0.000	0.000	0.000	0.008	0.000	0.014	0.113	65.790	8
TRC029	0.000	0.000	0.000	0.000	0.000	0.001	0.019	0.210	8
TRC030	0.000	0.000	0.000	0.108	0.000	0.664	1.775	99.172	8
TRC031	0.000	0.000	0.000	0.001	0.000	0.000	0.012	6.215	8
TRC032	0.000	0.000	0.000	0.010	0.000	0.087	0.127	90.621	8
TRC033	0.000	0.000	0.000	0.025	0.000	0.067	0.185	61.601	8
TRC034	0.000	0.000	0.000	0.006	0.000	0.009	0.201	89.128	8
TRC035	0.000	0.000	0.000	0.001	0.000	0.042	0.153	23.073	8
TRC036	0.000	0.000	0.000	0.085	0.000	0.196	0.941	96.689	8
TRC037	0.000	0.000	0.004	0.001	0.000	0.034	0.755	84.295	8
TRC038	0.000	0.000	0.000	0.025	0.000	0.093	0.083	88.810	8
TRC039	0.000	0.000	0.007	0.019	0.000	0.011	2.149	56.151	8
TRC040	0.000	0.000	0.004	0.023	0.000	0.009	0.483	22.312	8
TRC041	0.000	0.000	0.000	0.001	0.000	0.035	0.156	79.955	8
TRC042	0.000	0.000	0.000	0.003	0.000	0.009	0.091	85.454	8
TRC043	0.000	0.000	0.000	0.004	0.000	0.098	0.014	20.675	8
TRC044	0.000	0.000	0.000	0.001	0.000	0.050	0.182	92.091	8
TRC045	0.000	0.000	0.000	0.002	0.000	0.011	0.026	51.894	8
TRC046	0.000	0.000	0.000	0.002	0.000	0.006	0.016	21.352	8
TRC047	0.000	0.000	0.000	0.093	0.003	0.011	0.085	6.510	8
TRC048	0.000	0.000	0.000	0.176	0.000	0.068	0.485	96.834	8
TRC049	0.000	0.000	0.000	0.018	0.000	0.032	0.192	70.354	8
TRC050	0.000	0.000	0.000	0.065	0.000	0.006	0.116	38.637	8
TRC051	0.000	0.000	0.001	0.004	0.000	0.009	0.248	40.275	8
TRC052	0.000	0.000	0.000	0.055	0.001	0.004	0.085	24.897	8
TRC053	0.000	0.000	0.000	0.019	0.000	0.089	0.074	58.673	8
TRC054	0.000	0.000	0.000	0.016	0.000	0.099	0.072	77.589	8
TRC055	0.000	0.000	0.000	0.023	0.000	0.107	0.150	68.146	8
TRC056	0.000	0.000	0.000	0.004	0.000	0.003	0.089	5.040	8
TRC057	0.000	0.000	0.000	0.005	0.000	0.002	0.193	37.875	8
TRC058	0.000	0.000	0.000	0.006	0.000	0.011	0.064	27.109	8
TRC059	0.000	0.000	0.000	0.006	0.000	0.008	0.055	33.508	8
TRC060	0.000	0.000	0.001	0.009	0.000	0.030	0.280	67.728	8
TRC061	0.000	0.001	0.000	0.020	0.000	0.607	1.176	94.329	8
TRC062	0.000	0.000	0.001	0.005	0.000	0.041	0.408	51.446	8
TRC063	0.000	0.000	0.000	0.038	0.000	0.087	0.454	98.307	8
TRC064	0.000	0.000	0.000	0.012	0.000	0.025	0.142	94.208	8
TRC065	0.000	0.000	0.000	0.009	0.000	0.038	0.279	82.028	8
TRC066	0.000	0.000	0.000	0.000	0.000	0.000	0.022	30.015	8
TRC067	0.000	0.000	0.000	0.001	0.000	0.014	0.019	26.444	8
TRC068	0.000	0.000	0.000	0.001	0.000	0.001	0.041	27.786	8
TRC069	0.000	0.000	0.000	0.000	0.000	0.001	0.011	10.176	8
TRC070	0.000	0.000	0.000	0.001	0.000	0.005	0.112	34.308	8
TRC071	0.000	0.000	0.000	0.003	0.000	0.010	0.174	55.423	8
TRC072	0.000	0.000	0.000	0.000	0.000	0.005	0.040	26.625	8
TRC073	0.000	0.000	0.000	0.000	0.000	0.001	0.020	2.154	8

TRC074	0.000	0.000	0.000	0.000	0.000	0.000	0.012	1.215	8
TRC075	0.000	0.000	0.000	0.000	0.000	0.007	0.073	80.325	8
TRC076	0.000	0.000	0.000	0.011	0.000	0.041	0.152	90.686	8
TRC077	0.000	0.000	0.000	0.000	0.000	0.002	0.018	42.507	8
TRC078	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.036	8
TRC079	0.000	0.000	0.000	0.002	0.000	0.033	0.768	72.088	8
TRC080	0.000	0.000	0.000	0.002	0.000	0.004	1.498	10.939	8
TRC081	0.000	0.000	0.000	0.002	0.000	0.007	0.349	61.582	8
TRC082	0.000	0.000	0.001	0.002	0.000	0.017	0.518	40.506	8
TRC083	0.000	0.000	0.000	1.616	0.000	1.572	1.509	83.449	8
TRC084	0.000	0.000	0.000	1.612	0.000	0.185	0.638	58.543	8
TRC085	0.000	0.000	0.005	0.032	0.000	0.038	1.188	60.329	8
TRC086	0.000	0.000	0.000	0.354	0.000	0.003	1.735	19.832	8
TRC087	0.000	0.000	0.000	1.962	0.000	0.996	1.465	77.900	8
TRC088	0.000	0.000	0.000	0.004	0.000	0.003	0.044	6.578	8
TRC089	0.000	0.000	0.000	0.080	0.000	0.018	2.521	40.030	8
TRC090	0.000	0.000	0.000	0.015	0.000	0.012	0.479	30.067	8
TRC091	0.000	0.000	0.000	0.038	0.000	0.004	1.124	29.906	8
TRC092	0.000	0.000	0.000	0.014	0.000	0.021	0.474	46.992	8
TRC093	0.000	0.000	0.000	0.088	0.000	0.040	1.371	81.553	8
TRC094	0.000	0.000	0.017	0.043	0.000	0.028	0.751	14.365	8
TRC095	0.000	0.000	0.000	0.052	0.000	0.016	0.319	54.755	8
TRC096	0.000	0.000	0.000	0.032	0.000	0.086	0.479	77.858	8
TRC097	0.000	0.000	0.000	0.142	0.000	0.112	2.272	65.294	8
TRC098	0.000	0.000	0.000	0.147	0.000	0.013	1.282	20.512	8
TRC099	0.000	0.000	0.000	0.024	0.000	0.026	0.200	23.527	8
TRC100	0.000	0.000	0.000	0.003	0.000	0.004	0.039	25.715	8
TRC101	0.000	0.000	0.001	0.119	0.000	0.002	0.224	11.085	8
TRC102	0.000	0.000	0.000	0.075	0.000	0.003	0.691	1.573	8
TRC103	0.000	0.000	0.000	5.996	0.000	3.165	3.933	93.049	8
TRC104	0.000	0.000	0.000	0.009	0.000	0.141	0.310	88.311	8
TRC105	0.000	0.000	0.000	0.150	0.000	0.007	1.130	72.951	8
TRC106	0.000	0.000	0.000	0.012	0.000	0.061	0.134	48.055	8

Summary of Probabilities for Specimens in the file PC-TRCS

Group:

-----	0.01000	0.10000	1.00000	5.00000	10.00000	20.00000	100.00000
PC-E1	106	0	0	0	0	0	0
PC-E2	106	0	0	0	0	0	0
PC-E3	105	1	0	0	0	0	0
PC-E4	56	39	7	3	1	0	0
PC-E5	106	0	0	0	0	0	0
PC-E6	45	51	8	2	0	0	0
PC-SF	3	40	48	15	0	0	0

Probability Cutoff Values:

PC-CF	0	1	2	5	5	7	86
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Summary of Best Classification of Projected Specimens:
Classified into Group:

	PC-E2	PC-E3	PC-E4	PC-E5	PC-E6	PC-SF	PC-CF	Total
From Group:								
PC-TRCS	0	0	0	0	0	0	106	106
Total	0	0	0	0	0	0	106	106

PC-E1

Table 8. Mahalanobis distance-based probabilities and posterior classification for the Varga site artifacts TRC108 thru TRC261.

Reference groups and numbers of specimens:

	PC-E1	19	Fort Hood: Owl Creek
	PC-E2	21	Fort Hood: Gray-brown-green
	PC-E3	20	Fort Hood: Tan
1	PC-E4	20	Fort Hood: Texas Novaculite
2	PC-E5	20	Fort Hood: Heiner Lake Tan
3	PC-E6	18	Fort Hood: Gray
4	PC-SF	15	Segovia Formation (Turnbull's collection)
5	PC-CF	59	Edwards Formation mixture (Frederick's collection)
6	PC-TRCS	106	Edwards Formation samples from TRC

The following variables explaining more than 91% of the variance were used in these calculations:

9	PC02	PC03	PC04	PC05	PC06	PC07	PC08	PC09
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The following specimens are in the file PC-TRCA

ID. NO.	PC-E1	PC-E2	PC-E3	PC-E4	PC-E5	PC-E6	PC-SF	PC-CF	PC-TRCS	BEST GRP.
TRC108	0.000	0.000	0.013	0.033	0.000	0.008	0.763	24.938	52.870	9
TRC109	0.000	0.000	0.002	0.000	0.000	0.003	0.494	5.970	0.090	8
TRC110	0.000	0.000	0.000	0.002	0.000	0.004	0.617	50.485	21.687	8
TRC111	0.000	0.000	0.000	0.047	0.000	0.009	1.212	67.878	94.669	9
TRC112	0.000	0.000	0.000	0.001	0.000	0.004	0.093	1.635	4.463	9
TRC113	0.000	0.000	0.000	0.259	0.000	0.046	0.305	25.253	41.972	9
TRC114	0.000	0.000	0.000	0.000	0.000	0.002	0.129	18.886	6.768	8
TRC115	0.000	0.000	0.000	0.001	0.000	0.002	0.017	5.738	7.732	9
TRC116	0.000	0.000	0.000	0.238	0.000	0.004	2.373	3.233	24.123	9
TRC117	0.000	0.000	0.000	0.025	0.000	0.051	0.145	32.713	67.046	9
TRC118	0.000	0.000	0.001	0.002	0.000	0.053	0.863	57.171	18.380	8
TRC119	0.000	0.000	0.001	0.000	0.000	0.023	0.542	35.519	8.836	8
TRC120	0.000	0.000	0.000	0.003	0.000	0.026	0.083	87.113	96.557	9
TRC121	0.000	0.000	0.000	0.002	0.000	0.103	0.411	86.168	69.325	8
TRC122	0.000	0.000	0.000	0.064	0.000	0.011	7.404	27.618	47.678	9
TRC123	0.000	0.000	0.000	0.009	0.000	0.024	0.313	46.464	52.435	9
TRC124	0.000	0.000	0.000	0.001	0.000	0.004	0.200	7.099	2.709	8
TRC125	0.000	0.000	0.000	0.002	0.000	0.004	0.378	7.956	1.189	8
TRC126	0.000	0.000	0.000	0.132	0.000	0.202	1.916	67.703	57.606	8
TRC127	0.000	0.000	0.000	0.000	0.000	0.008	0.091	34.271	6.067	8
TRC128	0.000	0.000	0.001	0.012	0.000	0.029	0.435	68.824	89.552	9
TRC129	0.000	0.000	0.000	2.941	0.000	1.808	3.969	99.321	83.691	8
TRC130	0.000	0.000	0.000	0.025	0.000	0.055	2.381	53.340	14.099	8
TRC131	0.000	0.000	0.000	0.817	0.000	0.081	2.012	67.419	59.819	8

TRC132	0.000	0.000	0.000	0.001	0.000	0.002	0.026	14.603	25.738	9
TRC133	0.000	0.000	0.000	0.014	0.000	0.040	0.546	78.520	58.365	8
TRC134	0.000	0.000	0.000	0.144	0.000	0.077	0.252	64.062	82.519	9
TRC135	0.000	0.000	0.000	0.000	0.000	0.000	0.688	14.992	0.315	8
TRC136	0.000	0.000	0.000	0.060	0.000	0.056	2.533	53.251	16.726	8
TRC137	0.000	0.000	0.000	0.002	0.000	0.001	0.482	53.228	31.787	8
TRC138	0.000	0.000	0.001	0.003	0.000	0.021	0.476	90.439	78.837	8
TRC139	0.000	0.000	0.000	0.003	0.000	0.029	0.463	45.015	22.896	8
TRC140	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.000	7
TRC141	0.000	0.000	0.001	0.007	0.000	0.308	4.740	74.300	29.951	8
TRC142	0.000	0.000	0.000	0.001	0.000	0.030	0.124	72.273	59.601	8
TRC143	0.000	0.000	0.000	0.011	0.000	0.023	0.299	82.268	86.710	9
TRC144	0.000	0.000	0.000	0.001	0.000	0.000	0.156	9.054	1.229	8
TRC145	0.000	0.000	0.000	0.000	0.000	0.001	0.055	31.466	19.958	8
TRC146	0.000	0.000	0.000	0.010	0.000	0.010	0.076	38.095	57.271	9
TRC147	0.000	0.000	0.000	0.063	0.000	0.037	1.289	63.890	39.876	8
TRC148	0.000	0.000	0.000	0.017	0.000	0.235	0.239	55.090	50.125	8
TRC149	0.000	0.000	0.001	0.001	0.000	0.015	0.297	16.000	4.871	8
TRC150	0.000	0.000	0.000	0.005	0.000	0.003	0.722	81.411	55.804	8
TRC151	0.000	0.000	0.000	0.092	0.000	0.089	5.396	83.701	52.664	8
TRC152	0.000	0.000	0.000	0.002	0.000	0.006	0.220	32.095	7.114	8
TRC153	0.000	0.000	0.000	0.017	0.000	0.138	1.142	91.464	80.983	8
TRC154	0.000	0.000	0.000	0.000	0.000	0.001	0.017	20.918	17.575	8
TRC155	0.000	0.000	0.001	0.000	0.000	0.023	0.465	23.038	1.781	8
TRC156	0.000	0.000	0.000	0.000	0.000	0.000	0.056	1.588	0.477	8
TRC157	0.000	0.000	0.002	0.094	0.000	0.131	0.959	91.839	99.689	9
TRC158	0.000	0.000	0.000	0.000	0.000	0.001	0.038	9.912	2.244	8
TRC159	0.000	0.000	0.003	0.002	0.000	0.109	1.394	67.407	26.593	8
TRC160	0.000	0.000	0.000	0.000	0.000	0.001	0.033	22.844	2.529	8
TRC161	0.000	0.001	0.000	0.112	0.000	0.136	2.459	78.998	36.403	8
TRC162	0.000	0.000	0.000	0.005	0.000	0.159	0.431	97.954	91.782	8
TRC163	0.000	0.000	0.000	0.005	0.000	0.055	0.335	53.839	38.062	8
TRC164	0.000	0.000	0.000	0.082	0.000	0.240	9.094	97.965	49.210	8
TRC165	0.000	0.000	0.000	0.001	0.000	0.005	0.060	55.882	70.905	9
TRC166	0.000	0.000	0.000	0.000	0.000	0.011	0.328	45.857	14.939	8
TRC167	0.000	0.000	0.001	0.001	0.000	0.079	0.769	67.576	42.995	8
TRC168	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.999	9.148	9
TRC169	0.000	0.000	0.000	0.015	0.000	0.077	0.829	66.529	55.146	8
TRC170	0.000	0.000	0.000	0.003	0.000	0.016	0.607	76.998	48.386	8
TRC171	0.000	0.000	0.042	0.009	0.000	0.284	2.906	62.107	38.882	8
TRC172	0.000	0.000	0.000	0.057	0.000	0.014	0.104	26.751	31.678	9
TRC173	0.000	0.000	0.000	0.213	0.000	0.326	1.641	76.477	92.877	9
TRC174	0.000	0.000	0.000	0.011	0.000	0.005	0.122	51.062	81.868	9
TRC175	0.000	0.000	0.000	0.448	0.000	0.087	0.357	41.738	17.021	8
TRC176	0.000	0.000	0.000	0.000	0.000	0.002	0.077	0.306	0.159	8

TRC177	0.000	0.000	0.000	0.011	0.000	0.615	1.933	99.093	76.761	8
TRC178	0.000	0.000	0.001	0.001	0.000	0.019	0.328	59.735	43.789	8
TRC179	0.000	0.000	0.004	0.001	0.000	0.010	0.460	69.954	48.816	8
TRC180	0.000	0.000	0.000	0.000	0.000	0.001	0.018	17.004	9.250	8
TRC181	0.000	0.000	0.002	0.014	0.000	0.015	0.666	90.290	74.356	8
TRC182	0.000	0.000	0.000	0.005	0.000	0.046	0.126	89.906	91.435	9
TRC183	0.000	0.000	0.013	0.009	0.000	0.128	2.942	62.303	43.232	8
TRC184	0.000	0.000	0.000	0.017	0.000	0.033	1.228	83.063	22.789	8
TRC185	0.000	0.000	0.000	0.001	0.000	0.003	0.073	70.973	55.377	8
TRC186	0.000	0.000	0.000	0.000	0.000	0.007	0.165	51.582	41.052	8
TRC187	0.000	0.000	0.000	0.025	0.000	0.252	1.302	92.592	87.499	8
TRC188	0.000	0.000	0.000	0.004	0.000	0.031	0.075	8.696	20.634	9
TRC189	0.000	0.000	0.000	0.000	0.000	0.000	0.031	2.860	0.684	8
TRC190	0.000	0.000	0.001	15.285	0.000	0.192	16.375	98.266	2.857	8
TRC191	0.000	0.000	0.000	0.016	0.000	0.034	0.258	59.765	64.282	9
TRC192	0.000	0.000	0.000	0.000	0.000	0.001	0.073	33.179	5.652	8
TRC193	0.000	0.000	0.000	0.002	0.000	0.003	0.757	12.575	0.458	8
TRC194	0.001	0.000	0.019	0.009	0.000	0.027	2.939	57.438	41.141	8
TRC195	0.000	0.000	0.000	0.002	0.000	0.012	0.151	45.179	16.407	8
TRC196	0.000	0.000	0.000	0.000	0.000	0.003	0.133	58.431	17.222	8
TRC197	0.000	0.000	0.000	0.000	0.000	0.001	0.011	1.868	0.490	8
TRC198	0.000	0.000	0.008	0.001	0.000	0.024	1.570	65.663	16.372	8
TRC199	0.000	0.000	0.002	0.022	0.000	0.020	0.535	54.794	80.475	9
TRC200	0.000	0.000	0.000	0.000	0.000	0.000	0.037	9.098	9.409	9
TRC201	0.000	0.000	0.000	0.002	0.000	0.001	0.194	11.224	16.750	9
TRC202	0.001	0.000	0.002	0.012	0.000	0.041	0.212	23.037	31.422	9
TRC203	0.000	0.000	0.014	0.002	0.000	0.008	1.218	56.168	37.105	8
TRC204	0.000	0.000	0.000	0.236	0.000	0.157	0.677	18.075	56.408	9
TRC205	0.000	0.000	0.000	0.648	0.000	0.011	0.462	40.098	55.393	9
TRC206	0.000	0.000	0.000	0.004	0.000	0.011	0.094	30.479	51.516	9
TRC207	0.000	0.000	0.000	0.007	0.000	0.050	0.768	56.134	41.159	8
TRC208	0.000	0.000	0.000	0.010	0.000	0.022	0.683	52.833	88.876	9
TRC209	0.000	0.000	0.001	0.057	0.000	0.005	0.698	47.112	79.719	9
TRC210	0.000	0.000	0.000	0.502	0.000	0.935	2.808	80.920	29.561	8
TRC211	0.000	0.000	0.000	0.001	0.000	0.012	0.064	49.121	61.830	9
TRC212	0.000	0.000	0.000	0.001	0.000	0.006	0.031	13.912	16.015	9
TRC213	0.000	0.000	0.000	0.001	0.000	0.003	0.026	10.290	24.450	9
TRC214	0.000	0.000	0.000	0.005	0.000	0.011	0.080	24.397	51.559	9
TRC215	0.000	0.000	0.000	0.001	0.000	0.037	0.463	90.088	45.389	8
TRC216	0.000	0.000	0.000	0.001	0.000	0.022	0.514	1.140	0.084	8
TRC217	0.000	0.000	0.001	0.008	0.000	0.056	0.290	69.702	92.681	9
TRC218	0.000	0.000	0.001	0.000	0.000	0.004	0.971	62.442	10.401	8
TRC219	0.000	0.000	0.000	0.002	0.000	0.002	0.094	68.301	66.805	8
TRC220	0.000	0.000	0.000	0.009	0.000	0.010	0.138	72.570	72.696	9
TRC221	0.000	0.000	0.001	0.029	0.000	0.037	1.867	21.008	8.546	8

TRC222	0.000	0.000	0.000	0.003	0.000	0.018	0.096	84.720	90.490	9
TRC223	0.000	0.000	0.001	0.010	0.000	0.011	0.258	83.915	93.007	9
TRC224	0.000	0.000	0.000	0.020	0.000	0.081	0.454	91.022	95.970	9
TRC225	0.000	0.000	0.000	0.004	0.000	0.014	0.975	45.515	20.851	8
TRC226	0.000	0.000	0.000	0.004	0.000	0.004	0.153	58.450	84.622	9
TRC227	0.000	0.000	0.000	0.008	0.000	0.019	2.036	29.896	27.339	8
TRC228	0.000	0.000	0.004	0.002	0.000	0.098	1.474	70.189	33.812	8
TRC229	0.000	0.000	0.000	0.001	0.000	0.015	4.496	14.690	0.986	8
TRC230	0.000	0.000	0.000	0.010	0.000	0.027	0.107	57.984	93.991	9
TRC231	0.000	0.000	0.025	0.001	0.000	0.004	0.532	2.338	0.047	8
TRC232	0.000	0.000	0.000	0.009	0.000	0.104	0.390	95.400	97.995	9
TRC233	0.000	0.000	0.000	0.020	0.000	0.087	1.446	92.885	74.108	8
TRC234	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.760	0.566	8
TRC235	0.000	0.000	0.000	0.003	0.000	0.007	0.056	39.757	86.686	9
TRC236	0.000	0.000	0.000	0.007	0.000	0.014	0.698	32.010	18.597	8
TRC237	0.000	0.000	0.004	0.003	0.000	0.039	0.812	76.154	53.257	8
TRC238	0.000	0.000	0.000	0.008	0.000	0.001	0.060	24.869	17.488	8
TRC239	0.000	0.000	0.000	0.000	0.000	0.001	0.008	0.571	4.591	9
TRC240	0.000	0.000	0.000	0.001	0.000	0.001	0.025	18.549	24.874	9
TRC241	0.000	0.000	0.000	0.001	0.000	0.013	0.790	59.310	23.609	8
TRC242	0.000	0.000	0.000	0.033	0.000	0.006	0.070	70.585	50.458	8
TRC243	0.000	0.000	0.000	0.002	0.000	0.038	0.329	72.400	63.530	8
TRC244	0.000	0.000	0.000	0.001	0.000	0.017	0.195	67.677	46.879	8
TRC245	0.000	0.000	0.000	0.001	0.000	0.049	0.300	10.402	12.356	9
TRC246	0.000	0.000	0.000	0.023	0.000	0.238	0.505	60.356	51.834	8
TRC247	0.000	0.000	0.000	0.014	0.000	0.008	0.072	32.883	20.396	8
TRC248	0.000	0.000	0.000	0.000	0.000	0.000	0.250	42.166	7.423	8
TRC249	0.000	0.000	0.000	0.002	0.000	0.008	0.081	36.931	41.952	9
TRC250	0.000	0.000	0.000	0.000	0.000	0.002	0.016	24.733	19.242	8
TRC251	0.000	0.000	0.000	0.025	0.000	0.002	0.091	53.988	51.148	8
TRC252	0.000	0.000	0.000	0.001	0.000	0.016	0.090	80.333	69.141	8
TRC253	0.000	0.000	0.005	0.004	0.000	0.020	1.562	18.185	10.012	8
TRC254	0.000	0.000	0.000	0.000	0.000	0.009	0.123	35.144	10.659	8
TRC256	0.000	0.001	0.000	0.001	0.000	0.085	0.322	62.686	37.881	8
TRC257	0.000	0.000	0.000	0.000	0.000	0.004	0.087	31.038	8.164	8
TRC258	0.000	0.000	0.003	0.001	0.000	0.042	0.721	69.355	38.224	8
TRC259	0.000	0.000	0.000	0.024	0.000	0.003	0.166	32.800	6.211	8
TRC260	0.000	0.000	0.000	0.001	0.000	0.093	0.475	92.974	78.153	8
TRC261	0.000	0.000	0.000	0.022	0.000	0.025	0.319	85.657	41.435	8

Summary of Probabilities for Specimens in the file PC-TRCA

Group:

-----	0.01000	0.10000	1.00000	5.00000	10.00000	20.00000	100.00000
PC-E1	153	0	0	0	0	0	0
PC-E2	153	0	0	0	0	0	0
PC-E3	147	6	0	0	0	0	0
PC-E4	102	38	11	1	0	1	0
PC-E5	153	0	0	0	0	0	0
PC-E6	61	71	20	1	0	0	0
PC-SF	2	39	80	28	3	1	0
PC-CF	1	0	4	7	8	14	119
PC-TRCS	1	3	8	10	13	19	99

Probability Cutoff Values:

Summary of Best Classification of Projected Specimens:

	PC-E2	PC-E3	PC-E4	PC-E5	PC-E6	PC-SF	PC-CF	PC-TRCS	Total
From Group:									
PC-TRCA	0	0	0	0	0	1	102	50	153
Total	0	0	0	0	0	1	102	50	153

Classified Into Group:

APPENDIX G:

ANALYSIS OF THE FATTY ACID COMPOSITIONS OF ARCHAEOLOGICAL POTTERY AND ROCK RESIDUES FROM THE VARGA SITE (41ED28)

ANALYSIS OF THE FATTY ACID COMPOSITIONS OF ARCHAEOLOGICAL POTTERY AND ROCK RESIDUES FROM THE VARGA SITE (41ED28)

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G.1 INTRODUCTION

Eight pieces of pottery and 94 limestone samples from the Varga Site (41ED28) in Edwards County, Texas, were submitted for fatty acid analysis. Where necessary, subsamples were taken from larger pieces. Exterior surfaces were ground off to remove any contaminants. Samples were powdered, and absorbed lipid residues were extracted with organic solvents. Fatty acid components of the lipid extracts were analyzed using gas chromatography (GC). Residues were identified using criteria developed from the decomposition patterns of experimental residues. The first section of this appendix outlines the development of the identification criteria. Following this, analytical procedures and results are presented.

G.2 FATTY ACIDS AND DEVELOPMENT OF THE IDENTIFICATION CRITERIA

G.2.1 Introduction and Previous Research

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, which consist of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The “Cx” refers to a fatty acid with a carbon chain length of “x” number of atoms. The “y” represents the number of double bonds or points of unsaturation, and the “ωz” indicates the location of the most distal double bond on the carbon chain (i.e., closest to the methyl end). Thus, the fatty acid expressed as C18:1ω9, refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin et al. (1976), GC has been used extensively to analyze the fatty acid component of absorbed archaeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archaeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols, or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and non-volatile products that continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Attempts have been made to identify archaeological residues using criteria that discriminate uncooked foods (Marchbanks 1989; Skibo 1992; Loy 1994). Marchbanks' (1989) percent of saturated fatty acids (%S) criteria has been applied to residues from a variety of materials, including pottery, stone tools, and burned rocks (Marchbanks 1989; Marchbanks and Quigg 1990; Collins et al. 1990). Skibo (1992:89) could not apply the %S technique and instead used two ratios of fatty acids, C18:0/C16:0 and C18:1/C16:0. He (1992) reported that it was possible to link the uncooked foods with residues extracted from modern cooking pots actively used to prepare one type of food; however, the ratios could not identify food mixtures. The utility of these ratios did not extend to residues extracted from archaeological potsherds because the ratios of the major fatty acids in the residue changed with decomposition (Skibo 1992:97). Loy (1994)

proposed the use of a Saturation Index (SI), determined by the following ratio:

$$SI = 1 - [(C18:1 + C18:2) / (C12:0 + C14:0 + C16:0 + C18:0)]$$

He (1994) admitted, however, that poorly understood decomposition changes to the original suite of fatty acids make it difficult to develop criteria for distinguishing animal and plant fatty acid profiles in archaeological residues.

The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992), and Loy (1994) is that they have never been empirically tested. The proposed ratios are based on criteria that discriminate among food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decomposition changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archaeological samples.

To identify a fatty acid ratio unaffected by degradation processes, Patrick et al. (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded to identify a stable fatty acid ratio. Patrick et al. (1985) found that the ratio of two C18:1 isomers, oleic and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archaeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick et al. (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

G.2.2 Development of the Identification Criteria

As the first stage in developing the identification criteria used herein, the fatty acid compositions

of more than 130 uncooked native food plants and animals from Western Canada were determined using GC (Malainey 1997; Malainey et al. 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature (Table G-1). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens, and berries/seeds/nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries/seeds/nuts.

Samples in Cluster A, the large mammal and fish cluster, had elevated levels of C16:0 and C18:1 (Table G-1). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat, and high levels of very-long-chain unsaturated (VLCU) fatty acids in fish. Differences in the fatty acid composition of plant roots, greens, and berries/seeds/nuts reflect the amounts of C18:2 and C18:3 ω 3 present. The berry, seed, nut, and small mammal meat samples appearing in Cluster B have very high levels of C18:2, ranging from 35 to 64 percent (Table G-1). Samples in Subclusters V, VI and VII have levels of C18:1 isomers from 29 to 51 percent as well. Plant roots, plant greens, and some berries appear in Cluster C. All Cluster C samples have moderately high levels of C18:2; except for the berries in Subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3 ω 3 and/or very-long-chain saturated (VLCS) fatty acids are also common except in the roots that form Subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland, and forests of Western Canada were prepared by cooking samples of meats, fish, and plants, alone

or combined, in replica vessels over an open fire (Malainey 1997; Malainey et al. 1999b). After four days at room temperature, the vessels were broken and a set of sherds was analysed to determine changes after a short term of decomposition. A second set of sherds remained at room temperature for 80 days, and was then placed in an oven at 75°C for a period of 30 days to simulate the processes of long-term decomposition. The relative percentages were calculated on the basis of the 10 fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1w9, C18:1w11, and C18:2) that regularly appeared in Precontact Period vessel residues from Western Canada. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archaeological residues (Table G-2).

It was determined that levels of medium-chain fatty acids (C12:0, C14:0, and C15:0), C18:0, and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey et al. 1999b). These fatty acids are suitable for the identification criteria because saturated fatty acids are stable and the mono-unsaturated fatty acid degrades very slowly as compared to polyunsaturated fatty acids (deMan 1992). Higher levels of medium-chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens, and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0 were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally; the seventh type,

plant with large herbivore, was inferred (Table G-2). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey et al. 1999c; 2001b). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Continuing work has resulted in further understanding of the decomposition patterns of various foods and food combinations (Malainey et al. 2000a, 2000b, 2000c, 2001a; Quigg et al. 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano* Berlandier), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasyllirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*) and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg et al. 2000) or as a griddle. To accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75°C. After either 30 or 68 days, residues were extracted and analysed using GC.

The results of these decomposition studies enabled refinement of the identification criteria.

G.3 METHODOLOGY

Descriptions of the 102 samples from the Varga Site are presented in Table G-3. Possible contaminants were removed by grinding off

exterior surfaces with a Dremel[®] tool fitted with a silicon carbide bit. Immediately thereafter, each sample was crushed with a hammer mortar and pestle and the powder was transferred to an Erlenmeyer flask. Lipids were extracted using a variation of the method developed by Folch et al. (1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2 x 30 mL) using ultrasonication (2 x 10 min). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 16 mL of double-distilled water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform was removed by rotary evaporation. Any remaining water was removed by evaporation with benzene (1.5 mL). 1.5 mL of chloroform-methanol (2:1, v/v) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon[®]-lined cap. The sample was flushed with nitrogen and stored in a -20°C freezer.

A 450-μL sample of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 6 mL of 0.5-N anhydrous hydrochloric acid in methanol (68°C; 60 min). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 4 mL of double-distilled water was added. FAMES were recovered with petroleum ether (3 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen. The FAMES were dissolved in 75 μL of *iso*-octane, then transferred to a GC vial with a conical glass insert.

Solvents and chemicals were checked for purity by running a sample blank. The entire lipid extraction and methyl esterification process was

performed and FAMES were dissolved in 75 μL of *iso*-octane. Traces of contamination were subtracted from sample chromatograms. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample.

The step in the extraction procedure during which the chloroform, methanol, and lipid mixture is washed with water is a standard procedure for extracting lipids from modern samples. Following Evershed et al. (1990), who reported that this step was unnecessary for the analysis of archaeological residues, previously the solvent-lipid mixture was not washed. This step was recently adopted to remove impurities so that clearer chromatograms could be obtained in the region where very-long-chain fatty acids (C20:0, C20:1, C22:0, and C24:0) occur. It was anticipated that the detection and accurate assessment of these fatty acids could be instrumental in separating residues of animal origin from those of plant (Malainey et al. 2000a, 2000b, 2000c, 2001a).

To identify the residue, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very-long-chain fatty acids [see Table G-4]) and secondly with respect to the 10 fatty acids utilized in developing the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1w9, C18:1w11, and C18:2 [not shown]). The second step is necessary for the application of the identification criteria presented in Table G-2.

It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues. It is possible only to say that the

material of origin for the residue was similar in composition to the food(s) indicated.

G.3.1 Gas Chromatography Analysis Parameters

The GC analysis was performed on a Hewlett-Packard 5890 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a DB-23 fused silica capillary column (30 m x 0.25 mm ID; J&W Scientific, Folsom, California). An autosampler injected a 3- μ L sample using a split injection system with the ratio set at 1:20. Hydrogen was used as the carrier gas at a linear velocity of approximately 40 cm/sec. Column temperature was programmed from 155 to 215°C at 2°C per minute. The lower temperature was held for two minutes, and the upper temperature was held for 10 minutes. Chromatogram peaks were integrated using ChromPerfect® software and identified through comparisons with several external qualitative standards (NuCheck Prep; Elysian, Minnesota). Using this procedure, fatty acids are detectable to the nanogram (1×10^{-9} g) level.

G.4 RESULTS OF ARCHAEOLOGICAL DATA ANALYSIS

The fatty acid compositions of residues extracted from 101 samples from the Varga Site are presented in Table G-4. The term “Area” represents the area under the chromatographic peak of a given fatty acid, as calculated by the ChromPerfect® software minus the solvent blank. The term “Rel%” represents the relative percentage of the fatty acid with respect to the total fatty acids in the sample. Hydroxide or peroxide degradation products can interfere with the integration of the C22:0 and C22:1 peaks; these fatty acids were excluded. In some Varga Site samples, similar interference occurred with the C18:3 peak.

Insufficient fatty acids were recovered from one residue, 4VG 52, to attempt identification. Fatty acid recoveries were very low in five samples—4VG 8, 4VG 34, 4VG 62, 4VG 63, and 4VG 66.

Many of the Varga Site residues have significantly elevated levels of C18:1 isomers, which indicates the presence of fat or oil in the residue. Levels of C18:1 isomers in 14 residues are very high, ranging from more than 52 to 65 percent. These residues include 4VG 42, 4VG 44, 4VG 45, 4VG 47, 4VG 48, 4VG 51, 4VG 53, 4VG 59, 4VG 60, 4VG 73, 4VG 84, 4VG 86, 4VG 97, and 4VG 100. These levels were observed in the decomposed residues of foods of very-high-fat-content seeds or nuts, such as piñon. Rendered fats of certain mammals (other than large herbivores) exhibit similarly very high levels of fat content. All 14 residues have elevated levels of C18:2, between 6.62 and 14.45 percent. For this reason, they probably represent the residues of plant foods.

A total of 23 residues are characterized by high levels of C18:1 isomers, from 39.41 to 48.36 percent. Of these, 21 also have levels of C18:2 above five percent, which suggests that they are of plant origin. The residues include 4VG 13, 4VG 19, 4VG 26, 4VG 37, 4VG 41, 4VG 49, 4VG 50, 4VG 54, 4VG 64, 4VG 65, 4VG 70, 4VG 71, 4VG 75, 4VG 76, 4VG 78, 4VG 79, 4VG 87, 4VG 93, 4VG 94, 4VG 99, and 4VG 102. The most probable sources of these residues are locally available high-fat-content seeds and nuts. It is possible that the seeds or nuts were even those that produce residues with higher levels of C18:1 isomers (as described above); however, these residues are simply older and more decomposed. Monounsaturated fats, such as C18:1, slowly decompose over time, and the relative amount in a sample drops. Alternatively, a combination of moderate-high- and very-high-fat-content foods could produce similar residues. Two other

residues, 4VG 11 and 4VG 39, have high levels of C18:1 isomers but levels of C18:2 are low. Levels of neither medium nor very-long-chain saturated fatty acids are significantly elevated. The origin of these two residues is ambiguous (possibly animal).

A total of 11 residues fall on the border between moderate-high- and high-fat-content foods, and all are likely to be of plant origin. Differences in fatty acid compositions may indicate that more than one type of seed or nut produced these residues. Residues 4VG 3, 4VG 7, 4VG 8, and 4VG 28 all have elevated levels of medium-chain fatty acids. Residue 4VG 27 has elevated levels of very-long-chain saturated fatty acids. Residue 4VG 67 has a very high level of C18:2. In the other five residues, 4VG 35, 4VG 38, 4VG 43, 4VG 56, and 4VG 58, levels of all three indicators of the presence of plants are somewhat elevated.

Twenty-four residues are typical of foods of moderate-high fat content. These residues have fairly high levels of C18:1 isomers and somewhat lower levels of C18:0. Examples of moderate-high-fat-content foods include Texas ebony seeds and the fatty meat of medium-sized mammals, such as beaver. Of the 24 samples, 17 have strong indications of a plant origin; in the remaining seven samples, a plant origin is slightly favored. Nine residues are characterized by elevated levels of medium-chain fatty acids and rather low levels of C18:2. The level of C18:2 is less than five percent in 4VG 4, 4VG 5, 4VG 6, and 4VG 101; residues 4VG 30, 4VG 32, 4VG 33, 4VG 55, and 4VG 90 have only slightly higher levels of C18:2. It is possible that these residues have a common plant origin. Conversely, four residues have rather low levels of medium-chain fatty acids (6.36 percent and less) and levels of C18:2 ranging between 8.91 and 13.01 percent. These include 4VG 25, 4VG 29, 4VG 77, and 4VG 88. In four residues, both the medium-chain fatty

acids and C18:2 levels are elevated; these include 4VG 22, 4VG 89, 4VG 92 and 4VG 98. The final group, consisting of seven residues, is characterized by rather low levels of medium-chain fatty acids and only slightly elevated levels of C18:1. The origin of these residues is more ambiguous, but a plant source is slightly favored. These residues include 4VG 9, 4VG 34, 4VG 72, 4VG 80, 4VG 83, 4VG 95, and to a lesser degree 4VG 82.

Nine residues fall on the border between medium- and moderate-high-fat-content foods. On the basis of their elevated levels of C18:2, eight residues are probably of plant origin. These residues include 4VG 15, 4VG 18, 4VG 20, 4VG 36, 4VG 57, 4VG 66, 4VG 74, and 4VG 91. The origin of 4VG 10 is somewhat ambiguous, but a plant source is slightly favored.

Nine samples have elevated levels of C18:0, which occurs in residues produced from large herbivore meat. Other foods known to produce similar residues include javelina meat and the seed oils of certain tropical plants, such as sotol. Two residues, 4VG 1 and 4VG 2, appear to result from the preparation of lean meat or tropical seed oils alone. Six residues are similar in that levels of C18:1 isomers are elevated. Low levels of medium-chain fatty acids, C18:2, and VLCS fatty acids are found in two residues, 4VG 12 and 4VG 14; this is similar to residues of fatty or somewhat fatty large herbivore meat prepared alone. Four other residues, 4VG 16, 4VG 21, 4VG 23, and 4VG 24, are similar to those resulting from the preparation of fatty or somewhat fatty large herbivore meat; but they also have elevated levels of C18:2 and slightly elevated levels of VLCS fatty acids. This may indicate that the source was plant or that plants were mixed with meat. One residue, 4VG 17, was consistent with large herbivore prepared with plant or bone marrow.

Residue 4VG 63 falls on the border between medium-fat-content plant and large herbivore prepared with plant or bone marrow.

G.5 DISCUSSION

G.5.1 Residues by Artifact Type

Two artifact types, pottery and burned limestone rocks, were submitted for analysis. Residues extracted from the eight pottery sherds included two identified as large herbivore and three identified as moderate-high-fat-content food, likely to be of plant origin. The other three residues fell on the border between moderate-high- and high-fat-content food; all were likely to be of plant origin.

Ninety-four residues were extracted from burned limestone. Seventy-three, representing 77.7 percent of all burned rock residues, contain significantly elevated levels of fat or oil. Of these 73 residues, 64 (or 86.5 percent) are consistent with nuts or seeds with fat contents ranging from moderate-high to very high. Residues from 14 burned rocks were identified as very-high-fat-content food; all of which are likely to be of plant origin. Seven other burned rock residues fell on the border between high- and very-high-fat-content food, likely to be of plant origin. Twenty-three residues were identified as high-fat-content food, 21 of which were probably plants. Another eight residues fell on the border between high and moderate-high-fat-content food; all were probably of plant origin. A further 21 residues were identified as moderate-high-fat-content foods, 15 of which were probably plants.

Twenty residues had somewhat lower levels of fat or oil. Nine residues fell on the border between moderate-high- and medium-fat-content foods; all but one of these residues probably originated from plants. Two residues were identified as medium-fat-content food, both of which are likely to be of plant origin. One

residue was consistent with a low-fat-content plant. Eight residues may reflect the preparation of large herbivore products. One residue fell on the border between medium-fat-content plant and large herbivore prepared with plant or bone marrow. One residue was identified as large herbivore prepared with plant or bone marrow. Six residues are consistent with fatty or somewhat fatty large herbivore meat prepared alone or with plants.

The residue extracted from one sample of burned limestone contained insufficient fatty acids for analysis.

G.5.2 Residues by Component

G.5.2.1 Mission Period (After 250 B.P.)

Residues from two samples of pottery were analyzed from the Mission Period component (ca. 250 B.P. ff.); both are similar in composition to lean, large herbivore meat, javelina meat, and the tropical oils from the seeds of plants, such as sotol.

G.5.2.2 Late Prehistoric (Toyah Phase) Component (ca. 300 to 650 B.P.)

Residues from six pieces of pottery and 29 fragments of burned limestone were analyzed from the Late Prehistoric Period (Toyah Phase) component (ca. 300 to 650 B.P.). With respect to the pottery, three residues were characterized as moderate-high-fat-content foods likely to be of plant origin. The other three residues were similar in composition to moderate-high-fat-content foods likely to be of plant origin.

The Toyah Phase component burned rock residues were unique in two respects. Several Toyah Phase burned rocks contained residues similar in composition to large herbivore in that they had significantly elevated levels of C18:0.

Unlike the Archaic Period components, none of the Toyah Phase burned rocks contained residues identified as very-high-fat-content foods. Of the burned rock residues, five were identified as high-fat-content foods, four of which were probably of plant origin. Three fell on the border between moderate-high and high-fat-content food, and all were probably of plant origin. Of the eight residues identified as moderate-high-fat-content food, all but one were probably of plant origin. Similarly, four of the five residues identified as borderline medium and moderate-high-fat-content foods are likely of plant origin. One residue was identified as food of medium fat content and is likely to be of plant origin.

Seven of the Toyah Phase burned rock residues appear to result from the preparation of large herbivore products, javelina meat, or tropical seed oils. In two cases, the residues were similar to fatty or somewhat fatty meat prepared alone; in four other cases, residues resembled somewhat fatty large herbivore meat prepared with plants. One residue was similar in composition to large herbivore meat prepared with a moderate-fat-content plant or bone marrow.

G.5.2.3 Late Archaic Component (ca. 1700 to 2300 B.P.)

Thirty-four burned rock residues were analyzed from the Late Archaic component of the Varga site. Nine of the residues were identified as very-high-fat-content foods that were probably of plant origin. Four residues bordered very-high- and high-fat-content foods, and all were likely of plant origin. Nine were identified as high-fat-content foods, eight of which were probably of plant origin. Five were characterized as falling on the border between moderate-high- and high-fat-content food; all were probably of plant origin. One residue was identified as a moderate-high-fat-content food

likely of plant origin. Two residues were identified as borderline medium and moderate-high-fat-content foods and likely of plant origin. One residue was identified as food of medium fat content likely to be of plant origin. One residue was similar in composition to a low-fat-content plant. One residue fell on the border between medium-fat-content foods and the combination of large herbivore meat and medium-fat-content plant or large herbivore bone marrow. One Late Archaic burned rock residue contained insufficient fatty acids for analysis.

G.5.2.4 Middle Archaic Component (ca. 3900 to 4820 B.P.)

Of the nine burned rock residues analyzed from the Middle Archaic Period component (ca. 3900 to 4820 B.P.), all but two are likely to be of plant origin. Only one of the three residues identified as moderate-high-fat-content food has strong indications of a plant origin. Other Middle Archaic residues include one identified as very-high-fat-content food and four identified as high-fat-content food. One residue was identified as borderline medium and moderate-high-fat-content food, likely to be of plant origin.

G.5.2.5 Early Archaic Component (ca. 5200 to 6300 B.P.)

Twenty-two burned rock residues were analyzed from the Early Archaic Period component (ca. 5200 to 6300 B.P.). Four were identified as very-high-fat-content foods likely of plant origin. Three residues bordered very-high- and high-fat-content foods, and all were likely of plant origin. Five were identified as high-fat-content foods, all of which were likely from plants. A total of nine residues were identified as moderate-high-fat-content foods; of these, the source of six was probably plants. One residue fell on the border between medium and

moderate-high-fat-content foods; it was likely of plant origin.

G.5.3 Residues by Feature

G.5.3.1 Late Prehistoric (Toyah) Features

Limestone and pottery samples were analyzed from seven features associated with the Late Prehistoric Period (Toyah Phase) component.

Feature 8

Six residues were analyzed. Two were identified as high-fat-content foods, one of which was likely to be of plant origin. Two were similar in composition to fatty or somewhat fatty large herbivore meat. One was identified as moderate-high-fat-content food. One bordered on medium- and moderate-high-fat-content food.

Feature 9

Four residues were analyzed. Two bordered on medium- and moderate-high-fat-content food, likely to be of plant origin. One was similar in composition to fatty large herbivore meat, possibly prepared with plants. Another was identified as large herbivore meat cooked with plant or bone marrow.

Feature 18

The two residues from this feature were identified as moderate-high-fat-content food, likely of plant origin.

Feature 21

Three residues were analyzed. Two were identified as moderate-high-fat-content food of probable plant origin. The other was identified as medium-fat-content food, likely to be of plant origin.

Feature 25

Of the five residues analyzed, one was identified as high-fat-content food, likely to be of plant origin. One bordered moderate-high- and high-fat-content food; it was probably from plant. One was identified as moderate-high-fat-content food and another bordered medium-high-fat-content food, both of which were probably plants. The fifth residue was similar in composition to somewhat fatty large herbivore meat, possibly prepared with plant.

Feature 36

Two of the three residues fell on the border between moderate-high- and high-fat-content food, and the other was identified as moderate-high-fat-content food. All three were likely from plants.

Feature 38

One residue was identified as high-fat-content food and two were identified as moderate-high-fat-content food; all were likely of plant origin. Two residues were similar in composition to somewhat fatty large herbivore meat, possibly prepared with plant.

G.5.3.2 Late Archaic Features

Limestone samples were analyzed from eight features associated with the Late Archaic Period component.

Feature 1

Thirteen residues were analyzed from this feature. Two were identified as very-high-fat-content food, two fell on the border between high- and very-high-fat-content food, and three were identified as high-fat-content food. All seven were likely of plant origin. One residue fell on the border between moderate-high- and high-fat-content food. Two fell on the border between medium and moderate-high-fat-content

food; both of which were likely of plant origin. One residue was identified as medium-fat-content food and one as low-fat-content food; both likely represent plant residues. The last residue fell on the border between medium-fat-content food and large herbivore prepared with plant, or bone marrow.

Feature 1a

Two residues were identified as very-high-fat-content food and one fell on the border between high- and very-high-fat-content food. All three were likely of plant origin.

Feature 1b

One residue fell on the border between high- and very-high-fat-content food of probable plant origin. Two residues were identified as high-fat-content food; one is likely of plant origin. Two fell on the border between moderate-high- and high-fat-content food; both were likely of plant origin.

Feature 1c

One residue was identified as very-high-fat-content food, one was identified as high-fat-content food, and one fell on the border between moderate-high- and high-fat-content food. All three appear to represent plant residues.

Feature 1d

One residue was identified as very-high-fat-content food and two others were identified as high-fat-content food. The three were all likely of plant origin.

Feature 15

One residue was identified as high-fat-content food, one as moderate-high-fat-content food and another fell on the border between moderate-high- and high-fat-content food. All three likely originated from plants.

Feature 28

One residue was identified as very-high-fat-content food of probable plant origin. One residue contained insufficient fatty acid for analysis.

Feature 29

Both residues were identified as very-high-fat-content food, likely of plant origin.

G.5.3.3 Middle Archaic Features

Limestone samples were analyzed from two features associated with the Middle Archaic Period component.

Feature 11

One residue was identified as very-high-fat-content food. One was identified as high-fat-content food. One fell on the border between medium- and moderate-high-fat-content food. These three residues were likely of plant origin. The origin of one residue, identified as moderate-high-fat-content food, is ambiguous.

Feature 37

Four residues were analyzed. Two were identified as high-fat-content food likely to be of plant origin. The other two were identified as moderate-high-fat-content food.

G.5.3.4 Early Archaic Features

Limestone samples were analyzed from six features associated with the Early Archaic Period component.

Feature 12

The three residues were identified as very-high-fat-content, high-fat-content, and moderate-high-fat-content food; all were likely plant foods.

Feature 13

One residue was identified as very-high-fat-content food, one fell on the border between high- and very-high-fat-content food. One residue was identified as high-fat-content food and the other as moderate-high-fat-content food. All four residues were likely of plant origin.

Feature 26

One residue fell on the border between high- and very-high-fat-content food, likely a plant food. Two other residues were identified as moderate-high-fat-content food.

Feature 31

Two residues were identified as very-high-fat-content food. One was identified as high-fat-content food and one fell on the border between high- and very-high-fat-content food. All were probably derived from plants.

Feature 39

Three of the four residues were identified as moderate-high-fat-content food. One fell on the border between medium and moderate-high-fat-content food. All four were likely of plant origin.

Feature 40

Two residues were identified as high-fat-content food likely of plant origin. Two others were identified as moderate-high-fat-content food, one of which was probably of plant origin.

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**Table G-1. Summary of Average Fatty Acids Compositions
of Modern Food Groups Generated by Hierarchical Cluster Analysis**

Cluster	A					B					C				
Subcluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Type	Mammal Fat and Marrow	Large Herbivore Meat	Fish	Fish	Berries and Nuts	Mixed	Seeds and Berries	Roots	Seeds	Mixed	Greens	Berries	Roots	Greens	Roots
C16:0	19.90	19.39	16.07	14.10	3.75	12.06	7.48	19.98	7.52	10.33	18.71	3.47	22.68	24.19	18.71
C18:0	7.06	20.35	3.87	2.78	1.47	2.36	2.58	2.59	3.55	2.43	2.48	1.34	3.15	3.66	5.94
C18:1	56.77	35.79	18.28	31.96	51.14	35.29	29.12	6.55	10.02	15.62	5.03	14.95	12.12	4.05	3.34
C18:2	7.01	8.93	2.91	4.04	41.44	35.83	54.69	48.74	64.14	39.24	18.82	29.08	26.24	16.15	15.61
C18:3	0.68	2.61	4.39	3.83	1.05	3.66	1.51	7.24	5.49	19.77	35.08	39.75	9.64	17.88	3.42
VLCS	0.16	0.32	0.23	0.15	0.76	4.46	2.98	8.50	5.19	3.73	6.77	9.10	15.32	18.68	43.36
VLCU	0.77	4.29	39.92	24.11	0.25	2.70	1.00	2.23	0.99	2.65	1.13	0.95	2.06	0.72	1.10

VLCS Very-Long-Chain (C20, C22, and C24) Saturated Fatty Acids

VLCU Very-Long-Chain (C20, C22, and C24) Unsaturated Fatty Acids

Table G-2. Criteria for the Identification of Archaeological Residues Based on the Decomposition Patterns of Experimental Cooking Residues Prepared in Pottery Vessels

Identification	Medium Chain	C18:0	C18:1 Isomers
Large Herbivore	$\leq 15\%$	$\geq 27.5\%$	$\leq 15\%$
Large Herbivore with Plant or Bone Marrow	Low	$\geq 25\%$	$15\% \leq X \leq 25\%$
Plant with Large Herbivore	$\geq 15\%$	$\geq 25\%$	No data
Beaver	Low	Low	$\geq 25\%$
Fish or Corn	Low	$\leq 25\%$	$15\% \leq X \leq 27.5\%$
Fish or Corn with Plant	$\geq 15\%$	$\leq 25\%$	$15\% \leq X \leq 27.5\%$
Plant (except corn)	$\geq 10\%$	$\leq 27.5\%$	$\leq 15\%$

Table G-3. List of Samples Analyzed from the Varga Site

Lab No.	Specimen No.	Fea. No.	Description	Sample Mass (g)	Lab No.	Specimen No.	Fea. No.	Description	Sample Mass (g)
Mission (Historic) Period					Late Archaic Period (cont)				
4VG 1	1872-32a	NA	Ceramic	5.255	4VG 52	941-5-3-1a	28	Limestone	31.702
4VG 2	1872-6a	NA	Ceramic	17.486	4VG 53	941-5-3-2a	28	Limestone	14.793
Late Prehistoric Period (Toyah Phase)					4VG 54	801-5-3-1a	15	Limestone	37.525
4VG 3	900-8-1a		Ceramic	3.471	4VG 55	801-5-3-2a	15	Limestone	33.608
4VG 4	901-8-1a		Ceramic	3.364	4VG 56	801-5-3-3a	15	Limestone	35.608
4VG 5	965-8-1a		Ceramic	8.625	4VG 57	263-5-3-1a	1	Limestone	46.119
4VG 6	1030-5-4-8-1a	38	Ceramic	10.370	4VG 58	274-5-3-2a	1b	Limestone	31.957
4VG 7	1055-5-8-1a	25	Ceramic	8.822	4VG 59	187-5-3-2a	1	Limestone	43.245
4VG 8	1157-8-1a		Ceramic	6.001	4VG 60	80-5-3-1a	1	Limestone	44.253
4VG 9	865-5-3-1a	8	Limestone	31.036	4VG 61	187-5-3-1a	1	Limestone	13.642
4VG 10	865-5-3-2a	8	Limestone	30.543	4VG 62	179-5-3-2a	1	Limestone	18.589
4VG 11	865-5-3-3a	8	Limestone	44.009	4VG 63	98-5-3-1a	1	Limestone	15.576
4VG 12	843-5-3-1a	8	Limestone	31.167	4VG 64	179-5-3-1a	1	Limestone	35.177
4VG 13	843-5-3-2a	8	Limestone	37.451	4VG 65	274-5-3-1a	1b	Limestone	18.769
4VG 14	843-5-3-3a	8	Limestone	53.606	4VG 66	178-5-3-1a	1	Limestone	23.904
4VG 15	830-5-3-1a	9	Limestone	41.093	4VG 67	370-5-3-1a	1	Limestone	12.522
4VG 16	830-5-3-2a	9	Limestone	49.204	4VG 68	161-5-3-1a	1	Limestone	45.875
4VG 17	830-5-3-3a	9	Limestone	41.486	4VG 69	352-5-3-1a	1	Limestone	30.531
4VG 18	830-5-3-4a	9	Limestone	40.336	4VG 70	352-5-3-2a	1	Limestone	44.617
4VG 19	1051-5-3-1a	25	Limestone	15.747	4VG 71	81-5-3-1a	NA	Limestone	17.344
4VG 20	1051-5-3-2a	25	Limestone	17.006	Middle Archaic Period				
4VG 21	1051-5-3-3a	25	Limestone	14.082	4VG 72	276-5-3-1a	NA	Limestone	14.974
4VG 22	1051-5-3-4a	25	Limestone	21.803	4VG 73	515-5-3-1a	11	Limestone	25.918
4VG 23	1030-5-3-1a	38	Limestone	10.968	4VG 74	575-5-3-1a	11	Limestone	17.139
4VG 24	1030-5-3-2a	38	Limestone	19.288	4VG 75	583-5-3-1a	11	Limestone	24.281
4VG 25	1030-5-3-3a	38	Limestone	31.900	4VG 76	276-5-3-2a	NA	Limestone	43.454
4VG 26	1030-5-3-4a	38	Limestone	55.094	4VG 77	37-5-3-1a	37	Limestone	22.598
4VG 27	158-5-3-1a	36	Limestone	31.410	4VG 78	37-5-3-2a	37	Limestone	35.521
4VG 28	158-5-3-2a	36	Limestone	49.920	4VG 79	37-5-3-3a	37	Limestone	27.601
4VG 29	158-5-3-3a	36	Limestone	20.515	4VG 80	37-5-3-4a	37	Limestone	17.946
4VG 30	79-5-3-1a	21	Limestone	22.239	Early Archaic Period				
4VG 31	79-5-3-2a	21	Limestone	24.390	4VG 81	616-5-3-1a	26	Limestone	45.476
4VG 32	79-5-3-3a	21	Limestone	41.918	4VG 82	616-5-3-2a	26	Limestone	49.911
4VG 33	534-5-3-1a	18	Limestone	34.907	4VG 83	616-5-3-3a	26	Limestone	9.676
4VG 34	534-5-3-2a	18	Limestone	15.256	4VG 84	756-5-3-1a	31	Limestone	33.631
4VG 35	1005-3-1a	NA	Limestone	20.347	4VG 85	756-5-3-2a	31	Limestone	41.419
4VG 36	79-3-1a	NA	Limestone	25.052	4VG 86	756-5-3-3a	31	Limestone	44.018
4VG 37	79-3-2a	NA	Limestone	30.466	4VG 87	756-5-3-4a	31	Limestone	20.813
Late Archaic Period					4VG 88	203-5-3-1a	39	Limestone	27.897
4VG 38	273-5-3-1a	1b	Limestone	36.792	4VG 89	203-5-3-2a	39	Limestone	31.091
4VG 39	273-5-3-2a	1b	Limestone	19.717	4VG 90	203-5-3-3a	39	Limestone	19.210
4VG 40	273-5-3-3a	1b	Limestone	41.461	4VG 91	203-5-3-4a	39	Limestone	43.183
4VG 41	293-5-3-1a	1c	Limestone	57.633	4VG 92	128-5-3-1a	40	Limestone	40.440
4VG 42	293-5-3-2a	1c	Limestone	19.999	4VG 93	128-5-3-2a	40	Limestone	31.139
4VG 43	293-5-3-3a	1c	Limestone	35.197	4VG 94	128-5-3-3a	40	Limestone	18.126
4VG 44	89-5-3-1a	1a	Limestone	30.529	4VG 95	128-5-3-4a	40	Limestone	29.114
4VG 45	89-5-3-2a	1a	Limestone	51.168	4VG 96	658-5-3-1a	13	Limestone	59.587
4VG 46	89-5-3-3a	1a	Limestone	47.914	4VG 97	658-5-3-2a	13	Limestone	28.019
4VG 47	966-5-3-1a	29	Limestone	14.302	4VG 98	658-5-3-3a	13	Limestone	20.140
4VG 48	962-5-3-1a	29	Limestone	31.375	4VG 99	658-5-3-4a	13	Limestone	39.579
4VG 49	11-5-3-1a	1d	Limestone	22.206	4VG 100	644-5-3-1a	12	Limestone	27.033
4VG 50	11-5-3-2a	1d	Limestone	41.968	4VG 101	644-5-3-2a	12	Limestone	44.261
4VG 51	11-5-3-3a	1d	Limestone	46.867	4VG 102	644-5-3-3a	12	Limestone	40.073

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site

Fatty Acid	4VG 1 (1872-32a)		4VG 2 (1872-6a)		4VG 3 (900-6-1a)		4VG 4 (901-8-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	20950	0.37	24802	0.55	1935	0.42	0	0.00
C14:0	160439	2.83	224031	4.98	45942	9.92	23862	10.10
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	87740	1.55	89418	1.99	8244	1.78	4833	2.05
C16:0	2095745	36.94	2278915	50.70	145540	31.42	70330	29.76
C16:1	5561	0.10	5330	0.12	0	0.00	0	0.00
C17:0	228066	4.02	120256	2.68	2420	0.52	1395	0.59
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	2414796	42.56	1333385	29.67	26318	5.68	18915	8.00
C18:1s	568494	10.02	350226	7.79	167122	36.08	77649	32.86
C18:2	15701	0.28	11812	0.26	24645	5.32	8743	3.70
C18:3w3	8639	0.15	12559	0.28	20312	4.39	16899	7.15
C20:0	24773	0.44	13555	0.30	2749	0.59	2647	1.12
C20:1	18247	0.32	25208	0.56	12603	2.72	6789	2.87
C24:0	24920	0.44	5090	0.11	5358	1.16	4246	1.80
Total	5674071	100.00	4494587	100.00	463188	100.00	236308	100.00
Identification	Large Herbivore/Javelina/Tropical Seed Oil		Large Herbivore/Javelina/Tropical Seed Oil		Borderline Moderate-High and High Fat Content		Moderate-High Fat Content Food (Texas Ebony/Beaver)	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 5 (965-8-1a)		4VG 6 (1030-5-4-8-1a)		4VG 7 (1055-5-8-1a)		4VG 8 (1157-8-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	6039	1.07	13548	1.77	8039	1.11	4877	1.18
C14:0	76112	13.44	102452	13.36	97861	13.52	41014	9.89
C14:1	2386	0.42	13767	1.79	0	0.00	0	0.00
C15:0	12761	2.25	10295	1.34	20023	2.77	9882	2.38
C16:0	181508	32.05	219849	28.66	230939	31.89	116002	27.96
C16:1	0	0.00	0	0.00	0	0.00	0	0.00
C17:0	1475	0.26	0	0.00	4082	0.56	531	0.13
C17:1	1515	0.27	0	0.00	0	0.00	0	0.00
C18:0	31152	5.50	42043	5.48	38673	5.34	23735	5.72
C18:1s	186888	33.00	242821	31.65	273508	37.77	149329	36.00
C18:2	18249	3.22	29559	3.85	25418	3.51	30810	7.43
C18:3w3	23683	4.18	74533	9.72	25528	3.53	29017	6.99
C20:0	2810	0.50	0	0.00	0	0.00	2203	0.53
C20:1	15124	2.67	9660	1.26	0	0.00	3775	0.91
C24:0	6585	1.16	8579	1.12	0	0.00	3679	0.89
Total	566287	100.00	767106	100.00	724071	100.00	414854	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline Moderate-High and High Fat Content		Borderline Moderate-High and High Fat Content	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 9 (865-5-3-1a)		4VG 10 (865-5-3-2a)		4VG 11 (865-5-3-3a)		4VG 12 (843-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	1829	1.96	0	0.00	1834	0.83
C14:0	3522	5.93	2023	2.16	0	0.00	5486	2.49
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	483	0.81	1709	1.83	2644	2.42	4237	1.92
C16:0	14136	23.79	25951	27.77	25347	23.20	68514	31.05
C16:1	837	1.41	1197	1.28	2817	2.58	1057	0.48
C17:0	0	0.00	0	0.00	0	0.00	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	11127	18.72	20742	22.19	19017	17.41	80202	36.35
C18:1s	15771	26.54	22280	23.84	43059	39.41	39445	17.88
C18:2	3229	5.43	4249	4.55	3687	3.37	3991	1.81
C18:3w3	5905	9.94	7453	7.97	6507	5.96	9591	4.35
C20:0	1712	2.88	2292	2.45	2555	2.34	2190	0.99
C20:1	605	1.02	1223	1.31	0	0.00	1113	0.50
C24:0	2098	3.53	2515	2.69	3614	3.31	3003	1.36
Total	59425	100.00	93463	100.00	109247	100.00	220663	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline Medium and Moderate-High Fat Content		High Fat Content Food (Seed/Animal Fat)		Large Herbivore/Javelina/Tropical Seed Oil	

Fatty Acid	4VG 13 (843-5-3-2a)		4VG 14 (843-5-3-3a)		4VG 15 (830-5-3-1a)		4VG 16 (830-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	415	0.43	1817	0.94	1646	1.95	0	0.00
C14:0	2931	3.05	6074	3.15	4349	5.16	4120	2.07
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1459	1.52	2415	1.25	2262	2.68	3857	1.94
C16:0	20371	21.21	51585	26.73	23436	27.80	51259	25.79
C16:1	1592	1.66	1112	0.58	1224	1.45	1830	0.92
C17:0	0	0.00	593	0.31	0	0.00	2349	1.18
C17:1	0	0.00	0	0.00	0	0.00	184	0.09
C18:0	16502	17.18	55585	28.81	19425	23.04	54072	27.20
C18:1s	41870	43.60	55688	28.86	21874	25.95	49459	24.88
C18:2	6419	6.68	4632	2.40	5024	5.96	23079	11.61
C18:3w3	2241	2.33	10356	5.37	2045	2.43	0	0.00
C20:0	2242	2.33	1981	1.03	3007	3.57	4119	2.07
C20:1	0	0.00	1128	0.58	0	0.00	371	0.19
C24:0	0	0.00	0	0.00	0	0.00	4074	2.05
Total	96042	100.00	192966	100.00	84292	100.00	198773	100.00
Identification	High Fat Content Food (Seed/Animal fat)		Large Herbivore/Javelina/Tropical Seed Oil		Borderline Medium and Moderate-High Fat Content		Large Herbivore/Javelina/Tropical Seed Oil	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 17 830-5-3-3a)		4VG 18 830-5-3-4a)		4VG 19 1051-5-3-1a)		4VG 20 (1051-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	78	0.10	895	1.14	598	0.65	877	0.99
C14:0	1222	1.64	1874	2.39	1421	1.55	2111	2.38
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	971	1.30	1518	1.94	992	1.08	1903	2.15
C16:0	19491	26.20	21322	27.19	21239	23.19	26402	29.77
C16:1	672	0.90	0	0.00	899	0.98	988	1.11
C17:0	416	0.56	0	0.00	0	0.00	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	18765	25.22	18229	23.25	11455	12.51	21029	23.71
C18:1s	16980	22.82	20580	26.24	37387	40.81	21330	24.05
C18:2	13135	17.65	8626	11.00	13237	14.45	8993	10.14
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2677	3.60	2298	2.93	2223	2.43	2345	2.64
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	0	0.00	3079	3.93	2151	2.35	2700	3.04
Total	74407	100.00	78421	100.00	91602	100.00	88678	100.00
Identification	Large Herbivore/Javelina/ Tropical Seed Oil + Plant or Bone Marrow		Borderline Medium and Moderate-High Fat Content		High Fat Content Food (Seed/Animal Fat)		Borderline Medium and Moderate-High Fat Content	

Fatty Acid	4VG 21 (1051-5-3-3a)		4VG 22 (1051-5-3-4a)		4VG 23 (1030-5-3-1a)		4VG 24 (1030-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	2385	2.05	2517	3.23	3493	2.62	2357	2.33
C14:0	3638	3.12	3239	4.15	3263	2.45	3673	3.63
C14:1	0	0.00	0	0.00	1120	0.84	0	0.00
C15:0	3345	2.87	3666	4.70	3207	2.41	3583	3.54
C16:0	29981	25.72	17455	22.37	31402	23.58	25387	25.08
C16:1	0	0.00	1063	1.36	1014	0.76	0	0.00
C17:0	0	0.00	0	0.00	104	0.08	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	1037	1.02
C18:0	41870	35.92	13162	16.87	36590	27.47	26822	26.50
C18:1s	19533	16.76	22364	28.66	24548	18.43	22298	22.03
C18:2	11348	9.74	10506	13.46	21545	16.18	9733	9.62
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2109	1.81	2067	2.65	3765	2.83	3700	3.66
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	2358	2.02	1991	2.55	3133	2.35	2632	2.60
Total	116567	100.00	78030	100.00	133184	100.00	101222	100.00
Identification	Large Herbivore/Javelina/ Tropical Seed Oil		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Large Herbivore/Javelina/ Tropical Seed Oil		Large Herbivore/Javelina/ Tropical Seed Oil	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 25 (1030-5-3-3a)		4VG 26 (1030-5-3-4a)		4VG 27 (158-5-3-1a)		4VG 28 (158-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	146	0.22	0	0.00	0	0.00	0	0.00
C14:0	1801	2.67	3270	3.16	1381	2.07	5665	6.44
C14:1	0	0.00	0	0.00	281	0.42	0	0.00
C15:0	1753	2.60	2180	2.11	1208	1.81	3897	4.43
C16:0	18008	26.72	22136	21.41	17299	25.99	20805	23.65
C16:1	1098	1.63	2506	2.42	1892	2.84	2369	2.69
C17:0	0	0.00	0	0.00	42	Z	0	0.00
C17:1	0	0.00	937	0.91	717	1.08	906	1.03
C18:0	12417	18.43	14612	14.14	13664	20.52	12535	14.25
C18:1s	20102	29.83	45557	44.07	24306	36.51	31938	36.31
C18:2	7452	11.06	6159	5.96	218	0.33	5000	5.68
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2234	3.32	2667	2.58	2702	4.06	1965	2.23
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	2378	3.53	3345	3.24	2863	4.30	2877	3.27
Total	67389	100.00	103369	100.00	66573	100.00	87957	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		High Fat Content Food (Seed/Animal Fat)		Borderline Moderate-High and High Fat Content		Borderline Moderate-High and High Fat Content	

Fatty Acid	4VG 29 (158-5-3-3a)		4VG 30 (79-5-3-1a)		4VG 31 (79-5-3-2a)		4VG 32 (79-5-3-3a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	388	0.39	0	0.00	760	0.71
C14:0	3058	2.82	5116	5.20	2118	3.03	5392	5.01
C14:1	346	0.32	0	0.00	0	0.00	0	0.00
C15:0	1529	1.41	3287	3.34	1350	1.93	5895	5.47
C16:0	26326	24.30	26624	27.07	25405	36.31	33131	30.77
C16:1	1141	1.05	2084	2.12	881	1.26	1812	1.68
C17:0	4508	4.16	0	0.00	0	0.00	0	0.00
C17:1	0	0.00	1235	1.26	0	0.00	0	0.00
C18:0	21156	19.53	16452	16.73	14602	20.87	13787	12.80
C18:1s	29251	27.00	30756	31.27	15415	22.03	35498	32.96
C18:2	14100	13.01	5606	5.70	6670	9.53	6467	6.01
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	3277	3.02	2759	2.81	1710	2.44	1854	1.72
C20:1	427	0.39	0	0.00	0	0.00	0	0.00
C24:0	3226	2.98	4039	4.11	1821	2.60	3090	2.87
Total	108345	100.00	98346	100.00	69972	100.00	107686	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Medium Fat Content Food (Mesquite/Corn/Fish)		Moderate-High Fat Content Food (Texas Ebony/Beaver)	

**Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site
(cont.)**

Fatty Acid	4VG 33 (534-5-3-1a)		4VG 34 (534-5-3-2a)		4VG 35 (1005-53-1a)		4VG 36 (79-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	0	0.00	0	0.00	0	0.00
C14:0	6895	8.39	1972	3.21	3335	4.14	2691	3.97
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	4013	4.88	1762	2.87	2563	3.18	1527	2.25
C16:0	22732	27.65	15084	24.56	19930	24.72	19782	29.16
C16:1	1773	2.16	1523	2.48	1321	1.64	1906	2.81
C17:0	0	0.00	0	0.00	0	0.00	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	568	0.84
C18:0	12038	14.64	12588	20.50	13678	16.96	15867	23.39
C18:1s	24809	30.17	19583	31.89	30689	38.06	16183	23.85
C18:2	4461	5.43	4327	7.05	4514	5.60	3486	5.14
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1903	2.31	2201	3.58	2110	2.62	2596	3.83
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	3598	4.38	2370	3.86	2490	3.09	3235	4.77
Total	82222	100.00	61410	100.00	80630	100.00	67841	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline Moderate-High and High Fat Content		Borderline Medium and Moderate-High Fat Content	

Fatty Acid	4VG 37 (79-3-2a)		4VG 38 (273-5-3-1a)		4VG 39 (273-5-3-2a)		4VG 40 (273-5-3-3a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	0	0.00	1888	1.44	0	0.00
C14:0	3791	1.56	2320	2.97	5063	3.85	1978	1.19
C14:1	0	0.00	0	0.00	0	0.00	295	0.18
C15:0	4389	1.80	2504	3.21	1889	1.44	1295	0.78
C16:0	59492	24.41	19389	24.83	28359	21.59	34551	20.85
C16:1	2286	0.94	1367	1.75	4617	3.52	4688	2.83
C17:0	310	0.13	0	0.00	220	0.17	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	593	0.36
C18:0	20043	8.22	14137	18.11	19887	15.14	19225	11.60
C18:1s	117848	48.36	28695	36.75	62739	47.77	84491	50.99
C18:2	27293	11.20	4014	5.14	168	0.13	13258	8.00
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2602	1.07	2121	2.72	2783	2.12	2397	1.45
C20:1	1517	0.62	0	0.00	0	0.00	0	0.00
C24:0	4140	1.70	3533	4.52	3735	2.84	2921	1.76
Total	243711	100.00	78080	100.00	131348	100.00	165692	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		Borderline Moderate-High and High Fat Content		High Fat Content Food (Seed/Animal Fat)		Borderline High and Very High Fat Content	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 41 (293-5-3-1a)		4VG 42 (293-5-3-2a)		4VG 43 (293-5-3-3a)		4VG 44 (89-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	1732	0.76	3507	3.03	3127	0.65
C14:0	6233	3.78	5641	2.48	4647	4.01	5446	1.13
C14:1	607	0.37	515	0.23	0	0.00	0	0.00
C15:0	2748	1.67	1753	0.77	2492	2.15	2728	0.56
C16:0	39394	23.88	40022	17.57	28704	24.76	72795	15.05
C16:1	5137	3.11	7706	3.38	3721	3.21	21547	4.45
C17:0	0	0.00	686	0.30	0	0.00	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	17360	10.52	24485	10.75	17701	15.27	23996	4.96
C18:1s	76765	46.53	123362	54.15	42869	36.98	310916	64.28
C18:2	11060	6.70	16431	7.21	6663	5.75	37132	7.68
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2333	1.41	2329	1.02	2510	2.17	2226	0.46
C20:1	0	0.00	705	0.31	0	0.00	0	0.00
C24:0	3334	2.02	2430	1.07	3117	2.69	3757	0.78
Total	164971	100.00	227797	100.00	115931	100.00	483670	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)		Borderline Moderate-High and High Fat Content		Very High Fat Content Food (Seed/Animal Fat)	

Fatty Acid	4VG 45 (89-5-3-2a)		4VG 46 (89-5-3-3a)		4VG 47 (966-5-3-1a)		4VG 48 (962-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	3494	1.25	5973	2.10	0	0.00	0	0.00
C14:0	5842	2.09	5817	2.04	1357	1.30	3946	0.54
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	3006	1.08	6402	2.25	687	0.66	3104	0.42
C16:0	56347	20.17	52572	18.44	19476	18.69	138597	18.95
C16:1	3682	1.32	2886	1.01	1609	1.54	8409	1.15
C17:0	0	0.00	0	0.00	292	0.28	3410	0.47
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	20752	7.43	24845	8.72	12903	12.39	32373	4.43
C18:1s	157232	56.29	144280	50.62	54749	52.55	429380	58.71
C18:2	21972	7.87	36856	12.93	8752	8.40	105699	14.45
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2723	0.97	2509	0.88	2162	2.08	2630	0.36
C20:1	0	0.00	0	0.00	0	0.00	875	0.12
C24:0	4296	1.54	2907	1.02	2195	2.11	2877	0.39
Total	279346	100.00	285047	100.00	104182	100.00	731300	100.00
Identification	Very High Fat Content Food (Seed/Animal Fat)		Borderline High and Very High Fat Content		Very High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)	

**Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site
(cont.)**

Fatty Acid	4VG 49 (11-5-3-1a)		4VG 50 (11-5-3-2a)		4VG 51 (11-5-3-3a)		4VG 53 (941-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	1543	1.97	2200	2.66	0	0.00	997	0.74
C14:0	749	0.96	1533	1.86	1262	0.83	1908	1.43
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1328	1.70	1673	2.03	926	0.61	1109	0.83
C16:0	19988	25.57	17475	21.16	20703	13.62	23201	17.34
C16:1	1615	2.07	1001	1.21	1375	0.90	1905	1.42
C17:0	2931	3.75	0	0.00	3123	2.06	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	6578	8.41	10748	13.01	13419	8.83	12518	9.35
C18:1s	33654	43.05	35753	43.29	94212	62.00	74750	55.85
C18:2	8505	10.88	8190	9.92	12477	8.21	13019	9.73
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1292	1.65	2005	2.43	2165	1.42	2028	1.52
C20:1	0	0.00	0	0.00	0	0.00	391	0.29
C24:0	0	0.00	2017	2.44	2296	1.51	2008	1.50
Total	78183	100.00	82595	100.00	151958	100.00	133834	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)	

Fatty Acid	4VG 54 (801-5-3-1a)		4VG 55 (801-5-3-2a)		4VG 56 (801-5-3-3a)		4VG 57 (263-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	1365	1.66	3746	3.45	3449	3.48	2423	2.77
C14:0	1507	1.83	4355	4.01	3322	3.35	1951	2.23
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1266	1.54	3905	3.59	2570	2.59	2765	3.16
C16:0	15316	18.60	31885	29.33	21761	21.93	28370	32.47
C16:1	2126	2.58	5074	4.67	3281	3.31	1562	1.79
C17:0	0	0.00	762	0.70	635	0.64	0	0.00
C17:1	585	0.71	0	0.00	0	0.00	0	0.00
C18:0	8133	9.87	10285	9.46	10353	10.43	12770	14.61
C18:1s	39637	48.12	37732	34.71	38359	38.66	22825	26.12
C18:2	8280	10.05	6077	5.59	9824	9.90	7143	8.17
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1428	1.73	1798	1.65	1847	1.86	2408	2.76
C20:1	803	0.97	884	0.81	1784	1.80	2450	2.80
C24:0	1920	2.33	2200	2.02	2034	2.05	2716	3.11
Total	82366	100.00	108703	100.00	99219	100.00	87383	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline Moderate-High and High Fat Content		Borderline Medium and Moderate-High Fat Content	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 58 (274-5-3-2a)		4VG 59 (187-5-3-2a)		4VG 60 (80-5-3-1a)		4VG 61 (187-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	0	0.00	0	0.00	855	0.36	2671	2.33
C14:0	3047	3.67	2793	2.09	1056	0.44	2950	2.58
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	2322	2.79	1576	1.18	1017	0.43	2267	1.98
C16:0	17334	20.85	23477	17.59	34149	14.30	45244	39.49
C16:1	1625	1.95	1797	1.35	4532	1.90	0	0.00
C17:0	8547	10.28	0	0.00	0	0.00	0	0.00
C17:1	0	0.00	666	0.50	0	0.00	0	0.00
C18:0	8692	10.46	8832	6.62	14839	6.21	17559	15.33
C18:1s	30104	36.21	73885	55.36	143836	60.21	25857	22.57
C18:2	5061	6.09	13893	10.41	30839	12.91	11412	9.96
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1559	1.88	1389	1.04	1882	0.79	1362	1.19
C20:1	2890	3.48	3414	2.56	3712	1.55	3878	3.39
C24:0	1951	2.35	1749	1.31	2170	0.91	1358	1.19
Total	83132	100.00	133471	100.00	238887	100.00	114558	100.00
Identification	Borderline Moderate-High and High Fat Content		Very High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)		Medium Fat Content Food (Mesquite/Corn/Fish)	

Fatty Acid	4VG 62 (179-05-3-2a)		4VG 63 (98-5-3-1a)		4VG 64 (179-5-3-1a)		4VG 65 (274-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	3100	5.58	0	0.00	98	0.11	844	1.14
C14:0	2522	4.54	897	1.94	3078	3.57	1348	1.82
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1342	2.41	731	1.58	2950	3.42	1230	1.66
C16:0	17106	30.77	13443	29.09	19086	22.14	15522	20.93
C16:1	1009	1.82	560	1.21	3053	3.54	2569	3.46
C17:0	0	0.00	227	0.49	0	0.00	0	0.00
C17:1	592	1.06	0	0.00	756	0.88	0	0.00
C18:0	12073	21.72	10347	22.39	9276	10.76	7985	10.77
C18:1s	6184	11.12	9221	19.96	35683	41.38	33303	44.90
C18:2	4639	8.35	5507	11.92	8126	9.42	8190	11.04
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1863	3.35	1597	3.46	1166	1.35	1111	1.50
C20:1	3369	6.06	2093	4.53	1177	1.37	537	0.72
C24:0	1790	3.22	1585	3.43	1776	2.06	1526	2.06
Total	55589	100.00	46208	100.00	86225	100.00	74165	100.00
Identification	Low Fat Content Plant (Roots, Greens, Berries)		Borderline Med. Fat Content and Lg. Herb. + Plant/Bone Marrow		High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)	

**Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site
(cont.)**

Fatty Acid	4VG 66 (178-5-3-1a)		4VG 67 (370-5-3-1a)		4VG 68 (161-5-3-1a)		4VG 69 (352-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	3427	5.43	1814	1.62	184	0.12	0	0.00
C14:0	2261	3.58	1622	1.45	2639	1.71	1320	0.88
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1394	2.21	1013	0.91	1382	0.90	1145	0.77
C16:0	15906	25.20	29891	26.77	36992	23.96	33217	22.27
C16:1	1040	1.65	819	0.73	3900	2.53	992	0.67
C17:0	0	0.00	451	0.40	0	0.00	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	12097	19.16	17040	15.26	16368	10.60	19140	12.83
C18:1s	16369	25.93	41458	37.13	75926	49.19	72551	48.64
C18:2	7108	11.26	12951	11.60	12688	8.22	16048	10.76
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1727	2.74	2449	2.19	2015	1.31	2193	1.47
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	1800	2.85	2146	1.92	2267	1.47	2557	1.71
Total	63129	100.00	111654	100.00	154361	100.00	149163	100.00
Identification	Borderline Medium and Moderate-High Fat Content		Borderline Moderate-High and High Fat Content		Borderline High and Very High Fat Content		Borderline High and Very High Fat Content	

Fatty Acid	4VG 70 (352-5-3-2a)		4VG 71 (81-5-3-1a)		4VG 72 (276-5-3-1a)		4VG 73 (515-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	17	0.02	3007	2.70	318	0.32	0	0.00
C14:0	3180	2.85	2312	2.07	3576	3.59	2820	1.41
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	3330	2.99	1048	0.94	1306	1.31	1985	1.00
C16:0	26324	23.63	23385	20.98	29097	29.23	33351	16.72
C16:1	2832	2.54	2437	2.19	1861	1.87	6946	3.48
C17:0	0	0.00	361	0.32	273	0.27	0	0.00
C17:1	0	0.00	0	0.00	510	0.51	0	0.00
C18:0	13416	12.04	17617	15.81	17865	17.95	8551	4.29
C18:1s	47900	42.99	47243	42.39	32126	32.27	129390	64.88
C18:2	10082	9.05	9252	8.30	6812	6.84	13978	7.01
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1707	1.53	2288	2.05	2675	2.69	635	0.32
C20:1	0	0.00	0	0.00	0	0.00	321	0.16
C24:0	2632	2.36	2491	2.24	3135	3.15	1455	0.73
Total	111420	100.00	111441	100.00	99554	100.00	199432	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Very High Fat Content Food (Seed/Animal Fat)	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 74 (575-5-3-1a)		4VG 75 (583-5-3-1a)		4VG 76 (276-5-3-2a)		4VG 77 (37-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	3805	4.66	234	0.12	3485	2.10	390	0.32
C14:0	2854	3.49	3962	2.08	2251	1.36	4103	3.37
C14:1	0	0.00	0	0.00	0	0.00	547	0.45
C15:0	1633	2.00	1910	1.00	1429	0.86	1245	1.02
C16:0	24104	29.49	57944	30.48	38236	23.03	31465	25.86
C16:1	2036	2.49	2487	1.31	2824	1.70	2462	2.02
C17:0	406	0.50	268	0.14	249	0.15	192	0.16
C17:1	0	0.00	0	0.00	0	0.00	0	0.00
C18:0	15841	19.38	20216	10.64	20982	12.64	25246	20.75
C18:1s	21228	25.97	81402	42.83	71392	43.00	37586	30.90
C18:2	5148	6.30	16318	8.58	18909	11.39	10838	8.91
C18:3w3	0	0.00	0	0.00	1629	0.98	0	0.00
C20:0	2359	2.89	1561	0.82	2392	1.44	3288	2.70
C20:1	0	0.00	1833	0.96	740	0.45	1886	1.55
C24:0	2314	2.83	1941	1.02	1508	0.91	2405	1.98
Total	81728	100.00	190076	100.00	166026	100.00	121653	100.00
Identification	Borderline Medium and Moderate-High Fat Content		High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)	

Fatty Acid	4VG 78 (37-5-3-2a)		4VG 79 (37-5-3-3a)		4VG 80 (37-5-3-4a)		4VG 81 (616-5-3-1a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	726	0.58	0	0.00	0	0.00	0	0.00
C14:0	5837	4.66	2973	3.09	1767	2.55	4184	2.26
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1934	1.54	1153	1.20	1337	1.93	2082	1.13
C16:0	26007	20.75	21151	21.99	17387	25.06	39674	21.45
C16:1	2923	2.33	2414	2.51	1135	1.64	4773	2.58
C17:0	0	0.00	348	0.36	656	0.95	0	0.00
C17:1	0	0.00	0	0.00	626	0.90	981	0.53
C18:0	20399	16.28	16921	17.59	14109	20.34	21766	11.77
C18:1s	55699	44.45	39312	40.87	23950	34.52	93806	50.71
C18:2	7074	5.64	8064	8.38	4806	6.93	11591	6.27
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2560	2.04	1721	1.79	1406	2.03	2310	1.25
C20:1	0	0.00	0	0.00	0	0.00	406	0.22
C24:0	2159	1.72	2141	2.23	2201	3.17	3417	1.85
Total	125318	100.00	96198	100.00	69380	100.00	184990	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline High and Very High Fat Content	

**Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site
(cont.)**

Fatty Acid	4VG 82 (616-5-3-2a)		4VG 83 (616-5-3-3a)		4VG 84 (756-5-3-1a)		4VG 85 756-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	3086	2.53	2274	2.08	3228	0.60	0	0.00
C14:0	4098	3.36	3694	3.38	4591	0.85	2936	2.42
C14:1	0	0.00	0	0.00	0	0.00	353	0.29
C15:0	2676	2.19	1274	1.17	2125	0.39	1446	1.19
C16:0	28112	23.05	26286	24.05	78132	14.50	21888	18.01
C16:1	3197	2.62	2579	2.36	7819	1.45	2627	2.16
C17:0	0	0.00	0	0.00	1417	0.26	502	0.41
C17:1	1079	0.88	855	0.78	0	0.00	0	0.00
C18:0	24587	20.16	24429	22.35	35083	6.51	15276	12.57
C18:1s	38272	31.38	33244	30.42	351728	65.27	62371	51.33
C18:2	9626	7.89	7486	6.85	46664	8.66	10499	8.64
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	3775	3.09	3613	3.31	3358	0.62	1706	1.40
C20:1	0	0.00	0	0.00	969	0.18	0	0.00
C24:0	3474	2.85	3549	3.25	3782	0.70	1915	1.58
Total	121982	100.00	109283	100.00	538896	100.00	121519	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Very High Fat Content Food (Seed/Animal Fat)		Borderline High and Very High Fat Content	

Fatty Acid	4VG 86 (756-5-3-3a)		4VG 87 (756-5-3-4a)		4VG 88 (203-5-3-1a)		4VG 89 (203-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	264	0.20	2599	2.53	123	0.13	3617	3.59
C14:0	4560	3.38	2660	2.59	3193	3.50	3881	3.86
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	2070	1.53	1535	1.50	2479	2.72	2196	2.18
C16:0	25054	18.56	23182	22.58	19946	21.88	25197	25.03
C16:1	4870	3.61	2249	2.19	2178	2.39	2032	2.02
C17:0	0	0.00	3116	3.04	0	0.00	44	0.04
C17:1	554	0.41	0	0.00	787	0.86	0	0.00
C18:0	14221	10.54	13048	12.71	16878	18.52	18829	18.71
C18:1s	70609	52.31	42564	41.46	31292	34.33	31042	30.84
C18:2	8935	6.62	8092	7.88	8655	9.49	7357	7.31
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1795	1.33	1587	1.55	2528	2.77	2955	2.94
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	2055	1.52	2019	1.97	3096	3.40	3499	3.48
Total	134987	100.00	102651	100.00	91155	100.00	100649	100.00
Identification	Very High Fat Content Food (Seed/Animal Fat)		High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Moderate-High Fat Content Food (Texas Ebony/Beaver)	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 90 (203-5-3-3a)		4VG 91 (203-5-3-4a)		4VG 92 (128-5-3-1a)		4VG 93 (128-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	31	0.03	2778	3.10	1017	0.91	912	0.74
C14:0	5401	5.92	2889	3.22	4735	4.24	5054	4.12
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	2900	3.18	1379	1.54	5462	4.89	3386	2.76
C16:0	22190	24.30	23074	25.71	24204	21.66	23837	19.41
C16:1	1733	1.90	1257	1.40	2249	2.01	2575	2.10
C17:0	0	0.00	972	1.08	0	0.00	454	0.37
C17:1	1022	1.12	548	0.61	875	0.78	770	0.63
C18:0	19839	21.73	21115	23.53	17542	15.70	18788	15.30
C18:1s	25251	27.66	21796	24.29	39639	35.47	51981	42.32
C18:2	5252	5.75	8951	9.97	10158	9.09	8781	7.15
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	3265	3.58	2457	2.74	2790	2.50	2316	1.89
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	4422	4.84	2533	2.82	3089	2.76	3960	3.22
Total	91306	100.00	89749	100.00	111760	100.00	122814	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline Medium and Moderate-High Fat Content		Moderate-High Fat Content Food (Texas Ebony/Beaver)		High Fat Content Food (Seed/Animal Fat)	

Fatty Acid	4VG 94 (128-5-3-3a)		4VG 95 (128-5-3-4a)		4VG 96 (658-5-3-1a)		4VG 97 (658-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	2052	2.17	734	0.80	1361	0.86	196	0.14
C14:0	3915	4.15	3570	3.90	2185	1.38	2351	1.65
C14:1	0	0.00	0	0.00	524	0.33	0	0.00
C15:0	1693	1.79	2634	2.87	1329	0.84	951	0.67
C16:0	18508	19.61	23462	25.60	30855	19.48	21201	14.91
C16:1	2407	2.55	3231	3.53	3587	2.26	4429	3.11
C17:0	0	0.00	802	0.88	727	0.46	0	0.00
C17:1	0	0.00	0	0.00	0	0.00	1287	0.90
C18:0	12725	13.49	18870	20.59	18594	11.74	11533	8.11
C18:1s	42732	45.28	27458	29.96	79210	50.00	86915	61.12
C18:2	7093	7.52	6330	6.91	14268	9.01	9626	6.77
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	1472	1.56	1977	2.16	2507	1.58	2179	1.53
C20:1	0	0.00	0	0.00	557	0.35	0	0.00
C24:0	1767	1.87	2580	2.82	2707	1.71	1542	1.08
Total	94364	100.00	91648	100.00	158411	100.00	142210	100.00
Identification	High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)		Borderline High and Very High Fat Content		Very High Fat Content Food (Seed/Animal Fat)	

Table G-4. Fatty Acid Composition and Identification of Residues from the Varga Site (cont.)

Fatty Acid	4VG 98 (658-5-3-3a)		4VG 99 (658-5-3-4a)		4VG 100 (644-5-3-1a)		4VG 101 (644-5-3-2a)	
	Area	Rel%	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	2312	2.64	1398	1.31	381	0.28	1263	1.70
C14:0	3183	3.63	5062	4.75	2289	1.69	3757	5.07
C14:1	0	0.00	0	0.00	0	0.00	0	0.00
C15:0	1510	1.72	2256	2.12	1297	0.96	1847	2.49
C16:0	20959	23.91	23102	21.68	22143	16.36	20889	28.17
C16:1	2329	2.66	3237	3.04	3894	2.88	877	1.18
C17:0	183	0.21	0	0.00	148	0.11	0	0.00
C17:1	0	0.00	935	0.88	758	0.56	1041	1.40
C18:0	16165	18.44	15713	14.75	11927	8.81	14862	20.04
C18:1s	28603	32.62	45011	42.24	77315	57.13	20456	27.59
C18:2	7395	8.43	5312	4.99	11689	8.64	3344	4.51
C18:3w3	0	0.00	0	0.00	0	0.00	0	0.00
C20:0	2769	3.16	2129	2.00	1756	1.30	3292	4.44
C20:1	0	0.00	0	0.00	0	0.00	0	0.00
C24:0	2265	2.58	2394	2.25	1724	1.27	2522	3.40
Total	87673	100.00	106549	100.00	135321	100.00	74150	100.00
Identification	Moderate-High Fat Content Food (Texas Ebony/Beaver)		High Fat Content Food (Seed/Animal Fat)		Very High Fat Content Food (Seed/Animal Fat)		Moderate-High Fat Content Food (Texas Ebony/Beaver)	

Fatty Acid	4VG 102 (644-5-3-3a)	
	Area	Rel%
C12:0	3733	2.00
C14:0	5703	3.06
C14:1	0	0.00
C15:0	4186	2.25
C16:0	38326	20.56
C16:1	3990	2.14
C17:0	0	0.00
C17:1	2712	1.46
C18:0	19642	10.54
C18:1s	80960	43.44
C18:2	20457	10.98
C18:3w3	0	0.00
C20:0	2583	1.39
C20:1	0	0.00
C24:0	4085	2.19
Total	186377	100.00
Identification	High Fat Content Food (Seed/Animal Fat)	

APPENDIX H:

STABLE CARBON AND NITROGEN ISOTOPE ANALYSES

STABLE CARBON AND NITROGEN ISOTOPE ANALYSES

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April 19, 2004

Table H-1. Results from Batch One

Name	Sample ID	Provenience	Weight (mg)	N μ g	$\delta^{15}\text{N}$ (‰)	C μ g	$\delta^{13}\text{C}$ (‰)
Check				110.4	1.29	360.5	-23.88
Check				110.4	1.40	364.6	-23.84
Check				109.2	1.40	362.8	-23.82
Quigg a1	1217c	Soil column	50.888	129.3	8.32	1453.0	-28.47
a2	1218c	Soil column	50.283	137.1	8.43	1505.7	-28.28
a3	1219c	Soil column	50.559	154.3	8.22	1675.9	-28.67
a4	1220c	Soil column	50.435	165.0	8.30	1813.6	-29.44
a5	1221c	Soil column	50.351	128.5	8.40	1749.1	-28.93
a6	1222c	Soil column	49.957	125.2	8.24	1984.9	-29.90
a7	1223c	Soil column	50.886	107.5	8.03	1796.3	-29.40
a8	1224c	Soil column	50.170	100.1	8.37	1548.7	-28.41
a9	1225c	Soil column	49.915	83.7	8.70	1268.3	-27.82
a10	1226c	Soil column	49.830	78.4	8.72	1085.7	-27.07
a11	1227c	Soil column	50.369	78.4	8.77	1027.2	-26.81
a12	1228c	Soil column	50.560	66.1	8.94	844.4	-25.84
Check				110.4	1.30	369.3	-23.63
Check				109.6	1.43	369.5	-23.87
b1	1229c	Soil column	50.124	65.7	9.31	793.0	-25.57
b2	1230c	Soil column	50.403	62.0	9.26	727.8	-24.95
b3	1231c	Soil column	50.202	59.1	9.43	721.5	-24.97
b4	1232c	Soil column	50.757	62.0	9.28	767.8	-25.55
b5	1233c	Soil column	50.029	66.1	8.99	814.1	-25.61
b6	1234c	Soil column	50.343	72.2	9.25	932.6	-26.64
b7	1235c	Soil column	50.240	70.6	9.48	827.9	-25.81
b8	1236c	Soil column	49.987	91.1	8.34	1045.2	-27.09
b9	1207-4c	BT-M-1 Unit 4	49.865	38.0	9.40	440.6	-23.19
b10	1208-4c	BT-M-1 Unit 3	49.884	85.0	8.60	980.2	-26.59
b11	1209-4c	BT 7, BK2	50.881	49.7	9.63	558.1	-23.47
b12	1210-4c	BT 7, 2BK	49.990	67.3	9.17	730.9	-24.90
c1	1211-4c	BT 7, Cultural	50.289	102.6	8.49	1225.2	-26.98
Check				109.6	1.44	372.3	-23.83
Check				109.2	1.47	365.2	-23.89
Quigg soils A1	1872-32c	Lorenzo sherd	2.796	129.8	3.74	1408.3	-22.33
A2	274-5-3-1b	LA F1	2.998	21.4	5.63	376.8	-23.69
A3	801-5-3-2b	LA F15	3.360	24.6	6.62	378.6	-25.34
A4	293-5-3-1b	LA F1c	3.645	17.3	5.78	370.4	-24.18
A5	583-5-3-1b	MA F11	3.708	9.2	2.36	137.2	-25.54
A6	830-5-3-3b	T F9	4.438	33.0	6.44	413.3	-25.75
A7	843-5-3-1b	T F8	5.316	49.1	5.75	730.7	-18.43
A8	293-5-3-1b	LA F1c	5.439	32.3	6.72	533.1	-24.54

Appendix H: Stable Carbon and Nitrogen Isotope Analyses

Name	Sample ID	Provenience	Weight (mg)	N μ g	$\delta^{15}\text{N}$ (‰)	C μ g	$\delta^{13}\text{C}$ (‰)
A9	79-5-3-2b F21	T F21	5.808	35.3	2.80	368.5	-21.16
A10	271-5-3-1b	LA F1b	6.751	13.7	1.08	203.9	-25.66
A11	757-53-4b	EA F31	7.039	23.1	5.79	439.0	-25.26
A12	263-5-3-1b	LA F1	7.058	43.3	8.23	538.6	-24.13
Check				111.1	1.53	353.9	-23.86
Check				111.1	1.30	353.0	-23.86
B1	644-5-3-1b	EA F12	7.149	3.9	-11.67	60.9	-26.63
B2	658-5-3-3b	EA F13	7.308	27.1	2.91	337.4	-25.78
B3	79-5-3-1b	T F21	7.805	39.1	3.59	706.9	-24.80
B4	757-5-3-1b	EA F31	9.052	4.7	1.47	111.6	-26.89
B5	644-5-3-1b	EA F12	11.745	52.8	1.35	834.9	-25.61
B6	830-5-3-4b	T F9	12.351	83.3	6.67	1015.1	-20.97
B7	966-5-3-1b	LA F29	12.626	6.1	-5.96	54.6	-28.39
B8	128-5-3-4b	EA F40	12.956	32.7	8.16	569.7	-23.88
B9	128-5-3-1b	EA F40	15.867	41.4	5.67	597.2	-25.12
B10	203-5-3-4b	EA F39	16.736	81.4	1.90	1298.6	-25.76
B11	1872-32b	Lorenzo sherd	17.320	18.5	-0.52	547.8	-21.68
B12	965-8-1b	T na, sherd	19.270	12.1	-1.08	219.5	-27.63
Check				110.4	1.57	353.9	-23.89
Check				109.8	1.37	353.9	-23.87
C1	658-5-3-1b	EA F13	19.781	35.2	6.02	1408.3	-30.74
C2	37-5-3-4b	MA F37	22.228	40.9	8.35	655.7	-24.10
C3	293-5-3-3b	LA F1c	22.800	114.3	3.94	1746.7	-24.89
C4	89-5-3-1b	La F1a	23.362	26.0	2.49	475.5	-25.97
C5	161-5-3-1b	LA F1	26.233	91.0	6.08	2569.7	-30.62
C6	534-5-3-1b	T F18	26.876	54.9	1.89	1572.9	-27.99
C7	13003b	San Juan sherd	27.532	18.9	4.15	406.9	-25.04
Check				110.4	1.19	353.0	-23.84
Check				111.1	1.30	351.2	-23.89
D1	901-8-1b	T na, sherd	31.664	11.3	-1.11	176.5	-26.73
D2	128-5-3-2b	EA F40	32.291	48.4	6.50	791.0	-24.70
D3	801-5-3-3b	LA F15	32.874	164.6	7.92	2094.2	-23.21
D4	1157-8-1b	T na, sherd	38.133	19.6	5.02	320.1	-24.97
D5	1872-6b	Lorenzo sherd	38.412	29.2	4.20	901.7	-22.02
D6	158-5-3-3b	T F36	39.406	74.9	5.94	951.1	-24.80
D7	616-5-3-2b	EA F26	39.737	56.7	2.82	905.3	-24.47
D8	1030-5-4-8-1b	T F38, sherd	40.237	8.7	2.80	122.5	-24.27
D9	13008b	San Juan sherd	40.254	5.4	-2.26	93.3	-26.68
D10	801-5-3-1b	LA F15	40.271	43.8	5.53	752.6	-24.48
D11	352-5-3-1b	LA F1	40.293	171.1	2.00	2597.1	-26.33
D12	1055-5-8-1b	T F25, sherd	40.322	11.6	-2.59	215.8	-27.18
Check				110.4	1.22	360.3	-23.86

Name	Sample ID	Provenience	Weight (mg)	N μ g	$\delta^{15}\text{N}$ (‰)	C μ g	$\delta^{13}\text{C}$ (‰)
Check				110.4	1.36	354.8	-23.85
E1	865-5-3-1b	T F8	40.381	19.3	-4.21	354.8	-26.11
E2	187-5-3-2a	LA F1	40.472	10.1	4.63	162.8	-23.45
E3	11-5-3-1b	LA F1d	40.574	66.5	7.83	1033.4	-23.24
E4	1872-48b	Lorenzo sherd	40.738	22.0	-0.43	1079.1	-18.69
E5	830-5-3-2b	T F9	41.813	36.7	3.83	522.2	-23.57
E6	900-8-1b	T na, sherd	41.861	33.1	6.90	532.2	-27.23
E7	79-5-3-2b NO	T F21	42.012	28.4	3.56	417.9	-24.87
E8	1872-6c	Lorenzo sherd	42.104	29.5	5.24	923.6	-21.82
E9	158-5-3-2b	T F36	42.373	15.9	3.40	203.0	-24.78
E10	187-5-3-1b	LA F1	42.543	145.3	3.91	2350.2	-25.47
E11	1051-5-3-4b	T F25	42.672	129.8	2.02	1984.4	-25.70
E12	658-5-3-4b	EA F13	43.887	17.4	6.42	2853.2	-30.26
1	11-5-3-3b	LA F1d	47.687	26.0	3.17	516.7	-25.90
Check				109.8	1.17	353.0	-23.84
Check				109.1	1.10	355.7	-23.89
Check				110.4	1.34	353.9	-23.86

T = Toyah, LA = Late Archaic, EA = Early Archaic, BT = backhoe trench, F1 = Feature 1,

Table H-2. Results from Batch Two

Name	Sample ID	Provenience	Weight (mg)	N μg	$\delta^{15}\text{N}$ (‰)	C μg	$\delta^{13}\text{C}$ (‰)
Check				109.8	1.38	358.3	-23.85
Check				110.2	1.18	359.5	-23.84
Check				110.5	1.19	360.2	-23.82
Check				114.4	1.40	716.6	-23.87
Check				112.8	1.22	716.6	-23.87
Check				228.2	1.30	1340.6	-23.87
Quigg Varga a1	11-5-3-2b	LA F1d	30.178	376.7	3.41	2891.2	-24.97
a2	37-5-3-1b	MA F37	30.417	130.6	2.95	1630.9	-24.81
a3	37-5-3-2b	MA F37	10.522	120.4	-0.24	1470.3	-26.67
a4	37-5-3-3b	MA F37	17.881	106.2	1.24	1921.3	-25.53
a5	80-5-3-1b	LA F1	7.606	43.5	4.78	778.4	-23.88
a6	81-5-3-1b	LA F1	2.161	11.4	-3.15	180.4	-26.02
a7	89-5-3-2b	LA F1a	8.625	51.4	2.89	840.2	-25.37
a8	98-5-3-1b	LA F1	16.006	130.1	7.65	1019.3	-24.19
a9	128-5-3-3b	EA F40	30.871	128.4	5.95	1563.0	-24.66
a10	158-5-3-1b	T F36	15.883	122.3	6.08	1575.3	-24.31
a11	178-5-3-1b	LA F1	30.115	41.5	5.22	642.5	-21.78
a12	179-5-3-2b	LA F1	17.820	161.7	6.12	1841.0	-24.65
Check				110.4	1.32	393.5	-23.65
Check				109.9	1.39	369.4	-23.85
b1	179-5-3-1b	LA F1	8.294	98.0	4.55	1470.3	-24.67
b2	203-5-3-1b	EA F39	30.703	99.0	6.06	1390.0	-25.48
b3	203-5-3-3b	EA F39	30.518	137.1	6.49	1420.9	-23.69
b4	273-5-3-2b	LA F1b	19.183	182.6	5.93	2186.9	-25.09
b5	273-5-3-3b	LA F1b	30.054	79.7	6.81	1062.6	-22.55
b6	274-5-3-2b	LA F1	24.516	223.7	7.05	2656.4	-23.30
b7	276-5-3-1b	MA F11	20.335	107.9	6.59	1865.7	-26.28
b8	276-5-3-2b	MA F11	20.327	99.5	7.36	1408.5	-24.84
b9	352-5-3-2d	LA F1	1.650	23.0	4.64	396.6	-24.63
b10	370-5-3-1b	LA F1	30.608	96.5	7.09	1254.1	-23.19
b11	515-5-3-1b	MA F11	20.101	170.3	6.85	2063.4	-24.05
b12	534-5-3-2b	T F18	15.539	275.7	7.92	2384.6	-25.29
Check				110.9	1.43	380.6	-23.79
Check				108.9	1.42	371.9	-23.83
Check				108.1	1.15	362.9	-23.84
Check				108.6	1.19	362.9	-23.83
Check				111.1	1.30	711.1	-23.80
Check				111.1	1.09	711.1	-23.82

Name	Sample ID	Provenience	Weight (mg)	N μ g	$\delta^{15}\text{N}$ (‰)	C μ g	$\delta^{13}\text{C}$ (‰)
Check				226.6	1.39	1336.5	-23.96
c1	575-5-3-1b	MA F11	30.066	146.6	7.98	1747.2	-22.88
c2	616-5-3-1b	EA F26	22.694	92.3	4.65	1385.5	-24.15
c3	616-5-3-3b	EA F26	30.052	63.2	6.03	938.0	-22.21
c4	644-5-3-3b	EA F12	30.054	77.5	3.75	1820.8	-23.64
c5	658-5-3-1b	EA F13	3.415	20.1	1.89	593.4	-25.02
c6	756-5-3-2b	EA F31	1.000	2.0	5.44	147.7	-26.71
c7	756-5-3-3b	EA F31	30.070	90.4	6.14	987.0	-23.77
c8	865-5-3-2b	T F8	7.623	88.4	5.61	1293.5	-21.84
c9	865-5-3-3b	T F8	12.374	114.1	4.99	1416.1	-23.93
c10	941-5-3-1b	LA F28	7.756	25.7	2.38	717.3	-24.69
c11	941-5-3-2b	LA F28	30.576	211.3	8.66	2010.8	-22.05
c12	962-5-3-1b	LA F29	1.346	16.3	5.68	313.9	-26.71
Check				109.1	1.54	362.3	-23.81
Check				109.6	1.26	364.2	-23.82
d1	1005-3-1b	T na	4.901	71.6	4.80	1121.9	-21.45
d2	1030-5-3-1b	T F38	30.632	247.4	5.25	1520.4	-18.58
d3	1030-5-3-2b	T F38	13.640	221.2	4.21	1808.5	-22.07
d4	1030-5-3-3b	T F38	2.983	0.5	11.36	6.1	-23.23
d5	1030-5-3-4b	T F38	30.794	17.1	-2.19	221.9	-20.32
d6	1051-5-3-1b	T F25	3.849	54.3	5.42	649.8	-25.02
d7	1051-5-3-2b	T F28	23.835	244.4	4.85	3837.7	-18.45
d8	1051-5-3-3b	T F28	17.353	145.7	6.41	2660.6	-20.45
Check				112.1	1.45	369.1	-23.80
Check				110.6	1.35	366.0	-23.82
Check				111.1	1.41	363.5	-23.81
Check				110.2	1.30	728.5	-23.84
Check				107.7	1.36	734.7	-23.84
Check				108.7	1.30	734.5	-23.82
e1	CE32	Lechuguilla Cake	2.489	5.3	-2.65	924.3	-12.90
e2	ED-J	Juniper seeds - ED	2.633	39.3	2.10	1076.0	-28.11
e3	WM-B	Buckeye seed WM	2.522	57.3	-0.63	1544.1	-26.43
e4	VV-Hu	Huisache seed VV	2.552	177.5	0.37	1107.2	-26.76
e5	CE30	Arrowhead tuber TV	2.581	19.4	-0.49	853.9	-13.14
e6	CE34	Sotol hearth ED	2.517	9.4	-5.36	1372.3	-25.65
e7	ZL134	Flint corn nib	2.666	29.3	0.53	1036.9	-11.93
e8	C10	Amaranth seed	2.533	64.8	6.01	1087.2	-27.74
e9	PT89	Tepary bean	2.514	123.1	1.58	1004.8	-27.76
e10	EA5	Squash	2.728	119.2	3.55	1364.8	-27.94
e11	CE29	Youpon leaves TV	2.530	56.3	-1.75	1124.4	-28.24

Appendix H: Stable Carbon and Nitrogen Isotope Analyses

Name	Sample ID	Provenience	Weight (mg)	N μ g	$\delta^{15}\text{N}$ (‰)	C μ g	$\delta^{13}\text{C}$ (‰)
e12	VV-Mi	Catclaw seeds VV	2.532	78.8	1.41	1080.0	-26.75
Check				110.7	1.06	732.5	-23.85
Check				108.2	1.32	732.3	-23.84
f1	VV-Oak	Oak nut meat VV	2.591	20.1	-0.15	997.2	-24.33
f2	TV-Ev	Eves Neckless TV	2.647	24.2	9.77	1098.0	-28.64
f3	TV-BC	Buchcroton TV	2.588	59.8	1.07	1047.2	-29.96
f4	ED-Le	Lechuguilla seeds ED	2.656	87.3	-0.20	1154.2	-13.79
f5	CE18	Sotol seeds TV	2.444	90.7	4.44	1072.0	-28.40
f6	Buff	Buffalo grass seed	2.504	31.0	-0.96	1002.4	-14.05
f7	CE28	Acorn squash HEB	2.532	33.9	-1.32	932.9	-27.66
f8	Sot	Sotol Head RL	2.661	6.0	-6.16	951.6	-24.53
f9	Cam	Camas, Holland	2.565	21.0	3.36	844.3	-26.02
f10	VV-Le	Lechuguilla heart VV	2.684	27.6	-0.92	938.6	-11.94
f11	HO-Yuc	Yucca seeds VV	2.493	102.2	5.29	1121.0	-23.65
f12	Vop	Youpon berry TV	2.564	9.0	5.17	1171.1	-27.46
Check				109.7	1.42	736.5	-23.81
Check				108.7	1.48	730.1	-23.85
g1	Green	Greenbrier fruit TV	2.701	15.3	-3.12	1126.3	-27.50
g2	Milk	Milkweed seed BLM	2.513	121.7	0.07	1144.9	-28.00
g3	TV-MP	Mexican plum TV	2.562	15.9	-0.80	1012.6	-29.07
g4	TV-BP	Bush pepper TV	2.515	33.6	0.29	1081.5	-30.04
Check				108.7	1.03	723.0	-23.80
Check				111.2	1.25	735.4	-23.82
Check				112.1	1.45	369.1	-23.80
Check				110.6	1.35	366.0	-23.82
Check				111.1	1.41	363.5	-23.81
h1	CE31	Cottontail meat	1.026	152.1	4.59	451.8	-25.75
h2	Rab	Rabbit meat Burnet	1.040	148.1	6.69	462.9	-19.63
h3	Snail	<i>Rabdotus</i> meat TV	1.089	74.1	6.03	407.1	-27.29
h4	MO-Buf	Buffalo Missouri	1.017	137.3	7.33	461.0	-16.70
h5	Den-Buf	Buffalo Denver	1.015	125.9	6.26	450.6	-18.73
Check				110.6	1.33	364.8	-23.86
Check				110.1	1.29	364.2	-23.90

Boldface indicates questionable amounts leading to questionable values.

T = Toyah, LA = Late Archaic, EA = Early Archaic, MA = Middle Archaic, BT = backhoe trench, F1 = Feature 1, NA = not a feature, TV = Travis County, VV = Val Verde County, ED = Edwards County, RL = Real County, WM = Williamson County

APPENDIX I:

PLANT REMAINS FROM THE VARGA SITE (41ED28)

PLANT REMAINS FROM THE VARGA SITE (41ED28)

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January 2004

I.1 INTRODUCTION

TRC Environmental Corporation (TRC) submitted 44 flotation samples recovered from 18 features and other general proveniences from the Varga Site (41ED28) in Edwards County, Texas, for botanical analysis. These flotation samples totaled 404.5 liters in volume. An additional 75 charcoal or macrobotanical samples were examined and identified. This report presents a description of the plant materials from four cultural components at the site. The analysis will generate descriptive data that can be compared to other sites in the western Edwards Plateau and Lower Pecos River regions. Wood charcoal, seeds, nut fragments, and fiber bundles from evergreen rosette plants (agave, sotol, or yucca) were noted in the samples.

I.2 METHODS

The analysis follows standard archaeobotanical laboratory procedures. Each flotation sample is passed through a nested set of screens of 4-mm, 2-mm, and 0.450-mm mesh and examined for charred material that is separated for identification. Carbonized wood from the 4-mm and 2-mm screens (smaller pieces are seldom identifiable) is separated in a grab sample and identified. The charred material caught on all of the sieve levels, including the bottom pan, is scanned for floral parts, fruits, and seeds. Screen-collected macrobotanical samples (e.g., radiocarbon samples) are also sorted and identified. Identification of carbonized wood is accomplished by using the snap technique, examining the transverse and radial sections at 8X to 45X power with a binocular dissecting microscope, and comparing the material to reference specimens in the Shumla Archaeobotanical Services herbarium.

The anatomy of some woods is so similar that identification to species or even genus is not

possible. For this reason, I combine some taxa into wood types. For example, willow (*Salix* sp.) and cottonwood (*Populus* sp.), both members of the Salicaceae or willow family, have been lumped together to form an artificial category called a “type.” All identifications in the “type” category represent identifications to the taxon level indicated by the name of the type. Although it is likely that most of the wood referred to this group is cottonwood, I am using the more general “wood” type category because it is difficult to distinguish between cottonwood and willow charcoal.

Charred leaves and fiber-vascular bundles of agave, sotol, and yucca also present special identification problems. Both Bohrer (1987:72) and Kwiatkowski (1992:327) have determined that only fibers with trough-shaped or D-shaped cross-sections (transverse view) can be identified as agave. Agave fibers contain styloid (rod-shaped) or raphide (needle-shaped) calcium oxalate crystals. These researchers also note that sotol fiber bundles, leaves, or stems, do not contain calcium oxalate crystals. While I agree that these rules apply in most cases to plants in the Sonoran Desert, they do not apply to the most common agave in the Trans-Pecos, *Agave lechuguilla*, nor to the species of sotol growing throughout much of Texas, *Dasyllirion texanum*. A single leaf of *Agave lechuguilla*, a very common agave in the Trans-Pecos, may contain all round fibers, or fibers that are both round and D-shaped in transverse view. In addition, sotol growing in the Trans-Pecos and Edwards Plateau regions usually contains an abundance of styloid and raphide calcium oxalate crystals. Agave, sotol, and yucca can also be identified by the presence of other diagnostic parts, such as leaf fragments, spines, or flower stalks. Unfortunately, these types of remains are not often encountered in archaeological deposits. Because the sample size was quite small, I have elected for the purposes of this study to place all charred fiber-vascular bundles that contain

styloid or raphide crystals into the general category Agavaceae. These may actually be the remains of agave, sotol, or yucca; however, given the location of the Varga Site, it is most likely that they are the remains of sotol or yucca because *Agave lechuguilla* is most common along the rims of canyons in southern Edwards and Val Verde counties.

The term “cheno-am” is used to refer to the charred seeds (achenes) of either the genera *Chenopodium* (goosefoot) or *Amaranthus* (pigweed). Although it may be possible to distinguish these seeds when they are fresh and uncharred, quite often they swell and distort when exposed to heat. Therefore, I refer them to a seed type, “cheno-am,” and it is understood that this category refers to both genera.

I.3 RESULTS

Identifications and counts are presented in Tables I-1 to I-3. Preservation was very good, and 19 taxa were identified in the samples (Table I-1). Edible plant parts were represented by Agavaceae leaf and caudex (i.e., heart) fragments, prickly pear seed, mesquite seed, cheno-am seed (achenes), and nut fragments, both littleleaf walnut and a thin nutshell, probably pecan. The caudex of an Agavaceae (agave, sotol, yucca) is the compressed central stem to which the leaves are attached. It is the fleshy, edible part of the plant.

Wood types were mesquite, woody legume, hickory family (e.g., pecan), buttonbush, cottonwood/willow, juniper, sycamore, Mexican buckeye, pinyon, agarita, oak, buckthorn, elm, and lotebush. Taxa that are indicative of a typical western Edwards Plateau canyon or riparian flora are cottonwood/willow wood, littleleaf walnut, sycamore, Mexican buckeye, oak, buttonbush, elm, pecan, and cottonwood/willow. Plants indicative of upland

vegetation are mesquite, juniper, pinyon, oak, and lotebush. Plant materials that characterize desert food foraging activities in the western Edwards Plateau region are prickly pear seed, Agavaceae (yucca, sotol, or agave) leaf and caudex fragments, cheno-am seeds, littleleaf walnut and possible pecan nut fragments, and mesquite seeds.

Tables I-2 and I-3 present counts and weights of taxa identified in the samples. Table I-2 summarizes remains recovered from the macroplant samples, and Table I-3 lists the contents of flotation samples. The tables are organized by time period, feature, and sample number. In the following discussion, I will first describe the plant remains by feature, and then examine the results by time period.

I.3.1 Toyah Component Features

The Late Prehistoric period Toyah Phase component is represented by Features 2, 3, 8, 9, 18, 21, 22, 25, 30, 35, 36, and 38.

Features 2 and 3—A single macrobotanical sample from each feature contained oak wood charcoal.

Feature 8—Five macrobotanical samples and three flotation samples contained nine wood charcoal types. Lotebush, a common shrub of the region, was the most abundant of the wood types. Oak, juniper, agarita, condalia, elm, buttonbush, mesquite, and another woody legume (possibly leadtree or an acacia) were the other wood types. Both upland and riverine or canyon species are represented in the sample. A single charred nut fragment of littleleaf walnut was noted in sample 843-5-7-2a. The abundance of wood charcoal and the relatively large number of taxa suggest repeated use of the feature.

Table I-1. Plant Taxa Identified in the Varga Site Samples

Taxon	Common Name	Part
Agavaceae	Sotol-Yucca-Agave Type	Heart
<i>Berberis trifoliata</i>	Agarita	Wood
<i>Carya</i> sp.	Hickory Family (e.g., pecan)	Wood
<i>Cephalanthus occidentalis</i>	Buttonbush	Wood
<i>Chenopodium-Amaranthus</i>	Cheno-am	Seed
<i>Condalia</i> sp.	Condalia or Buckthorn	Wood
Fabaceae	Woody Legume	Wood
<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut
<i>Juniperus</i> sp.	Juniper	Wood
<i>Opuntia</i> sp.	Prickly Pear	Seed
<i>Pinus</i> sp.	Pinyon	Wood
<i>Platanus occidentalis</i>	Sycamore	Wood
<i>Prosopis glandulosa</i>	Mesquite	Seed, Wood
<i>Querus</i> sp.	Oak	Wood
Salicaceae	Cottonwood/Willow	Wood
Thin Nut Type	Pecan?	Nut
<i>Ulmus</i> sp.	Elm	Wood
<i>Ungnadia speciosa</i>	Mexican Buckeye	Wood
<i>Ziziphus obtusifolia</i>	Lotebush	Wood

Table I-2. Varga Site Macrobotanical Sample Counts

Feature	Cat. No.	Taxon	Common Name	Part	Count/ Volume	Wgt. (g)
Modern						
N/A	1123-7-1a	<i>Platanus occidentalis</i>	Sycamore	Wood	19	8.1
Late Prehistoric (ca. Toyah Phase [300-650 B.P.])						
2	525-5-7-1b	<i>Quercus</i> sp.	Oak	Wood	1	0.1
3	119-5-7-1a	<i>Quercus</i> sp.	Oak	Wood	7	0.2
8	843-5-7-1b	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.2
8	843-5-7-2a	Indeterminate	N/A	Wood	7	0.4
8	843-5-7-2a	<i>Quercus</i> sp.	Oak	Wood	6	0.4
8	865-5-4-7-1b	<i>Quercus</i> sp.	Oak	Wood	1	0.1
8	865-5-7-2a	Indeterminate	N/A	Wood	4	0.1
8	865-5-7-2b	No Sample	N/A	—	—	—
8	867-5-7-1a	<i>Condalia</i> sp.	Green <i>Condalia</i>	Wood	3	0.2
8	867-5-7-1a	Indeterminate	N/A	Wood	4	0.4
8	867-5-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	3	0.1
8	867-5-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	5	0.4
8	867-5-7-1a	<i>Ulmus</i> sp.	Elm	Wood	5	0.3
9	830-5-7-1a	<i>Quercus</i> sp.	Oak	Wood	4	0.2
9	830-5-4-7-1b	<i>Quercus</i> sp.	Oak	Wood	21	0.2
21	78-5-7-3	<i>Juniperus</i> sp.	Juniper	Wood	4	0.4
21	78-5-7-3	<i>Prosopis glandulosa</i>	Mesquite	Wood	2	0.1
21	78-5-7-3	<i>Quercus</i> sp.	Oak	Wood	7	0.3
21	78-5-7-3	<i>Ulmus</i> sp.	Elm	Wood	2	0.1
21	79-5-4-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
21	79-5-4-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
25	1021-5-7-1a	Indeterminate	N/A	Wood	2	0.1
25	1021-5-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	4	0.2
25	1021-5-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	11	1.4
25	1025-5-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
25	1025-5-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.4
25	1055-5-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.4
25	1055-5-7-1b	<i>Quercus</i> sp.	Oak	Wood	26	1.8
36	158-5-7-1b	<i>Quercus</i> sp.	Oak	Wood	3	0.1
36	160-5-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	3	0.3
36	159-5-7-1b	Fabaceae	Woody Legume	Wood	2	0.4
38	1030-5-7-1b	Salicaceae	Willow-Cottonwood	Wood	2	0.2
38	1030-5-7-2a	Fabaceae	Woody Legume	Wood	20 ml	3.9
30	109-7-1a	Indeterminate	N/A	Wood	5	0.2
30	109-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1

Feature	Cat. No.	Taxon	Common Name	Part	Count/ Volume	Wgt. (g)
NA	109-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	4	1
NA	377-7-1a	<i>Quercus</i> sp.	Oak	Wood	1	0.1
NA	450-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
NA	481-7-1a	Indeterminate	N/A	Wood	17	3
NA	490-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
NA	52-7-1a	<i>Quercus</i> sp.	Oak	Wood	7	1
NA	550-7-1a	<i>Quercus</i> sp.	Oak	Wood	1	0.1
NA	573-7-1a	<i>Quercus</i> sp.	Oak	Wood	4	0.4
NA	748-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
NA	748-7-1a	<i>Quercus</i> sp.	Oak	Wood	5	0.1
NA	78-5-7-2	Indeterminate	N/A	Wood	16	0.6
NA	78-5-7-2	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
NA	78-5-7-2	<i>Platanus occidentalis</i>	Sycamore	Wood	7	0.2
NA	78-5-7-2	<i>Prosopis glandulosa</i>	Mesquite	Wood	17	0.7
NA	78-5-7-2	<i>Quercus</i> sp.	Oak	Wood	9	0.2
NA	800-7-1a	<i>Quercus</i> sp.	Oak	Wood	2	0.1
NA	825-7-1a	Salicaceae	Willow-Cottonwood	Wood	2	0.3
NA	841-7-1a	Indeterminate	N/A	Wood	2	0.3
NA	841-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	4	0.5
NA	841-7-1a	<i>Quercus</i> sp.	Oak	Wood	3	0.4
NA	848-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	15	1.6
NA	848-7-1a	<i>Quercus</i> sp.	Oak	Wood	4	0.5
NA	944-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
Late Archaic (ca. 1700-2300 B.P.)						
1a	89-5-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	5	0.4
1	NA	81-7-1a	<i>Quercus</i> sp.	Oak	Wood	1
1	98-5-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	7	0.3
1	98-5-7-1a	Fabaceae	Woody Legume	Wood	4	0.4
1	98-5-7-1a	<i>Quercus</i> sp.	Oak	Wood	8	0.5
1	98-5-7-1a	<i>Condalia</i> sp.	Green <i>Condalia</i>	Wood	5	0.3
1	98-5-7-1a	Indeterminate	N/A	Wood	2	0.1
1	100-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	14	1.7
1	162-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	34 ml	12.4
1	171-5-7-1a	—	—	—	—	—
1	171-5-7-1b	<i>Juniperus</i> sp.	Juniper	Wood	5	0.2
1	171-7-2a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
1	203-7-1b	<i>Prosopis glandulosa</i>	Mesquite	Wood	12	1.2
1	361-5-7-1b	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
1c	293-5-7-1b	<i>Juniperus</i> sp.	Juniper	Wood	4	0.2
1b	362-5-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1

Feature	Cat. No.	Taxon	Common Name	Part	Count/ Volume	Wgt. (g)
1	407-7-1a	<i>Quercus</i> sp.	Oak	Wood	3	0.7
NA	899-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
Middle Archaic (ca. 3900-4820 B.P.)						
NA	199-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	10	0.5
NA	418-7-1b	Indeterminate	N/A	Wood	1	0.1
Early Archaic (ca. 5200-6300 B.P.)						
23	735-5-4-7-1a	Indeterminate	N/A	Wood	1	0.1
23	735-5-7-1b	Indeterminate	N/A	Flecks	–	–
39	202-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
39	202-7-2a	<i>Prosopis glandulosa</i>	Mesquite	Wood	3	0.2
39	204-7-1a	<i>Quercus</i> sp.	Oak	Wood	6	0.9
40	128-5-4-7-1b	<i>Quercus</i> sp.	Oak	Wood	1	0.1
NA	29-7-1a	<i>Quercus</i> sp.	Oak	Wood	3	0.1
NA	38-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
NA	64-7-1a	<i>Quercus</i> sp.	Oak	Wood	1	0.1
NA	75-7-1a	Indeterminate	N/A	Flecks	–	–
NA	76-7-1a	Indeterminate	N/A	Wood	1	0.1
NA	154-7-1b	<i>Quercus</i> sp.	Oak	Wood	5	0.1
NA	216-7-1a	<i>Quercus</i> sp.	Oak	Wood	2	0.2
NA	216-7-1a	<i>Prosopis glandulosa</i>	Mesquite	Wood	4	0.3
NA	323-7-1a	Indeterminate	N/A	Wood	1	0.1
NA	344-7-1b	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.1
NA	345-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	4	0.3
NA	346-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	7	0.3
NA	347-7-1a	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.1
NA	375-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
NA	402-7-1a	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	2	0.2
NA	402-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	3	0.1
NA	432-7-1a	<i>Juniperus</i> sp.	Juniper	Wood	10 ml	2.8
NA	465-7-1a	Indeterminate	N/A	Wood	1	0.1
NA	531-7-1b	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.1
NA	546-7-1a	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.2
NA	570-7-1b	Indeterminate	N/A	Wood	1	0.1
NA	607-7-1b	<i>Juglans</i>	Walnut	Nut	2	0.1
NA	607-7-1b	Indeterminate		Wood	2	0.1

Table I-3. Plant Remains from Flotation Samples

Feature	Cat. No.	Taxon	Common	Part	Count/ Volume	Wgt (g)
Toyah (ca. 300-650 B.P.)						
8	865-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	9	0.5
8	843-5-4-1	Fabaceae	Woody Legume	Wood	5	0.2
8	843-5-4-1	Indeterminate	N/A	Wood	6	0.2
8	843-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	3	0.1
8	843-5-4-1	<i>Cephalanthus occidentalis</i>	Buttonbush	Wood	8	0.3
8	843-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	10 ml	2.8
8	867-5-4-1	<i>Quercus</i> sp.	Oak	Wood	10	0.3
8	867-5-4-1	<i>Berberis trifoliata</i>	Agarita	Wood	25	6.3
9	830-5-4-1	<i>Berberis trifoliata</i>	Agarita	Wood	11	0.3
9	830-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	7	0.8
9	830-5-4-1	Salicaceae	Cottonwood/Willow	Wood	10	0.3
9	830-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	9	0.3
9	830-5-4-1	<i>Quercus</i> sp.	Oak	Wood	30	0.7
9	830-5-4-1	<i>Platanus occidentalis</i>	Sycamore	Wood	4	0.3
9	830-5-4-1	<i>Ungnadia speciosa</i>	Mexican Buckeye	Wood	9 ml	1.7
9	830-5-4-1	Fabaceae	Woody Legume	Wood	9	0.2
9	830-5-4-1	<i>Pinus</i> sp.	Pinyon	Wood	1	0.1
9	830-5-4-1	Indeterminate	N/A	Seed	1	—
18	533-5-4-1	<i>Quercus</i> sp.	Oak	Wood	25	0.2
21	78-5-4-1	<i>Quercus</i> sp.	Oak	Wood	8 ml	1.5
21	78-5-4-1	<i>Carya</i> sp.	Hickory Family	Wood	3	0.1
21	78-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	9	0.2
21	78-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	6	0.2
21	78-5-4-1	Indeterminate	N/A	Wood	4 ml	0.9
21	78-5-4-1	Thin Nut Type	Pecan (cf)	Nut	3	0.1
21	79-5-4-1	<i>Quercus</i> sp.	Oak	Wood	9 ml	1.5
21	79-5-4-1	<i>Ulmus</i> sp.	Elm	Wood	4 ml	0.3
21	79-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	14	0.2
21	79-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	15 ml	2.5
21	79-5-4-1	Indeterminate	N/A	Wood	20	0.5
21	79-5-4-1	Fabaceae	Woody Legume	Wood	1	0.1
21	79-5-4-1	<i>Chenopodium-Amaranthus</i>	Cheno-am Type	Seed	2	—
21	87-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Heart	13	2.6
21	87-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	21	1.2
21	87-5-4-1	Indeterminate	N/A	Wood	7	0.7
21	87-5-4-1	<i>Ulmus</i> sp.	Elm	Wood	9	0.5
21	87-5-4-1	<i>Carya</i> sp.	Hickory Family	Wood	9	0.3
21	87-5-4-1	Fabaceae	Woody Legume	Wood	5	0.1

Feature	Cat. No.	Taxon	Common	Part	Count/ Volume	Wgt (g)
21	87-5-4-1	Thin Nut Type	Pecan (cf)	Nut	2	0.1
21	87-5-4-1	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	1	0.1
21	87-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	17	0.6
21	88-5-4-1	<i>Quercus</i> sp.	Oak	Wood	10 ml	1.8
21	88-5-4-1	<i>Ulmus</i> sp.	Elm	Wood	2	0.2
21	88-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	2	0.1
21	88-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	13 ml	1.8
21	88-5-4-1	Indeterminate	N/A	Wood	11 ml	1.7
21	88-5-4-1	Fabaceae	Woody Legume	Wood	5	0.8
22	603-5-4-1	Indeterminate	N/A	Wood	13	0.2
30	109-5-4-1	<i>Quercus</i> sp.	Oak	Wood	8	0.3
30	109-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	2	1
30	109-5-4-1	Indeterminate	N/A	Wood	21	0.2
30	109-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Seed	1	–
30	109-5-4-1	Indeterminate	N/A	Slag	8	0.6
35	119-5-4-1	Indeterminate	N/A	Wood	8ml	0.8
35	119-5-4-1	<i>Quercus</i> sp.	Oak	Wood	2	0.1
35	119-5-4-1	Fabaceae	Woody Legume	Wood	12	0.3
35	119-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
35	119-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Heart	4	0.1
36	262-5-4-1	<i>Quercus</i> sp.	Oak	Wood	5	0.1
36	262-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
25	1051-5-4-1	Salicaceae	Cottonwood/Willow	Wood	5	0.1
25	1051-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
25	1051-5-4-1	<i>Ulmus</i> sp.	Elm	Wood	1	0.1
25	1051-5-4-1	<i>Quercus</i> sp.	Oak	Wood	11	0.2
25	1051-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	15	0.4
25	1051-5-4-1	Indeterminate	Independent	Wood	24	0.6
25	1051-5-4-1	<i>Platanus occidentalis</i>	Sycamore	Wood	2	0.1
25	1051-5-4-1	<i>Juglans microcarpa</i>	Littleleaf Walnut	Nut	3	0.1
38	1030-5-4-1	<i>Quercus</i> sp.	Oak	Wood	24	1.1
38	1030-5-4-1	<i>Cephalanthus occidentalis</i>	Buttonbush	Wood	5 ml	1.1
38	1030-5-4-1	Salicaceae	Cottonwood/Willow	Wood	5	0.1
38	1030-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	5	0.2
38	1030-5-4-1	Indeterminate	N/A	Wood	8	0.6
38	1030-5-4-1	Fabaceae	Woody Legume	Wood	14	0.4
38	1030-5-4-1	Indeterminate	N/A	Fragment- seed	1	–
38	1030-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Leaf	3	0.5

Feature	Cat. No.	Taxon	Common	Part	Count/ Volume	Wgt (g)
Late Archaic (ca. 1700-2300 B.P.)						
38	1030-5-4-1	<i>Opuntia</i> sp.	Prickly Pear	Seed	2	–
1d	11-4-1	No Identifiable Plant Remains	N/A	–	–	–
1	80-5-4-1	Indeterminate	N/A	Wood	21	0.3
1	80-5-4-1	<i>Cephalanthus occidentalis</i>	Buttonbush	Wood	1	0.1
1	80-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
1	80-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
1	81-5-4-1	Indeterminate	N/A	Wood	8	0.1
1a	89-5-4-1	Indeterminate	N/A	Wood	11	0.1
1	161-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Seed	1	--
1	161-5-4-1	Indeterminate	N/A	Wood	8	0.1
1	178-5-4-1	Indeterminate	N/A	Wood	5ml	0.4
1	179-5-4-1	<i>Opuntia</i> sp.	Prickly Pear	Seed	3	--
1	179-5-4-1	<i>Quercus</i> sp.	Oak	Wood	2	0.1
1	179-5-4-1	Indeterminate	N/A	Wood	12	0.1
1	179-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
1	179-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Leaf	2	0.1
1	187-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	6	0.1
1	187-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	1	0.1
1	187-5-4-1	Indeterminate	N/A	Wood	20	0.1
1	263-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	1	0.1
1	263-5-4-1	<i>Ziziphus obtusifolia</i>	Lotebush	Wood	1	0.1
1	263-5-4-1	Indeterminate	N/A	Wood	14	0.1
1	263-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Leaf	1	0.1
1	263-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
1b	273-5-4-1	<i>Opuntia</i> sp.	Prickly Pear	Seed	1	--
1b	273-5-4-1	Agavaceae	Sotol-Yucca-Agave Type	Leaf	6	--
1b	273-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
1b	273-5-4-1	<i>Prosopis glandulosa</i>	Mesquite	Wood	3	0.1
1b	274-5-4-1	<i>Cephalanthus occidentalis</i>	Buttonbush	Wood	1	0.1
1b	274-5-4-1	Indeterminate	N/A	Wood	12	0.1
1b	274-5-4-1	<i>Quercus</i> sp.	Oak	Wood	1	0.1
1b	274-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	14ml	1.1
1	352-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	8	0.1
1	352-5-4-1	<i>Quercus</i> sp.	Oak	Wood	2	0.1
1	352-5-4-1	Indeterminate	N/A	Wood	19	0.1
15	801-5-4-1	No Identifiable Plant Remains	–	–	–	–
Middle Archaic (ca. 3900-4820 B.P.)						
11	507-5-4-1	No Identifiable Plant Remains	–	–	–	–
11	515-5-4-1	No Identifiable Plant Remains	–	–	–	–
37	37-5-4-1	No Identifiable Plant Remains	–	–	–	–

Feature	Cat. No.	Taxon	Common	Part	Count/ Volume	Wgt (g)
Early Archaic (ca. 5200-6300 B.P.)						
12	644-5-4-1	No Identifiable Plant Remains	—	—	—	—
26	615-5-4-1	<i>Opuntia</i> sp.	Prickly Pear	Seed	3	—
26	615-5-4-1	<i>Juniperus</i> sp.	Juniper	Wood	2	0.1
26	615-5-4-1	Indeterminate	N/A	Wood	15	0.1
31	756-5-4-1	No Identifiable Plant Remains	—	—	—	—
40	128-5-4-1	No Identifiable Plant Remains	—	—	—	—

Feature 9—Two macrobotanical samples and a single flotation sample contained eight wood types, including the only example of pinyon recovered from the site. No seeds or other edible plant fragments occurred in the samples. Lotebush, cottonwood/willow type, woody legume, agarita, juniper, and Mexican buckeye wood were identified. The fact that six woody taxa were identified in the feature suggests that it was utilized on numerous occasions.

Feature 18—A single flotation sample from this feature yielded oak wood charcoal. It is possible that this is a single-use feature as the only charcoal from this feature was identified as oak.

Feature 21—Four flotation samples and two macrobotanical samples from this feature contained seven wood types, including hickory-family wood (possibly pecan), mesquite, oak, elm, woody legume (leadtree or acacia), and a large quantity of juniper. Littleleaf walnut and pecan nut fragments, as well as sotol-yucca-agave caudex (stem) fragments were also identified in the samples. The most abundant wood in the sample was oak, followed by juniper. Both of these taxa provide excellent fuel for earth ovens and the quantity suggests that the feature was associated with an earth oven. The charred caudex fragments probably represent the part of the food load that was accidentally charred during the baking process. The thin nut fragments, most likely pecan, and the littleleaf walnut fragments are a good

indication that nuts of both types were gathered nearby and processed at the site.

Feature 22—A single flotation sample from this feature yielded a small quantity of wood that was too deteriorated to identify.

Feature 25—Two macrobotanical samples and a flotation sample were submitted from this feature. The macrobotanical samples contained mostly oak, some mesquite wood, with a smaller amount of juniper wood. The flotation sample contained cottonwood/willow wood, elm, oak, and sycamore in addition to mesquite and juniper. Littleleaf walnut pericarp fragments were also identified in the sample.

Feature 30—A single macrobotanical sample yielded juniper and indeterminate wood. One flotation sample yielded oak and mesquite wood. In addition to the wood charcoal, a single mesquite seed was noted. The presence of mesquite seed suggests that mesquite beans were processed at the site.

Feature 35—This feature is also represented by a single flotation sample. This context yielded sotol-yucca-agave-type caudex fragments. Juniper, woody legume, and oak wood charcoal were also identified in the sample.

Feature 36—Three macrobotanical samples and a flotation sample were analyzed from this context. The flotation sample contained oak and juniper, and the macrobotanical samples

contained mesquite, a woody legume, and oak wood. No seeds, fruit, or nut fragments were noted in the sample.

Feature 38—Two macrobotanical samples and a single flotation sample contained prickly pear seed and sotol-yucca-agave leaf. Wood types included cottonwood/willow, buttonbush, oak, juniper, and woody legume. One of the sotol-yucca-agave leaf fragments was fairly large, measuring 22 by 11 mm, and was most likely a sotol leaf base. Woody legume wood (acacia or leadtree) was the most common wood from the feature, and most of that material came from sample 1030-5-7-2a. The flotation sample yielded an abundance of buttonbush and oak and smaller amounts of the other wood types.

I.3.2 Late Archaic Component Features

The Late Archaic Period is represented by Features 1, 1a, 1b, 1c, 1d, and 15. A single flotation sample was analyzed from Feature 15, but it did not contain any identifiable carbonized plant remains. Although Feature 1 is subdivided into five subfeatures, I am going to discuss it as a single feature that was probably the site of several different use episodes and different food processing activities, a common characteristic of foraging sites.

A total of 11 flotation samples and 12 macrobotanical samples were analyzed from the feature. The samples contained sotol-yucca-agave leaf fragments, mesquite seed, and prickly pear seed. Juniper wood was the most abundant of all wood types in the Late Archaic samples, comprising almost 50 percent of the total weight of the charcoal from this context. Other wood types included buttonbush, mesquite, oak, and lotebush.

The wide variety of wood types, including small trees, such as juniper or oak and the shrubs lotebush and buttonbush, suggest multiple use episodes and different activities requiring

different fuel types. The denser woods, such as mesquite, oak, and juniper, are ideal for earth oven use, and the smaller wood types are useful for small, quick-burning surface fires.

I.3.3 Middle Archaic Component Features

Two features, Features 11 and 37, were sampled from Middle Archaic contexts. No identifiable plant remains were recovered from these samples. Mesquite and oak wood charcoal were identified in macrobotanical samples originating from non-feature contexts in the Middle Archaic levels.

I.3.4 Early Archaic Component Features

Six features were sampled from Early Archaic contexts. Flotation samples were taken from Features 12, 26, 31, and 40. Macrobotanical samples were examined from Features 23, 39, and 40 as well as several non-feature contexts.

Features 12 and 31—Each of these features was sampled by a single flotation sample; however, identifiable plant remains were not recovered from any of these contexts.

Feature 23—Two macrobotanical samples contained a minute amount of charred wood and charcoal flecks that were not identifiable.

Feature 26—The single flotation sample from this feature contained three prickly pear seeds and a small quantity of juniper wood.

Feature 39—Mesquite wood was the only plant material identified from this feature.

Feature 40—No identifiable plant remains.

In addition to the feature samples, 20 non-feature macrobotanical samples were examined. Six of these samples contained littleleaf walnut fragments. Wood charcoal was sparse in the Early Archaic levels, and only three taxa—

mesquite, oak, and juniper—were identified in these contexts.

I.4 DISCUSSION: INTERSITE COMPARISON AND ETHNOBOTANICAL SUMMARY

Recent archeobotanical research at sites located on the western Edwards Plateau has begun to illuminate prehistoric land use in the region. Work conducted in conjunction with the widening of Highway 277 (Cliff et al. 2003) provides comparative data from burned rock midden sites immediately west of the Varga Site (Table I-4).

Most of the differences between the two projects probably result from two factors. First, adequately sampling burned rock middens is very difficult because so many different types of activities are performed at forager sites. Even the center of an earth oven is likely to contain plant parts that are not directly associated with earth oven function because mixing of deposits

occurs when the ovens are cleaned and reused (Black et al. 1997; Dering 1999). Second, archeobotanical assemblages reflect what is immediately available in the surrounding landscape on a seasonal basis, and vegetation varies widely over short distances in semiarid regions. Thus, the plant signatures will vary somewhat from site to site depending on the immediate location of the site relative to plant resources, the season of occupation, plant processing activities that occurred, and other factors such as cooking accidents. Obviously, the larger the flotation sample set, the better chance the archaeologist has to encounter cooking accidents and obtain a more accurate impression of plant resource use at the site. The flotation sample effort at the Varga Site was much larger (at 405 liters) than that of the Highway 277 project (which totaled 136 liters). This may explain why a taxon seldom encountered at burned rock midden sites was recovered from the Varga Site.

Table I-4. Edible Plant Part Ubiquity Compared

Plant Resource	Highway 277 Project ¹	41ED28
Sotol-Yucca (stem/leaf)	20.9%	13.6%
Prickly Pear (seeds)	2.3%	9.1%
Mesquite (seeds)	—	4.5%
Walnut (nut)	53.5%	4.5%
Pecan (nut)	—	4.5%
Cheno-am seeds	—	2.3%

¹ Includes four sites, 41VV1982, 41VV1893, 41VV1895, and 41VV1897, in Val Verde County, Texas

Although seldom recovered from open sites anywhere on the Edwards Plateau until the late 1990s, the leaf bases of sotol-yucca are the most widely occurring of the plant resources from both projects. The low numbers of open sites from which sotol-yucca have been recovered may be because most of the burned rock middens sampled are located in the eastern half of the Plateau, and these were probably not utilized to process yucca, sotol, or agave. Instead, the earth ovens, and the burned rock middens they form, were used for cooking small bulbs and roots (Dering 2003).

The low walnut numbers from the Vargas Site flotation samples are puzzling given that 6 of the 74 macrobotanical samples contained littleleaf walnut fragments. The presence of thin nut fragments, most likely pecan, is indicative of the location of the Varga Site to the east of the Val Verde County sites. The westernmost distribution of native pecan is the Devils River canyon, and pecan has yet to be identified from upland open sites in any part of that watershed.

I.5 ETHNOBOTANICAL NOTES

Because processing usually dictates what plant or part of a plant will survive to be incorporated into the archaeological record, the following notes emphasize plant processing. Plant materials survive in archaeological deposits located in open settings primarily because they have been accidentally carbonized. It follows that food plants, more explicitly certain parts of food plants that are cooked or parched (exposed to hot coals for a brief time), stand the best chance of being preserved at archaeological sites. Although some of the following food preparation descriptions utilize ethnobotanical references from the Southwest, the processes described across the region are relatively consistent and probably apply well to the sites located on the western Edwards Plateau.

I.5.1 Prickly Pear

Prickly pear (*Opuntia* sp.) is documented as a major plant resource in southern Texas and the western Edwards Plateau and throughout the Southwest and northern Mexico (Dering 1999; Heubner 1991; Sobolik 1991). Archaeological evidence abounds for the consumption of seeds as well as the large, very fibrous prickly pear pads in the lower Pecos region and Coahuila (Dering 1999; Huebner 1991; Sobolik 1996; Williams-Dean 1978), but not in the Sonoran Desert. Interestingly, most of the groups in the Sonoran Desert region limit the consumption of prickly pear fruit, citing problems with illness if too much is consumed (Castetter and Underhill 1935:32; Curtin 1949:61; Rea 1997:276; Russell 1908:75-76). This contrasts with discussions of lower Pecos River region diet, in which the pear is portrayed as a very large part of the diet (cf. Huebner 1991). The distinction may be because many of the Sonoran Desert groups either rely primarily on agriculture or maritime resources (Felger and Moser 1985), or it may be that the archaeological visibility of prickly pear is much greater than other resources at sites on the Edwards Plateau and in the Trans-Pecos. Not only the fruit but also the pads were consumed throughout the southwest (Williams-Dean 1978; Rea 1997).

Prickly pear was a staple plant resource for inhabitants of the Rio Grande Plains and adjacent regions (de Vaca, translated by Favata and Fernandez 1993:71). Prickly pear fruit (tuna) was gathered in late summer and consumed raw or sun-dried like figs. Campbell and Campbell (1981:32) note that prickly pear may be consumed either ripe or green, and that the latter was pit-baked in ovens. Tuna ripening is a process that spans several weeks, and fully grown, green tunas contain an abundance of seeds and moisture. Therefore, a pit-baking episode would have the potential to generate charred seeds. Experimental ovens have yielded

green tunas that contain about 50 seeds each and have the consistency of boiled okra and a bland but inoffensive flavor (Daring, field notes). It is therefore conceivable that the seeds recovered from the Varga Site were from fruits that were cooked in an earth oven. Eating tunas, however, involves consuming hundreds of seeds, which raises the possibility that waste seeds from uncooked fruits may have been accidentally incorporated into the midden fill during repeated use of the oven facility.

I.5.2 Mesquite

Mesquite (*Prosopis glandulosa*) pods have provided a critical source of carbohydrates for people throughout the regions where this very useful plant grows (Felger 1977). The pod is processed by pounding in a mortar. Experiments have demonstrated that it is virtually impossible to grind mesquite on a metate (Hodgson 2001:185). In the early part of the 20th century, Russell (1908) observed that the beans were pounded with a stone pestle, or with a wooden one if a large quantity was processed. During the pounding process, the seeds are often separated from the pod meal and are immediately discarded. Although the seed is edible if ground into meal, it is very hard and is encased in a woody, inedible endocarp (Felger 1977). Therefore, the pod meal is sifted through a mat, separating the pod meal from the remaining inedible material. The endocarp is usually discarded with the seed inside, which accounts for the presence of the charred seeds in the archaeological assemblage.

I.5.3 Purslane

Purslane (*Portulaca oleracea*) is a commonly recovered seed from Hohokam sites. In most areas, it ripens in mid- to late summer. Its use as a quelite is widespread throughout the Southwest, and after flowering and fruiting, the seeds were collected and ground into flour

(Cushing 1920; Palmer 1878; Hodgson 2001). In fact, flowering plants could be collected, stored on mats, and the seeds would mature and be collected from the plant much later.

I.5.4 Sotol/Yucca

Agave, sotol, and yucca have evergreen leaves arranged in a rosette, much like an artichoke, and thickened central stems that are modified for storing carbohydrates. Due to the fact that distribution of *Agave lechuguilla* is limited primarily to the Rio Grande embayment, it is most likely that the material from the Varga Site is either sotol or yucca, so I will refer to this material as sotol-yucca in the text. Because these plants store carbohydrates in a vegetative part of the plant instead of the fruit, the carbohydrates are linked to poisonous or indigestible compounds that require exposure to heat for 24 to 48 hours to render them edible (Bell and Castetter 1941; Nobel 1988; Castetter et al. 1938). These compounds discourage grazing animals from availing themselves of the carbohydrates. By the Early Archaic period, however, the populations of the Trans-Pecos region were utilizing earth ovens to prepare the plants in order to break down the poisonous compounds and the long-chain carbohydrates into digestible sugars. Evidence that sotol, lechuguilla, and yucca were processed in these ovens has been recorded in several sites located on the central and western Edwards Plateau and across the Trans-Pecos region (Black et al. 1997; Brown 1991; Dering 1997, 1999).

It is increasingly evident that both yucca and sotol were utilized as important food sources in the Edwards Plateau region. For example, Brown (1991) identified large quantities of San Angelo yucca, a plant with an inedible fruit, from deposits at Baker Cave, and a similar yucca has been identified in abundance at Hinds Cave (Dering 1999). When baked in an earth oven, the central stem of San Angelo and other related

yuccas is edible. Likewise, sotol central stems are rendered edible by baking in an earth oven (Bell and Castetter 1941). An eyewitness account described sotol processing by a Lipan group living in the west-central reaches of the Edwards Plateau. The eyewitness, F. M. Buckelew, was captured in the vicinity of the Sabinal River:

Another choice food of these Indians, and *one in almost constant use* [my emphasis], was bread made from the bulb of the sotol plant, which grew in abundance along these western rivers. In preparing this plant for food, large quantities of bulbs were cooked in a kiln. In this kiln they would place wood and rocks in a way that they would be thoroughly heated by the time the wood was burned. The rocks and fire was removed and the rocks replaced. The sotol was placed on these and brush and leaves were placed next to the sotol, and the entire heap covered over with dirt so as to make it air tight. This was allowed to remain for several days and during this time the heated rock would thoroughly cook the bulbs (Dennis and Dennis 1977:97).

This passage describes both the mechanics of earth oven use and the importance of sotol as a plant resource to the Lipan. The sotol was removed from the pit and pounded into thin sheets, sun-dried, and often ground into flour for making flatcakes. When dried, the thin sheets of cooked sotol and agave will keep for several months and is very light and transportable (Dering, field notes).

I.5.5 Cheno-am

Cheno-am refers to *Chenopodium* (goosefoot) and *Amaranthus* (pigweed). The tender leaves and stems of both of these plants provided a source of greens that were either eaten or utilized as packing material for earth ovens (Hrdlicka 1908). The seeds of both *Chenopodium* and *Amaranthus* plants also were

eaten, and were parched, ground, and prepared in a drink or a gruel (Curtin 1949). Cheno-am seeds occur infrequently at open sites on the Edwards Plateau and have not been noted in rockshelters of the Lower Pecos. It is not clear how important these plants were to prehistoric foragers of the area. Consumption of the greens would probably not leave a detectable archaeological signature. Unfortunately, the most common amaranth in the region today is a European introduction, and alien introductions have also crowded out many native chenopods. This factor also makes assessing the importance of cheno-ams difficult.

I.5.6 Pinyon and Cottonwood/Willow

Both pinyon and cottonwood/willow have several uses associated with technological applications as well as food. Cottonwood is utilized to fashion mortars for pounding mesquite (Rea 1997:177). Although any mortar or pestle combination probably was utilized, Bean and Saubel (1972:109) describe the use of wooden mortars made from either cottonwood or mesquite stumps. The stump was hollowed out with hot coals and the carbonized interior was scraped clean using chipped stone tools. A wood or stone pestle was employed for pounding the pods. This description is very similar to the description of a mortar presented by Rea (1979:42) regarding the Pima, who used a two-foot cottonwood implement to pound mesquite beans. Although mesquite generates excellent, long lasting coals, cottonwood is also a very good source of coals for parching, because they are not as hot and therefore are easier to use. Both willow and cottonwood are excellent structural materials, and their use as central posts, as roofing material, and as vigas in ceilings is recorded in many areas throughout the southwest (Russell 1908:155). Willow branches were used in basketry (Rea 1997) and in the wattle-and-daub storage containers at

Schoolhouse Mound in the Tonto Basin (Dering 1995).

Despite the fact that pinyon is widespread across the western areas of the Edwards Plateau, direct botanical evidence for the use of pinyon nuts has yet to be documented for this region. This is probably the result of a lack of excavations in the region, because pinyon nuts are consumed throughout the distribution of this valuable plant resource (see Basehart 1974:185; Reagan 1928:159). Although the nuts have not been recovered, pinyon use has been documented by two chance finds. Two wooden mortars, both made from pinyon logs, have been recovered from sites located in the Lower Pecos (Collins and Hester 1968; Prewitt 1981).

I.5.7 Pecan

The potential of pecan as a prehistoric resource has been assessed by Hall (2002). Nevertheless, pecan is seldom recovered from archaeological sites on either the Edwards Plateau, the South Texas Plains, or the Coastal Plains of Texas. Thick lenses of pecan were noted in Baker Cave on the Devils River, but pecan has not been reported from open sites in these regions. This is due in part to the dearth of fieldwork that has been conducted in areas where pecan stands are the densest. It also may be that because pecan has a thinner pericarp (shell), it is underrepresented in botanical assemblages from sites excavated in these areas. Pecan use was reported in early historic observations by Cabeza de Vaca (Campbell and Campbell 1981:18), presumably on the Guadalupe River. The reference actually refers to walnut, but pecan is by far the most abundant nut-bearing tree in the region and the Spanish did not have a word for pecan at that time. Continued fieldwork along the coastal plain may provide more data regarding the use of pecan in the region.

I.5.8 Walnut

Littleleaf walnut (*Juglans microcarpa*) is a small relative of the black walnut. Walnuts provide a necessary source of oil that is rare in desert environments, because large game is relatively rare and small game is quite lean (cf. Kelly 1995). Littleleaf walnut is commonly recovered from rockshelters in the Lower Pecos region (Dering 1999). Although it is widely distributed across the western Edwards Plateau and the Chihuahuan Desert, many historic records do not distinguish the littleleaf walnut from other walnut species. Standley (1912:459) lists the littleleaf walnut as a useful plant of New Mexico and Sturtevant notes that the “small nuts are sweet and edible” (Hedrick 1919:320).

Although they refer to *Juglans major*, the Sonoran Desert walnut, several references note that walnut meat was mixed with baked agave. For example, Gifford (1932) provides a very detailed description of the preparation that may be analogous to the activities that occurred along the western Edwards Plateau/Chihuahuan Desert regions. The Southeastern Yavapai pounded the fruits with a river-rolled cobblestone to remove the leathery out hull, then pounded the nut on a metate. The fragments were shaken in a basket to separate the meat from the endocarp. The nutmeat was then placed on a dried agave cake and pounded. This mix was soaked in water and consumed. Castetter and Opler (1936:37) note that ground walnuts are added to baked agave by the Mescalero Apache. In an interesting observation, Gifford (1936) noted that the Northeastern Yavapai consumed walnuts with agave syrup, which raises the possibility that walnuts were processed with sotol (or lechuguilla to the south), two resource types usually thought to be gathered at different seasons.

I.6 SUMMARY AND CONCLUSIONS

The current analysis provides abundant evidence of plant processing at the Varga Site. A total of 20 plant taxa was identified, seven of which (sotol/yucca, goosefoot/pigweed, mesquite, pecan, littleleaf walnut, and prickly pear) provide direct evidence of food resource utilization in the form of seeds or fruit. The assemblage also includes 14 wood types. Both mesquite wood and seeds were identified at the site.

It is clear that the site was used for processing different types of plant resources during separate visits. We can glean this information by examining the evidence for plant processing, and the potential season in which the plant resource was most likely to be available. Mesquite beans and cheno-am seeds usually ripen in mid summer. Although rainfall plays a critical role and the plants are best after a good rainy season, the best time to process either yucca or sotol is spring, just before the flower stalk develops. Nuts ripen in late summer to mid-fall.

The plant taxa therefore suggest that the site would have been occupied over the years during different times of the year—spring, summer, or fall. The season of occupation would have depended on the distribution and quantity of rainfall in a given year, the seasonal round of the groups, and other social and environmental factors. The nature of the botanical evidence is not unusual for a hunter-gatherer site on the Edwards Plateau and surrounding areas. These types of sites are often palimpsests; that is, they contain the compressed remains of multiple occupations from redundant activities that occurred over a relatively long period of time.

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APPENDIX J:

**ANALYSIS OF UNKNOWN MATERIAL
FROM PHASE I DATA RECOVERY INVESTIGATIONS**

ANALYSIS OF UNKNOWN MATERIAL FROM PHASE I DATA RECOVERY INVESTIGATIONS

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J.1 INTRODUCTION

Under contract to the Texas Department of Transportation (TxDOT), archeologists from the Cultural Resources Department of TRC Environmental Corporation's (TRC's) Austin, Texas, office conducted data recovery excavations at the Varga Site (41ED28) in Edwards County Texas. During the Phase I data recovery fieldwork, conducted from January to February 2002, several anomalous linear decomposed structures were identified in three adjacent units and labeled Feature 6.

Feature 6 consists of three linear segments of very decomposed structures exposed in three units immediately south of BT 2 and west of RR 335. The first segment was encountered at 96 cmbd in the southwestern quadrant of unit N103/E55. Two adjacent 1 by 1 m units N102/E54 and N102/E55 immediately south of the first were opened and two more linear segments of the same materials were found at 96 and 98 cmbd within stratigraphic unit 3. The three linear sections measured 38, 45, and 50 cm long and were nearly in a level. The material consisted of small, less than 2 cm long chunks and powder of white/light gray (10YR 7.5/2 dry) material with a vascular-like structure that was confined to a linear area about 1.5 cm wide. When the first piece was encountered in N103/E55, further work in the unit was stopped and TxDOT archeologists were notified. The following day, TxDOT geomorphologist/geoarcheologist, Dr. James Abbott, visited the site and viewed the materials, but he was also unable to positively identify the material. All three linear segments were exposed on pedestals and removed in plaster jackets for transport to the TRC's Austin laboratory.

On July 11, 2002, Dr. Nancy Kenmotsu, Environmental Affairs Division of the Texas Department of Transportation (TxDOT)

requested that TRC Environmental Corporation (TRC) archeologists prepare this document to provide (1) an introduction to the series of electronic reports and communications that unfolded surrounding the Feature 6 "mineral" from the Phase I data recovery excavations at 41ED28 as background to the development of the Phase I interim report, and (2) to summarize the timing of events and shifting interpretations of Feature 6. This report is provided in an electronic file and paper format in order to assist TxDOT to comply with a request made by the Comanche Nation to assist them in understanding the nature of Feature 6.

In reviewing the various documents, it is important to realize that archeology is a discovery process, and that participants formulate working hypotheses both during field and laboratory work. These hypotheses are then tested (refined, modified, discarded) as additional information is obtained from excavations and/or other laboratory information becomes available. Initial working hypotheses often use terms, language, or ideas that, if removed from their temporal context, can be misconstrued and misleading in light of later information. For this reason it is important to take into account the chronology of information available and look at the entire body of information surrounding this feature before reaching a conclusion about the nature of the material.

The following summary discusses the nature of the shifting interpretations of the remains comprising Feature 6. A chronological summary of the field and laboratory activities surrounding the exposure, removal, and laboratory analysis of the Feature 6 is presented in Table J-1. Finally it provides an inventory of files pertaining to the identification of the "mineral" present in Feature 6.

J.2 SUMMARY OF FIELD ASSUMPTIONS

Even though the material lacked a cortical or exterior surface and therefore lacked all shape indications of bone—especially near the cortical surfaces—Dr. Lintz’s initial working assumption was that he had some severely decomposed long bones based on color, general size, and linear appearance. Although Dr. Lintz had not seen materials exactly like these in the past 35 years of archeological field projects, he thought that the differences in preservation were due to degradation of the bones in the soils, probably due to the age of the feature. He suspected based on the depth (ca. 96 cmbd) and kinds of point styles found around the materials (Late to Middle Archaic) that it probably is about 3,000 to 5,000 years old.

Dr. Lintz further assumed based on the width, lack of curvature and length that the “bone” was from an animal larger than a deer; yet smaller than bison. He compared the alignment of the in situ materials against modern deer limb bones from a nearby animal carcass dump to verify that the Feature 6 pieces were bigger than modern deer tibia, femur, and humerus elements.

J.3 SUMMARY OF LABORATORY ACTIVITIES

One encased specimen (#3) was opened and inspected, but was too decomposed to allow for reliable identification based on visual inspection. At TxDOT’s request, three physical anthropologists, Dr. John Kappleman of the Anthropology Department at University of Texas; Dr. Gary Ruttenburg of the Mental Health and Mental Retardation Department in Austin; and Dr. David Glassman at Southwest Texas State University in San Marcos (now Texas State University) were contacted and brought in for their professional opinions. These scientists concluded that the materials, if in fact composed of bone, could not be assigned to a

species, though one concluded that the size and position of the materials were consistent with articulated human leg bones (see actual letters below). Given the inconclusive results, TxDOT submitted a sample of the material to a bone histologist Dr. Robert R. Paine at Texas Tech University for examination of the cellular structure of the material. The histologist and his academic advisor both concluded that the material was not bone (see letter below). The histology information was also submitted to another physical anthropologist Mr. Greig Parker of TRC in California, who reaffirmed the conclusion that the material was not bone.

J.4 SUMMARY

Three anomalous linear structures (labeled Feature 6) were identified in alluvial sediments during the first phase of data recovery excavations conducted at the Varga Site. Based on the overall linear alignment of these structures and their association with a prehistoric archeological site, the possibility existed that the materials may consist of osteological material (i.e., bone) associated with a prehistoric human burial. The three linear segments were jacketed in situ in the field and returned to the laboratory for more detailed inspections. Three physical anthropologists were brought in and their professional opinions were obtained. A bone histologist examined the cellular structure of the material. Once all the scientific opinions were gathered, TxDOT’s archeological staff, TRC archeologists, and the Texas Historical Commission (THC) concluded that the material was not human in origin (these materials are now believed to be sediment cavities, probably root casts that were subsequently filled with carbonates). Based on this conclusion, it was determined that the second phase of data recovery excavations at the Varga Site could proceed.

Table J-1. Chronology of Field and Laboratory Events Surrounding Feature 6 at 41ED28

Field Activities:

1/14/02	Phase I data recovery excavations at 41ED28 begin (first session—1/14/02 to 1/18/02)
1/17/02	“Bone 1” found in 50-by-50-cm unit (N103/E55)—TxDOT archeologists notified by phone of suspected discovery.
ca. 1/18/02	TxDOT geomorphologist J. Abbott visits site and views “Bone 1.”
1/19-27/02	Break occurs between first and second field sessions.
1/28/02	Second field session begins (second session—1/28/02 to 1/30/02)
1/28-29/02	“Bone 1” removed in plaster jacket.
1/28-29/02	“Bones 2 and 3” found. Feature form and profiles completed.
1/31 to 2/3/02	Weekend for second session (10 days long).
2/7/02	TxDOT archeologists (Ellis, Price, & Abbott) and TRC’s Principal Investigator (Lintz) visit and discuss site, including Feature 6.
2/9/02	Sample “Bones 2 and 3” (Specimens 2 and 3) removed from the site in plaster jackets.
2/12/02	End of third session (8 days long) and end of Phase I data recovery excavations.

Laboratory Studies:

ca. 1/21-25/02	Plaster jacket of Specimen 1 opened and TxDOT archeologists (Kemotsu, Price, Abbott, Ellis, & Hickman) inspect specimen in the TRC laboratory, Austin.
2/1/02	Begin process of lining up three physical anthropologists for in-lab analysis.
2/1/02	Request of TxDOT permission to allow consultants to remove sample for analysis; also inquire about issue of continued excavation near the Feature 6.
2/6-8/02	Physical Anthropologists Mr. Ruttenburg, Dr. Glassman and Dr. Kappelman make separate visits to TRC laboratory in Austin to inspect Sample “Bone” 1; other “Bones” not yet extracted from the field. Dr. Glassman and TRC request permission to send sample of bone to Dr. Paine for histological examination.
2/8/02	Physical Anthropologist’s Ruttenburg’s report submitted.
ca. 2/11-15/02	Dr. Glassman gives sample to Dr. Paine at National Physical Anthropology meetings.
2/22/02	Physical Anthropologist Dr. Glassman report submitted.
3/5/02	Dr. Kappelman’s report submitted.
3/5/02	Electronic copies of reports from Mr. Ruttenburg, Dr. Glassman, and Dr. Kappelman sent to TxDOT; along with preliminary phone call from Dr. Paine’s histology report that material is not bone. Also request for permission to open other plaster jackets and recommendation for need for studies by macrobotanical specialist, Dr. Phil Dering.
3/6/02	TxDOT concurs with need for other studies.
3/7/02	Dr. Phil Dering (Macrobotanicalist) solicited for help—no immediate response.
3/19/02	Sample from Specimen 2 shipped to Dr. Dering; a piece from Sample 2 also sent to Dr. Paine.
4/16/02	Dr. Dering phones in results; these are passed on to TxDOT.
4/19/02	Dr. Paine’s report submitted stating that material is not bone.
4/19/02	Mr. Greig Parker contacted to comment on photographs from Paine.
4/21/02	Mr. Parker’s phone response supports Dr. Paine’s conclusion, it is not bone.
4/22/02	TxDOT notified of results from Dr. Paine and Mr. Parker.
4/26/02	Dr. Paine clarifies scale of photographs.
Post 4/26/02	Conclusion that material is not bone and thus written into interim report as mineral (Lintz et al. 2002) and subsequently referred to as mineral.

Figure J-1. Thin-Section Photographs of Unknown Material from Feature 6

Skeletal Remains Recovered from 41ED28 by TRC for TxDot

Gary W. Rutenberg, PhD
Consulting Physical Anthropologist
Anthropos

February 8, 2002

The recovered bone presented for analysis is extremely friable, fragmentary, and consists of small splinters that at most may be a centimeter long and half that wide.

The overall length of the recovered material is approximately 38.5 cm. One end of the bone appears flattened and slightly wider than the majority of the shaft. The diaphysis is uncurved. The thickness of the cortical bone is approximately .25 cm. Both the periosteal and endosteal surfaces appear eroded. A fragment, approximately 3 cm in length and located mid-diaphysis appears to have longitudinal ridges approximating muscle attachments and a portion of a nutrient foramen. Material recovered parallel to the long bone may be from a second bone.

The bone is consistent with the length and width of a human fibula. However, no definitive diagnostic features or articulations are present. Neither are there definitive diagnostic features indicating that the bone is faunal. Indigenous 'large animals' such as horse have a rudimentary fibulae, or completely lack a fibula (vis a vis, deer). The bone is larger than the expected size of a bear.

It is **possible** that the size, shape, and orientation of the recovered bone and the bone left in situ is consistent with the lower limb orientation of an individual buried in a semi-flexed position. The accompanying diagram suggests the orientation of the skeletal remains if this is, in fact, a human burial.

Unfortunately, because of the condition of the recovered remains and the lack of diagnostic landmarks it is not possible to definitively conclude whether or not the skeletal remains are human.

Recommendations:

The condition of the bone precludes complete certainty that the remains are human or otherwise. However, the orientation of the bone as shown on the attached page is suggestive of a possible human burial. Further testing immediately north and northwest of the remains may uncover more bone; possibly with diagnostic features.

Department of Anthropology

TO: Dr. Chris Lintz, TRC Environmental, 505 Huntland Drive, Suite 250, Austin, Texas 78752

FROM:

A handwritten signature in black ink, appearing to be "D. Glassman", is written over the "FROM:" label.

Dr. David M. Glassman, Professor of Anthropology, Southwest Texas State University, San Marcos, Texas 78666

SUBJECT: Analysis of Fragmented Bone

DATE: February 22, 2002

This report describes the morphology of a fragmentary bone excavated by TRC Environmental at the site of 41 ED28. The examination took place on Friday, February 8, 2002. Photographs and plan view maps of two other bones were also made available for examination.

The bone was highly fragmentary and had been jacketed in plaster. The bone was incomplete, missing both its proximal and distal segments. The incomplete bone length measured approximately 38.5 cm. Mid-shaft thickness was approximately 1.96 cm and expanded to 2.87 cm near one end. The bone cortex was thin and minimal trabecular bone was present. The small amount of trabeculae did not exhibit a ribbon-like form. The bone shaft was straight and approximately circular in cross-section. The bone's external surface exhibited some taphonomic erosion expressed as striations.

The gross morphology of the bone appeared to be non-human, although the estimated length, cross-sectional shape and bone thickness was within the range for an adult human fibula. Without further skeletal material to exam, I would conclude that the bone was of equivocal origin. The photographs and plan view maps did not provide enough additional information to render a more specific conclusion. One photograph did suggest the possibility of the bone having been articulated with another in the excavation unit.

I suggest that a bone fragment be sent to a physical anthropologist trained in the preparation of bone thin sections and analysis of bone histology. It is possible that plexiform-type bone or osteons may be identified in the thin section revealing a more consistent pattern with either human or non-human animal.

John Kappelman, Ph.D. *Consulting Anthropology and Geology*

Chris Lintz, Ph.D., RPA
TRC Environmental
505 Huntland Dr, 250
Austin, Texas 78752.

Dear Dr. Lintz,

I am writing to provide you with the results of my inspection of the materials from Edwards County that I examined on 13 February 2002 in your offices on Huntland Drive as well as the copies of the photographs that you sent me by electronic mail.

It is my opinion that even though the material is likely to be skeletal, is too far degraded to permit an informed identification as to either the body part or species that it represents.

If any better-preserved material is encountered, please feel free to contact me.

Sincerely,

John Kappelman, Ph.D.
1102 Maufrais Street
Austin, TX 78703

1102 Maufrais Street, Austin, Texas 78703

512/469-0675

Email: jkappelman@mail.utexas.edu

April 19, 2002

Dear Dr. Chris Lintz:

Early March 2002 your office requested aid in the identification of unknown material recovered from an archaeological survey, site 41ED-28. I agreed to subject two fragments of the material for histological assessment. The following summarizes the observations and conclusions concerning this material.

Standard histological preparation was used specific for poorly preserved archaeological material. Each fragment piece was embedded in a hardener and resin to ensure structural integrity as they were cut and ground to @ 75 microns thick. A standard light microscope equipped with 10x eye pieces and 10x & 20x objectives were used during the examination of the material.

The purpose of the histological examination was to confirm gross observations suggesting the material was bone. Secondly, if it was bone, to attempt to determine its taxa origin. Specifically, we were looking for typical histological features such as secondary osteons, osteocytes, primary lamellar bone, plexiform bone as identifying criteria (see emailed photo of the material).

None of these features were observed from either of the fragments examined. Despite the solid appearance of the material, histologically it was very porous. There are several features that characterized these specimens: round features of a porotic nature, very small circular features with brown/red center, and linear segmented features that cut across the cross-section. None of these features are characteristic of bone, horn or antler. Bone, antler, and horn typical polarize using polarizing filters, in this case neither sample polarized with the use of these filters.

Neither of the fragments exhibited micro-anatomical features specific to bone. Therefore, it is my opinion that this material is something other than bone and it does not represent bone of human origin. It might represent mineral deposit. Several folks from the biology department at Texas Tech have also examined this material and they did not recognize it as plant material.

If you have questions concerning this report please contact me via email at robel.paine@ttu.edu or by phone (806) 742-2401 x241.

Respectively submitted,

Robert R. Paine, Ph.D.
Skeletal Histology
Physical Anthropologist

APPENDIX K:

GRANULOMETRY RESULTS

GRANULOMETRY RESULTS

By:

Mary Jo Schabel

Prepared for:

**TRC Environmental Corporation
505 East Huntland Drive, Suite 250
Austin, Texas 78752**

Prepared by:

**Mary Jo Schabel
Milwaukee Soils Laboratory, LLC
6917 West Oklahoma Ave.
Milwaukee, WI 53219**

December 8, 2003

Table K-1. Granulometry Results

Lab No.	TRC Sample No.	Provenience, Depth (cmbs)	% Sand	% Silt	% Clay	Sieved Sand % (#270)	Sand Silt % Difference	% 1.0 mm	% 0.5 mm	% 0.25 mm	% 0.0625 mm	% 0.05 mm
1	1207	BT M2, 100	35	28	37	37.9	-2.9	22.5	31.9	24.8	6.9	2.8
2	1208	BT M1, 90	25	32	43	21.6	3.4	19.3	24.0	21.5	13.2	5.4
3	1209	BT 7, 2BK	47	23	30	46.4	0.6	43.2	29.4	14.7	4.4	1.7
4	1210	BT 7, BK2	17	35	48	15.8	1.2	18.7	18.3	19.3	17.0	6.8
5	1211	BT 7, A, 15-20	9	36	55	7.8	1.2	9.7	25.0	22.4	16.2	9.4
6	1220	N103/E50, 23-24	21	42	37	21.8	-0.8	21.0	27.1	22.2	10.4	5.0
7	1222	N103/E50, 33-34	11	43	46	13.0	-2.0	13.8	26.2	23.0	13.8	7.1
8	1224	N103/E50, 46-47	18	33	49	15.5	2.5	18.4	28.3	20.9	12.3	5.9
9	1229	N103/E50, 71-72	15	36	49	15.6	-0.6	17.6	26.6	21.4	13.0	6.1
10	1234	N103/E50, 95-96	19	33	48	16.4	2.6	22.4	18.2	19.6	15.7	6.8
dupl			25	32	43	21.1	3.9	21.3	22.9	20.8	13.1	5.3

Table K-2. Chemical Results

Lab No.	TRC Sample No.	Provenience, Depth (cmbs)	% Organic Matter	% Carbonate	Available Phosphate (mg/kg)
1	1207	BTM2, 100	1.8	45.9	26.4
2	1208	BTM1, 90	3.7	41.0	24.3
3	1209	BT 7, 2BK	1.9	55.2	0.2
4	1210	BT 7, BK2	3.0	43.2	0.2
5	1211	BT 7, A, 15-20	4.7	23.7	110.1
6	1220	N103/E50, 23-24	6.2	33.8	133.5
7	1222	N103/E50, 33-34	6.5	28.6	110.3
8	1224	N103/E50, 46-47	5.0	34.8	50.0
9	1229	N103/E50, 71-72	3.2	39.5	1.6
10	1234	N103/E50, 95-96	2.9	46.7	0.0
2 dupl			3.8	41.5	21.8

APPENDIX L:

**OPTICALLY STIMULATED LUMINESCENCE OF ALLUVIAL SEDIMENTS
FROM EDWARDS COUNTY, TEXAS**

OPTICALLY STIMULATED LUMINESCENCE OF ALLUVIAL SEDIMENTS FROM EDWARDS COUNTY, TEXAS

By:

James Feathers, Ph.D.

Prepared for:

**TRC Environmental Corporation
505 East Huntland Drive, Suite 250
Austin, Texas 78752**

Prepared by:

**James Feathers, Ph.D.
Luminescence Dating Laboratory
University of Washington
Seattle, Washington 98195**

May 27, 2004

L.1 INTRODUCTION

Six sediment samples were collected during data recovery excavations at the Varga Site (41ED28) from a second alluvial terrace above Hackberry Creek in Edwards County, Texas. These six samples were submitted for optically stimulated luminescence (OSL) dating by J. Michael Quigg of TRC Environmental Corporation (TRC). Table L-1 lists the samples with associated laboratory numbers, provenience information, and projected ages based on diagnostic projectile points and radiocarbon dates.

The samples were collected by TRC personnel in light-tight plastic polyvinyl chloride (PVC) tubing. These were sealed in the field and opened in the laboratory under safe red light. The end portions of the samples were removed for radioactivity analysis and the remainders were processed for luminescence measurements.

L.2 DOSE RATE

Radioactivity was measured by alpha counting in conjunction with atomic emission for ^{40}K . Samples for alpha counting are crushed in a mill to flour consistency, packed into plexiglass containers with ZnS:Ag screens, and sealed for one month before counting. The pairs technique is used to separate the U and Th decay series. For atomic emission measurements, samples are dissolved in HF and other acids and analyzed by a Jenway[®] flame photometer. K concentrations for each sample are determined by bracketing between standards of known concentration. Conversion to ^{40}K is by natural atomic abundance. Radioactivity was also measured, as a check, by beta counting using a Risø low-level beta GM multicounter system. About 0.5 g of crushed sample is placed on each of four plastic sample holders. Each is counted for 24 hours. The average is converted to dose rate following Bøtter-Jensen and Mejdahl (1988) and compared

with the beta dose rate calculated from the alpha counting and flame photometer results. Cosmic radiation is determined following Prescott and Hutton (1988). Radioactivity concentrations are translated into dose rates following Adamiec and Aitken (1998).

Moisture content was measured from vials collected by TRC from the Varga Site. These ranged from 15 to 26% moisture by weight, averaging about 21%. This is close to typical moisture content for fine-grained sediments in temperate climates (Brady 1974). Edwards County is semiarid, but Hackberry Creek is characterized by frequent flooding and the sediments are often saturated. For dating purposes, the past moisture content for all samples was estimated to average $21 \pm 5\%$.

Table L-2 gives the radioactivity data and also compares beta dose rates derived directly from beta counting with those calculated from alpha counting and flame photometry assuming secular equilibrium in the decay series. While the latter are somewhat higher than the values derived from beta counting, they are within error limits, providing no evidence of disequilibrium. In general, the radioactivity seems to decrease with depth, the opposite trend of what would be expected if any downward leaching of radionuclides had occurred over time.

L.3 EQUIVALENT DOSE

L.3.1 Procedures

The sediments are generally fine-grained with very few sand-sized particles. An attempt was nevertheless made to extract fine sand-sized quartz grains for OSL measurements. Luminescence measurements were then carried out individually on 90 to 125 μm quartz grains using single aliquot methods. Because fine grains predominate in these sediments, single aliquot methods were also applied to 4 to 11 μm polymineral extracts. Because it is not practical

Table L-1. Sample Numbers, Proveniences, and Estimated Ages

Lab ID	Cat. No.	Unit	Depth (cm)	Projected Age (years B.P.)
UW1047	1237	N104 E47	24-36	200-1200
UW1048	1238	N125 E75	22-26	200-1200
UW1049	1239	N125 E75	28-33	1200-4500
UW1050	1240	N104 E47	36-42	1200-4500
UW1051	1242	N106 E50	80-88	4500-8000
UW1052	1243	N103 E51	94-102	4500-8000

Table L-2. Radioactivity Data and Beta Dose Rates

Sample	²³⁸ U (ppm)	²³² Th (ppm)	K(%)	Beta dose rate (Gy/ka)	
				β-counting	α-counting/flame photo.
UW1047	2.21±0.21	12.68±1.50	1.21±0.02	1.586±0.107	1.642±0.184
UW1048	2.70±0.22	11.77±1.46	1.08±0.03	1.475±0.098	1.580±0.057
UW1049	1.47±0.20	17.44±1.67	1.36±0.05	1.655±0.133	1.781±0.067
UW1050	3.14±0.23	9.29±1.29	1.30±0.03	1.629±0.126	1.758±0.054
UW1051	1.95±0.17	7.90±1.14	0.66±0.02	0.951±0.092	1.034±0.045
UW1052	1.87±0.19	11.98±1.43	0.90±0.03	1.200±0.119	1.325±0.055

to measure individual fine grains, these analyses used multigrain aliquots, each containing thousands of grains.

The quartz grains were extracted by sieving, treatment with HCl and H₂O₂, a 40-minute HF etch, and density separation using a 2.67 specific gravity solution of sodium polytungstate. Fine grains were isolated, after treatment with HCl and H₂O₂, by settling for 2 and 20 minutes in 6 cm of acetone.

Equivalent dose was determined for both extracts using the single aliquot regenerative dose (SAR) protocol (Murray and Wintle 2000). The SAR method measures the natural signal

and the signal from a series of regeneration doses on a single aliquot. The method uses a small test dose to monitor and correct for sensitivity changes brought about by preheating, irradiation, or light stimulation. SAR consists of the following steps: (1) preheat, (2) measure natural signal (OSL or infrared-stimulated luminescence [IRSL]), L_N , (3) test dose, (4) cut heat, (5) measure test dose signal (T_N), (6) regenerate dose, (7) preheat, (8) measure signal from regeneration (L_1), (9) test dose, (10) cut heat, (11) measure test dose signal (T_1), and (12) repeat Steps 6 through 11 for various regeneration doses. A growth curve is constructed from the L_i/T_i ratios and the

equivalent dose is found by interpolation of L_N/T_N . A zero regeneration dose and a repeated regeneration dose are employed to ensure that the procedure is working properly.

All measurements were made on a Risø TL-DA-15 automated reader. Luminescence on the quartz grains was stimulated for 1s at 125°C by the 532 nm laser fitted to the single-grain attachment of the Risø reader. Emitted light was collected through 7 mm of Hoya U340 ultraviolet filters. Analysis used the first 0.06s of the decay curve with the final 0.7-0.9s subtracted as background. On two regeneration cycles, a long infrared exposure preceded the green light exposure. This check for the presence of feldspars, whose luminescence signals are sensitive to infrared. No feldspars were detected in any samples. A 240°C, 10-second preheat was used for both these and the fine grain analysis.

Stimulation of the fine grains occurred in three steps—first, 100s at 125°C of infrared (880 nm diodes), second 300s at 200°C of infrared, and, third, 100s at 125°C of blue light (470 nm diodes). Detection filters were the same as for quartz. The first and third stimulations are used to construct IRSL and OSL growth curves so that two estimations of equivalent dose are available. Only feldspars are sensitive to IRSL, but they are also sensitive

to blue light. The second stimulation, a high-temperature IRSL wash, is inserted to remove the blue-sensitive feldspar signal (Jain and Singhvi 2001) so that the subsequent blue stimulation mainly produces a luminescence signal from quartz. This should minimize anomalous fading.

L.3.2 Results

Single-grain data were limited because the samples contained so few coarse grains. The number of measured grains ranged from 976 for UW1049 to 99 for UW1051 and UW1052. The number of datable grains, however, is smaller still because many grains fail to produce a measurable signal or in some way violate the assumptions of the SAR method. In addition, several grains in these samples yielded equivalent dose values not significantly different from zero. The frequency of these modern-aged grains decreased with depth, so they may represent recently exposed grains that have worked their way down the deposit. Whatever their origin, all grains with equivalent doses within two standard deviations of zero were eliminated from analysis. A single, low outlier was also eliminated from UW1051. Table L-3 summarizes the single-grain data.

Table L-3. Summary of the Single-Grain Data

Sample	No. of Grains Measured	No. Rejected as Unmeasurable	No. of Zero-Aged Grains	No. of Datable Grains
UW1047	195	103	17	75
UW1048	199	151	36	12
UW1049	976	708	30	238
UW1050	198	165	3	30
UW1051	99	91	1	7
UW1052	99	74	1	24

The distribution of equivalent dose values among single grains is not easy to interpret. The error for an individual grain is determined by a combination of counting statistics and regression fit to the growth curve. Variation in precision due to brightness of the signal (brighter grains produce better counting statistics) can cause a broad distribution in equivalent dose values even for single-aged grains. Further dispersion (called over-dispersion), not accounted for by differential precision, is also common and is attributed to heterogeneity in microdosimetry and mixture of grains of different ages (or mixture of grains that have been differentially bleached). The effect of microdosimetry variation is not easily quantified, but over-dispersion of 20 to 25% is not uncommon for samples thought to be unmixed and well bleached.

These samples exhibit very high over-dispersion, although less so for the two deepest samples. The data are presented in Figures L1 to L-6 as radial graphs, which are more appropriate than histograms for data with high differential precision. The x-axis represents relative precision, with points toward the right having the highest precision. The y-axis represents equivalent dose standardized around some reference point. All data points are plotted according to the number of standard deviations that each individual equivalent dose value is away from the reference point. The scale on the right side is drawn so that a line drawn from the origin through any point intersects the scale at the equivalent dose value. The straight lines represent reference points and the shaded areas encompass all points whose individual equivalent dose values are within two standard deviations of the reference point. Over-dispersion is represented by points outside the shaded areas.

Two reference points are graphed for each sample. The larger value (horizontal line)

represents equivalent dose determined by what is called the “central age” model. This model presumes that the grains are the same age and that any over-dispersion is caused by variation in microdosimetry or other luminescence characteristics. The central age model may not be appropriate for mixed samples. Fluvial sediments in particular often are a mixture of different-aged or differentially bleached grains. Distributions are typically positively skewed with a large number of well bleached grains (which yield the youngest ages and are most likely to represent the age of the deposit) and a long tail of partially bleached grains (yielding older ages). A “minimum-age” model has been recommended to statistically estimate the smallest equivalent dose value (the second reference line, drawn obliquely), which should correspond to the youngest age. Statistics for both models are described by Galbraith et al. (1999). Given the wide dispersion of these samples and their fluvial origin, the minimum age model is most likely to yield the age of the deposit. This could be confused, however, by post-depositional mixing, as evident from the modern age grains. Table L-4 gives the equivalent dose values for both central and minimum age models and over-dispersion values.

Table L-4. Equivalent Dose Values for Central Age and Minimum Age Models and Over-Dispersion Values

Sample	Equivalent Dose (Gy)		Over-Dispersion (%)
	Central Age	Minimum Age	
UW1047	14.8±1.41	2.80±0.44	79±7.0
UW1048	4.39±1.60	2.09±0.68	123±27
UW1049	8.34±0.48	2.10±0.18	84±4.2
UW1050	8.52±0.81	4.93±0.87	46±7.6
UW1051	21.4±2.98	15.4±3.84	26±13
UW1052	21.7±1.64	13.1±1.55	29±6.6

The central-age model was used to estimate the equivalent dose for the fine grain analyses. Eight aliquots were measured for each sample and over-dispersion was less than 0.2 percent. This is expected because of averaging among the 1000s of grains on each disk. Table L-5 gives the equivalent dose from the IRSL and OSL analyses. An IRSL signal was only measurable on three samples. The lower IRSL equivalent dose is due to anomalous fading of feldspars.

L.4 AGES

Table L-6 computes the ages determined using different equivalent dose values. On four samples, the minimum age determination from the quartz single grains and the central age determination from the fine grains are in statistical agreement. The weighted average of these two values is given in the final column. The fact that the central age of the fine grains agrees with the minimum age of the coarse grains suggests that differential bleaching only affects the coarse grains. This is reasonable given that in a fluvial environment coarse grains will be transported along the bottom of the stream and therefore will be less likely to be fully exposed to daylight than fine grains, which are carried higher in the water. If the minimum age represents the fully bleached grains, then this is evidence that the fine grains as a whole are well bleached. The lower minimum age for UW1049 coarse grains is somewhat anomalous given that the fine-grain age agrees with that for UW1050, which was sampled from the same stratigraphic level. Post-depositional mixing has undoubtedly played some role in these samples, and this is perhaps more manifest in this sample than in the others. The high minimum age for UW1051 coarse grains is also anomalous, but this could be due to the small sample size ($n=7$). Grains with lower equivalent dose values were simply not sampled. For both these anomalous samples, the fine grain central age value was taken as the best estimate, while the weighted

average was taken as the best estimate for the other samples. These ages are consistent stratigraphically and agree with the projected ages based on diagnostic projectile points and radiocarbon ages.

Table L-5. Equivalent Dose from the IRSL and OSL Analyses

Sample	Equivalent Dose (Gy)	
	IRSL	OSL
UW1047		3.95±0.56
UW1048		4.30±0.29
UW1049	4.55±1.52	9.36±0.69
UW1050		9.34±0.82
UW1051	10.6±2.64	17.5±1.16
UW1052	10.9±2.21	16.5±1.15

Table L-6. Ages Determined Using Different Equivalent Dose Values

Sample	Ages (in 1,000 years before 2004)			
	Quartz Single Grains		Fine Grains	Weighted Average
	Central Age	Minimum Age	Central Age	
UW1047	6.32±0.675	1.20±0.197	1.03±0.210	1.12±0.144
UW1048	1.95±0.718	0.927±0.305	1.13±0.186	1.07±0.159
UW1049	3.23±0.243	0.812±0.080	2.21±0.392	
UW1050	3.57±0.379	2.07±0.377	2.40±0.399	2.22±0.274
UW1051	13.9±2.07	10.0±2.55	6.67±1.11	
UW1052	11.2±0.722	6.74±0.871	5.00±0.864	5.86±0.613

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Figure L-1. Equivalent Dose (D_e) Distribution for UW1047 Quartz Grains

Figure L-2. Equivalent Dose (D_e) Distribution for UW1048 Quartz Grains

Figure L-3. Equivalent Dose (D_e) Distribution for UW1049 Quartz Grains

Figure L-4. Equivalent Dose (D_e) Distribution for UW1050 Quartz Grains

Figure L-5. Equivalent Dose (De) Distribution of UW1051 Quartz Grains

Figure L-6. Equivalent Dose (De) Distributions for UW1052 Quartz Grains

APPENDIX M:

**USE-WEAR ANALYSIS OF TWO GRAVERS
FROM THE VARGA SITE (41ED28)**

USE-WEAR ANALYSIS OF TWO GRAVERS FROM THE VARGA SITE (41ED28)

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M.1 INTRODUCTION

The late prehistoric Toyah-interval component at the Varga Site (41ED28) in Edwards County, Texas, has produced a number of odd chipped stone artifacts. Two are discussed here from the vantage point of microscopic use-wear analysis. Each is a small, bifacially worked artifact that is pointed on at least one end. Although their forms differ in significant ways, they are both fashioned from flake blanks, possibly of Edwards chert. One is totally bifacially worked, the other only so on its margins. The analysis addressed related functional issues concerning the manner in which they were held or hafted, their intended use, possible contact materials (substances with which a tool comes into direct contact), serviceability or discard, and post-depositional taphonomic effects that might obscure any or all of the other functional observations. The Varga Site tools are typical examples of formal tools whose tool edge is well understood from experimentation with modern replicas of gravers. Thus, the question for these kinds of tools is to define the actual zone of contact of the tool edge with a worked material, as expressed by microscopic wear traces, and the character of these wear traces.

This study is grounded in realistic experiments in stone tool use and observation of wear traces. This discussion draws upon previous publications about microscopy, taphonomy, characteristics of wear traces and their formation (Hardy et al. 2001; Kay 1996, 1997, 1998, 1999), and microscopic examination of experimental chipped stone gravers and other tool replicas used to work hide, wood, bone, and antler.

The microscopic observations principally address kinematics (or friction-related features of surface-to-surface contact) of tool use and manufacture as judged from wear traces. Wear traces often occur as multiples, may show

sequential development from abrasive to additive forms, develop as tools are used, and may differentiate contact materials. Striae, abrasive particles, abrasive polishes, soluble inorganic residues that are likely silica gels, and other potential wear traces are common in experimental studies of stone tool use. These all occur on the Varga Site artifacts, whose wear traces are dominated by soluble inorganic residues.

Soluble inorganic residues build up with moisture availability and as use progresses to form discrete microplates. Soluble inorganic residues are impervious to most acids and strong bases. They are among the more valuable wear traces because of their long-term stability, sensitivity to motion, and effects on the microgeometry of a tool edge. They exhibit the flow characteristics of a viscous liquid and desiccation cracks as they harden. Microplating infills striations, becomes striated whenever abrasive particles strike, and crystallizes as brilliant white translucent filaments on the trailing (i.e., opposite from the) border of contact with a worked or manipulated material. Microplates bond to stone surfaces and edges as use continues. Experimental controls indicate that hardening occurs coincident with use or shortly thereafter. Unless deliberately removed, microplating so dulls an edge that it can no longer function.

For formal implements, tool edge wear should be readily identifiable to the edge (and adjacent surfaces) that is prepared for use, or that is generally opposite the haft element or area of prehension, or hand-holding a stone tool.

As a general rule, haft wear consists of invasive abrasion, abrasive particles, striations, and possibly microplating buildup and even the presence of a mastic as a consequence of binding, or attaching, a tool to a handle and to movement within the haft due mainly to tool

use. It is significantly more extensive and often has oriented wear traces as opposed to those more typical of prehension. Haft wear may complement deliberate attempts to fashion a formal haft element (such as lateral edge grinding).

Tool edge microgeometry, striation density, placement and orientation, and microplating attributes all differentiate contact materials, although not perfectly. The most conservative approach is to simply regard these as indicators of relative hardness. On an ordinal scale of soft to hard, working soft materials tends to round tool edges while hard materials tend to break them, causing them to remain relatively angular to subangular in cross-section. A difference between soft plant and hide processing is the character of the polish that develops at and near a tool edge. Herbaceous plant polish tends to be bright and to have a melted appearance. This wear pattern also applies to a large degree to polish resulting from contact with harder wood, but results in fewer striations. Hide polishes tend to have a dull or matte-like appearance and a rough texture, and it is generally easy to separate plant from hide work.

Microscopic examination of wear traces is simply the only way to reliably acquire these insights. Complementary macroscopic indicators of tool edge damage can be understood in the context of this microscopic use-wear evidence but are absolutely dependent upon them.

M.2 METHODS

The two artifacts from the Varga Site were not cleaned. They were examined for wear traces by using a differential-interference binocular compound microscope with polarized light and Nomarski optics at magnifications ranging from 100 to 400 diameters. The evaluations systematically covered the edges and unlabeled surface of the artifacts and took note of edge

cross-sectional shape and damage. Wear traces were photographed and their position and orientation on the artifact were recorded on digitally scanned images of each artifact. Observations about edge damage, tool edge placement and extent, and hafting indicators were also recorded on the scanned images. Other details of the investigation were recorded on a standard form for each artifact.

For macroscopic photography, but not microscopic examination, artifacts were also smoked with water-soluble ammonium chloride to form a uniform, thin, white coating. Under oblique light, this coating shows flake scar patterns and edge damage. Simple immersion in water dissolves the ammonium chloride.

M.3 RESULTS

Wear traces are present on both specimens. Using the criteria outlined above, it was easy to determine that each was hafted and the extent of the haft element (Figure M-1). Although the chert is well suited to this analysis, the microwear is neither spectacular nor especially attractive. Nonetheless, it is unambiguous in its meaning. The two artifacts are described individually below.

M.3.1 Specimen #726-010

This specimen was labeled as a Perdiz projectile point. It was a hafted graver, probably used once as a drill against hard contact material. The graver tip is broken and there is no use-wear to speak of; however, there is some general abrasion on the tip and a few possible divots. The latter are more likely lances due to conchoidal fracture.

The most important detail of the analysis is identification of the haft element. This consists of a symmetrical tang with deliberately ground edges (Figure M-2) and a snapped tip opposite a broad flange. Only the graver tip is likely to

have projected from the haft. It appears to have broken in use and was not subjected to further repair.

M.3.2 Specimen #837-011

The smaller of the two specimens was also a hafted graver, with relatively similar functional proportions for hafting. It differs in function from the other tool principally in the likely contact material. The graver tip is still in good shape. It is just slightly rounded and has striations in several directions at the immediate edge (Figure M-3). Graver experiments show this wear to indicate rotary motion; however, it is not possible to say if the rotation was back-and-forth or in one circular direction only. It appears to have been used against a relatively soft to medium-soft material, such as deciduous wood. The tool appears to be in a still serviceable condition.

The most obvious wear is likely post-depositional trampling damage, or pseudo-wear (Figure M-4b). In addition, the haft wear, in part, has a striated microplating wash (Figure M-4a) typical of wood contact. Thus, it seems likely that the handle was fashioned from wood.

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Figure M-1. Hafted Gravers from the Varga site (41ED28).

Horizontal tick marks show maximum extent of haft element. Specimens #726-010 (a) and #837-011 (b)

Figure M-2. Oriented Photomicrograph of Haft Element Deliberate Lateral Edge Grinding of the Tang

Specimen #726-010

Figure M-3. Oriented Photomicrographs of Rotary Motion of the Graver Tip

Specimen #837-011

Figure M-4. Oriented Photomicrographs of the Haft Element of Specimen #837-011

- (a) Microplating wash with filled-in striations, spot crystallization, and abrasive particles
- (b) Probable post-depositional trampling damage

APPENDIX N:

**INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF POTTERY
FROM THE LORENZO MISSION (41RE1), SAN JUAN MISSION (41BX5),
AND VARGA (41ED28) SITES IN REAL, BEXAR, AND EDWARDS COUNTIES,
TEXAS**

**INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS
OF POTTERY FROM THE LORENZO MISSION (41RE1),
SAN JUAN MISSION (41BX5), AND VARGA (41ED28) IN
REAL, BEXAR, AND EDWARDS COUNTIES, TEXAS**

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N.1 INTRODUCTION

Instrumental neutron activation analysis (INAA) has been undertaken on 19 pottery clay samples from sites located in Real, Baxar, and Edwards Counties, Texas. The analyses were conducted at the University of Missouri Research Reactor Center (MURR). Here we describe sample preparation and analytical techniques used at MURR and report on the subgroup structure discovered in the chemical data.

N.2 SAMPLE PREPARATION

The 19 pottery samples were prepared for INAA using procedures standard at MURR. Fragments of about 1 cm² were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research. Clay samples were fired in a furnace to 700° Celsius for one hour. Portions of approximately 150 mg of powder were weighed into small polyvials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into the high-purity quartz vials used for long irradiations. Along with the unknown samples, reference standards of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay.

N.3 IRRADIATION AND GAMMA-RAY SPECTROSCOPY

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a

total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascok 1992; Neff 1992, 2000). As discussed in detail by Glascok (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of $8 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$. The 720-second count yields gamma spectra containing peaks for short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples encapsulated in quartz vials are subjected to a 24-hour irradiation at a neutron flux of $5 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 2,000 seconds (the “middle count”) on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 9,000 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

Elemental concentration data from the two irradiations and three counts (a total of 33 elements) are assembled into a single tabulation and stored in a dBASE file along with descriptive information available for each sample. Tables N-1 and N-2 summarize the raw and calcium-corrected data.

N.4 QUANTITATIVE ANALYSIS OF THE CHEMICAL DATA

The analyses at MURR described previously produced elemental concentration values for 32 or 33 elements in most of the analyzed samples. Data for Ni was below detection limits in several samples and were removed from consideration in the analysis. Quantitative analysis was subsequently carried out on base-10 logarithms of concentrations for these data. Use of log concentrations instead of raw data compensates for differences in magnitude between the major elements, such as calcium, on one hand and trace elements, such as the rare earth or lanthanide elements (REEs), on the other hand. Transformation to base-10 logarithms also yields a more nearly normal distribution for many trace elements.

A number of specimens had calcium concentrations in excess of 5%, a concentration that implies sufficient calcium carbonate is present to dilute the concentrations of other elements. This calcium-related dilution was counteracted using a correction introduced by Blackman (Steponaitis et al. 1996; cf. Cogswell et al. 1998). As is standard practice with calcium-corrected data, Ca, Ba, and Sr were not included in quantitative analyses of the data.

The goal of quantitative analysis of the chemical data is to recognize compositionally homogeneous groups within the analytical database. Based on the “provenance postulate” (Weigand et al. 1977), such groups are assumed to represent geographically restricted sources or source zones. The location of sources or source zones may be inferred by comparing the unknown groups to knowns (source raw materials) or by indirect means. Such indirect means may include the “criterion of abundance” (Bishop et al. 1982) or arguments based on geological and sedimentological characteristics (e.g., Steponaitis et al. 1996).

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes) or from application of pattern-recognition techniques to the chemical data. Principal component analysis (PCA) is a technique that can be used to recognize patterns (i.e., subgroups) in compositional data. PCA provides new reference axes that are arranged in decreasing order of variance subsumed. The data can be displayed on combinations of these new axes, just as they can be displayed relative to the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode to search for subgroups in an undifferentiated data set or in a more evaluative mode to assess the coherence of hypothetical groups suggested by other criteria (e.g., archaeological context, decoration). Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

One strength of PCA, discussed by Baxter (1992) and Neff (1994), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. The two-dimensional plot of element coordinates on the first two principal components is the best possible two-dimensional representation of the correlation or variance-covariance structure in the data. Small angles between vectors from the origin to variable coordinates indicate strong positive correlation, angles close to 90° indicate no correlation, and angles close to 180° indicate negative correlation. Likewise, the plot of object coordinates is the best two-dimensional representation of Euclidean relations among the

objects in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying objects and variables on the same plots makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is called a “biplot” in reference to the simultaneous plotting of objects and variables. The variable interrelationships inferred from a biplot can be verified directly by inspection of bivariate elemental concentration plots (note that a bivariate plot of elemental concentrations is not a biplot”).

Whether or not a group is discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual points and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber et al. 1976; Bishop and Neff 1989; Neff 2002; Harbottle 1976; Sayre 1975) is:

$$D_{y,x}^2 = [y - \bar{X}]' I_x [y - \bar{X}] \quad (1)$$

where y is the $1 \times m$ array of logged elemental concentrations for the individual point of interest, X is the $n \times m$ data matrix of logged concentrations for the group to which the point is being compared with **Error! Bookmark not defined.** $\bar{X}$ being its $1 \times m$ centroid, and I_x being the inverse of the $m \times m$ variance-covariance matrix of group X . Because the Mahalanobis distance takes into account variances and covariances in the multivariate group, it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into

probabilities of group membership for individual specimens (e.g., Bieber et al. 1976; Bishop and Neff 1989; Harbottle 1976). For relatively small sample sizes, it is appropriate to base probabilities on Hotelling’s T^2 , which is the multivariate extension of the univariate Student’s t .

N.5 RESULTS AND CONCLUSION

As a first step in interpreting the data, a Euclidean distance search was used to scan the entire MURR databank of 35,000+ ceramic analyses from around the world. The purpose of this search was to identify individual specimens that are compositionally similar to the individual specimens in the data set of interest. The technique is straightforward. Euclidean (straight-line) distances are calculated between a given individual specimen and all specimens in the comparison databank, and the top specimens are extracted for comparison. Actually, the distance measure for which minima are sought is the average Euclidean distance:

$$ED_{a,b} = \frac{\sqrt{\sum_{i=1}^m (a_i - b_i)^2}}{m} \quad (2)$$

where a and b are vectors containing m elemental concentrations for the two individual specimens being compared. The vast majority of samples identified as being compositionally similar to the pottery samples of interest were samples analyzed for Dr. Darrell Creel, Director of the Texas Archeological Research Laboratory (TARL) in Austin, Texas (Creel 2002, 2003). With the exception of one sample (TRC278) identified as being similar to pottery from the El Paso, Texas, area, most samples suggested similarities to the Central Texas-1 and Central Texas-2 reference groups or other unassigned pottery from this area.

The subgroup structure for the complete 19-specimen ceramic data set is documented in the figures and tables presented at the end of this appendix. Table N-1 lists the analyzed specimens and shows the compositional affiliations determined in the present investigation together with various descriptive information. Table N-2 lists Mahalanobis distance-based probabilities of membership in the Central Texas-1 and 2 reference groups and the El Paso Polychrome reference group. These probabilities are based on the 29 elements retained for quantitative analysis, and are “jackknifed,” as discussed above. With the exception of TRC278, which has high probability of membership in the El Paso Polychrome reference group, all samples have less than 4% probability of membership in the Central Texas-1 and 2 compositional groups.

Figures N-1 and N-2 are biplots based on PCA of the 220-specimen dataset (19 TRC samples plus 201 samples analyzed for Creel). What is apparent in these two plots is that most of the analyzed samples fall outside of the 90% confidence ellipses calculated for the three reference groups. A bivariate plot of thorium and sodium base-10 logged data (Figure N-2) likewise suggests that most of the samples cannot be firmly associated with the Central Texas reference groups. Based on the Mahalanobis distance calculations and visual inspection of the data, we conclude that 18 of the samples do not have membership in the Central Texas reference groups. Sample TRC278 has high probabilities of membership in the El Paso reference group and plots consistently within the 90% confidence ellipse for this group. Additionally, visual inspection of this sample by Speakman also supports the classification of this sample as El Paso Polychrome.

Despite the fact that only one sample can be firmly associated with previously established

compositional groups, there is nonetheless clear chemical patterning in the remaining 18 specimens. All samples from San Juan Mission form a distinct compositional group, pottery from Varga forms two groups, and two of the three samples from Lorenzo Mission cluster together. Three samples are unassigned. Figures N-4 to N-8 illustrate the chemical patterning identified among the three sites. Because the four groups are represented by so few samples, any attempt to statistically validate these groups would be a purely subjective exercise. Despite the limitations with sample size, the INAA data suggest that additional analyses of pottery from these sites would result in identification of several chemically distinct reference groups. Establishing a database for these samples could ultimately aid in assessing late prehistoric pottery movement among these sites.

N.6 ACKNOWLEDGMENTS

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Figure N-2. Variance-Covariance Matrix Biplot of Principal Components 1 and 3
(without vectors)

Figure N-3. Bivariate Plot of Thorium and Sodium Base-10 Logged Concentrations

Ellipses represent 90% confidence interval for reference groups. Individual TRC samples are labeled.

Figure N-4. Variance-Covariance Matrix Biplot of Principal Components 1 and 2 Showing Subgroup Patterning Within the TRC Pottery Data Set

Sample TRC278, which was assigned to the El Paso reference group, is not included in this projection. Ellipses represent 90% confidence interval for group membership. Individual specimens are labeled.

Figure N-5. Bivariate Plot of Cesium and Vanadium Base-10 Logged Concentrations Showing Subgroup Patterning Within the TRC Pottery Data Set

Sample TRC278, which was assigned to the El Paso reference group, is not included in this projection. Ellipses represent 90% confidence interval for group membership.

Figure N-6. Bivariate Plot of Cesium and Vanadium Base-10 Logged Concentrations Showing Subgroup Patterning Within the TRC Pottery Data Set (with Individual Specimens Labeled)

Figure N-7. Bivariate plot of Chromium and Dysprosium Base-10 Logged Concentrations Showing Subgroup Patterning Within the TRC Pottery Data Set

Sample TRC278, which was assigned to the El Paso reference group, is not included in this projection. Ellipses represent 90% confidence interval for group membership.

Figure N-8. Bivariate plot of Chromium and Dysprosium Base-10 Logged Concentrations Showing Subgroup Patterning Within the TRC Pottery Data Set (with Individual Specimens Labeled)

Table N-1. Chemical Group Assignments and Descriptive Information for the 19-Specimen TRC Pottery Data Set

Anid	Chem.	Alt. ID	Site Name	Site #	County	Description
TRC262	LM	1872-32c	Lorenzo Mission	41RE1	Real	Black, sand inclusions, thin, flat, undecorated
TRC263	LM-unas.	1872-6c	Lorenzo Mission	41RE1	Real	Black, large coarse additives, smoothed, knot-impressed
TRC264	LM	1872-c	Lorenzo Mission	41RE1	Real	Black, fine additives, thick, flat base, wheel-made
TRC265	SJM	SAAN 13002a	San Juan Mission	41BX5	Bexar	Thin, smooth inter. & exter., lots white bone additives
TRC266	SJM	SAAN 13006a	San Juan Mission	41BX5	Bexar	Thick, smooth inter. & exter., white bone additive, gray core
TRC267	SJM	SAAN 13008a	San Juan Mission	41BX5	Bexar	Thick, smooth exter., wiped inter., white bone added, gray
TRC268	SJM	SAAN 13010a	San Juan Mission	41BX5	Bexar	Thin, brown, few white bone, no décor or slip
TRC269	SJM	SAAN 13013a	San Juan Mission	41BX5	Bexar	Thin, slipped exter. white bone added
TRC270	Varga-1	1054-8-1a	Varga	41ED28	Edwards	Thin, gray exter., wiped inter., tiny white bone added, V1
TRC271	Varga-1	1030-8-a	Varga	41ED28	Edwards	Thin, gray exter., wiped inter., tiny white bone added, V1
TRC272	Varga-2	1129-8-1a	Varga	41ED28	Edwards	Thin, smooth exter. & inter., black bone added, beige, V2
TRC273	Varga-2	936-8-a	Varga	41ED28	Edwards	Thin, smooth exter. & inter., black bone added, beige, V2
TRC274	Varga-2	272-8-a	Varga	41ED28	Edwards	Thick, smooth exter. & inter., white bone, gray core, V4
TRC275	Varga-2	159-8-1c	Varga	41ED28	Edwards	Thick, smooth exter. & inter., white bone, gray core, V4
TRC276	Varga-1	840-8-1a	Varga	41ED28	Edwards	Thin, smooth exter. & inter., white bone, slipped, V3
TRC277	Varga-unas.	867-8-1a	Varga	41ED28	Edwards	Thin, smooth exter. & inter., white bone, slipped, V3
TRC278	El Paso	1261-8-3a	Varga	41ED28	Edwards	Very thin, reddish brown slipped, black core, sand, V5
TRC279	Varga-unas.	840-8-1b	Varga	41ED28	Edwards	Thin, curved, smooth exter., few additives, figurine-like object
TRC280	Varga-2	1259-004b	Varga	41ED28	Edwards	T-2, Unit 3, Bk horizon, 65-70 cmbs, dark gray sediment

V1 = Vessel Group 1, V2 = Vessel Groups 2, V3 = Vessel group 3, V 4 = Vessel Group 4, V5 = Vessel Group 5

Table N-2. Mahalanobis Distance Calculation and Posterior Classification for Two or More Groups

Reference Groups and Numbers of Specimens						
1	Central Texas 1	(CT1)	71			
2	Central Texas 2	(CT2)	90			
3	El Paso Ref.	(ELP)	40			
Variables Used						
AS	LA	LU	ND	SM	U	YB
CE	CO	CR	CS	EU	FE	HF
RB	SB	SC	TA	TB	TH	ZN
ZR	AL	DY	K	MN	NA	TI
V						
Specimens in the TRC Pottery File						
ID No.	Probabilities:					
	CT1	CT2	ELP			
TRC262	0.000000	0.000009	0.003506			
TRC263	0.000000	0.002781	0.000111			
TRC264	0.000000	0.000001	0.002419			
TRC265	0.000861	0.158811	0.043946			
TRC266	0.063044	0.011962	0.055590			
TRC267	0.484251	0.002053	0.055050			
TRC268	0.040536	0.064239	0.132103			
TRC269	0.013779	0.010288	0.187208			
TRC270	0.000000	0.000000	0.000001			
TRC271	0.000000	0.000000	0.000001			
TRC272	0.066443	2.110429	0.005487			
TRC273	0.009694	0.000005	0.000005			
TRC274	0.164844	2.099762	0.069662			
TRC275	3.087568	0.381212	0.089850			
TRC276	0.000000	0.000000	0.000004			
TRC277	0.000000	0.000000	0.000008			
TRC278	0.000000	0.000066	98.546705			
TRC279	0.000000	0.000000	0.000003			
TRC280	0.000000	0.105855	0.001289			

APPENDIX O:

**METRIC AND NON-METRIC DATA AND
VARGA SITE ARTIFACT DATABASE**

O.1 METRIC AND NON-METRIC DATA

Individual observations, metric measurements, and provenience information on individual stone tools within each artifact classes (points, bifaces, scrapers, drills, unifaces, cores, and pottery) are presented in individual tables by class and component. Individual point types are presented separately by point type by component (i.e., Perdiz points, Late Archaic points, Gower points, etc.). The summaries of the observations and metric measurements that are presented in the body of the text for the different classes of

artifacts by component were derived from these tables. The data in the tables is presented in Microsoft Excel files.

O.2 ARCHEOLOGICAL DATABASE

The entire Varga Site database is presented in Microsoft Access format. The database includes information about collected artifact and samples, including the catalog numbers, provenience information, counts, weights, and metric and non-metric observations on the various tools.

Table O-1. Perdiz Point Data from the Toyah Component

Cat. No.	108-013	158-021	159-024	159-025	176-015	271-016	302-021	335-010
Condition	Proximal	Proximal	Distal	Complete	Complete	Complete	Proximal	Proximal
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	Burned	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener	Indeterminate	None	None	None	None	None	None	Indeterminate
Length (mm)				28.3	38.9	29.6		
Width (mm)								
Thick (mm)		2.7	2.7	3.7	5.5	3.1		2.9
Weight (g)			1.4	1.1	3.5	0.8		
Long X-Section	Indeterminate	Flat	Flat	Flat	Flat	Flat	Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Biconvex Asymmetrical	Biconvex Symmetrical	Biconvex Symmetrical	Biconvex Symmetrical
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Indeterminate	Indeterminate	Triangular	Triangular	Triangular	Triangular	Indeterminate	Triangular
Flaking Pattern	Indeterminate	Chevron	Flake Blank Remnant	Chevron	Chevron	Chevron	Indeterminate	Indeterminate
Edge Rounding	Present	Present	Absent	Absent	Present	Absent	Absent	Present
Blade Length (mm)			23.6	20.1	28.1	19.4		
Blade Width (mm)		14.9	16.5	14.2	20.9	10.1	25.5	11.7
Left Lateral Edge Shape	Indeterminate	Indeterminate	Straight	Straight	Excurvate	Straight	Indeterminate	Indeterminate
Right Lateral Edge Shape	Indeterminate	Indeterminate	Straight	Straight	Excurvate	Straight	Excurvate	Indeterminate
Shoulder Width (mm)		17.8	21.1	19.7			26.7	
Left Notch Depth (mm)	5.3	3.9		4.6	4.9	5.1	5.5	
Right Notch Depth (mm)		4.9		5			5.5	
Left Notch Width (mm)	6.9	7.2		9.2	9.2	6.8	9.4	
Right Notch Width (mm)		7.7		9.4			10	
Left Notch Angle	18	36	19	45	31	28	21	36
Right Notch Angle		33	27	34			13	
Stem Shape	Contracting	Contracting	Indeterminate	Contracting	Contracting	Contracting	Contracting	Contracting
Stem Length (mm)	8.3	7.8		8.2	10.8	10.2	9.3	
Stem Dist Width (mm)	8.3	5.6	6.7	5.9	10.2	5.9	10	
Stem Prox Width (mm)	6.4	3.5		2.2	6.6	3.2	6	
Stem Thick (mm)	2.9	2.6	2.5	2.4	3.2	2.6	3.3	
Base Depth (mm)	-1.3	-0.7		-0.7	-1.3	-1.5	-1	
Break Type	Use	Use	Use	Use	Use	Use	Use	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	348-011	405-015	405-016	441-016	482-010	489-010	504-013	525-010
Condition	Proximal	Proximal	Complete	Complete	Proximal	Medial	Medial	Complete
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	75
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	Heat-Treated	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpening	Indeterminate	Indeterminate	None	Indeterminate	None	Indeterminate	None	None
Length (mm)			25.3	36.9				35.8
Width (mm)								
Thick (mm)		3.3	3.1	3.4	2.9	2.6	4.6	2.7
Weight (g)			0.8	1.6	1.1			1.3
Long X-Section	Indeterminate	Indeterminate	Flat	Tapered Base/Tip	Flat	Indeterminate	Flat	Flat
Trans X-Section	Indeterminate	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Indeterminate	Indeterminate	Triangular	Triangular	Triangular	Indeterminate	Triangular	Triangular
Flaking Pattern	Indeterminate	Flake Blank Remnant	Oblique Parallel	Chevron	Chevron	Flake Blank Remnant	Flake Blank Remnant	Flake Blank Remnant
Edge Rounding	Absent	Present	Absent	Absent	Present	Absent	Present	Present
Blade Length (mm)			19.3	29			23.2	22.4
Blade Width (mm)			12	14.8	17	14.7	21.9	18
Left Lateral Edge Shape	Indeterminate	Indeterminate	Straight	Incurvate	Straight	Indeterminate	Excurvate	Excurvate
Right Lateral Edge Shape	Indeterminate	Indeterminate	Straight	Incurvate	Straight	Indeterminate	Excurvate	Excurvate
Shoulder Width (mm)		26.1	18.7	23	18.7		23.4	18.8
Left Notch Depth (mm)		5.9	4.4	5.2	4.8			4.1
Right Notch Depth (mm)		5.4	5.6	5.9	6.1			4.3
Left Notch Width (mm)		8.4	6.5	10.9	7.9			10.1
Right Notch Width (mm)		7.4	7.4	11.3	7.7			8.7
Left Notch Angle		36	33	26	29	16	10	21
Right Notch Angle		23	21	14	14		17	27
Stem Shape	Contracting	Contracting	Contracting	Contracting	Contracting	Indeterminate	Indeterminate	Contracting
Stem Length (mm)	14.8	9.6	6	7.9	9			13.4
Stem Dist Width (mm)	6.2	9.3	4.3	6.2	6.2	5		8.9
Stem Prox Width (mm)	5.1	8.6	3.8	4.1	4.8			7.8
Stem Thick (mm)	2.9	3.1	2.3	2.4	2.2			2.1
Base Depth (mm)	-2.7	-3.3	-1.5	-1.8	-4.1			-4.1
Break Type	Use	Use	Use	Unbroken	Use	Use	Use	Unbroken
Micro-wear	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	526-010	533-017	602-017	602-018	726-010	726-011	781-012	782-016
Condition	Complete	Complete	Complete	Complete	Complete	Proximal	Complete	Complete
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener	None	None	None	Break Compensation	None	Indeterminate	None	None
Length (mm)	34.1	34.7	35.4	23.4	24		30.5	26.1
Width (mm)								
Thick (mm)	2.4	3	2.9	2.1	2.3		2.4	2.6
Weight (g)	1.1	1.2	1.1	0.5	0.3		0.8	0.6
Long X-Section	Flat	Flat	Flat	Flat	Flat	Indeterminate	Flat	Flat
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Triangular	Triangular	Triangular	Triangular	Indeterminate	Indeterminate	Triangular	Triangular
Flaking Pattern	Oblique Parallel	Oblique Parallel	Chevron	Chevron	Subparallel	Oblique Parallel	Flake Blank Remnant	Chevron
Edge Rounding	Present	Absent	Absent	Present	Present	Present	Absent	Present
Blade Length (mm)	22.9	22.7	25.1	15.8	9.1		24.3	20.6
Blade Width (mm)	15.3	13.3	15.4	12.7	2.6		13	9.4
Left Lateral Edge Shape	Straight	Excurvate	Excurvate	Straight	Incurvate	Indeterminate	Straight	Straight
Right Lateral Edge Shape	Straight	Straight	Straight	Straight	Incurvate	Indeterminate	Straight	Straight
Shoulder Width (mm)	18.6		17.3	16.2	11.3		14.7	13.5
Left Notch Depth (mm)	4	7.6	3.4	3.4	1.9	5.1	3.8	2.7
Right Notch Depth (mm)	3.2		4.1	3.4	3.2		3.8	
Left Notch Width (mm)	8.3	10.1	9.2	6.8	11.7	6.9	5.6	5.5
Right Notch Width (mm)	8.8		6.5	7.2	13.2		4.7	
Left Notch Angle	36	24	23	36	28	26	23	27
Right Notch Angle	31		34	35	27	30	30	28
Stem Shape	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting
Stem Length (mm)	11.2	12	10.3	7.6	14.9	7.9	6.2	5.5
Stem Dist Width (mm)	8.8	6.4	8.6	6.4	5.9	5.1	4.9	5
Stem Prox Width (mm)	7.8	1.9	5.6	5	1.3	2.5	3.8	3.1
Stem Thick (mm)	2.6	2.4	2	2.1	1.8	2.2	1.7	1.7
Base Depth (mm)	-4.6	-0.9	-2.2	-2.4	-0.9	-1.5	-1.2	-1.1
Break Type	Unbroken	Use	Unbroken	Use	Use	Use	Unbroken	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	815-010	825-010	851-014	862-020	863-012	876-013	881-018	885-022
Condition	Medial	Complete	Medial	Complete	Complete	Complete	Medial	Complete
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener	Indeterminate	None	Indeterminate	None	Break Compensation	None	Indeterminate	None
Length (mm)		36.4		23	35.9	23.8		27.5
Width (mm)								
Thick (mm)		3.4	3	3	3.1	2.2		2.9
Weight (g)		1.9		0.5	1.3	0.7		0.7
Long X-Section	Indeterminate	Flat	Indeterminate	Flat	Flat	Flat	Indeterminate	Flat
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Indeterminate	Triangular	Indeterminate	Triangular	Triangular	Triangular	Indeterminate	Triangular
Flaking Pattern	Indeterminate	Oblique Parallel	Indeterminate	Subparallel	Chevron	Oblique Subparallel	Indeterminate	Chevron
Edge Rounding	Present	Present	Absent	Present	Absent	Present	Present	Present
Blade Length (mm)		28.4		16.9	24.7	16.1		19.3
Blade Width (mm)		14.9		9	15	15.3	13.9	12.7
Left Lateral Edge Shape	Indeterminate	Straight	Indeterminate	Straight	Excurvate	Excurvate	Indeterminate	Straight
Right Lateral Edge Shape	Indeterminate	Excurvate	Indeterminate	Straight	Excurvate	Straight	Indeterminate	Straight
Shoulder Width (mm)	11.6			13.3		18.9	15.4	14.6
Left Notch Depth (mm)		4.4		2.5		4.8		3.8
Right Notch Depth (mm)				2.3	5.4			3.7
Left Notch Width (mm)		6.6		6.9		7		7.6
Right Notch Width (mm)				6.7	10.8			7.5
Left Notch Angle	41	33	32	31		34	24	29
Right Notch Angle	37			25	19	30	22	23
Stem Shape	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting	Indeterminate	Contracting
Stem Length (mm)	5.6	8		6.1	11.2	7		7.7
Stem Dist Width (mm)	6.9	5.5	6.2	5.9	6.7	6.2	5	6
Stem Prox Width (mm)	3.7	4.2	3.3	2.6	2.5	3.1		2.4
Stem Thick (mm)	2.1	2.8	2.8	2	2.1	1.7	1.5	1.8
Base Depth (mm)	-0.5	-3.4		-1.3	-2.1	-1		-0.7
Break Type	Use	Use	Use	Unbroken	Use	Use	Use	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	903-028	930-016	939-013	945-016	949-016	988-013	989-020	992-016
Condition	Distal	Proximal	Proximal	Complete	Proximal	Proximal	Proximal	Proximal
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener	Break Compensation	None	Break Compensation	Beveled Unifacial	None	Indeterminate	None	Indeterminate
Length (mm)				40.8				
Width (mm)								
Thick (mm)	3	3.1	3.2	3.3	2.3		2.3	
Weight (g)	0.7		1	2.2	0.8		0.6	
Long X-Section	Flat	Flat	Flat	Flat	Flat	Indeterminate	Flat	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Triangular	Triangular	Lanceolate	Triangular	Triangular	Indeterminate	Lanceolate	Indeterminate
Flaking Pattern	Chevron	Subparallel	Subparallel	Flake Blank Remnant	Chevron	Indeterminate	Chevron	Parallel
Edge Rounding	Absent	Present	Absent	Absent	Absent	Absent	Present	Absent
Blade Length (mm)	13.5			31.3				
Blade Width (mm)	11.4	17.8	10.8	16.4	11.8		10.1	13.5
Left Lateral Edge Shape	Straight	Straight	Straight	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate
Right Lateral Edge Shape	Straight	Straight	Excurvate	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate
Shoulder Width (mm)		22.9	15.9		14.6	17.1	16.2	
Left Notch Depth (mm)		6.7	2.9	2.4	3.2	3		
Right Notch Depth (mm)		6.6	3.6		2.1	3.4	1.3	5.9
Left Notch Width (mm)		11.2	6	9.3	5.4	9.5		
Right Notch Width (mm)		11.2	7.8		7.9	5.2	5.3	7.9
Left Notch Angle	30	20	41	38	28	27		
Right Notch Angle	24	20	17	37	22	31	28	13
Stem Shape	Indeterminate	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting
Stem Length (mm)		9.6	7.5	9.5	5.5	7.5	4.8	10.2
Stem Dist Width (mm)	7.3	6.9	6.1	8.3	6.4	7.9	9.3	5.6
Stem Prox Width (mm)		3.1	3.3	5.1	3.6	3.8	4.2	3.2
Stem Thick (mm)		2.6	2.5	2.9	1.8	3	1.4	1.8
Base Depth (mm)		-1.5	-1.5	-1.2	-1.4	-2.1	-1.2	-2.5
Break Type	Use	Use	Use	Use	Use	Use	Use	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	999-020	1008-017	1021-011	1031-013	1098-010	1100-016	1125-017	1137-012
Condition	Medial	Medial	Medial	Proximal	Proximal	Complete	Proximal	Distal
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Perent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	Heat-Treated	None	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener	None	None	None	None	Indeterminate	None	None	None
Length (mm)						24.3		25.7
Width (mm)								
Thick (mm)	3.2	4.3	2.8	2.8		3.5	2.7	2.3
Weight (g)		1.8				0.9		0.6
Long X-Section	Flat	Flat	Flat	Flat	Indeterminate	Flat	Indeterminate	Flat
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Shape	Triangular	Lanceolate	Indeterminate	Triangular	Indeterminate	Triangular	Indeterminate	Triangular
Flaking Pattern	Chevron	Chevron	Flake Blank Remnant	Chevron	Flake Blank Remnant	Chevron	Indeterminate	Flake Blank Remnant
Edge Rounding	Absent	Absent	Absent	Present	Absent	Absent	Present	Present
Blade Length (mm)						17.8		18.3
Blade Width (mm)	12.6	14.2	22.9			12	14.1	13.1
Left Lateral Edge Shape	Straight	Straight	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate	Straight
Right Lateral Edge Shape	Straight	Straight	Excurvate	Indeterminate	Indeterminate	Straight	Indeterminate	Straight
Shoulder Width (mm)					18		15.9	
Left Notch Depth (mm)				4.9	1.7		2.8	
Right Notch Depth (mm)					2.1		2.8	
Left Notch Width (mm)				9.5	7.1		7.3	
Right Notch Width (mm)					7.8		6.2	
Left Notch Angle	20	30		26	36		33	24
Right Notch Angle		20			29	28	32	24
Stem Shape	Indeterminate	Indeterminate	Indeterminate	Contracting	Contracting	Contracting	Contracting	Contracting
Stem Length (mm)				10.5	7.8	6.4	5.8	7.4
Stem Dist Width (mm)		6.9	9.3	6.9	9.6	6	7.8	4.4
Stem Prox Width (mm)				4.4	5.6	4.7	4.1	3.6
Stem Thick (mm)				2.5	1.6	2	2.3	1.1
Base Depth (mm)				-2.9	-2.4	-1.6	-1.5	
Break Type	Use	Use	Use	Use	Use	Use	Use	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE

Table O-1. Perdiz Point Data from the Toyah Component Continued

Cat. No.	1162-011	1176-010	1214-010	1215-010	1256-005-010
Condition	Proximal	Medial	Distal	Proximal	Medial
Raw Material	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0
Perent Cortex	0	0	0	0	0
Cortex Type	None	None	None	None	None
Heating	None	None	None	None	None
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent
Resharpener	None	None	Indeterminate	Indeterminate	None
Length (mm)					
Width (mm)					
Thick (mm)	2.9	2.4	3	2.2	3
Weight (g)			1.7		1.2
Long X-Section	Flat	Indeterminate	Flat	Flat	Flat
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake
Shape	Triangular	Indeterminate	Triangular	Indeterminate	Triangular
Flaking Pattern	Parallel	Flake Blank Remnant	Flake Blank Remnant	Chevron	Chevron
Edge Rounding	Present	Absent	Absent	Present	Absent
Blade Length (mm)			24		
Blade Width (mm)	19	12.5	18.5	10.8	15.6
Left Lateral Edge Shape	Indeterminate	Indeterminate	Excurvate	Indeterminate	Straight
Right Lateral Edge Shape	Indeterminate	Indeterminate	Excurvate	Indeterminate	Excurvate
Shoulder Width (mm)		15.1	19.7	14.8	
Left Notch Depth (mm)				2.7	
Right Notch Depth (mm)	4.4			2.5	
Left Notch Width (mm)				5.6	
Right Notch Width (mm)	11.8			5.3	
Left Notch Angle	37	29	33	40	36
Right Notch Angle	32	35	27	24	30
Stem Shape	Contracting	Indeterminate	Indeterminate	Contracting	Indeterminate
Stem Length (mm)	10.6			5.8	
Stem Dist Width (mm)	10.4	5.7	8.6	6.1	6.4
Stem Prox Width (mm)	7.5			4.1	
Stem Thick (mm)	2.1	1.7	1.6	2	2.8
Base Depth (mm)	-2.9			-1.4	
Break Type	Use	Use	Use	Use	Use
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	TRUE	FALSE	FALSE	FALSE	FALSE

Table O-2. Clifton Point Data

Cat. No.	12-010*	22-014*	814-016	913-017	914-011	918-010
Unit	N99,E51	N99,E52	N116,E72	N122,E74	N122,E74	N123,E68
Depth (cmbd)	20-30	20-30	0-10	8-24	24-38	9-19
Condition	Proximal	Proximal	Proximal	Proximal	Complete	Proximal
Break Type	Use	Use	Use	Use	Use	Use
Resharpener Type	Indeterminate	None	None	Indeterminate	Beveled Unifacial	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0
Percent Cortex	50	0	0	0	0	0
Cortex Type	Pebble/cobble	None	None	None	None	None
Heating	None	None	None	None	None	None
Length (mm)					38.3	
Thick (mm)		4.4		3.4	17.4	3.4
Wt. (g)					2.8	
Long X-Section	Indeterminate	Wedge Base, Flat	Flat	Wedge Base, Flat	Tapered Base/Tip	Indeterminate
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Blade Length (mm)					31.6	
Blade Width (mm)		21.1	14.5	20.7	16.6	15.6
Left Lateral edge	Indeterminate	Straight	Straight	Excurvate	Straight	Straight
Right Lateral Edge	Indeterminate	Straight	Straight	Indeterminate	Excurvate	Straight
Shoulder Width (mm)	21.6	22.3	17	22.2		17.6
Left Notch Depth (mm)	3.8	3.5	1.7	3.2	1.6	
Right Notch Depth (mm)	3.2	2.7	1.4	4.2		
Left Notch Width (mm)	6.6	12.1	3.6	11.1	10.4	
Right Notch Width (mm)	7.9	10.9	4	11.1		
Left Notch Angle	34	27	40	40	45	
Right Notch Angle	19	40	28	23		
Stem Shape	Contracting	Contracting	Contracting	Contracting	Contracting	Contracting
Stem Length (mm)	5.7	7.6	3.5	8.4	6.7	4.2
Distal Stem Width (mm)	9.3	9.2	6	8.4	12	14.2
Proximal Stem Width (mm)	4.7	2.9	3.2	5	3.8	3.9
Stem Thickness (mm)	2.7	3.7	1.6	2.3	2.5	2.8
Base Depth (mm)	1.5	-1.4	-1.5	-3.7	-1.4	-1.8
Micro-wear	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
NAA	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE

Table O-2. Clifton Point Data Continued

Cat. No.	943-018	967-024	1002-013	1054-016	1154-010	1183-010
Unit	N123,E74	N124,E75	N126,E70	N127,E75	N131,E72	N132,E75
Depth (cmbd)	12-26	0-10	8-20	20-30	20-30	20-30
Condition	Proximal	Proximal	Proximal	Proximal	Proximal	Complete
Break Type	Use	Use	Use	Use	Use	Unbroken
Resharpener Type	None	Break Compensation	Beveled Unifacial	None	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None
Heating	None	None	None	None	None	None
Length (mm)						38.4
Thick (mm)	4.8	4.3	4.8	1.9	2.7	4.7
Wt. (g)	3.6					3.7
Long X-Section	Tapered Base/Tip	Indeterminate	Indeterminate	Flat	Tapered Base/Tip	Tapered Base/Tip
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Blade Length (mm)						
Blade Width (mm)	21.2	18.7	22.7		17.4	22.5
Left Lateral edge	Excurvate	Straight	Straight	Straight	Straight	Excurvate
Right Lateral Edge	Excurvate	Indeterminate	Straight	Indeterminate	Straight	Excurvate
Shoulder Width (mm)	23.2	20.6	24.2		17.4	23.4
Left Notch Depth (mm)	1.7	2.9	1.4	2.7	1.9	
Right Notch Depth (mm)	2.4	1.1	0		1.2	
Left Notch Width (mm)	12.1	6.8	11.7	8.1	12.1	
Right Notch Width (mm)	9.3	5.4			9.2	
Left Notch Angle	47	38	33	40	38	
Right Notch Angle	29	38	37		54	
Stem Shape	Contracting	Contracting	Contracting	Contracting	Contracting	Indeterminate
Stem Length (mm)	4.9	5.8	6.1	7.5	7	
Distal Stem Width (mm)	6.9	7.9	11.8	7.9	9.1	
Proximal Stem Width (mm)	2.6	5	4.3	3.5	2.5	
Stem Thickness (mm)	1.8	2	2.3	1.6	2.9	
Base Depth (mm)	-1.3	-1.8	-1.6	-2.1	1	
Micro-wear	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
NAA	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE

* This point was not from the Toyah component, but slightly lower in Late Archaic context.

Table O-3. Bonham Point Data

Cat. No.	Unit	Depth (cmbs)	Feature No.	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Raw Material	Texture
159-023	N101,E47	30-40	36	distal, refit with 282-17					
220-013	N101,E54	20-30		Proximal	Use	Absent	None	Chert	Fine
262-020	N102,E47	30-40	36	Complete	Use	Absent	None	Chert	Fine
282-017	N102,E51	20-30		Complete	Use	Absent	None	Chert	Fine
360-005-010 *	N103,E51	30-40	1	Proximal	Use	Absent	None	Chert	Fine
473-010	N105,E55	0-10		Complete	Unbroken	Absent	None	Chert	Fine
562-010*	N107,E49	30-40		Complete	Unknown	Absent	None	Chert	Fine

Cat. No.	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt (g)	Long X-Section	Trans X-Section	Preform
159-023											
220-013	0	0	None	None			3.1		Flat	Plano-Convex	Flake
262-020	0	0	None	None	40.2		2.5	1.5	Flat	Plano-Convex	Flake
282-017	0	0	None	None	32.9		2.8	1.6	Wedge Base, Flat	Plano-Convex	Flake
360-005-010 *	0	0	None	None					Indeterminate	Indeterminate	Flake
473-010	0	0	None	None	28.1		3.3	1	Tapered Base/Tip	Biconvex Asymmetrical	Flake
562-010*	0	0	None	None	26.8		3.5	0.9	Wedge Base, Flat	Biconvex Symmetrical	Flake

Cat. No.	Overall Shape	Flaking Pattern	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)
159-023									
220-013	Triangular	Chevron	Present		11.2	Incurvate	Incurvate		
262-020	Triangular	Parallel	Present	32.3	16.3	Excurvate	Excurvate		
282-017	Triangular	Flake Blank Remnant	Present	25.6	20.1	Excurvate	Excurvate	20.8	6.4
360-005-010 *	Indeterminate	Blank	Present			Indeterminate	Indeterminate		
473-010	Triangular	Chevron	Absent	20.9	17.1	Straight	Straight	19.5	5.8
562-010*	Triangular	Indeterminate	Present	18.6	11	Straight	Straight	17.6	3.2

Cat. No.	Right Notch Width	Left Notch Angle	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Micro-wear	NAA
159-023									FALSE	FALSE
220-013	8.8		24	Straight	7.8	5.3	5.9	2.3	FALSE	TRUE
262-020	7.9		20	Straight	7.9	6.4	6.7	1.8	FALSE	TRUE
282-017	7	14	25	Straight	7.3	6	5.3	2.8	FALSE	TRUE
360-005-010 *				Straight			5.9		FALSE	FALSE
473-010	6.6	25	22	Straight	7.2	5.3	6.2	2.7	TRUE	FALSE
562-010*	8.1	47	27	Straight	8.2	6.4	6.4	3	FALSE	TRUE

* This point was not in the Toyah component, slightly lower in mixed, unknown context.

Table O-4. Non-Perdiz Point Data from the Toyah Component

Cat. No.	Unit	Depth (cmbd)	Feature No.	Point Type	Condition	Break Type	Resharpener Type	Raw Material	Texture	Percent Patination	Percent Cortex
291-014	N102,E52	0-10		Guerrero	Proximal	Use	None	Chert	Fine	0	0
349-013	N103,E47	10-20		Cuney	Complete	Unbroken	None	Chert	Fine	0	0
406-010	N104,E47	20-30		Guerrero	Complete	Unbroken	None	Chert	Fine	0	0
534-014	N106,E55	10-20		Scallorn	Distal	Use	None	Chert	Fine	0	0
783-010	N114,E75	15-35		Edwards	Proximal	Use	Indeterminate	Chert	Fine	0	0
882-011	N121,E70	10-18		Harrell	Distal	Use	None	Chert	Fine	0	0
1030-005-010	N126,E76	30-40	38	Padre	Complete	Unbroken	None	Chert	Fine	0	0
1092-015	N129,E72	20-30		Scallorn	Complete	Unbroken	None	Chert	Fine	0	0

Cat. No.	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Shape	Flaking Pattern
291-014	None			2.4		Indeterminate	Biconvex Symmetrical	Flake	Triangular	Oblique Subparallel
349-013	None	40.9		4.2	2.1	Wedge Base, Flat	Biconvex Symmetrical	Flake	Triangular	Subparallel
406-010	None	23		3.9	1	Tapered Base/Tip	Biconvex Symmetrical	Flake	Triangular	Chevron
534-014	None			2.7	1.1	Flat	Plano-Convex	Flake	Triangular	Subparallel
783-010	None					Indeterminate	Indeterminate	Flake	Indeterminate	Flake Blank Remnant
882-011	None	20.3		2.5	0.4	Flat	Plano-Convex	Flake	Triangular	Parallel
1030-005-010	None	28.7		3.3	1	Wedge Base, Flat	Plano-Convex	Flake	Bipointed	Flake Blank Remnant
1092-015	None	28.6		3.4	1.1	Wedge Base, Flat	Plano-Convex	Flake	Triangular	Chevron

Cat. No.	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral	Right Lateral	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle
291-014	Present		13.2	Straight	Straight	14.3					
349-013	Present	33.3	15.9	Straight	Straight	22.8	5.2	5.3	9.5	9.2	26
406-010	Absent		13.6	Straight	Straight						
534-014	Absent	30.9	14.1	Straight	Straight	17.8					10
783-010	Present			Indeterminate	Indeterminate					3.1	
882-011	Absent	11	11.2	Straight	Straight		1.1	2.9	2.2	0.9	57
1030-005-010	Present		13.2	Excurvate	Excurvate						
1092-015	Present	21.8	12.3	Straight	Straight	15.6	2.8	3	3.1	3.3	74

Cat. No.	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
291-014							2.2	10.4	FALSE	TRUE
349-013	34	Straight	7.6	5.7	4.9	2.4	0		FALSE	TRUE
406-010							1	8.7	TRUE	FALSE
534-014	3	Indeterminate		4.5					FALSE	FALSE
783-010	15	Contracting	4.5		5.1	1.8	-1.3		FALSE	FALSE
882-011	101	Contracting	7	5.8		2.3	2.4		FALSE	TRUE
1030-005-010									TRUE	FALSE
1092-015	47	Expanding	6.8	8.5	13.6	2.9	-1.6		FALSE	TRUE

Table O-5. Toyah Component Dart Point Data

Cat. No.	Unit	Depth (cmbd)	Point Type	Raw Material	Condition	Resharpener Type	Break Type	Edge Rounding	Texture	Percent Patination
1046-011	N127,E73	10-17	Unknown Dart	Chert	Distal		Use	Absent	Fine	0
109-010	N100,E53	10-20	Unknown Dart	Chert	Medial		Use	Absent	Fine	0
131-010	N100,E55	10-20	Unknown Dart	Chert	Medial		Use	Absent	Fine	0
131-011	N100,E55	10-20	Unknown Dart	Chert	Medial		Use	Absent	Fine	0
496-014	N106,E50	0-10	Unknown Dart	Chert	Medial		Use	Absent	Fine	0
517-010	N106,E53	0-10	Unknown Dart	Chert	Medial		Use	Present	Fine	0
602-019	N107,E55	10-20	Unknown Dart	Chert	Indeterminate		Use	Absent	Fine	0
758-013	N109,E70	10-20	Unknown Dart	Chert	Medial		Use	Absent	Fine	0
220-014	N101,E54	20-30	Frio	Chert	Proximal	Beveled Bifacial	Use	Present	Fine	0
525-005-013	N106,E54	35-40	Frio	Chert	Proximal	None	Use	Absent	Fine	0
526-011	N106,E54	40-50	Frio	fits with 220-14	Distal		Use			
916-010	N122,E75	0-10	Frio	Chert	Medial	Indeterminate	Use	Absent	Fine	0
653-012	N108,E53	0-10	Baker	Chert	Proximal	Beveled Unifacial	Use	Absent	Fine	0
324-016	N102,E55	50	Group II	Chert	Proximal	None	Use	Absent	Fine	0

Cat. No.	Percent Cortex	Heating	Length (mm)	Width (mm)	Thickness (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform
1046-011	0	None					Indeterminate	Indeterminate	Indeterminate
109-010	0	None			5.8		Indeterminate	Biconvex Symmetrical	Biface
131-010	0	None					Indeterminate	Indeterminate	Indeterminate
131-011	0	None					Indeterminate	Indeterminate	Indeterminate
496-014	0	None					Indeterminate	Indeterminate	Indeterminate
517-010	0	None					Indeterminate	Indeterminate	Indeterminate
602-019	0	Burned					Indeterminate	Indeterminate	Indeterminate
758-013	0	Heat-Treated					Indeterminate	Indeterminate	Indeterminate
220-014	0	None			5.5		Indeterminate	Biconvex Symmetrical	Biface
525-005-013	0	Indeterminate	54.5		12.4	11.6	Tapered Base/Tip	Biconvex Symmetrical	Biface
526-011									
916-010	0	None			6.4		Indeterminate	Plano-Convex	Flake
653-012	0	None			7		Indeterminate	Biconvex Symmetrical	Biface
324-016	0	Heat-Treated					Indeterminate	Biconvex Symmetrical	Biface

Table O-5. Toyah Component Dart Point Data Continued

Cat. No.	Shape	Flaking Pattern	Left Lateral Edge Shape	Right Lateral Edge Shape	Stem Shape	Resharpener Type	Shoulder Width	Left Notch Depth	Right Notch Depth
1046-011	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
109-010	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
131-010	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
131-011	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
496-014	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
517-010	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
602-019	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
758-013	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate			
220-014	Lanceolate	Subparallel	Straight	Incurvate			16.5	2.4	1.4
525-005-013	Triangular	Chevron	Excurvate	Straight			30.4	9.6	10.2
526-011									
916-010	Indeterminate	Indeterminate	Indeterminate	Indeterminate			19.6		1.5
653-012	Indeterminate	Oblique	Indeterminate	Indeterminate					3.1
324-016	Indeterminate	Chevron	Straight	Straight				7	

Cat. No.	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Basal Notch Width
1046-011											
109-010											
131-010											
131-011											
496-014											
517-010											
602-019											
758-013											
220-014	6.9	6.7	73	84	Expanding	8.7	13.8	18.3	5.1	2.8	10.6
525-005-013	8.4	7.4	66	64	Expanding	10.6	20.4	30	4.8	3.6	10.4
526-011											
916-010		6.6		75	Indeterminate		15.5		6.2		
653-012		9.4		37	Curved	13.5	15.2	16	5.7	5.3	8
324-016		4.5	43	29	Expanding	9.5	16.3	21.3	4.6	2.6	10.6

Table O-6. Biface Data From Toyah Component

Cat. No.	87-010	97-017	130-005-010	157-012	159-005-026	159-005-028	159-005-029	159-016
Unit	N100,E51	N100,E52	N100,E55	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47
Depth (cmbd)	0-10	0-10	0-10	10-20	30-40	30-40	30-40	30-40
Feature No.			35		36	36	36	36
Condition	Distal	Distal	Proximal	Proximal	Distal	Complete	Distal	Distal
Break Type	Indeterminate	Use	Use	Use	Use	Unbroken	Use	Use
Biface Stage	Late	Late	Late	Indeterminate	Late	Late	Late	Middle
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	Indeterminate	None	Indeterminate	None	Alternate Beveled Unifacial	Indeterminate	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	50	0	0	0	0	0	0	0
Cortex Type	Pebble/Cobble	None	None	None	None	None	None	None
Heating	None	Indeterminate	None	Heat-Treated	None	None	None	None
Length (mm)						99.2		
Width (mm)	33.7		43.3			33.8		
Thick (mm)	7.3	5.7	7.7		5.2	6.7		8
Wt. (g)						28.5		
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip	Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical
Preform	Biface	Indeterminate	Biface	Indeterminate	Flake	Biface	Flake	Biface
Overall Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Bipointed	Indeterminate	Indeterminate
Flaking Pattern	Flake Blank Remnant	Chevron	Random	Indeterminate	Flake Blank Remnant	Subparallel	Flake Blank Remnant	Oblique Subparallel
Edge Rounding	Absent	Present	Absent	Present	Present	Present	Present	Absent
Left Lateral Edge Shape	Incurvate	Indeterminate	Excurvate	Indeterminate	Excurvate	Excurvate	Straight	Indeterminate
Right Lateral Edge Shape	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Excurvate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	186-010	220-015	232-010	244-012	244-013	260-015	272-019	291-015
Unit	N101,E51	N101,E54	N101,E55	N101,E56	N101,E56	N102,E47	N102,E50	N102,E52
Depth (cmbd)	10-20	20-30	10-20	0-10	0-10	10-20	20-30	0-10
Feature No.						36		
Condition	Indeterminate	Distal	Medial	Proximal	Complete	Distal	Complete	Distal
Break Type	Use	Use	Use	Use	Unbroken	Thermal/Crenated	Unbroken	Use
Biface Stage	Indeterminate	Late	Late	Middle	Middle	Late	Early	Middle
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	Indeterminate	Alternate Beveled Unifacial	None	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	100	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	Burned	None	Indeterminate	None	None	Burned	None	None
Length (mm)					76.1		47.7	
Width (mm)		47.3	36	41.1	47		21.9	41.6
Thick (mm)	6.2	8.5	5	8.6	15	6.5	7.2	11.9
Wt. (g)					60.9		4.9	
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip	Indeterminate	Tapered Base/Tip	Indeterminate
Trans X-Section	Indeterminate	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Biconvex Asymmetrical	Biconvex Symmetrical
Preform	Indeterminate	Biface	Flake	Biface	Biface	Biface	Flake	Biface
Overall Shape	Indeterminate	Indeterminate	Indeterminate	Triangular	Ovate	Indeterminate	Lanceolate	Indeterminate
Flaking Pattern	Indeterminate	Oblique Parallel	Random	Oblique Subparallel	Random	Collateral	Oblique Parallel	Random
Edge Rounding	Absent	Present	Absent	Present	Absent	Present	Absent	Absent
Left Lateral Edge Shape	Indeterminate	Excurvate	Excurvate	Straight	Excurvate	Straight	Excurvate	Excurvate
Right Lateral Edge Shape	Indeterminate	Excurvate	Indeterminate	Straight	Excurvate	Excurvate	Excurvate	Excurvate
Micro-wear	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	291-016	303-016	324-017	393-011	414-013	427-011	450-027	450-028
Unit	N102,E52	N102,E53	N102,E55	N103,E56	N104,E56	N105,E47	N105,E52	N105,E52
Depth (cmbd)	0-10	0-10	40-50	0-10	10-20	30-40	0-10	0-10
Feature No.								
Condition		Complete	Distal	Distal	Distal		Proximal	Indeterminate
Break Type		Unbroken	Use	Use	Use		Use	Use
Biface Stage		Early	Late	Late	Middle		Late	Late
Rejuvenation Scar		Absent	Absent	Absent	Absent		Absent	Absent
Resharpener Type		None	None	Indeterminate	Indeterminate		Indeterminate	Indeterminate
Raw Material		Chert	Chert	Chert	Chert		Chert	Chert
Texture		Fine	Fine	Fine	Fine		Fine	Fine
Percent Patination		0	0	0	0		75	0
Percent Cortex		0	0	0	0		0	0
Cortex Type		None	None	None	None		None	None
Heating		None	None	Heat-Treated	None		None	None
Length (mm)		57						67.1
Width (mm)		49	23.8				30.6	
Thick (mm)		14.9	3.6	4.8	10.6		6.5	9.3
Wt. (g)		44.3						
Long X-Section		Bi-wedge-shaped	Flat	Indeterminate	Indeterminate		Indeterminate	Tapered Base/Tip
Trans X-Section		Biconvex Symmetrical	Plano-Convex	Plano-Convex	Indeterminate		Plano-Convex	Indeterminate
Preform		Biface	Flake	Flake	Biface		Flake	Biface
Overall Shape		Triangular	Indeterminate	Indeterminate	Indeterminate		Indeterminate	Ovate
Flaking Pattern		Random	Flake Blank Remnant	Subparallel	Random		Oblique Parallel	Random
Edge Rounding		Absent	Present	Absent	Absent		Absent	Present
Left Lateral Edge Shape		Excurvate	Excurvate	Indeterminate	Indeterminate		Straight	Indeterminate
Right Lateral Edge Shape		Excurvate	Straight	Excurvate	Indeterminate		Straight	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	474-011	489-011	504-014	555-012	565-015	602-013	602-014	611-013
Unit	N105,E55	N106,E47	N106,E51	N107,E48	N107,E50	N107,E55	N107,E55	N107,E56
Depth (cmbd)	10-20	10-20	10-20	10-20	0-10	10-20	10-20	10-20
Feature No.								
Condition	Distal	Distal	Proximal	Medial	Distal		Medial	Medial
Break Type	Indeterminate	Use	Use	Manufacture	Use		Thermal/Crenated	Manufacture
Biface Stage	Late	Late	Middle	Late	Late		Late	Middle
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent		Absent	Absent
Resharpener Type	Indeterminate	Indeterminate	None	Indeterminate	Indeterminate		Indeterminate	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert		Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine		Fine	Fine
Percent Patination	0	0	0	0	0		0	0
Percent Cortex	0	0	0	0	0		0	0
Cortex Type	None	None	None	None	None		None	None
Heating	None	None	None	None	None		Burned	None
Length (mm)								
Width (mm)	25.1		58.3		29.4			49.3
Thick (mm)	5.8	8.6	14.8	6.4	6.8		5.1	16.2
Wt. (g)								
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate		Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Indeterminate	Plano-Convex	Plano-Convex	Plano-Convex		Biconvex Symmetrical	Indeterminate
Preform	Flake	Biface	Biface	Biface	Flake		Flake	Biface
Overall Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate		Indeterminate	Indeterminate
Flaking Pattern	Random	Random	Random	Random	Subparallel		Chevron	Random
Edge Rounding	Present	Present	Absent	Absent	Present		Absent	Absent
Left Lateral Edge Shape	Straight	Excurvate	Straight	Indeterminate	Excurvate		Indeterminate	Excurvate
Right Lateral Edge Shape	Straight	Indeterminate	Straight	Excurvate	Excurvate		Indeterminate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	666-013	685-012	685-013	758-010	767-013	776-012	782-014	797-011
Unit	N108,E55	N109,E48	N109,E48	N109,E70	N114,E69	N114,E73	N114,E75	N115,E72
Depth (cmbd)	6-20	0-10	0-10	10-20	0-10	0-10	15-25	10-20
Feature No.								
Condition	Indeterminate	Indeterminate	Distal	Medial	Complete	Indeterminate	Distal	Distal
Break Type	Indeterminate	Thermal/Crenated	Use	Use	Use	Indeterminate	Indeterminate	Manufacture
Biface Stage	Middle	Indeterminate	Middle	Late	Late	Middle	Late	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	Indeterminate	Indeterminate	Indeterminate	None	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	25	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	Burned	None	None	None	None	None	None
Length (mm)	72.4				77.5			
Width (mm)					35.7		33	22.4
Thick (mm)	17.5		11.2	5.2	13.3	13.6	4.8	4.1
Wt. (g)					30.8			
Long X-Section	Bi-wedge-shaped	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip	Indeterminate	Indeterminate	Flat
Trans X-Section	Plano-Convex	Indeterminate	Plano-Convex	Plano-Convex	Biconvex Asymmetrical	Indeterminate	Plano-Convex	Plano-Convex
Preform	Biface	Biface	Biface	Biface	Biface	Biface	Flake	Flake
Overall Shape	Ovale	Indeterminate	Indeterminate	Indeterminate	Ovale	Indeterminate	Indeterminate	Triangular
Flaking Pattern	Random	Indeterminate	Random	Oblique Subparallel	Subparallel	Indeterminate	Chevron	Oblique Subparallel
Edge Rounding	Absent	Present	Absent	Present	Present	Absent	Absent	Absent
Left Lateral Edge Shape	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate	Straight	Straight
Right Lateral Edge Shape	Excurvate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Excurvate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	814-015	822-010	831-014	835-013	838-016	841-016	843-005-011	843-005-012
Unit	N116,E72	N116,E75	N117,E72	N117,E74	N117,E75	N118,E69	N118,E70	N118,E70
Depth (cmbd)	0-10	0-10	10	0-10	10-20	10-20	10-20	10-20
Feature No.							8	8
Condition	Complete	Medial	Distal	Complete	Proximal	Distal	Medial	Complete
Break Type	Unbroken	Thermal/ Crenated	Use	Unbroken	Indeterminate	Thermal/ Crenated	Use	Unbroken
Biface Stage	Middle	Middle	Late	Late	Late	Indeterminate	Late	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	Alternate Beveled Unifacial	Indeterminate	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	25	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	Burned	None	Indeterminate	None	Burned	None	None
Length (mm)	123.5			53.6				41.6
Width (mm)	42.4	48.9		22.9				26.1
Thick (mm)	24	11.6	6.7	7.6	8.8		4.8	4.1
Wt. (g)	113	46.5		10.9				3.8
Long X-Section	Tapered Base/Tip	Indeterminate	Indeterminate	Tapered Base/Tip	Flat	Indeterminate	Flat	Flat
Trans X-Section	Biconvex Symmetrical	Plano- Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano- Convex	Indeterminate	Plano- Convex	Plano- Convex
Preform	Biface	Biface	Biface	Biface	Biface	Indeterminate	Flake	Flake
Overall Shape	Ovate	Ovate	Triangular	Lanceolate	Ovate	Indeterminate	Indeterminate	Triangular
Flaking Pattern	Chevron	Random	Chevron	Oblique Subparallel	Random	Indeterminate	Collateral	Chevron
Edge Rounding	Absent	Absent	Absent	Present	Present	Present	Absent	Absent
Left Lateral Edge Shape	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate	Indeterminate	Excurvate	Straight
Right Lateral Edge Shape	Excurvate	Excurvate	Excurvate	Straight	Excurvate	Indeterminate	Excurvate	Straight
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	847-017	857-014	859-017	871-010	878-010	878-011	878-021	880-013
Unit	N118,E72	N118,E74	N118,E75	N119,E73	N119,E75	N119,E75	N119,E75	N120,E69
Depth (cmbd)	0-10	14	0-10	0-10	10-20	10-20	10-20	0-18
Feature No.								
Condition	Medial	Indeterminate	Medial	Distal	Proximal	Proximal	Complete	Medial
Break Type	Use	Use	Indeterminate	Use	Indeterminate	Use	Unbroken	Indeterminate
Biface Stage	Late	Late	Middle	Late	Late	Late	Late	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	None	Alternate Beveled Unifacial	None	Indeterminate	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	Indeterminate
Length (mm)							46	
Width (mm)	23.3	27.8			36.9		24.1	
Thick (mm)	5.3	7.8	8.3	4.7	8.4	5.3	5.8	5.8
Wt. (g)		16.4					6.3	
Long X-Section	Indeterminate	Flat	Indeterminate	Flat	Indeterminate	Indeterminate	Wedge Base, Flat	Indeterminate
Trans X-Section	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Indeterminate
Preform	Flake	Biface	Flake	Flake	Indeterminate	Flake	Flake	Indeterminate
Overall Shape	Indeterminate	Lanceolate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Teardrop	Indeterminate
Flaking Pattern	Oblique Parallel	Random	Random	Chevron	Random	Indeterminate	Random	Indeterminate
Edge Rounding	Absent	Absent	Present	Present	Absent	Absent	Present	Present
Left Lateral Edge Shape	Indeterminate	Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate
Right Lateral Edge Shape	Indeterminate	Excurvate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	885-020	893-017	893-018	894-015	894-016	897-012	902-014	903-022
Unit	N120,E72	N120,E74	N120,E74	N120,E75	N120,E75	N122,E69	N122,E70	N122,E71
Depth (cmbd)	0-10	20-30	20-30	0-10	0-10	0-10	20-30	0-10
Feature No.								
Condition	Complete	Proximal	Indeterminate	Indeterminate	Indeterminate	Medial	Distal	Complete
Break Type	Unbroken	Use	Use	Indeterminate	Thermal/ Crenated	Thermal/ Crenated	Thermal/ Crenated	Unbroken
Biface Stage	Middle	Late	Late	Late	Middle	Late	Late	Early
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	Indeterminate	Indeterminate	Indeterminate	Indeterminate	None	Alternate Beveled Unifacial
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	Heat-Treated	None	None	None	Burned	Burned	Burned	Heat-Treated
Length (mm)	62.8							60.1
Width (mm)	47.3	33.7					29.2	58.3
Thick (mm)	9.1	7.1			12.9	6	10.4	10.5
Wt. (g)	31.1							41.1
Long X-Section	Tapered Base/Tip	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex	Biconvex Symmetrical	Indeterminate
Preform	Flake	Flake	Flake	Flake	Biface	Flake	Biface	Flake
Overall Shape	Round	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Triangular	Round
Flaking Pattern	Random	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Subparallel	Indeterminate	Random
Edge Rounding	Absent	Present	Absent	Present	Absent	Absent	Present	Present
Left Lateral Edge Shape	Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Straight	Excurvate
Right Lateral Edge Shape	Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Straight	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	903-026	915-020	934-019	936-015	937-010	937-011	940-015	945-011
Unit	N122,E71	N122,E75	N123,E71	N123,E72	N123,E72	N123,E72	N123,E73	N123,E75
Depth (cmbd)	0-10	0-10	12 cmbs	0-10	10-20	10-20	12-26	0-10
Feature No.								
Condition	Indeterminate	Proximal	Distal	Medial	Proximal	Medial	Medial	Complete
Break Type	Indeterminate	Use	Use	Indeterminate	Use	Indeterminate	Manufacture	Use
Biface Stage	Late	Late	Late	Late	Early	Late	Late	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	Indeterminate	None	None	Beveled Unifacial	None	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	Burned	None	None	None	None	None	None	Burned
Length (mm)								40
Width (mm)			43.4	24.1	26.4			27.4
Thick (mm)	6.9		6.8	4.1	4.1	4.2	7.6	6.2
Wt. (g)								7.5
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Flat	Tapered Base/Tip	Indeterminate	Indeterminate	Flat
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex
Preform	Biface	Biface	Biface	Flake	Flake	Flake	Flake	Flake
Overall Shape	Indeterminate	Indeterminate	Indeterminate	Triangular	Ovate	Indeterminate	Indeterminate	Ovate
Flaking Pattern	Indeterminate	Indeterminate	Random	Subparallel	Flake Blank Remnant	Random	Indeterminate	Flake Blank Remnant
Edge Rounding	Absent	Absent	Absent	Absent	Present	Present	Absent	Present
Left Lateral Edge Shape	Indeterminate	Indeterminate	Excurvate	Straight	Excurvate	Indeterminate	Excurvate	Excurvate
Right Lateral Edge Shape	Indeterminate	Indeterminate	Excurvate	Straight	Excurvate	Indeterminate	Indeterminate	Excurvate
Micro-wear	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	969-020	984-018	987-016	990-011	992-015	994-011	1002-018	1013-010
Unit	N124,E75	N125,E72	N125,E73	N125,E74	N125,E75	N125,E75	N126,E70	N126,E72
Depth (cmbd)	20-30	10-20	10-20	10-20	0-10	20-30	10-20	70-80
Feature No.								
Condition	Proximal	Distal	Medial	Medial	Distal	Distal	Distal	Indeterminate
Break Type	Use	Use	Use	Indeterminate	Manufacture	Indeterminate	Use	Indeterminate
Biface Stage	Late	Late	Late	Late	Late	Late	Late	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	Indeterminate	None	Indeterminate	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	Heat-Treated	None
Length (mm)				52.2				
Width (mm)	21.3		45.5				37.3	
Thick (mm)	6.8	6.8	8.1	13.9	6.3		6.9	
Wt. (g)								
Long X-Section	Flat	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flat	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Indeterminate	Plano-Convex	Plano-Convex	Plano-Convex	Indeterminate
Preform	Flake	Flake	Flake	Biface	Flake	Flake	Flake	Indeterminate
Overall Shape	Lanceolate	Indeterminate	Indeterminate	Indeterminate	Lanceolate	Indeterminate	Indeterminate	Indeterminate
Flaking Pattern	Random	Random	Random	Indeterminate	Oblique Subparallel	Indeterminate	Collateral	Indeterminate
Edge Rounding	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent
Left Lateral Edge Shape	Straight	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate	Excurvate	Indeterminate
Right Lateral Edge Shape	Straight	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	1019-015	1021-015	1041-014	1049-011	1051-010	1054-018	1085-013	1095-014
Unit	N126,E73	N126,E74	N127,E71	N127,E74	N127,E74	N127,E75	N128,E75	N129,E73
Depth (cmbd)	10-20	24	10-20	10-20	25-35	20-30	20-30	10-20
Feature No.						25		
Condition	Distal	Distal	Complete	Distal	Medial	Medial	Complete	Medial
Break Type	Use	Indeterminate	Unbroken	Thermal/ Crenated	Thermal/ Crenated	Thermal/ Crenated	Unbroken	Thermal/ Crenated
Biface Stage	Late	Late	Late	Indeterminate	Late	Late	Middle	Late
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	Beveled Bifacial	Indeterminate	Indeterminate	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	100	0	0	0	0
Percent Cortex	0	0	0	0	0	0	25	0
Cortex Type	None	None	None	None	None	None	Pebble/Cobble	None
Heating	None	Burned	Heat-Treated	Burned	Burned	Burned	None	Burned
Length (mm)			93.2				63	
Width (mm)		35.3	33.7				55.8	
Thick (mm)	6	7.7	11.9		5.1	5.9	14.3	
Wt. (g)			24.3				46.6	
Long X-Section	Indeterminate	Flat	Tapered Base/Tip	Indeterminate	Indeterminate	Indeterminate	Bi-wedge-shaped	Indeterminate
Trans X-Section	Biconvex Asymmetrical	Plano-Convex	Biconvex Symmetrical	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Indeterminate
Preform	Flake	Flake	Biface	Indeterminate	Flake	Flake	Flake	Indeterminate
Overall Shape	Indeterminate	Indeterminate	Bipointed	Indeterminate	Indeterminate	Indeterminate	Round	Indeterminate
Flaking Pattern	Oblique Subparallel	Subparallel	Random	Indeterminate	Indeterminate	Chevron	Random	Indeterminate
Edge Rounding	Present	Present	Present	Present	Present	Absent	Absent	Absent
Left Lateral Edge Shape	Indeterminate	Excurvate	Excurvate	Indeterminate	Excurvate	Indeterminate	Excurvate	Indeterminate
Right Lateral Edge Shape	Indeterminate	Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	1098-016	1100-014	1122-018	1133-010	1137-010	1137-013	1156-012	1170-010
Unit	N129,E74	N129,E75	N130,E72	N130,E75	N131,E70	N131,E70	N131,E73	N132,E72
Depth (cmbd)	10-20	0-10	20-30	20-30	30-40	30-40	0-10	10-20
Feature No.								
Condition	Medial	Medial	Medial	Medial	Medial	Medial	Complete	Complete
Break Type	Thermal/ Crenated	Use	Indeterminate	Use	Use	Thermal/ Crenated	Unbroken	Unbroken
Biface Stage	Late	Late	Late	Late	Late	Late	Middle	Middle
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	Indeterminate	Indeterminate	Indeterminate	None	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	25	0
Cortex Type	None	None	None	None	None	None	Pebble/Cobble	None
Heating	Burned	None	Heat-Treated	None	None	Burned	None	None
Length (mm)							62.8	52.4
Width (mm)		31.2					60.7	46.1
Thick (mm)		6.6				7.1	15.2	11
Wt. (g)							66.5	34.2
Long X-Section	Indeterminate	Flat	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Bi-wedge-shaped	Tapered Base
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Overall Shape	Indeterminate	Triangular	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Round	Round
Flaking Pattern	Indeterminate	Random	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flake Blank Remnant	Random
Edge Rounding	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Left Lateral Edge Shape	Indeterminate	Straight	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate	Excurvate
Right Lateral Edge Shape	Indeterminate	Straight	Straight	Indeterminate	Indeterminate	Straight	Excurvate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-6. Biface Data From Toyah Component Continued

Cat. No.	1180-010	1189-013	1256-005-011
Unit	N132,E74	N133,E72	N126,E74
Depth (cmbd)	30-35	10-20	10-20
Feature No.			25
Condition	Proximal	Complete	Medial
Break Type	Thermal/Crenated	Indeterminate	Use
Biface Stage	Late	Early	Late
Rejuvenation Scar	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	Alternate Beveled Unifacial
Raw Material	Chert	Chert	Chert
Texture	Fine	Fine	Fine
Percent Patination	0	0	0
Percent Cortex	0	25	0
Cortex Type	None	Pebble/Cobble	None
Heating	Burned	None	Indeterminate
Length (mm)		63.6	
Width (mm)		50.6	33.8
Thick (mm)	5	20.5	8.5
Wt. (g)		55.5	
Long X-Section	Indeterminate	Wedge Base, Thick Body	Indeterminate
Trans X-Section	Plano-Convex	Plano-Convex	Biconvex Symmetrical
Preform	Flake	Flake	Biface
Overall Shape	Indeterminate	Irregular	Indeterminate
Flaking Pattern	Random	Random	Random
Edge Rounding	Present	Absent	Present
Left Lateral Edge Shape	Indeterminate	Excurvate	Straight
Right Lateral Edge Shape	Indeterminate	Excurvate	Straight
Micro-wear	FALSE	FALSE	TRUE
NAA	FALSE	FALSE	FALSE

Table O-7. Toyah Component Scraper Data

Cat. No.	78-005-011	169-011	176-010	186-013	195-013	302-013	376-015	490-010	796-016	800-011	803-010	814-014	820-010
Unit	N100,E50	N101,E50	N101,E50	N101,E51	N101,E52	N102,E53	N103,E52	N106,E47	N115,E72	N115,E73	N115,E74	N116,E72	N116,E74
Depth (cmbd)	0-10	30-40	0-10	10-20	0-10	0-10	0-10	20-30	0-10	10-20	10-20	7	0-10
Feature No.	21												
Tool Subtype	End-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	Side/End Scraper	Side-Scraper	Side/End Scraper	Side-Scraper	End-Scraper	End-Scraper
Condition	Distal	Complete	Complete	Complete	Complete	Distal	Complete	Complete	Complete	Distal	Complete	Complete	Complete
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Shape	Irregular	Ovate	Triangular	Teardrop	Round	Indeterminate	Lanceolate	Irregular	Lanceolate	Indeterminate	Irregular	Irregular	Lanceolate
Break Type	Use	Unbroken	Unbroken	Unbroken	Unbroken	Use	Unbroken	Unbroken	Unbroken	Indeterminate	Unbroken	Unbroken	Unbroken
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Coarse	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Cortex	0	25	50	0	0	0	25	0	0	0	25	0	25
Cortex Type	None	Pebble/Cobble	Pebble/Cobble	None	None	None	Pebble/Cobble	None	None	None	Pebble/Cobble	None	Pebble/Cobble
Heating	None	None	None	None	None	Burned	None	None	None	None	None	None	None
Length (mm)		53.5	49.7	42.8	36.4		96.3	74.5	99.6		53.9	108.4	71.2
Width (mm)		73.5	48.2	30.3	32.6		31.4	54	32.8		76.6	84.3	30
Thickness (mm)	10.3	18.3	16.6	8.3	15	5.2	19.4	24.1	13.7	6.5	18.2	21.6	11.4
Wt. (g)		8	40.8	11.8	14.8		59.8	63.3	48.8		60.8	166.4	25.7
Edge Rounding	Present	Absent	Present	Present	Present	Present	Present	Present	Present	Absent	Present	Absent	Present
Edge Flaking	Distal/Lateral	Distal/Lateral	Lateral Only	Distal/Lateral	Distal/Lateral	Distal	Distal/Lateral	Proximal/ Lateral	Distal/Lateral	Distal/Lateral	Proximal/ Lateral	Distal/Lateral	Distal/Lateral
No. of Bits	2	1	1	3	1	1	3	2	2	1	1	4	2
Bit 1 Location	Lateral/Distal	Distal	Lateral	Lateral	Lateral/Distal	Distal	Lateral	Proximal	Lateral	Lateral/Distal	Lateral/ Proximal	Lateral/Distal	Distal
Bit 1 Shape	Excurvate	Excurvate	Straight	Straight	Excurvate	Excurvate	Straight	Straight	Incurvate	Excurvate	Straight	Straight	Excurvate
Bit 1 Retouch	Irregular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous	Irregular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous	Irregular Continuous
Bit 1 Length (mm)	25.1	50.1	27	28.3	74.6	19.2	35.7	30.1	62.8	42.9	47.8	46	29.2
Bit 1 Thickness (mm)	5	7.9	7.5	3.5	12	2.4	2.6	3.6	9.1	5	7.3	9.9	4.7
Bit 1 Angle	47	67	69	47	63	44	63	75	78	62	76	73	71
Bit 2 Location	Distal			Distal			Lateral	Lateral	Distal			Lateral	Lateral
Bit 2 Shape	Excurvate	Straight	Straight				Straight	Excurvate	Straight	Straight		Straight	
Bit 2 Retouch	Irregular Discontinuous	Regular Continuous	Regular Continuous				Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous		Irregular Continuous	
Bit 2 Length (mm)	36.1	18.6	17.1				16.9	36.2	22.9	29.4		63.2	
Bit 2 Thickness (mm)	2.4	2.5	3				4.8	3.6	1.5	5.5		2	
Bit 2 Angle	66			68			75	72	71			77	48
Bit 3 Location				Lateral			Distal					Lateral	
Bit 3 Shape				Straight			Excurvate					Straight	
Bit 3 Retouch				Irregular Continuous			Irregular Continuous					Regular Continuous	
Bit 3 Length (mm)				23			39					33.4	
Bit 3 Thickness (mm)				3.9			4.5					2.7	
Bit 3 Angle				45			64					53	
Flake Size			7	5	4		10	10	10		8	11	7
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-7. Toyah Component Scraper Data Continued

Cat. No.	838-010	844-017	856-012	864-013	874-011	878-012	878-019	880-011	888-014	893-010	901-010	903-012	903-024
Unit	N117,E75	N118,E71	N118,E74	N119,E70	N119,E74	N119,E75	N119,E75	N120,E69	N120,E73	N120,E74	N122,E70	N122,E71	N122,E71
Depth (cmbd)	10-20	0-10	0-10	0-10	0-10	10-20	10-20	0-18	0-10	20-30	10-20	0-10	0-10
Feature No.				8	missing								
Tool Subtype	End-Scraper	End-Scraper	End-Scraper	End-Scraper		End-Scraper	End-Scraper	Side-Scraper	End-Scraper	Side-Scraper	End-Scraper	Side-Scraper	Side/End Scraper
Condition	Complete	Distal	Complete	Distal		Complete	Complete	Complete	Complete	Distal	Complete	Complete	Distal
Rejuvenation Scar	Absent	Absent	Absent	Absent		Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Shape	Irregular	Indeterminate	Round	Indeterminate		Ovate	Lanceolate	Irregular	Teardrop	Indeterminate	Triangular	Irregular	Indeterminate
Break Type	Unbroken	Use	Unbroken	Use		Unbroken	Unbroken	Unbroken	Unbroken	Use	Unbroken	Unbroken	Indeterminate
Raw Material	Chert	Chert	Chert	Chert		Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine		Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	25	0		0	0	0	0	0	0	0	0
Percent Cortex	50	0	25	0		0	0	0	0	25	0	0	0
Cortex Type	Pebble/Cobble	None	Pebble/Cobble	None		None	None	None	None	Pebble/Cobble	None	None	None
Heating	None	Burned	None	None		None	None	None	None	None	None	None	None
Length (mm)	52.6		37			72.9	73.1	52.1	66.2		32.5	53.7	
Width (mm)	35.5		33.4			56.6	32.9	36	34.1	21.6	30.9	28.3	
Thickness (mm)	12	8.7	13.8	7		18.1	10	8.4	12	8.7	8.1	14.4	8.9
Wt. (g)	23.7		17.1			81.8	24.9	16	28		10	20.5	
Edge Rounding	Present	Absent	Present	Present		Present	Present	Present	Absent	Absent	Absent	Absent	Absent
Edge Flaking	Distal/Lateral	Distal	Distal	Distal		Distal	Whole Edge	Lateral Only	Distal/Lateral	Lateral Only	Distal/Lateral	Distal/Lateral	Distal/Lateral
No. of Bits	3	1	1	1		1	3	1	3	1	2	1	1
Bit 1 Location	Lateral/Distal	Distal	Distal	Distal		Distal	Distal	Lateral	Distal	Lateral	Distal	Lateral/Distal	Lateral/Distal
Bit 1 Shape	Recurvate	Excurvate	Excurvate	Excurvate		Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Incurvate	Excurvate
Bit 1 Retouch	Irregular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous		Regular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous	Irregular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous
Bit 1 Length (mm)	40.2	53.6	20.3	36.1		54.9	62.1	42.7	63.9	28	30	26	58
Bit 1 Thickness (mm)	6.6	3.7	4.4	6		13.4	6.2	3.8	9.6	5.4	3.5	5.8	6.9
Bit 1 Angle	74	58	80	66		75	71	70	70	67	85	75	71
Bit 2 Location	Lateral						Lateral		Lateral		Lateral/ Proximal		
Bit 2 Shape	Straight		Straight	Excurvate				Excurvate			Incurvate	Straight	Excurvate
Bit 2 Retouch	Regular Continuous		Irregular Continuous	Irregular Continuous				Regular Continuous			Regular Continuous	Regular Continuous	Regular Continuous
Bit 2 Length (mm)	33.7		24.7	37				38.7			9.4	20.7	21.6
Bit 2 Thickness (mm)	7		2.2	3				6.8			4.9	3.7	6.1
Bit 2 Angle	53						56		38		55		
Bit 3 Location	Lateral/ Distal						Lateral		Lateral/ Proximal				
Bit 3 Shape	Straight						Straight		Straight				
Bit 3 Retouch	Regular Continuous						Irregular Continuous		Regular Continuous				
Bit 3 Length (mm)	19.4						47		19.5				
Bit 3 Thickness (mm)	2.2						4.6		1.5				
Bit 3 Angle	44						54		56				
Flake Size	6		4			8	8	6	7		5	6	
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-7. Toyah Component Scraper Data Continued

Cat. No.	903-025	908-012	915-011	928-010	928-014	930-012	946-011	946-013	952-012	954-010	956-015	967-021	968-010
Unit	N122,E71	N122,E73	N122,E75	N123,E69	N123,E69	N123,E70	N123,E75	N123,E75	N124,E70	N124,E71	N124,E71	N124,E75	N124,E75
Depth (cmbd)	0-10	0-10	0-10	8-20	8-20	0-10	10-20	10-20	10-20	7	17	0-10	10-20
Feature No.													
Tool Subtype	end only	Side-Scraper	End-Scraper	Side-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	End-Scraper	Side-Scraper	End-Scraper	End-Scraper
Condition	Distal	Complete	Complete	Proximal	Complete	Complete	Distal	Complete	Complete	Proximal	Proximal	Complete	Complete
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Shape	Indeterminate	Lanceolate	Triangular	Indeterminate	Teardrop	Ovate	Indeterminate	Irregular	Ovate	Irregular	Irregular	Ovate	Irregular
Break Type	Indeterminate	Unbroken	Unbroken	Use	Unbroken	Unbroken	Use	Unbroken	Unbroken	Indeterminate	Indeterminate	Unbroken	Unbroken
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	25	0	0	0	0	0
Percent Cortex	0	25	25	0	25	50	0	0	0	0	0	0	25
Cortex Type	None	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	None	None	None	None	None	None	Pebble/Cobble
Heating	None	None	None	None	None	Burned	None	None	None	Burned	None	None	None
Length (mm)		110.8	44		94.4	59.7		33.2	64.4			62.9	43.1
Width (mm)		40.4	65	35.7	59.7	49.5		29.1	40.3	28.7	47.1	49.6	72.4
Thickness (mm)	16.6	20.6	14.8	9.7	16.6	17.2	9.9	7	15.7	7.7	10.1	12.2	14.8
Wt. (g)		94.9	40.1		113.3	56.6		8.3	52.3	7.6	29.3	44.7	47.8
Edge Rounding	Absent	Absent	Present	Present	Present	Present	Present	Absent	Present	Present	Present	Absent	Present
Edge Flaking	Lateral Only	Lateral Only	Distal	Proximal/ Lateral	Distal/Lateral	Distal/Lateral	Distal	Distal/Lateral	Distal/Lateral	Proximal/ Lateral	Lateral Only	Distal	Distal
No. of Bits	2	1	1	2	2	1	1	3	3	2	2	1	1
Bit 1 Location	Lateral	Lateral	Distal	Lateral/ Proximal	Lateral/Distal	Distal	Distal	Distal	Distal	Proximal	Lateral	Distal	Distal
Bit 1 Shape	Straight	Straight	Excurvate	Straight	Excurvate	Excurvate	Excurvate	Recurvate	Excurvate	Excurvate	Straight	Excurvate	Straight
Bit 1 Retouch	Regular Continuous	Irregular Continuous	Regular Discontinuous	Regular Continuous	Regular Continuous	Irregular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous
Bit 1 Length (mm)	12.6	72.3	67.6	30.9	123.5	49.3	16.8	34.9	38.5	25.2	41.6	84.6	64.5
Bit 1 Thickness (mm)	8.4	5.2	6.8	8.7	14.9	9	4	4.2	14.9	3.2	3.6	10.2	7.1
Bit 1 Angle	82	65	68	88	72	75	54	62	76	67	75	49	79
Bit 2 Location	Lateral			Lateral	Lateral			Lateral	Lateral	Lateral	Lateral		
Bit 2 Shape	Incurvate			Incurvate	Straight	Straight						Straight	
Bit 2 Retouch	Regular Continuous			Irregular Continuous	Regular Continuous	Irregular Discontinuous						Irregular Continuous	
Bit 2 Length (mm)	18.3			28.5	24	36						45.9	
Bit 2 Thickness (mm)	3.1			5.4	2.6	2.6						2.5	
Bit 2 Angle	42			63	72			55	66	59	71		
Bit 3 Location								Lateral	Lateral				
Bit 3 Shape								Recurvate	Excurvate				
Bit 3 Retouch								Irregular Continuous	Irregular Continuous				
Bit 3 Length (mm)								22.3	52.9				
Bit 3 Thickness (mm)								2.4	3.9				
Bit 3 Angle								60	57				
Flake Size		11	7		10	7		4	7		7	7	8
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-7. Toyah Component Scraper Data Continued

Cat. No.	969-016	969-017	97-016	973-010	981-014	982-012	985-010	996-010	1002-012	1002-019	1023-012	1024-012	1035-012
Unit	N124,E75	N124,E75	N100,E52	N125,E69	N125,E71	N125,E71	N125,E72	N126,E68	N126,E70	N126,E70	N126,E75	N126,E75	N127,E69
Depth (cmbd)	20-30	20-30	0-10	0-10	0-10	10-20	20-30	10-20	8-20	10-20	0-10	10-20	8
Feature No.											25	25	
Tool Subtype	Edge only	End-Scraper	Side/End Scraper	End-Scraper	End-Scraper	End-Scraper	Side-Scraper	End-Scraper	End-Scraper	End-Scraper	Side/End Scraper	End-Scraper	End-Scraper
Condition	Indeterminate	Complete	Complete	Distal	Distal	Complete	Complete	Distal	Proximal	Distal	Distal	Complete	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent
Shape	Indeterminate	Quadrilateral	Teardrop	Indeterminate	Indeterminate	Ovale	Round	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Quadrilateral	Indeterminate
Break Type	Indeterminate	Unbroken	Unbroken	Thermal/Crenated	Use	Indeterminate	Unbroken	Use	Manufacture	Indeterminate	Indeterminate	Unbroken	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0	0	50	0
Percent Cortex	0	25	0	0	25	0	0	0	0	0	0	25	0
Cortex Type	None	Pebble/Cobble	None	None	Pebble/Cobble	None	None	None	None	None	None	Pebble/Cobble	None
Heating	None	None	None	Burned	Heat-Treated	Burned	None	None	None	None	None	None	Heat-Treated
Length (mm)		60.3	60.5			72.2	55.9					66.6	
Width (mm)		34.3	47.2		45.2	39	49.7		38.8		29.9	50.4	43.6
Thickness (mm)	5.9	12.3	11.4	16.1	9.6	20.6	12.2	9.2	8.7	8.1	8.4	16.7	11.8
Wt. (g)		23.4	38.8			55.9	31.9		12.2			67.5	
Edge Rounding	Present	Present	Present	Present	Present	Present	Present	Present	Present	Absent	Absent	Present	Absent
Edge Flaking	Indeterminate	Distal/Lateral	Distal/Lateral	Distal	Distal	Distal/Lateral	Distal/Lateral	Distal	Distal/Lateral	Distal/Lateral	Distal/Lateral	Distal	Indeterminate
No. of Bits	1	1	1	1	1	2	1	1	3	2	3	1	1
Bit 1 Location	Indeterminate	Distal	Lateral/Distal	Distal	Distal	Distal	Lateral/Distal	Distal	Distal	Distal	Lateral	Distal	Indeterminate
Bit 1 Shape	Indeterminate	Excurvate	Excurvate	Excurvate	Straight	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Straight	Excurvate	Excurvate
Bit 1 Retouch	Regular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous
Bit 1 Length (mm)		40.2	123.6	38.4	24	51.7	48.8	60.1		38.8	18.5	45.1	30.6
Bit 1 Thickness (mm)	5.1	5	8.4	10.3	5.5	16.2	6.7	6.3	3.6	2.5	1.8	8	5.6
Bit 1 Angle	50	65	71	70	52	73	83	65	77	64	57	80	70
Bit 2 Location						Lateral			Lateral	Lateral	Lateral/Distal		
Bit 2 Shape	Straight		Straight			Excurvate			Excurvate	Straight			Straight
Bit 2 Retouch	Irregular Discontinuous		Regular Continuous			Regular Continuous			Regular Continuous	Irregular Continuous			Irregular Continuous
Bit 2 Length (mm)	22.5		15.7			37			27.4	39			19
Bit 2 Thickness (mm)	1.2		2.8			7.4			3.6	3.2			2.9
Bit 2 Angle						55			56	60	58		
Bit 3 Location									Lateral		Distal		
Bit 3 Shape									Incurvate		Excurvate		
Bit 3 Retouch									Regular Discontinuous		Regular Continuous		
Bit 3 Length (mm)									21.8		36.4		
Bit 3 Thickness (mm)									1.5		7.1		
Bit 3 Angle									51		74		
Flake Size		7	7			8	6		7			7	
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-7. Toyah Component Scraper Data Continued

Cat. No.	1036-016	1038-018	1041-013	1050-013	1052-012	1053-014	1054-020	1095-013	1132-010	1161-010	1166-010	1174-010	1270-010
Unit	N127,E69	N127,E70	N127,E71	N127,E74	N127,E75	N127,E75	N127,E75	N129,E73	N130,E75	N131,E74	N132,E71	N132,E73	N98,E51
Depth (cmbd)	14	10-20	10-20	15-27	0-10	10-20	20-30	10-20	10-20	20-30	10-20	10-20	52
Feature No.				25	25	25	25						
Tool Subtype	End-Scraper	Side-Scraper	End-Scraper	End-Scraper	Side-Scraper	Side-Scraper	End-Scraper	End-Scraper	Side-Scraper	End-Scraper	End-Scraper	Side-Scraper	End-Scraper
Condition	Distal	Complete	Complete	Complete	Complete	Medial	Complete	Distal	Complete	Complete	Complete	Proximal	Complete
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	Absent	Present	Absent
Shape	Indeterminate	Irregular	Ovate	Ovate	Lunate	Indeterminate	Lanceolate	Indeterminate	Teardrop	Irregular	Ovate	Indeterminate	Round
Break Type	Indeterminate	Unbroken	Unbroken	Unbroken	Unbroken	Use	Unbroken	Thermal/Crenated	Unbroken	Unbroken	Unbroken	Manufacture	Unbroken
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0	0	0	0
Percent Cortex	50	0	25	25	0	0	0	0	0	0	0	0	0
Cortex Type	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	None	None	None	None	None	None	None	None	None
Heating	None	Heat-Treated	None	None	Heat-Treated	None	None	Burned	None	None	None	Heat-Treated	None
Length (mm)		49.4	49.6	82.5	66.1		77.1		93	101	75.2		52.3
Width (mm)	35	29.6	41.4	50.3	36.7	63.8	38.6		47.8	68.6	45.9	41.4	55.2
Thickness (mm)	7.4	8.4	18.2	12.1	8.7	12.9	14.2	7.1	15.4	26.5	12.2	9.7	17.2
Wt. (g)		11.8	39.2	53.5	19.9		36.9		77.6	180.7	40.8		44.2
Edge Rounding	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Present	Absent	Present	Present
Edge Flaking	Distal	Proximal/ Lateral	Distal/Lateral	Distal/Lateral	Whole Edge	Lateral Only	Distal/Lateral	Distal	Distal/Lateral	Distal	Distal/Lateral	Lateral Only	Distal
No. of Bits	1	2	2	2	4	1	2	1	3	1	4	2	1
Bit 1 Location	Distal	Lateral	Distal	Distal	Lateral/ Proximal	Lateral	Distal	Distal	Lateral	Distal	Distal	Lateral	Distal
Bit 1 Shape	Excurvate	Recurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate
Bit 1 Retouch	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous	Regular Continuous	Irregular Discontinuous	Regular Continuous	Regular Continuous	Irregular Continuous	Regular Continuous
Bit 1 Length (mm)	72	38.2	62	39.5	29	44.4	44.6	30.2	95.2	63.5	58.9	48.9	109.4
Bit 1 Thickness (mm)	4.1	5.4	13.8	6.7	4.4	6.3	6.7	4.7	2.5	11.7	7.1	8.4	16.5
Bit 1 Angle	60	65	83	63	67	56	62	60	56	76	63	64	72
Bit 2 Location		Lateral/ Proximal	Lateral	Lateral	Lateral/ Proximal		Lateral		Distal		Lateral	Lateral	
Bit 2 Shape	Excurvate	Straight	Excurvate								Straight		
Bit 2 Retouch	Irregular Continuous	Regular Continuous	Regular Continuous								Irregular Continuous		
Bit 2 Length (mm)	53.3	14.3	53.9								26.6		
Bit 2 Thickness (mm)	2.6	1.9	7.1								4.6		
Bit 2 Angle		63	41	54	69		53		46		63	35	
Bit 3 Location					Lateral/ Distal				Lateral		Lateral		
Bit 3 Shape					Excurvate				Straight		Incurvate		
Bit 3 Retouch					Regular Continuous				Irregular Continuous		Regular Continuous		
Bit 3 Length (mm)					23.9				72.4		19.9		
Bit 3 Thickness (mm)					1.7				3.7		4.5		
Bit 3 Angle					57				52		77		
Flake Size		5	6	9	7		8		10	13	8		6
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-8. Uniface Data from Toyah Component

Cat. No.	Unit	Depth (cmbd)	Feat.N o.	Condition	Shape	Rejuvenation Scar	Raw Material	Texture	Percent Patination	Percent Cortex	Heating	Length (mm)	Width (mm)
159-005-027	N101,E47	30-40	36	Indeterminate	Indeterminate	Absent	Chert	Fine	0	0	None		64.4
196-011	N101,E52	10-20		Proximal	Indeterminate	Absent	Chert	Fine	0	0	None		32.2
857-012	N118,E74	10-20		Medial	Indeterminate	Absent	Chert	Fine	0	0	None		23.7
990-015	N125,E74	10-20		Indeterminate	Indeterminate	Absent	Chert	Fine	0	0	None		
1021-005-014	N126,E74	29	25	Complete	Ovate	Absent	Other Rock	Fine	0	0	None	47.9	25.1
1055-013	N127,E75	33	25	Complete	Ovate	Absent	Chert	Fine	0	0	None	53.2	40
1171-013	N132,E72	20-30		Distal	Indeterminate	Absent	Chert	Fine	0	0	None		

Cat. No.	Thickness (mm)	Wt. (g)	Edge Flaking	Edge Rounding	No. of Bits	Bit 1 Location	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)	Bit 1 Angle	Bit 2 Location
159-005-027	11.7		Lateral Only	Absent	2	Lateral	Excurvate	Irregular Continuous	67.6	2.8	47	Lateral
196-011	5.1		Proximal Lateral	Present	3	Lateral Proximal	Excurvate	Regular Continuous	25.2	3.5	58	Proximal
857-012	3		None	Present	0							
990-015	3.8		Whole Edge	Absent	1	Indeterminate	Excurvate	Irregular Continuous	61.3	2.8	43	
1021-005-014	7.1	8.2	Distal/ Lateral	Absent	1	Lateral/Distal	Excurvate	Irregular Continuous	69.3	4	53	
1055-013	7.4	15.3	Distal/ Lateral	Present	2	Lateral/Distal	Excurvate	Irregular Continuous	62	5.1	45	Lateral /Distal
1171-013			Distal/ Lateral	Present	2				18.3	2.2	49	Lateral /Distal

Cat. No.	Bit 2 Shape	Bit 2 Retouch	Bit 2 Length (mm)	Bit 2 Thick (mm)	Bit 2 Angle	Flake Size	Micro-wear	NAA
159-005-027	Excurvate	Regular Discontinuous	59.3	3.5	58		TRUE	FALSE
196-011	Excurvate	Regular Continuous	22.6	2.6	46		FALSE	FALSE
857-012							FALSE	FALSE
990-015							FALSE	FALSE
1021-005-014						5	FALSE	FALSE
1055-013	Excurvate	Irregular Discontinuous	61.4	2.3	55	6	FALSE	FALSE
1171-013	Straight	Irregular Continuous	10.6	1.2	42		FALSE	FALSE

Table O-9. Drill Data From Toyah Component

Cat. No.	195-014	260-014	518-012	624-014	800-010	827-012	837-011	859-016
Unit	N101,E52	N102,E47	N106,E53	N108,E48	N115,E73	N117,E70	N117,E75	N118,E75
Depth (cmbd)	0-10	0-10	10-20	0-10	10-20	0-10	0-10	0-10
Feature No.		36						
Condition	Medial	Proximal	Distal	Medial	Proximal	Medial	Complete	Distal
Break Type	Use	Use	Indeterminate	Use	Use	Use	Use	Use
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Edge Rounding	Present	Present	Present	Present	Present	Present	Present	Present
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	25	0	0	0	25	0	0	0
Cortex Type	Pebble/Cobble	None	None	None	Pebble/Cobble	None	None	None
Heating	None	None	None	None	None	None	None	None
Length (mm)							14	
Width (mm)								
Thick (mm)	6	4.8		5.7	3.9	3.6	2.8	
Wt. (g)					1.5	1.4	0.3	
Trans X-Section	Biconvex Asymmetrical	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Biconvex Asymmetrical	Biconvex Asymmetrical	Biconvex Symmetrical
Preform	Flake	Flake	Flake	Flake	Flake	Flake	Flake	Flake
Stem Shape	Indeterminate	Irregular	Indeterminate	Irregular	Straight	Contracting	Contracting	Indeterminate
Stem Length (mm)		26.5			23.4		5.8	
Stem Width (mm)	25.9	27.2			14.3	14.4	6	
Bit Width (mm)	5.2	6.1	6.6	7.1	5.5	7.9	1.8	5
Micro-wear	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE
NAA	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-9. Drill Data From Toyah Component Continued

Cat. No.	875-018	893-016	895-012	942-018	974-011	989-010	1054-019	1074-015
Unit	N119,E74	N120,E74	N120,E75	N123,E74	N125,E69	N125,E74	N127,E75	N128,E72
Depth (cmbd)	10-20	20-30	10-20	0-10	10-20	0-10	20-30	20-30
Feature No.							25	
Condition	Medial	Distal	Medial	Proximal	Medial	Proximal	Distal	Proximal
Break Type	Use	Use	Use	Use	Use	Use	Use	Use
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Edge Rounding	Absent	Present	Present	Present	Absent	Absent	Present	Present
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None
Length (mm)								
Width (mm)								
Thick (mm)	3.5	3.6	2.9	4.2	3.5	4.7		4.9
Wt. (g)	1.4							
Trans X-Section	Biconvex Asymmetrical	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex
Preform	Flake	Biface	Flake	Flake	Flake	Flake	Flake	Flake
Stem Shape	Indeterminate	Indeterminate	Indeterminate	Contracting	Indeterminate	Straight	Indeterminate	Irregular
Stem Length (mm)				16.8		18.1		22.2
Stem Width (mm)			16.2	22.7	16.5	15.2		
Bit Width (mm)	6.1	6.6	5.9	5.6	6.1	6.9	7.3	7.7
Micro-wear	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE

Table O-10. Toyah Core Data

Cat. No.	157-013	158-005-023	169-012	177-010	177-011	219-016	270-023	314-025	368-012	424-016
Unit	N101,E47	N101,E47	N101,E50	N101,E50	N101,E50	N101,E54	N102,E50	N102,E54	N103,E51	N105,E47
Depth (cmbd)	10-20	20-30	30-40	10-20	10-20	10-20	10	40-50	10-20	0-10
Feature No.		36								
Condition	Complete	Exhausted	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Complete
Tool Type	Bifacial	Bifacial	Bifacial	Multi-Directional	Bifacial	Bifacial	Bifacial	Bifacial	Multi-Directional	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0
Percent Cortex	25	25	25	0	50	0	50	50	0	25
Cortex Type	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble
Heating	None	None	None	None	None	None	None	None	None	Indeterminate
Length (mm)	59.5	59.8	76.2	61.9	72.9	77.9	138.9	69.5	70.8	73.1
Width (mm)	58.9	43.8	54.5	57.2	63.5	66.1	91.5	58.1	55.6	60.4
Thick (mm)	26.4	28.7	29	44.3	40	36.4	56.6	37.8	34.6	42.6
Wt. (g)	105.8	72.3	118.5	139.6	154.3	149.5	680	174.8	177.1	222.5

Cat. No.	474-012	490-011	549-013	618-010	802-015*	806-020*	814-012*	842-014*	885-019*	889-010*
Unit	N105,E55	N106,E47	N107,E47	N108,E47	N115,E74	N115,E75	N116,E72	N118,E70	N120,E72	N120,E73
Depth (cmbd)	10-20	20-30	10-20	0-10	0-10	15-30	3 cmbs	0-10	0-10	10-20
Feature No.										
Condition	Complete	Fragmented	Complete	Complete	Complete	Complete	Complete	Exhausted	Complete	Exhausted
Tool Type	Multi-Directional	Bifacial	Bifacial	Bifacial	Unifacial	Multi-Directional	Bifacial	Bifacial	Multi-Directional	Bifacial
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	25	0	0	0	0
Percent Cortex	50	25	0	50	50	25	0	25	25	25
Cortex Type	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble
Heating	None	None	None	Indeterminate	None	None	Heat-Treated	None	None	None
Length (mm)	73.1	72.4	95.7	111.9	64.1	86.8	78.1	50	81.8	55.6
Width (mm)	47.1	52.9	73.8	72.1	61.8	55.4	62.8	42.4	56.8	46.3
Thick (mm)	35.6	34.8	33.8	29.9	52.1	50.6	40.2	19.6	45.5	30.2
Wt. (g)	119.9	168.7	235.2	214.2	170.1	224.1	178.8	31.7	226.9	66.9

Table O-10. Toyah Core Data Continued

Cat. No.	889-010*	889-019*	893-014*	897-016*	913-016*	918-013*	942-010*	956-010*	975-010*	991-0118
Unit	N120,E73	N120,E73	N120,E74	N122,E69	N122,E74	N123,E68	N123,E74	N124,E71	N125,E69	N125,E74
Depth (cmbd)	10-20	10-20	20-30	0-10	8-24	9-11	0-10	20-30	20-30	18-2
Feature No.										
Condition	Exhausted	Complete	Complete	Complete	Complete	Complete	Complete	Complete	Exhausted	Complete
Tool Type	Bifacial	Bifacial	Bifacial	Multi-Directional	Multi-Directional	Multi-Directional	Multi-Directional	Bifacial	Multi-Directional	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0
Percent Cortex	25	50	25	50	50	25	25	25	0	25
Cortex Type	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble
Heating	None	Heat-Treated	None	None	None	None	None	None	None	None
Length (mm)	55.6	71.4	65.3	68.1	96	77.5	57.6	66.3	37.7	75.9
Width (mm)	46.3	60	56.8	66.6	60.5	70.8	39.1	62.1	31.5	47.9
Thick (mm)	30.2	33.6	43.5	44.9	42.8	50.4	37.6	26.1	23.8	44
Wt. (g)	66.9	121.3	220	242.4	346.2	407	82.4	117.7	31	132.7

Cat. No.	975-010*	991-0118	1000-010*	1024-020	1036-013*	1044-010*	1052-011*	1078-011*	1101-010*	1129-013*
Unit	N125,E69	N125,E74	N126,E69	N126,E75	N127,E69	N127,E72	N127,E75	N128,E73	N129,E75	N130,E74
Depth (cmbd)	20-30	18-2	20-30	10-20	18	18	0-10	20-30	10-20	20-30
Feature No.							25			
Condition	Exhausted	Complete	Complete	Fragmented	Complete	Complete	Complete	Complete	Complete	Complete
Tool Type	Multi-Directional	Multi-Directional	Bifacial	Bifacial	Multi-Directional	Bifacial	Multi-Directional	Bifacial	Bifacial	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0
Percent Cortex	0	25	25	25	25	50	50	25	75	25
Cortex Type	None	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble
Heating	None	None	None	None	None	None	None	None	None	None
Length (mm)	37.7	75.9	84.8	59	80.9	71.1	99.6	96.9	80.2	111.6
Width (mm)	31.5	47.9	66.8	58	74.6	52.1	54.5	65.9	55.5	77.3
Thick (mm)	23.8	44	23.9	18.1	35.7	28.5	57.8	30	24	44.2
Wt. (g)	31	132.7	120	64.5	224.3	93.8	438.2	206.3	121.2	344

Table O-11. Vessel Group 1 Data

Cat. No.	158-005-008	271-008	785-008	841-008-1	841-008-2	842-008-2	843-008	845-008	865-005-008
Unit	N101,E47	N102,E50	N115,E69	N118,E69	N118,E69	N118,E70	N118,E70	N118,E71	N119,E70
Depth (cmbd)	20-30	10-20	0-10	10-20	10-20	0-10	10-20	10-20	12-22
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White	Bone, White, Grey	Bone, White, Gray, Sand	Bone, White, Gray, Sand	Bone, White	Bone, White, Gray, Sand	Bone, Gray, White, Sand	Bone, White, Gray
Sherd Diameter (mm)	13.5	18	14	28	19.3	12		26.2	21.5
Thickness (mm)	4.7	5	6.1	4.7	4.7	4.6	5.3	5.1	6.7
Wt. (g)	0.7	1.7	0.6	2.3	1.1	0.4	1.4	2	1.7
Exterior Surface Finish	Smooth	Smooth	Smooth	Polished	Polished	Smooth	Smooth	Smooth	Polished
Interior Surface Finish	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Smooth	Polished
Exterior Surface Color	5YR 6/4	7.5YR 6/4	7.5YR 6/4	7.5YR 5/2	7.5YR 5/2	7.5YR 6/4	7.5YR 6/4	5YR 5/2	10YR 5/1
Core Color	5YR 5/1	10YR 4/1	7.5YR 5/2	10YR 4/1	10YR 4/1	7.5YR 5/2	7.5YR 6/2	5YR 5/3	10YR 2/1 & 10YR 5/2
Interior Surface Color	5YR 5/4	7.5YR 5/6	7.5YR 6/2	5YR 5/3	5YR 5/3	7.5YR 5/2	7.5YR 6/2	5YR 5/4	10YR 5/1
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	878-008	903-008	917-008	940-008	950-008-1	950-008-2	962-008*	989-008	996-008
Unit	N119,E75	N122,E71	N122,E75	N123,E73	N124,E69	N124,E69	N124,E73	N125,E74	N126,E68
Depth (cmbd)	10-20	0-10	20-30	12-26	18-26	18-26	20-30	0-10	10-20
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White	Bone, White	Bone, White, Gray	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White, Sand
Sherd Diameter (mm)	19.1	14.6	16.9	14.6	15.7	14.2	14	13.6	16
Thickness (mm)	4	4.5	4.1		5.5	4.8	4.9	5.9	3.9
Wt. (g)	1.1	0.8	0.4	0.5	0.7	0.4	0.9	1.1	1.1
Exterior Surface Finish	Smooth	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Smooth
Interior Surface Finish	Smooth	Rough	Smooth	Rough	Smooth	Smooth	Smooth	Rough	Smooth
Exterior Surface Color	5YR 5/2	5YR 6/3	10YR 6/3	5YR 6/4	5YR 6/4	5YR 6/4	5YR 6/4	7.5YR 6/4	5YR 5/1
Core Color	7.5YR 6/2	5YR 6/2	7.5YR 5/2	5YR 5/1	5YR 4/1	5YR 4/1	5YR 5/1	5YR 5/2	5YR 6/2
Interior Surface Color	7.5YR 6/4	5YR 5/1	7.5YR 6/4	5YR 6/3	5YR 6/3	5YR 6/3	5YR 5/1	5YR 6/6	5YR 6/3
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-11. Vessel Group 1 Data Continued

Cat. No.	999-008	1008-008-2	1023-008-1	1023-008-2	1030-005-004-008	1030-005-004-008-1	1030-005-008	1030-008	1050-008-1
Unit	N126,E69	N126,E72	N126,E75	N126,E75	N126,E76	N126,E76	N126,E76	N126,E76	N127,E74
Depth (cmbd)	10-20	20-30	0-10	0-10	35-40	35-40	30-40	30-40	15-25
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White	Bone, White, Sand	Bone, White, Sand	Bone, White	Bone, White	Bone, White	Bone, White, Gray	Bone, Gray, White
Sherd Diameter (mm)	31.5	22	16.8	27.1	25.6	28	28.2	18	21
Thickness (mm)	4.9	5.2	4.9	4.9	5.1	5	5.1	6	6.3
Wt. (g)	2.7	2	0.8	2.4	3.4	14.5	3.5	1.6	2.2
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Polished	Smooth
Interior Surface Finish	Smooth	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Rough
Exterior Surface Color	7.5YR 5/2	5YR 6/4	10YR 5/1	10YR 5/1	10YR 4/1	10YR 4/1	5YR 4/1	5YR 6/4	7.5YR 5/2
Core Color	5YR 4/1	5YR 5/1	5YR 4/1	5YR 4/1	5YR 4/1	5YR 4/1	5YR 4/1	5YR 5/1	5YR 4/1
Interior Surface Color	7.5YR 5/4	7.5YR 5/2	5YR 6/4	5YR 6/4	5YR 6/6	5YR 6/6	5YR 6/6	5YR 6/6	7.5YR 6/6
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1b	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1a	FALSE	FALSE	FALSE

Cat. No.	1050-008-2	1054-008-1	1054-008-2	1054-008-3	1054-008-4	1054-008-5	1055-005-008	1074-008	1078-008
Unit	N127,E74	N127,E75	N127,E75	N127,E75	N127,E75	N127,E75	N127,E75	N128,E72	N127,E73
Depth (cmbd)	15-25	20-30	20-30	20-30	20-30	20-30	32	20-30	17-25
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, Gray, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, Sand, White, Sand	Bone, White	Bone, White, Gray, Sand
Sherd Diameter (mm)	30		47.2	34.5	15.7	12	39.8	10.7	17
Thickness (mm)	6.1		5.3	6.3	4.9	4.9	5.1	5.2	5.5
Wt. (g)	2.1	3.4	11.7	4.1	0.9	0.6	9.2	0.6	0.8
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Polished
Interior Surface Finish	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Rough
Exterior Surface Color	7.5YR 5/2	10YR 6/3	10YR 6/3	10YR 6/3	10YR 6/3	10YR 6/3	5YR 7/4	7.5YR 6/2	5YR 5/1
Core Color	5YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	5YR 5/1	7.5YR 7/4	5YR 6/1
Interior Surface Color	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	5YR 5/2	7.5YR 7/4	5YR 5/2
NAA	FALSE	TRUE = 1a	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1b	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1a	FALSE	FALSE

Table O-11. Vessel Group 1 Data Continued

Cat. No.	1081-008	1089-008	1096-008-1	1137-008-1	1137-008-2	1137-008-3	1162-008-2	1162-008-3	1163-008	1261-008-1
Unit	N128,E74	N129,E71	N129,E73	N131,E70	N131,E70	N131,E70	N131,E75	N131,E75	N131,E75	Surface
Depth (cmbd)	0-10	30-35	20-30	30-40	30-40	30-40	0-10	0-10	10-20	0
Count	1	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White, Gray, Sand	Bone, White, Gray, Sand	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White, Gray
Sherd Diameter (mm)	25.4	26.6	13.4	11.4	13.6	12.2	16.9	18.8	12.5	28.3
Thickness (mm)	6.2	7.1	4.8	5.4	5.7	4.7	3.9	5.7	4.5	5.1
Wt. (g)	2.4	3.9	0.7	0.7	0.6	0.3	0.9	1.2	0.7	2.4
Exterior Surface Finish	Smooth	Smooth	Polished	Polished	Polished	Polished	Smooth	Smooth	Polished	Polished
Interior Surface Finish	Rough	Rough	Rough	Smooth	Smooth	Smooth	Rough	Smooth	Polished	Smooth
Exterior Surface Color	10YR 5/1	7.5YR 5/6	10YR 5/2	5YR 5/4	5YR 5/4	5YR 5/4	5YR 5/2	5YR 5/4	7.5YR 6/4	5YR 5/4
Core Color	10YR 4/1	7.5YR 5/4	7.5 YR 6/2	10YR 4/1	10YR 4/1	10YR 4/1	5YR 6/1	5YR 5/1	5YR 6/3	10YR 5/2
Interior Surface Color	5YR 6/6	7.5YR 6/4	5YR 6/4	10YR 5/2	10YR 5/2	10YR 5/2	5YR 5/2	5YR 6/4	7.5YR 6/4	10R 5/8
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

* From Late Archaic Component

Table O-12. Vessel Group 2 Data

Cat. No.	781-008	799-008-2	842-008-1	856-008	908-008	936-008	945-008	965-008
Unit	N114,E75	N115,E73	N118,E70	N118,E74	N122,E73	N123,E72	N123,E75	N124,E74
Depth (cmbd)	0-15	0-10	0-10	0-10	0-10	0-10	0-10	10-20
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, Gray, White	Bone, Gray, Black	Bone, Black, Gray	Bone, Black, Gray	Bone, Gray	Bone, Black, Gray	Bone, Gray, Black	Bone, Gray, Black
Sherd Diameter (mm)	13.8	21.2	19.5	25	14.3	14.8	22.2	39.4
Thickness (mm)	4.9	5.7	6	8.1	5.4	6.5	8	7.3
Wt. (g)	0.9	1.6	2.6	2.3	1.2	1.6	3.7	8.9
Exterior Surface Finish	Smooth	Polished	Polished	Polished	Polished	Polished	Polished	Polished
Interior Surface Finish	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	7.5YR 6/6	7.5YR 6/4	10YR 6/4	5YR 7/3	7.5YR 7/6	5YR 7/3	7.5YR 6/4	10YR 7/6
Core Color	7.5YR 7/4	5YR 6/3	7.5YR 7/4	7.5YR 7/4	7.5YR 7/4	5YR 6/1	10YR 5/1	5YR 7/4
Interior Surface Color	7.5YR 7/4	7.5YR 3/0	7.5YR 6/4	5YR 6/3	7.5YR 7/4	5YR 7/3	7.5YR 7/4	7.5YR 6/4
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
Petrographic	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE

Cat. No.	968-008	977-008	981-008	984-008-1	984-008-2	987-008-1a	992-008	1000-008
Unit	N124,E75	N125,E70	N125,E71	N125,E72	N125,E72	N125,E73	N125,E75	N126,E69
Depth (cmbd)	10-20	0-10	0-10	10-20	10-20	10-20	0-10	20-30
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Sand	Bone, Black	Bone, Black	Bone, Gray, Black	Bone, Gray, Black	Bone, Black, Gray	Bone, Black, Gray	Bone, White, Black
Sherd Diameter (mm)	1.1	24	22	19.9	18.4	19.6	19.6	21.8
Thickness (mm)	6.5	6.5	5.7	5.9	5.6	6.6	5.7	6.7
Wt. (g)	0.5	2.7	1.7	2	1	3	1.5	1.9
Exterior Surface Finish	Polished	Smooth	Polished	Smooth	Smooth	Polished	Polished	Smooth
Interior Surface Finish	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	10YR 5/2	7.5YR 6/4	10YR 5/2	7.5YR 7/4	7.5YR 7/4	7.5YR 7/6	10YR 7/3	5YR 6/4
Core Color	10YR 4/1	7.5YR 5/0	10YR 6/3	5YR 7/4	5YR 7/4	7.5YR 7/4	5YR 5/1	5YR 6/3
Interior Surface Color	5YR 5/4	7.5YR 6/6	7.5YR 6/4	7.5YR 7/4	7.5YR 7/4	10YR 5/1	7.5YR 7/4	5YR 6/3
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-12. Vessel Group 2 Data Continued

Cat. No.	1008-008-1	1096-008-2	1096-008-3	1100-008	1129-008-1a	1157-008	1162-008-1	1181-008	1187-008
Unit	N126,E72	N129,E73	N129,E73	N129,E75	N130,E74	N131,E73	N131,E75	N132,E75	N133,E71
Depth (cmbd)	20-30	20-30	20-30	0-10	20-30	0-10	0-10	0-10	20-30
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, Gray	Bone, Gray, Black	Bone, Gray, Black	Bone, Gray, Black, Sand	Bone, Gray	Bone, Black	Bone, Gray, Black	Bone, Black, Gray	Bone, Gray
Sherd Diameter (mm)	18.2	15.3	17.6	21	12.8	37	17	20	31.3
Thickness (mm)	7	5.5	5.7	4.9	5.6	6.5	6.5	6.6	4.8
Wt. (g)	1.5	1.4	2.2	1.2	0.9	6.4	0.9	3.1	2.2
Exterior Surface Finish	Polished	Smooth	Smooth	Smooth	Smooth	Polished	Polished	Polished	Smooth
Interior Surface Finish	Smooth	Smooth	Smooth	Rough	Smooth	Smooth	Rough	Smooth	Smooth
Exterior Surface Color	5YR 7/4	7.5YR 7/4	7.5YR 7/4	5YR 6/2	7.5YR 7/4	7.5YR 7/4	7.5YR 7/4	5YR 7/3	5YR 6/1
Core Color	5YR 6/2	7.5YR 7/4	7.5YR 7/4	5YR 6/2	7.5YR 7/4	7.5YR 7/4	5YR 5/1	5YR 5/1	10YR 6/3
Interior Surface Color	5YR 6/2	7.5YR 6/4	7.5YR 6/4	5YR 6/3	7.5YR 7/4	7.5YR 6/4	7.5YR 8/4	5YR 7/3	10YR 5/2
NAA	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1b	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1a	FALSE	FALSE	FALSE

Table O-13. Vessel Group 3 Data

Cat. No.	262-005-008	281-008	405-008	481-008	782-008-1	782-008-2	796-008	806-008
Unit	N102,E47	N102,E51	N104,E47	N105,E56	N114,E75	N114,E75	N115,E72	N115,E75
Depth (cmbd)	30-40	10-20	10-20	10-20	15-25	15-25	0-10	15-30
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Rim	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray	Bone, White, Sand	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White, Sand	Bone, Gray, White, Sand
Sherd Diameter (mm)	18.2	13.6	16.8	16.2	26.3	15.7	15.4	12.5
Thickness (mm)		5.4	6.1	5.6	6.3	6.3	5.5	5.8
Wt. (g)	1.5	0.5	1.1	1.1	1.7	2.3	1	0.5
Exterior Surface Finish	Polished	Smooth	Smooth	Polished	Polished	Smooth	Polished	Smooth
Interior Surface Finish	Gone	Smooth	Smooth	Polished	Polished	Smooth	Smooth	Smooth
Exterior Surface Color	5YR 6/2	7.5YR 6/4	10YR 6/4	5YR 6/4	5YR 7/6	7.5YR 5/2	7.5YR 6/2	5YR 6/4
Core Color	5YR 5/1	5YR 5/1	7.5YR 6/4	5YR 6/3	5YR 7/2	10YR 4/1	5YR 6/2	5YR 5/2
Interior Surface Color		5YR 6/4	7.5YR 7/4	5YR 7/4	5YR 7/4	7.5YR 6/4	5YR 6/4	5YR 6/4
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	840-008	862-008	867-008-1	867-008-2	867-008-3	875-008	879-008	880-008
Unit	N118,E69	N119,E69	N119,E71	N119,E71	N119,E71	N119,E74	N119,E75	N120,E69
Depth (cmbd)	0-10	0-10	10-20	10-20	10-20	10-20	20-30	0-18
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray, Sand	Bone, White, Gray	Bone, White	Bone, White	Bone, White, Gray	Bone, White	Bone, Gray, White, Sand	Bone, White, Sand, Gray
Sherd Diameter (mm)	13.6	22.2	14		11	21.3	22	
Thickness (mm)	6.3	6.6	6.6	7.3	6	4.9	5.8	6.6
Wt. (g)	1.2	1.4	1.2	1	0.4	1	2.2	1.9
Exterior Surface Finish	Polished	Polished	Polished	Smooth	Polished	Smooth	Smooth	Rough
Interior Surface Finish	Smooth	Rough	Polished	Rough	Polished	Smooth	Rough	Smooth
Exterior Surface Color	7.5YR 6/4	7.5YR 6/6	7.5YR 7/6	5YR 7/3	7.5YR 4/4	5YR 6/3	5YR 6/4	7.5YR 5/4
Core Color	7.5YR 6/2	7.5YR 5/2	7.5YR 6/4	10YR 5/1	5YR 4/1	5YR 5/2	5YR 4/1	5YR 5/2
Interior Surface Color	7.5YR 5/4	7.5YR 6/4	7.5YR 7/4	10YR 6/3	5YR 4/4	5YR 6/6	5YR 5/4	7.5YR 7/2
NAA	TRUE = 1a	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-13. Vessel Group 3 Data Continued

Cat. No.	881-008	884-008	888-008	900-008	901-008	933-008	937-008-1b
Unit	N120,E70	N120,E71	N120,E73	N122,E70	N122,E70	N123,E71	N123,E72
Depth (cmbd)	0-10	10-20	0-10	0-10	10-20	0-10	10-20
Count	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White, Sand	Bone, White, Gray, Sand	Bone, White, Sand	Bone, Gray, Sand, White	Bone, White	Bone, White
Sherd Diameter (mm)	24.8	16.6	19.1			15	
Thickness (mm)	6.7	4.9	6	7.5	7.1	4.4	5.7
Wt. (g)	3.1	1.1	0.8	3.8	3.6	0.7	1.4
Exterior Surface Finish	Polished	Smooth-Dull	Smooth	Polished	Smooth	Polished	Smooth
Interior Surface Finish	Polished	Polished	Rough	Polished	Smooth	Smooth	Smooth
Exterior Surface Color	7.5YR 7/6	10YR 5/2	5YR 6/4	5YR 6/4	10YR 5/1	5YR 7/2	7.5YR 6/4
Core Color	7.5YR 6/4	10YR 5/2	5YR 5/4	7.5YR 5/2	7.5YR 5/4	7.5YR 6/4	5YR 6/6
Interior Surface Color	7.5YR 6/4	5YR 5/4	5YR 6/4	7.5YR 6/4	7.5YR 6/4	7.5YR 6/2	5YR 6/4
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	TRUE = 1a	TRUE = 1a	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	TRUE = 1b	TRUE = 1b	FALSE	TRUE

Cat. No.	949-008	961-008	1002-008	1036-008	1044-008	1118-008	1133-008
Unit	N124,E69	N124,E73	N126,E70	N127,E69	N127,E72	N130,E71	N130,E75
Depth (cmbd)	8-18	10-20	8-19	10-20	10-20	20-30	20-30
Count	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White, Gray, Sand	Bone, White, Sand	Bone, White	Bone, White, Sand	Bone, White	Bone, White
Sherd Diameter (mm)	13.8	13.6	18.5	20	20.4	17.6	22.1
Thickness (mm)	6	6.7	4.7		6.2	4.5	6.4
Wt. (g)	1	0.8	1	1.3	1.3	0.9	1.2
Exterior Surface Finish	Polished	Polished	Polished	Eroded	Polished	Polished	Polished
Interior Surface Finish	Smooth	Smooth	Smooth	Polished	Smooth	Smooth	Polished
Exterior Surface Color	5YR 6/3	5YR 7/3	10YR 5/1 & 5/4	5YR 6/3	7.5YR 6/2	5YR 7/4	7.5YR 7/4
Core Color	7.5YR 6/4	5YR 6/2	10YR 5/2 & 5YR 5/4	5YR 5/1	5YR 5/1	5YR 7/4	7.5YR 6/6
Interior Surface Color	5YR 6/4	5YR 6/4	5YR 5/4	5YR 6/4	7.5YR 5/4	5YR 7/4	5YR 6/6
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-14. Vessel Group 4 Data

Cat. No.	159-005-008-1	159-005-008-2	159-005-008-3	159-005-008-4	159-005-008-5	159-005-008-6
Unit	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47
Depth (cmbd)	30-40	30-40	30-40	30-40	30-40	30-40
Count	1	1	1	1	1	1
Sherd Type	Body	Rim	? Base	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray
Sherd Diameter (mm)	26	28	22.5	19.4	18.5	14
Thickness (mm)	8.4	5.2	8.5	5.6	6.4	7.4
Wt. (g)	6.8	2.8	3.1	1.8	1.4	
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Interior Surface Finish	Smooth	Rough	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	7.5YR 6/4	10YR 5/2	7.5YR 6/4	7.5YR 7/4	7.5YR 6/4	7.5YR 6/4
Core Color	10YR 4/1	5 YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1
Interior Surface Color	7.5YR 6/6	7.5YR 5/4	7.5YR 6/6	7.5YR 7/4	7.5 YR 6/6	7.5 YR 6/6
NAA	TRUE = 1c	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	159-005-008-7	168-008-1b	206-008	272-008	618-008	799-008-1
Unit	N101,E47	N101,E50	N101,E53	N102,E50	N108,E47	N115,E73
Depth (cmbd)	30-40	20-30	0-10	20-28	0-10	0-10
Count	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain		Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray	Bone, White	Bone, White	Bone, White, Black	Bone, White	Bone, Black, Gray
Sherd Diameter (mm)			34.4	14.1	33.3	
Thickness (mm)		8.3	9	8.7	8.3	8.3
Wt. (g)		1.2	3.8	1.7	8.7	3.5
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Rough
Interior Surface Finish	Smooth	Smooth	Rough	Rough	Rough	Rough
Exterior Surface Color	7.5YR 6/4	5YR 7/3	7.5YR 6/4	5YR 7/3	10YR 6/2	7.5YR 7/4
Core Color	10YR 4/1	5YR 4/1	10YR 4/1	5YR 5/1	10YR 4/1	10YR 5/1
Interior Surface Color	7.5 YR 6/6	5YR 5/2	7.5YR 4/2	5YR 6/3	10YR 5/2	10YR 6/3
NAA	FALSE	TRUE = 1c	FALSE	TRUE	FALSE	FALSE
Petrographic	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Lipid Residue	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data

Cat. No.	158-005-008	159-005-008-1	159-005-008-2	159-005-008-3	159-005-008-4	159-005-008-5	159-005-008-6	159-005-008-7
Unit	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47	N101,E47
Depth (cmbd)	20-30	30-40	30-40	30-40	30-40	30-40	30-40	30-40
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Rim	Base	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray	Bone, White, Gray
Sherd Diameter (mm)	13.5	26	28	22.5	19.4	18.5	14	
Thickness (mm)	4.7	8.4	5.2	8.5	5.6	6.4	7.4	
Wt. (g)	0.7	6.8	2.8	3.1	1.8	1.4		
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Interior Surface Finish	Rough	Smooth	Rough	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	5YR 6/4	7.5YR 6/4	10YR 5/2	7.5YR 6/4	7.5YR 7/4	7.5YR 6/4	7.5YR 6/4	7.5YR 6/4
Core Color	5YR 5/1	10YR 4/1	5 YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1
Interior Surface Color	5YR 5/4	7.5YR 6/6	7.5YR 5/4	7.5YR 6/6	7.5YR 7/4	7.5 YR 6/6	7.5 YR 6/6	7.5 YR 6/6
Vessel Group	1	4	4	4	4	4	4	4
NAA	FALSE	TRUE = 1c	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	168-008-1b	206-008	262-005-008	271-008	272-008	281-008	405-008	481-008	618-008
Unit	N101,E50	N101,E53	N102,E47	N102,E50	N102,E50	N102,E51	N104,E47	N105,E56	N108,E47
Depth (cmbd)	20-30	0-10	30-40	10-20	20-28	10-20	10-20	10-20	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type		Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White	Bone, White, Gray	Bone, White	Bone, White, Black	Bone, White, Sand	Bone, White	Bone, White	Bone, White
Sherd Diameter (mm)		34.4	18.2	18	14.1	13.6		16.2	33.3
Thickness (mm)	8.3	9		5	8.7	5.4	6.1	5.6	8.3
Wt. (g)	1.2	3.8	1.5	1.7	1.7	0.5	1.1	1.1	8.7
Exterior Surface Finish	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Polished	Smooth
Interior Surface Finish	Smooth	Rough	Gone	Smooth	Rough	Smooth	Smooth	Polished	Rough
Exterior Surface Color	5YR 7/3	7.5YR 6/4	5YR 6/2	7.5YR 6/4	5YR 7/3	7.5YR 6/4	10YR 6/4	5YR 6/4	10YR 6/2
Core Color	5YR 4/1	10YR 4/1	5YR 5/1	10YR 4/1	5YR 5/1	5YR 5/1	7.5YR 6/4	5YR 6/3	10YR 4/1
Interior Surface Color	5YR 5/2	7.5YR 4/2		7.5YR 5/6	5YR 6/3	5YR 6/4	7.5YR 7/4	5YR 7/4	10YR 5/2
Vessel Group	4	4	3	1	4	3	3	3	4
NAA	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
Petrographic	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	781-008	782-008-1	782-008-2	785-008	796-008	799-008-1	799-008-2	806-008	832-008
Unit	N114,E75	N114,E75	N114,E75	N115,E69	N115,E72	N115,E73	N115,E73	N115,E75	N117,E72
Depth (cmbd)	0-15	15-25	15-25	0-10	0-10	0-10	0-10	15-30	16
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Rim	Body	Body	Body	Body	Body	Body	
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	
Temper	Bone, Gray, White	Bone, White	Bone, White	Bone, White, Grey	Bone, White, Sand	Bone, Black, Gray	Bone, Gray, Black	Bone, Gray, White, Sand	
Sherd Diameter (mm)	13.8			14			21.2	12.5	
Thickness (mm)	4.9	6.3	6.3	6.1	5.5	8.3	5.7	5.8	
Wt. (g)	0.9	1.7	2.3	0.6	1	3.5	1.6	0.5	
Exterior Surface Finish	Smooth	Polished	Smooth	Smooth	Polished	Rough	Polished	Smooth	
Interior Surface Finish	Smooth	Polished	Smooth	Smooth	Smooth	Rough	Smooth	Smooth	
Exterior Surface Color	7.5YR 6/6	5YR 7/6	7.5YR 5/2	7.5YR 6/4	7.5YR 6/2	7.5YR 7/4	7.5YR 6/4	5YR 6/4	
Core Color	7.5YR 7/4	5YR 7/2	10YR 4/1	7.5YR 5/2	5YR 6/2	10YR 5/1	5YR 6/3	5YR 5/2	
Interior Surface Color	7.5YR 7/4	5YR 7/4	7.5YR 6/4	7.5YR 6/2	5YR 6/4	10YR 6/3	7.5YR 3/0	5YR 6/4	
Vessel Group	2	3	3	1	3	4	2	3	
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	840-008	841-008-1	841-008-2	842-008-1	842-008-2	843-008	845-008	856-008	862-008
Unit	N118,E69	N118,E69	N118,E69	N118,E70	N118,E70	N118,E70	N118,E71	N118,E74	N119,E69
Depth (cmbd)	0-10	10-20	10-20	0-10	0-10	10-20	10-20	0-10	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray, Sand	Bone, White, Gray, Sand	Bone, White, Gray, Sand	Bone, Black, Gray	Bone, White	Bone, White, Gray, Sand	Bone, Gray, White, Sand	Bone, Black, Gray	Bone, White, Gray
Sherd Diameter (mm)	13.6	28	19.3	19.5	12		26.2	25	
Thickness (mm)	6.3	4.7	4.7	6	4.6	5.3	5.1	8.1	6.6
Wt. (g)	1.2	2.3	1.1	2.6	0.4	1.4	2	2.3	1.4
Exterior Surface Finish	Polished	Polished	Polished	Polished	Smooth	Smooth	Smooth	Polished	Polished
Interior Surface Finish	Smooth	Smooth	Smooth	Polished	Smooth	Rough	Smooth	Smooth	Rough
Exterior Surface Color	7.5YR 6/4	7.5YR 5/2	7.5YR 5/2	10YR 6/4	7.5YR 6/4	7.5YR 6/4	5YR 5/2	5YR 7/3	7.5YR 6/6
Core Color	7.5YR 6/2	10YR 4/1	10YR 4/1	7.5YR 7/4	7.5YR 5/2	7.5YR 6/2	5YR 5/3	7.5YR 7/4	7.5YR 5/2
Interior Surface Color	7.5YR 5/4	5YR 5/3	5YR 5/3	7.5YR 6/4	7.5YR 5/2	7.5YR 6/2	5YR 5/4	5YR 6/3	7.5YR 6/4
Vessel Group	3	1	1	2	1	1	1	2	3
NAA	TRUE = 1a	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	865-005-008	867-008-1	867-008-2	867-008-3	875-008	878-008	879-008	880-008	881-008
Unit	N119,E70	N119,E71	N119,E71	N119,E71	N119,E74	N119,E75	N119,E75	N120,E69	N120,E70
Depth (cmbd)	12-22	10-20	10-20	10-20	10-20	10-20	20-30	0-18	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White, Gray	Bone, White	Bone, White	Bone, White, Gray	Bone, White	Bone, White	Bone, Gray, White, Sand	Bone, White, Sand, Gray	Bone, White
Sherd Diameter (mm)	21.5	14		11		19.1	22		
Thickness (mm)	6.7	6.6	7.3	6	4.9	4	5.8	6.6	6.7
Wt. (g)	1.7	1.2	1	0.4	1	1.1	2.2	1.9	3.1
Exterior Surface Finish	Polished	Polished	Smooth	Polished	Smooth	Smooth	Smooth	Rough	Polished
Interior Surface Finish	Polished	Polished	Rough	Polished	Smooth	Smooth	Rough	Smooth	Polished
Exterior Surface Color	10YR 5/1	7.5YR 7/6	5YR 7/3	7.5YR 4/4	5YR 6/3	5YR 5/2	5YR 6/4	7.5YR 5/4	7.5YR 7/6
Core Color	10YR 2/1 & 10YR 5/2	7.5YR 6/4	10YR 5/1	5YR 4/1	5YR 5/2	7.5YR 6/2	5YR 4/1	5YR 5/2	7.5YR 6/4
Interior Surface Color	10YR 5/1	7.5YR 7/4	10YR 6/3	5YR 4/4	5YR 6/6	7.5YR 6/4	5YR 5/4	7.5YR 7/2	7.5YR 6/4
Vessel Group	1	3	3	3	3	1	3	3	3
NAA	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	884-008	886-008	888-008	900-008	901-008	903-008	908-008	915-008	917-008
Unit	N120,E71	N120,E72	N120,E73	N122,E70	N122,E70	N122,E71	N122,E73	N122,E75	N122,E75
Depth (cmbd)	10-20	10-20	0-10	0-10	10-20	0-10	0-10	0-10	20-30
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body		Body	Body	Body	Body	Body		Body
Ceramic Type	Leon Plain		Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain		Leon Plain
Temper	Bone, White, Sand		Bone, White, Gray, Sand	Bone, White, Sand	Bone, Gray, Sand, Gray, White	Bone, White	Bone, Gray		Bone, White
Sherd Diameter (mm)			19.1			14.6	14.3		16.9
Thickness (mm)	4.9		6	7.5	7.1	4.5	5.4		4.1
Wt. (g)	1.1		0.8	3.8	3.6	0.8	1.2		0.4
Exterior Surface Finish	Smooth-Dull		Smooth	Polished	Smooth	Smooth	Polished		Smooth
Interior Surface Finish	Polished		Rough	Polished	Smooth	Rough	Smooth		Smooth
Exterior Surface Color	10YR 5/2		5YR 6/4	5YR 6/4	10YR 5/1	5YR 6/3	7.5YR 7/6		10YR 6/3
Core Color	10YR 5/2		5YR 5/4	7.5YR 5/2	7.5YR 5/4	5YR 6/2	7.5YR 7/4		7.5YR 5/2
Interior Surface Color	5YR 5/4		5YR 6/4	7.5YR 6/4	7.5YR 6/4	5YR 5/1	7.5YR 7/4		7.5YR 6/4
Vessel Group	3		3	3	3	1	2		1
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	TRUE =1a	TRUE = 1a	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	933-008	936-008	937-008-1b	940-008	945-008	949-008	950-008-1	950-008-2	961-008
Unit	N123,E71	N123,E72	N123,E72	N123,E73	N123,E75	N124,E69	N124,E69	N124,E69	N124,E73
Depth (cmbd)	0-10	0-10	10-20	12-26	0-10	8-18	18-26	18-26	10-20
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, Black, Gray	Bone, White	Bone, White, Gray	Bone, Gray, Black	Bone, White	Bone, White	Bone, White	Bone, White, Gray, Sand
Sherd Diameter (mm)	15	14.8		14.6	22.2		15.7	14.2	13.6
Thickness (mm)	4.4	6.5	5.7		8	6	5.5	4.8	6.7
Wt. (g)	0.7	1.6	1.4	0.5	3.7	1	0.7	0.4	0.8
Exterior Surface Finish	Polished	Polished	Smooth	Polished	Polished	Polished	Smooth	Smooth	Polished
Interior Surface Finish	Smooth	Smooth	Smooth	Rough	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	5YR 7/2	5YR 7/3	7.5YR 6/4	5YR 6/4	7.5YR 6/4	5YR 6/3	5YR 6/4	5YR 6/4	5YR 7/3
Core Color	7.5YR 6/4	5YR 6/1	5YR 6/6	5YR 5/1	10YR 5/1	7.5YR 6/4	5YR 4/1	5YR 4/1	5YR 6/2
Interior Surface Color	7.5YR 6/2	5YR 7/3	5YR 6/4	5YR 6/3	7.5YR 7/4	5YR 6/4	5YR 6/3	5YR 6/3	5YR 6/4
Vessel Group	3	2	3	1	2	3	1	1	3
NAA	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	962-008*	965-008	968-008	977-008	981-008	984-008-1	984-008-2	987-008-1a	989-008
Unit	N124,E73	N124,E74	N124,E75	N125,E70	N125,E71	N125,E72	N125,E72	N125,E73	N125,E74
Depth (cmbd)	20-30	10-20	10-20	0-10	0-10	10-20	10-20	10-20	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, Gray, Black	Bone, White, Sand	Bone, Black	Bone, Black	Bone, Gray, Black	Bone, Gray, Black	Bone, Black, Gray	Bone, White
Sherd Diameter (mm)	14	39.4	1.1	24	22	19.9	18.4	19.6	13.6
Thickness (mm)	4.9	7.3	6.5	6.5	5.7	5.9	5.6	6.6	5.9
Wt. (g)	0.9	8.9	0.5	2.7	1.7	2	1	3	1.1
Exterior Surface Finish	Smooth	Polished	Polished	Smooth	Polished	Smooth	Smooth	Polished	Smooth
Interior Surface Finish	Smooth	Smooth	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Rough
Exterior Surface Color	5YR 6/4	10YR 7/6	10YR 5/2	7.5YR 6/4	10YR 5/2	7.5YR 7/4	7.5YR 7/4	7.5YR 7/6	7.5YR 6/4
Core Color	5YR 5/1	5YR 7/4	10YR 4/1	7.5YR 5/0	10YR 6/3	5YR 7/4	5YR 7/4	7.5YR 7/4	5YR 5/2
Interior Surface Color	5YR 5/1	7.5YR 6/4	5YR 5/4	7.5YR 6/6	7.5YR 6/4	7.5YR 7/4	7.5YR 7/4	10YR 5/1	5YR 6/6
Vessel Group	1	2	?	2	2	2	2	2	1
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	992-008	996-008	999-008	1000-008	1002-008	1008-008-1	1008-008-2	1023-008-1	1023-008-2
Unit	N125,E75	N126,E68	N126,E69	N126,E69	N126,E70	N126,E72	N126,E72	N126,E75	N126,E75
Depth (cmbd)	0-10	10-20	10-20	20-30	8-19	20-30	20-30	0-10	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, Black, Gray	Bone, White, Sand	Bone, White	Bone, White, Black	Bone, White, Sand	Bone, Gray	Bone, White	Bone, White, Sand	Bone, White, Sand
Sherd Diameter (mm)	19.6	16	31.5	21.8		18.2	22	16.8	27.1
Thickness (mm)	5.7	3.9	4.9	6.7	4.7	7	5.2	4.9	4.9
Wt. (g)	1.5	1.1	2.7	1.9	1	1.5	2	0.8	2.4
Exterior Surface Finish	Polished	Smooth	Smooth	Smooth	Polished	Polished	Smooth	Smooth	Smooth
Interior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Smooth	Smooth
Exterior Surface Color	10YR 7/3	5YR 5/1	7.5YR 5/2	5YR 6/4	10YR 5/1 & 5/4	5YR 7/4	5YR 6/4	10YR 5/1	10YR 5/1
Core Color	5YR 5/1	5YR 6/2	5YR 4/1	5YR 6/3	10YR 5/2 & 5YR 5/4	5YR 6/2	5YR 5/1	5YR 4/1	5YR 4/1
Interior Surface Color	7.5YR 7/4	5YR 6/3	7.5YR 5/4	5YR 6/3	5YR 5/4	5YR 6/2	7.5YR 5/2	5YR 6/4	5YR 6/4
Vessel Group	2	1	1	2	3 ?	2	1	1	1
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Cat. No.	1030-005-004-008	1030-005-004-008-1	1030-005-008	1030-008	1036-008	1044-008
Unit	N126,E76	N126,E76	N126,E76	N126,E76	N127,E69	N127,E72
Depth (cmbd)	35-40	35-40	30-40	30-40	10-20	10-20
Count	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, White	Bone, White	Bone, White, Gray	Bone, White	Bone, White, Sand
Sherd Diameter (mm)	25.6	28	28.2	18	20	20.4
Thickness (mm)	5.1	5	5.1	6		6.2
Wt. (g)	3.4	14.5	3.5	1.6	1.3	1.3
Exterior Surface Finish	Smooth	Smooth	Smooth	Polished	Eroded	Polished
Interior Surface Finish	Smooth	Smooth	Smooth	Rough	Polished	Smooth
Exterior Surface Color	10YR 4/1	10YR 4/1	5YR 4/1	5YR 6/4	5YR 6/3	7.5YR 6/2
Core Color	5YR 4/1	5YR 4/1	5YR 4/1	5YR 5/1	5YR 5/1	5YR 5/1
Interior Surface Color	5YR 6/6	5YR 6/6	5YR 6/6	5YR 6/6	5YR 6/4	7.5YR 5/4
Vessel Group	1	1	1	1	3	3
NAA	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	1050-008-1	1050-008-2	1054-008-1	1054-008-2	1054-008-3	1054-008-4	1054-008-5	1055-005-008
Unit	N127,E74	N127,E74	N127,E75	N127,E75	N127,E75	N127,E75	N127,E75	N127,E75
Depth (cmbd)	15-25	15-25	20-30	20-30	20-30	20-30	20-30	32
Count	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, Gray, White	Bone, Gray, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, White	Bone, Sand, White, Sand
Sherd Diameter (mm)	21	30		47.2	34.5	15.7	12	39.8
Thickness (mm)	6.3	6.1		5.3	6.3	4.9	4.9	5.1
Wt. (g)	2.2	2.1	3.4	11.7	4.1	0.9	0.6	9.2
Exterior Surface Finish	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Interior Surface Finish	Rough	Rough	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	7.5YR 5/2	7.5YR 5/2	10YR 6/3	10YR 6/3	10YR 6/3	10YR 6/3	10YR 6/3	5YR 7/4
Core Color	5YR 4/1	5YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	10YR 4/1	5YR 5/1
Interior Surface Color	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	7.5YR 6/6	5YR 5/2
Vessel Group	1	1	1	1	1	1	1	1
NAA	FALSE	FALSE	TRUE = 1a	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1b

Cat. No.	1074-008	1078-008	1081-008	1089-008	1096-008-1	1096-008-2	1096-008-3	1100-008	1102-008
Unit	N128,E72	N127,E73	N128,E74	N129,E71	N129,E73	N129,E73	N129,E73	N129,E75	N129,E75
Depth (cmbd)	20-30	17-25	0-10	30-35	20-30	20-30	20-30	0-10	20-30
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	
Temper	Bone, White	Bone, White, Gray, Sand	Bone, White	Bone, White, Gray, Sand	Bone, White, Gray, Sand	Bone, Gray, Black	Bone, Gray, Black	Bone, Gray, Black, Sand	
Sherd Diameter (mm)	10.7	17	25.4	26.6	13.4	15.3	17.6	21	
Thickness (mm)	5.2	5.5	6.2	7.1	4.8	5.5	5.7	4.9	
Wt. (g)	0.6	0.8	2.4	3.9	0.7	1.4	2.2	1.2	
Exterior Surface Finish	Smooth	Polished	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	
Interior Surface Finish	Rough	Rough	Rough	Rough	Rough	Smooth	Smooth	Rough	
Exterior Surface Color	7.5YR 6/2	5YR 5/1	10YR 5/1	7.5YR 5/6	10YR 5/2	7.5YR 7/4	7.5YR 7/4	5YR 6/2	
Core Color	7.5YR 7/4	5YR 6/1	10YR 4/1	7.5YR 5/4	7.5 YR 6/2	7.5YR 7/4	7.5YR 7/4	5YR 6/2	
Interior Surface Color	7.5YR 7/4	5YR 5/2	5YR 6/6	7.5YR 6/4	5YR 6/4	7.5YR 6/4	7.5YR 6/4	5YR 6/3	
Vessel Group	1	1	1	1	1	2	2	3	
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	TRUE = 1b	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-15. All Ceramic Data Continued

Cat. No.	1118-008	1129-008-1a	1133-008	1137-008-1	1137-008-2	1137-008-3	1157-008	1162-008-1	1162-008-2
Unit	N130,E71	N130,E74	N130,E75	N131,E70	N131,E70	N131,E70	N131,E73	N131,E75	N131,E75
Depth (cmbd)	20-30	20-30	20-30	30-40	30-40	30-40	0-10	0-10	0-10
Count	1	1	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain
Temper	Bone, White	Bone, Gray	Bone, White	Bone, White	Bone, White	Bone, White	Bone, Black	Bone, Gray, Black	Bone, White
Sherd Diameter (mm)		12.8		11.4	13.6	12.2	37	17	16.9
Thickness (mm)	4.5	5.6	6.4	5.4	5.7	4.7	6.5	6.5	3.9
Wt. (g)	0.9	0.9	1.2	0.7	0.6	0.3	6.4	0.9	0.9
Exterior Surface Finish	Polished	Smooth	Polished	Polished	Polished	Polished	Polished	Polished	Smooth
Interior Surface Finish	Smooth	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Rough	Rough
Exterior Surface Color	5YR 7/4	7.5YR 7/4	7.5YR 7/4	5YR 5/4	5YR 5/4	5YR 5/4	7.5YR 7/4	7.5YR 7/4	5YR 5/2
Core Color	5YR 7/4	7.5YR 7/4	7.5YR 6/6	10YR 4/1	10YR 4/1	10YR 4/1	7.5YR 7/4	5YR 5/1	5YR 6/1
Interior Surface Color	5YR 7/4	7.5YR 7/4	5YR 6/6	10YR 5/2	10YR 5/2	10YR 5/2	7.5YR 6/4	7.5YR 8/4	5YR 5/2
Vessel Group	3	2	3	1	1	1	2	2	1
NAA	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Petrographic	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE = 1b	FALSE	FALSE

Cat. No.	1162-008-3	1163-008	1181-008	1187-008	1261-008-1	1261-008-2	1261-008-3
Unit	N131,E75	N131,E75	N132,E75	N133,E71	SURFACE	SURFACE	SURFACE
Depth (cmbd)	0-10	10-20	0-10	20-30	0	0	0
Count	1	1	1	1	1	1	1
Sherd Type	Body	Body	Body	Body	Body	Body	Body
Ceramic Type	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Leon Plain	Unknown	Unknown
Temper	Bone, White	Bone, White	Bone, Black, Gray	Bone, Gray	Bone, White, Gray	Quartz	Quartz
Sherd Diameter (mm)	18.8	12.5	20	31.3	28.3	10.6	13.7
Thickness (mm)	5.7	4.5	6.6	4.8	5.1	3.1	3.2
Wt. (g)	1.2	0.7	3.1	2.2	2.4	0.4	0.7
Exterior Surface Finish	Smooth	Polished	Polished	Smooth	Polished	Dull Rough	Dull Rough
Interior Surface Finish	Smooth	Polished	Smooth	Smooth	Smooth	Smooth	Smooth
Exterior Surface Color	5YR 5/4	7.5YR 6/4	5YR 7/3	5YR 6/1	5YR 5/4	5YR 5/3	5YR 5/3
Core Color	5YR 5/1	5YR 6/3	5YR 5/1	10YR 6/3	10YR 5/2	7.5YR N/2	7.5YR N/2
Interior Surface Color	5YR 6/4	7.5YR 6/4	5YR 7/3	10YR 5/2	10R 5/8	5YR 5/6	5YR 5/6
Vessel Group	1	1	2	2	1	5	5
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
Petrographic	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
Isotope Analyses	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

* From Late Archaic Component

Table O-16. Frio Point Data

Cat. No.	Unit	Depth (cmbd)	Feat. No.	Component	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Raw Material	Texture	Percent Patination
22-015	N99,E52	30-40 cmbd		Late Archaic	Proximal	Use	Absent	Break Compensation	Chert	Fine	0
89-010	N100,E51	27 cmbd	1	Late Archaic	Proximal	Use	Absent	Break Compensation	Chert	Fine	0
187-011	N101,E51	25.5 cmbd	1	Late Archaic	Proximal	Use	Absent	Indeterminate	Chert	Fine	0
220-014	N101,E54	20-30 cmbd		Toyah	Proximal	Use	Absent	Beveled Bifacial	Chert	Fine	0
525-005-013	N106,E54	35-40 cmbd	2	Toyah	Proximal	Use	Absent	None	Chert	Fine	0
526-011*	N106,E54	40-50 cmbd		Toyah	Medial	Use					
562-012	N107,E49	30-40 cmbd		Mixed	Complete	Unbroken	Absent	Break Compensation	Chert	Fine	0
916-010	N122,E75	10-20 cmbd		Toyah	Medial	Use	Absent	Indeterminate	Chert	Fine	0

Cat. No.	Percent Cortex	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Shape	Flaking Pattern	Edge Rounding
22-015	0	None		6.6		Tapered Base/Tip	Biconvex Symmetrical	Biface	Triangular	Subparallel	Present
89-010	0	Burned		6.3		Indeterminate	Biconvex Symmetrical	Biface	Triangular	Subparallel	Absent
187-011	0	None		6.9		Indeterminate	Biconvex Symmetrical	Biface	Triangular	Subparallel	Present
220-014	0	None		5.5		Indeterminate	Biconvex Symmetrical	Biface	Lanceolate	Subparallel	Present
525-005-013	0	Indeterminate	54.5	12.4	11.6	Tapered Base/Tip	Biconvex Symmetrical	Biface	Triangular	Chevron	Absent
526-011*											
562-012	0	None	32.7	5.7	3.6	Indeterminate	Plano-Convex	Biface	Indeterminate	Indeterminate	Present
916-010	0	None		6.4		Indeterminate	Plano-Convex	Flake	Indeterminate	Indeterminate	Absent

Cat. No.	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle
22-015		26.8	Straight	Straight	29.8		7.7		6.2		51
89-010		28	Excurvate	Straight	29.3	3.9		8.4		63	55
187-011		29.5	Straight	Straight	34.2	7.9	7.3	8	5.9	57	50
220-014		13.3	Straight	Incurvate	16.5	2.4	1.4	6.9	6.7	73	84
525-005-013	43.9	31.2	Excurvate	Straight	30.4	9.6	10.2	8.4	7.4	66	64
526-011*											
562-012	19.6	15.1	Indeterminate	Indeterminate	17.4	2.3		6		78	
916-010		16	Indeterminate	Indeterminate	19.6		1.5		6.6		75

Table O-16. Frio Point Data Continued

Cat. No.	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	NAA
22-015	Expanding	10.8			4.2	1.5		TRUE
89-010	Expanding	9.8	18.3		3.4	4.4		TRUE
187-011	Expanding	11.5	19.1	30.5	5.8	3	10.4	FALSE
220-014	Expanding	8.7	13.8	18.3	5.1	2.8	10.6	FALSE
525-005-013	Expanding	10.6	20.4	30	4.8	3.6	10.4	TRUE
526-011*								FALSE
562-012	Expanding	13.1	15.1	19.4	5.3	2.5	8.6	FALSE
916-010	Indeterminate		15.5		6.2			FALSE

* Medial section refits with base #525-5-13

Table O-17. Late Archaic Projectile Point Data

Cat. No.	Unit	Depth (cmbd)	Point Type	Condition	Break Type	Shape	Rejuvenation Scar	Resharpener Type	Raw Material	Texture
11-005-014	N99,E51	7-20	Edgewood	Complete	Unbroken	Triangular	Absent	Alternate Beveled Unifacial	Chert	Fine
187-010	N101,E51	24.5	Marcos	Complete	Use	Triangular	Absent	Alternate Beveled Unifacial	Chert	Fine
197-014	N101,E52	20-30	Unknown Dart	Medial	Use	Indeterminate	Absent	Indeterminate	Chert	Fine
197-015	N101,E52	20-30	Unknown Dart	Distal	Use	Indeterminate	Absent	Indeterminate	Chert	Fine
198-010	N101,E52	30-40	Montell	Medial	Use	Triangular	Absent	None	Chert	Fine
394-010	N103,E56	10-20	Castroville	Proximal	Use	Indeterminate	Absent	Indeterminate	Chert	Fine
691-011	N109,E49	10-20	Ensor	Proximal	Use	Triangular	Absent	Beveled Unifacial	Chert	Fine

Cat. No.	Percent Patination	Percent Cortex	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Flaking Pattern
11-005-014	0	0	None	33.5	5.6	4.3	Wedge Base, Thick Body	Plano-Convex	Flake	Chevron
187-010	0	0	Heat-Treated	36.7	5.7	5.8	Wedge Base, Flat	Biconvex Symmetrical	Biface	Chevron
197-014	0	0	Indeterminate				Indeterminate	Indeterminate	Indeterminate	Indeterminate
197-015	0	0	Indeterminate				Indeterminate	Indeterminate	Indeterminate	Indeterminate
198-010	0	0	Heat-Treated		6.7	5.5	Tapered Base/Tip	Biconvex Asymmetrical	Biface	Chevron
394-010	0	0	None				Indeterminate	Biconvex Symmetrical	Biface	Indeterminate
691-011	0	0	None		4.5		Indeterminate	Plano-Convex	Flake	Flake Blank Remnant

Cat. No.	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle
11-005-014	Absent	24.7	22	Incurvate	Straight	24.4	3.4	4.8	5	9	63	69
187-010	Present	28.1	23.4	Straight	Straight	31.4	6.7	5.9	4.9	5.1	55	49
197-014	Absent			Indeterminate	Indeterminate							
197-015	Absent			Indeterminate	Indeterminate							
198-010	Absent		20.6	Straight	Straight	22.4		2.8		5.3	45	51
394-010	Present			Indeterminate	Indeterminate							
691-011	Present		19.5	Indeterminate	Indeterminate		4.5		6.2		60	50

Table O-17. Late Archaic Projectile Point Data Continued

Cat. No.	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
11-005-014	Expanding	8.8	15	21.7	4.2	1.8	12.6	TRUE	FALSE
187-010	Expanding	8.6	16.5	24.2	3.7	0.9	12.6	FALSE	TRUE
197-014	Indeterminate							FALSE	FALSE
197-015	Indeterminate							FALSE	FALSE
198-010	Expanding	6.6	16		3.2	2.9		TRUE	FALSE
394-010	Expanding	15.1	22.6	26.4	5	-2.8		FALSE	FALSE
691-011	Expanding	5.3	13.8		3.5	0.8		FALSE	TRUE

Table O-18. Late Archaic Component Biface Data

Cat. No.	Unit	Depth (cmbs)	Feature No	Biface Stage	Condition	Break Type	Raw Material	Texture	Percent Patination	Percent Cortex
2-012	N99,E50	10-20	1	Late	Complete	Unbroken	Chert	Fine	0	0
197-016	N101,E52	20-30	1	Middle	Proximal	Indeterminate	Chert	Fine	0	0
233-010	N101,E55	20-30		Middle	Complete	Unbroken	Chert	Fine	0	25
263-010	N102,E47	30-40	1	Late	Proximal	Manufacture	Chert	Fine	0	0
274-005-011	N102,E50	40-50	1b	Late	Distal	Use	Chert	Fine	0	0
283-015	N102,E51	28-40	1b	Late	Indeterminate	Use	Chert	Fine	0	0
293-005-012	N102,E52	20-30	1c	Middle	Indeterminate	Unbroken	Chert	Fine	0	0
459-011	N105,E53	20		Late	Distal	Use	Chert	Fine	0	0

Cat. No.	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform
2-012	None	None	87.6	48.7	20.1	81.6	Tapered Base/Tip	Biconvex Symmetrical	Flake
197-016	None	None	65.2		9.7		Bi-wedge-shaped	Biconvex Symmetrical	Flake
233-010	Pebble/Cobble	None	45.2	35.5	9.8	18.3	Bi-wedge-shaped	Biconvex Symmetrical	Flake
263-010	None	None		57.9	18.4		Tapered Base/Tip	Biconvex Symmetrical	Flake
274-005-011	None	None		21.2	7.3	9.8	Tapered Base/Tip	Biconvex Symmetrical	Flake
283-015	None	Heat-Treated					Indeterminate	Indeterminate	Biface
293-005-012	None	Burned					Indeterminate	Indeterminate	Indeterminate
459-011	None	None			7.3		Indeterminate	Biconvex Symmetrical	Biface

Cat. No.	Shape	Flaking Pattern	Rounding on edges	Left Lateral Edge	Right Lateral Edge	Rejuvenation Scar	Resharpener Type	Micro-wear	NAA
2-012	Ovate	Random	Absent	Excurvate	Excurvate	Absent	None	TRUE	FALSE
197-016	Indeterminate	Random	Present	Straight	Indeterminate	Absent	None	FALSE	TRUE
233-010	Round	Random	Absent	Excurvate	Straight	Absent	None	TRUE	FALSE
263-010	Ovate	Random	Absent	Excurvate	Excurvate	Absent	None	TRUE	FALSE
274-005-011	Lanceolate	Oblique Parallel	Absent	Excurvate	Excurvate	Absent	None	TRUE	FALSE
283-015	Indeterminate	Random	Present	Indeterminate	Indeterminate	Absent	None	FALSE	TRUE
293-005-012	Indeterminate	Indeterminate	Absent	Indeterminate	Indeterminate	Absent	None	FALSE	TRUE
459-011	Indeterminate	Random	Present	Straight	Straight	Absent	None	FALSE	TRUE

Table O-19. Late Archaic Component Scraper Data, 41ED28, Varga Site

Cat. No.	Unit	Depth (cmbd)	Tool Subtype	Condition	Break Type	Raw Material	Texture	Percent Patination	Percent Cortex	Cortex Type
2-010	N99,E50	10-20	End-Scraper	Distal	Use	Chert	Fine	0	25	Pebble/Cobble
3-010	N99,E50	20-30	Side/End Scraper	Complete	Unbroken	Chert	Fine	0	50	Pebble/Cobble
293-005-013	N102,E52	20-30	Side/End Scraper	Complete	Unbroken	Chert	Fine	0	25	Pebble/Cobble

Cat. No.	Heating	Length (mm)	Width (mm)	Thickness (mm)	Wt. (g)	Shape	Edge Flaking	Edge Rounding	No. Bits	Bit 1 Location
2-010	None			15.8		Indeterminate	Distal	Absent	1	Distal
3-010	None	72.5	45.3	20.1	69.2	Lanceolate	Distal/Lateral	Absent	2	Distal
293-005-013	None	70.6	40.5	25	63	Ovate	Distal/Lateral	Absent	3	Lateral

Cat. No.	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)	Bit 1 Angle	Bit 2 Location	Bit 2 Shape	Bit 2 Retouch	Bit 2 Length (mm)	Bit 2 Thick (mm)
2-010	Excurvate	Irregular Continuous	62.4	7.2	72					
3-010	Excurvate	Regular Continuous	31.6	5	57	Lateral	Excurvate	Regular Continuous	32.8	8.7
293-005-013	Straight	Irregular Continuous	61.1	4.8	74	Distal	Excurvate	Regular Continuous	29.8	23.5

Cat. No.	Bit 2 Angle	Bit 3 Location	Bit 3 Shape	Bit 3 Retouch	Bit 3 Length (mm)	Bit 3 Thick (mm)	Bit 3 Angle	Rejuvenation Scar	Flake Size	Micro-wear	NAA
2-010								Absent		TRUE	TRUE
3-010	77							Absent	8	TRUE	FALSE
293-005-013	60	Lateral	Excurvate	Regular Continuous	44.2	5.3	55	Absent	7	TRUE	FALSE

Table O-20. Late Archaic Core Data

Cat. No.	161-011	178-010	197-013	293-005-014	352-010	378-011	378-012	491-012	807-012*	929-011*
Unit	N101,E47	N101,E50	N101,E52	N102,E52	N103,E47	N103,E52	N103,E52	N106,E47	N115,E75	N123,E69
Depth (cmbd)	45-50	20-30	20-30	20-30	30-40	20-30	20-30	30-40	30-45	20-25
Feature No.	1	1	1	1c	1					
Condition	Complete	Exhausted	Fragmented	Fragmented	Exhausted	Complete	Complete	Complete	Complete	Complete
Heating	None	None	None	None	None	None	None	None	None	None
Tool Type	Multi-Directional	Bifacial	Bifacial	Bifacial	Bifacial	Multi-Directional	Multi-Directional	Multi-Directional	Bifacial	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0	0
Percent Cortex	0	0	25	0	0	25	25	25	50	0
Cortex Type	None	None	Pebble/Cobble	None	None	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None
Length (mm)	86.9	54.1	80.8	89.3	70.9	93.9	97.8	92.2	102	107
Width (mm)	53.5	45	50.6	53.8	51.4	78.5	64.8	74.2	70.4	70.4
Thick (mm)	46.4	22	24	35	12.7	35.4	62	58.5	44.1	52.3
Wt. (g)	220.5	43.8	102.5	196.3	42.8	268.2	443	512.3	415.3	401.5

Table O-21. MA Projectile

Cat. No.	Unit	Depth (cms)	Point Type	Condition	Break Type	Resharpener Type	Raw Material	Texture	Percent Patination	Percent Cortex	Heating
138-012*	N100,E55	80-90	Early Triangular	Proximal	Use	None	Chert	Fine	0	0	None
182-013	N101,E50	60-70	Early Triangular	Complete	Unbroken	None	Chert	Fine	0	0	None
213-012	N101,E53	70-80	Carrizo	Distal	Use	None	Chert	Fine	0	0	None
225-011	N101,E54	70-80	Unknown Dart	Distal	Use	None	Chert	Fine	0	0	Heat-Treated
278-027**	N102,E50	80-90	Early Triangular	Distal	Use	Beveled Unifacial	Chert	Fine	0	0	None
308-011	N102,E53	60-70	Early Triangular	Proximal	Use	None	Chert	Fine	0	0	None
537-017	N106,E55	40-50	Early Triangular	Proximal	Use	None	Chert	Fine	0	0	None
648-012	N108,E52	20-30	Unknown Dart	Distal	Use	Indeterminate	Chert	Fine	0	0	Indeterminate
654-010	N108,E53	10-20	Early Triangular	Distal	Use	None	Chert	Fine	0	0	Burned
655-011	N108,E53	20-30	Unknown Dart	Proximal	Use	Indeterminate	Chert	Fine	0	0	Burned
675-010	N108,E56	30-40	Unknown Dart	Barb	Use	Indeterminate	Chert	Fine	0	0	Burned
729-010**	N109,E54	30-40	Early Triangular	Proximal	Use	None	Chert	Fine	0	0	Heat-Treated
922-010***	N123,E68	49-59	Early Triangular	Proximal	Use	Alternate Beveled Bifacial	Chert	Fine	25	0	Indeterminate
1140-010***	N131,E70	60-70	Early Triangular	Proximal	Use	Alternate Beveled Bifacial	Chert	Fine	0	0	Indeterminate

Cat. No.	Length (mm)	Thickness (mm)	Blade Width (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Shape	Flaking Pattern	Left Lateral Edge
138-012*		6.5		6.1	Indeterminate	Biconvex Symmetrical	Biface	Triangular	Chevron	Indeterminate
182-013	52.9	4.9	38.3	8.9	Tapered Base/Tip	Indeterminate	Biface	Triangular	Oblique Subparallel	Excurvate
213-012		7.7				Plano-Convex	Flake	Lanceolate	Subparallel	Excurvate
225-011		7.1		7.4	Indeterminate	Biconvex Symmetrical	Biface	Triangular	Chevron	Excurvate
278-027**	31.2	5		4.4	Tapered Base/Tip	Plano-Convex	Biface	Triangular	Subparallel	Indeterminate
308-011		6	34.5		Tapered Base/Tip	Biconvex Asymmetrical	Biface	Triangular	Chevron	Excurvate
537-017		6	28.3		Tapered Base/Tip	Biconvex Symmetrical	Biface	Triangular	Subparallel	Straight
648-012					Indeterminate	Biconvex Symmetrical	Biface	Triangular	Indeterminate	Indeterminate
654-010	3	5.4		4.8	Tapered Base	Plano-Convex	Biface	Triangular	Indeterminate	Indeterminate
655-011				6.6	Tapered Base/Tip	Biconvex Symmetrical	Biface	Triangular	Indeterminate	Straight
675-010					Indeterminate	Indeterminate	Biface	Indeterminate	Indeterminate	Indeterminate
729-010**		7.7	34.9	14.8	Wedge Base, Flat	Biconvex Symmetrical	Biface	Lanceolate	Parallel	Straight
922-010***		6	33.5		Indeterminate	Plano-Convex	Biface	Triangular	Chevron	Indeterminate
1140-010***		5.1	31.9		Indeterminate	Biconvex Asymmetrical	Biface	Triangular	Indeterminate	Indeterminate

Table O-21. MA Projectile Continued

Cat. No.	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle	Stem Shape	Micro-wear
138-012*							FALSE
182-013							TRUE
213-012							FALSE
225-011						Indeterminate	FALSE
278-027**							FALSE
308-011							TRUE
537-017							TRUE
648-012						Indeterminate	FALSE
654-010							FALSE
655-011	4.2		12.6	60	37	Expanding	FALSE
675-010						Indeterminate	FALSE
729-010**							TRUE
922-010***							
1140-010***							FALSE

* From mixed context; ** From the Early Archaic component; *** From Block B

Table O-22. Middle Archaic Component Biface Data

Cat. No.	Unit	Depth (cmbd)	Biface Stage	Condition	Break Type	Raw Material	Texture	Percent Patination	Percent Cortex	Cortex Type
70-010	N99,E56	50-60	Late	Indeterminate	Indeterminate	Chert	Fine	0	0	None
149-010	N100,E56	60-70	Late	Proximal	Manufacture	Chert	Fine	0	0	None
213-010	N101,E53	70-80	Middle	Proximal	Manufacture	Chert	Fine	0	0	None
287-010	N102,E51	70-80	Early	Complete	Unbroken	Chert	Fine	0	25	Pebble/Cobble
417-013	N104,E56	40-50	Middle	Complete	Unbroken	Chert	Fine	0	0	None
418-028	N104,E56	50-60	Late	Indeterminate	Use	Chert	Fine	0	0	None
419-012	N104,E56	60-70	Middle	Complete	Unbroken	Chert	Fine	0	0	None
416-10 428-010	N104,E47 N105,E47	40-50	Late	Distal Proximal	Use	Chert	Fine	25	0	None
544-012	N106,E56	20-30	Late	Indeterminate	Use	Chert	Fine	0	0	None
545-010	N106,E56	30-40	Late	Distal	Use	Chert	Fine	25	0	None
648-013	N108,E52	20-30	Middle	Distal	Use	Chert	Fine	0	0	None

Cat. No.	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Shape
70-010	None					Indeterminate	Indeterminate	Flake	Indeterminate
149-010	None			8		Indeterminate	Biconvex Symmetrical	Biface	Indeterminate
213-010	Burned		43.4	15.4		Indeterminate	Biconvex Symmetrical	Biface	Indeterminate
287-010	None	39.4	32.2	13.7	20.5	Indeterminate	Plano-Convex	Biface	Indeterminate
417-013	None	87.2	66.7	20.6	103.7	Bi-wedge-shaped	Biconvex Symmetrical	Biface	Ovate
418-028	None			8.3		Indeterminate	Plano-Convex	Flake	Indeterminate
419-012	Heat-Treated	82	54.7	14.2	76.9	Tapered Base	Plano-Convex	Flake	Lunate
416-10 428-010	None	59		9.1	15.2	Tapered Base/Tip	Biconvex Symmetrical	Biface	Teardrop
544-012	Burned			8.4		Indeterminate	Biconvex Symmetrical	Biface	Indeterminate
545-010	None			10		Indeterminate	Biconvex Symmetrical	Biface	Indeterminate
648-013	Burned			7.1		Indeterminate	Plano-Convex	Biface	Indeterminate

Cat. No.	Flaking Pattern	Edge Rounding	Left Lateral Edge	Right Lateral Edge	Rejuvenation Scar	Resharpenting Type	Micro-wear	NAA
70-010	Random	Absent	Indeterminate	Indeterminate	Absent	None	FALSE	TRUE
149-010	Parallel	Present	Excurvate	Indeterminate	Present	None	FALSE	TRUE
213-010	Random	Absent	Excurvate	Excurvate	Absent	None	FALSE	FALSE
287-010	Indeterminate	Present	Excurvate	Straight	Absent	None	FALSE	FALSE
417-013	Random	Absent	Excurvate	Excurvate	Absent	None	FALSE	TRUE
418-028	Subparallel	Absent	Straight	Excurvate	Absent	None	TRUE	FALSE
419-012	Random	Absent	Excurvate	Excurvate	Absent	None	TRUE	FALSE
416-10 428-010	Random	Absent	Indeterminate	Excurvate	Absent	None	FALSE	TRUE
544-012	Random	Absent	Indeterminate	Indeterminate	Absent	None	FALSE	TRUE
545-010	Random	Absent	Straight	Excurvate	Absent	None	FALSE	TRUE
648-013	Flake Blank Remnant	Present	Indeterminate	Excurvate	Absent	Beveled Unifacial	FALSE	FALSE

Table O-23. Middle Archaic Component Scraper Data

Cat. No.	Unit	Depth (cmbd)	Tool Subtype	Condition	Break Type	Raw Material	Texture	Percent Patination	Percent Cortex	Cortex Type
100-011	N100,E52	30-40	End-Scraper	Complete	Unbroken	Chert	Fine	0	25	Pebble/Cobble
124-010	N100,E54	60-70	Side-Scraper	Distal	Use	Chert	Fine	0	25	Pebble/Cobble
318-014	N102,E54	80-90	Side-Scraper	Proximal	Use	Chert	Fine	0	0	None

Cat. No.	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Shape	Edge Flaking	Edge Rounding	No. Bits	Bit 1 Location
100-011	Burned	60.2	77.6	16.8	62	Round	Distal/Lateral	Absent	3	Lateral/Distal
124-010	Heat-Treated	50.8	46	16.7	29.9	Irregular	Distal/Lateral	Present	1	Lateral/Distal
318-014	Indeterminate	46.3	41.1	10.7	23.1	Round	Lateral Only	Present	1	Lateral

Cat. No.	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)	Bit 1 Angle	Bit 2 Location	Bit 2 Shape	Bit Retouch 2	Bit 2 Length (mm)	Bit 2 Thick (mm)
100-011	Excurvate	Regular Continuous	50.8	5.9	70	Distal	Excurvate	Regular Continuous	41	3.1
124-010	Straight	Regular Continuous	37.9	8.5	82					
318-014	Excurvate	Regular Continuous	51.4	5.7	71					

Cat. No.	Bit 2 Angle	Bit 3 Location	Bit 3 Shape	Bit 3 Retouch	Bit 3 Length (mm)	Bit 3 Thick (mm)	Bit 3 Angle
100-011	74	Lateral/Distal	Excurvate	Regular Continuous	42.4	2	43
124-010							
318-014							

Cat. No.	Rejuvenation Scar	Flake Size	Micro-wear	NAA
100-011	Absent	8	TRUE	TRUE
124-010	Absent	6	FALSE	FALSE
318-014	Absent	5	FALSE	FALSE

Table O-24. Middle Archaic Core Data

Cat. No.	Unit	Depth (cmbd)	Condition	Tool Type	Raw Material	Texture	Percent Patination
83-011	N100,E50	50-60	Complete	Unifacial	Chert	Fine	0
90-010	N100,E51	30-40	Complete	Multi-Directional	Chert	Fine	0
100-012	N100,E52	30-40	Complete	Multi-Directional	Chert	Fine	25
327-010	N102,E55	70-80	Complete	Multi-Directional	Chert	Fine	25
339-010	N102,E56	40-50	Complete	Multi-Directional	Chert	Fine	0
409-012	N104,E47	40- 50	Complete	Multi-Directional	Chert	Fine	0
409-013	N104,E47	50-60	Complete	Multi-Directional	Chert	Fine	0
429-010	N105,E47	50-60	Exhausted	Bifacial	Chert	Fine	0

Cat. No.	Percent Cortex	Cortex Type	Heating	Rejuvenation Scar	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)
83-011	50	Pebble/Cobble	None	Absent	63.2	60.6	37.1	203.2
90-010	0	None	None	Absent	94.5	82.1	36.1	336.1
100-012	25	Pebble/Cobble	None	Absent	123.2	84.2	68.5	697.6
327-010	25	Pebble/Cobble	None	Absent	90.5	66.9	37.4	246.9
339-010	0	None	None	Absent	95.1	63.1	52.5	413.5
409-012	25	Pebble/Cobble	None	Absent	74.5	52.7	41.2	175.9
409-013	25	Pebble/Cobble	None	Absent	111.1	91.9	47.8	440.6
429-010	0	None	None	Absent	50.8	43.1	20.2	39.7

Table O-25. Gower Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharp Type	Preform	Shape	Raw Material	Texture
11-005-013	N99,E51	7-20	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
29-010	N99,E52	90-100	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
50-013	N99,E54	100-110	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
62-014	N99,E55	100-110	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
86-019	N100,E50	80-90	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
86-020	N100,E50	80-90	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
153-028	N100,E56	100-110	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
154-020	N100,E56	110-120	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
192-011	N101,E51	70-80	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
215-019	N101,E53	90-100	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
215-020	N101,E53	90-100	Medial	Use	Absent	None	Biface	Indeterminate	Chert	Fine
215-021	N101,E53	90-100	Proximal	Indeterminate	Absent	Indeterminat e	Indeterminate	Indeterminate	Chert	Fine
228-014	N101,E54	100-110	Proximal	Use	Present	Indeterminat e	Biface	Lanceolate	Chert	Fine
254-014	N101,E56	100-110	Complete	Use	Absent	None	Biface	Triangular	Chert	Fine
255-030	N101,E56	110-120	Complete	Use	Absent	None	Biface	Lanceolate	Chert	Fine
289-021	N102,E51	90-100	Proximal	Use	Absent	Beveled Unifacial	Biface	Lanceolate	Chert	Fine
289-022	N102,E51	90-100	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
289-023	N102,E51	90-100	Medial	Use	Absent	None	Biface	Indeterminate	Chert	Fine
332-011	N102,E55	120-130	Medial	Use	Absent	None	Biface	Indeterminate	Chert	Fine
333-022	N102,E55	130-140	Complete	Unbroken	Present	None	Biface	Triangular	Chert	Fine
345-026	N102,E56	100-110	Proximal	Use	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
345-027	N102,E56	100-110	Complete	Unbroken	Absent	Beveled Bifacial	Biface	Lanceolate	Chert	Fine
391-011	N103,E55	120-130	Complete	Unbroken	Absent	Beveled Bifacial	Biface	Lanceolate	Chert	Fine
411-016	N104,E47	70-80	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
591-017	N107,E53	50-60	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
591-018	N107,E53	50-60	Proximal	Use	Absent	Indeterminat e	Indeterminate	Indeterminate	Chert	Fine
632-016	N108,E49	30-40	Proximal	Thermal/ Crenated	Absent	Indeterminat e	Biface	Indeterminate	Chert	Fine
689-021	N109,E48	40-50	Proximal	Use	Absent	Indeterminat e	Indeterminate	Indeterminate	Chert	Fine
1205-010	Block A	SURFAC E	Distal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
1206-010	BT 1		Complete	Use	Absent	None	Biface	Triangular	Chert	Fine
1213-010		SURFAC E	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
1216-010		SURFAC E	Distal	Thermal/ Crenated	Absent	Indeterminat e	Biface	Triangular	Chert	Fine

Table O-25. Gower Point Data Continued

Cat. No.	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Flaking Pattern
11-005-013	0	0	None	Burned		6.4		Indeterminate	Biconvex Symmetrical	Indeterminate
29-010	0	0	None	None				Indeterminate	Biconvex Symmetrical	Indeterminate
50-013	0	0	None	Burned		7.2		Indeterminate	Biconvex Symmetrical	Subparallel
62-014	0	0	None	None		6.1		Tapered Base/Tip	Biconvex Symmetrical	Subparallel
86-019	0	0	None	None		6.7		Indeterminate	Plano-Convex	Subparallel
86-020	0	0	None	None		6.7		Indeterminate	Biconvex Asymmetrical	Subparallel
153-028	0	0	None	Burned		6.5		Indeterminate	Biconvex Symmetrical	Indeterminate
154-020	0	0	None	None				Indeterminate	Indeterminate	Indeterminate
192-011	0	0	None	Burned		6.5		Indeterminate	Biconvex Symmetrical	Indeterminate
215-019	0	0	None	None				Indeterminate	Biconvex Symmetrical	Indeterminate
215-020	0	0	None	Burned				Indeterminate	Plano-Convex	Oblique Subparallel
215-021	0	0	None	None				Indeterminate	Indeterminate	Indeterminate
228-014	0	0	None	None	43	6.5	4.9	Tapered Base/Tip	Biconvex Symmetrical	Subparallel
254-014	0	0	None	Heat-Treated	40.1	3.6	2.2	Flat	Biconvex Symmetrical	Oblique Subparallel
255-030	0	0	None	Indeterminate	44.2	7	4.4	Tapered Base/Tip	Biconvex Symmetrical	Subparallel
289-021	0	0	None	None		6.7	4.4	Tapered Base/Tip	Biconvex Symmetrical	Oblique Subparallel
289-022	0	0	None	Burned		7		Indeterminate	Biconvex Symmetrical	Indeterminate
289-023	0	0	None	Burned		6.5		Indeterminate	Biconvex Symmetrical	Indeterminate
332-011	0	0	None	Burned		5.7		Indeterminate	Indeterminate	Subparallel
333-022	0	50	Pebble/Cobble	None	39.7	7.6	4.5	Wedge Base, Thick Body	Biconvex Symmetrical	Subparallel
345-026	0	0	None	None				Indeterminate	Indeterminate	Indeterminate
345-027	25	0	None	None	58.4	5.8	5.7	Wedge Base, Flat	Plano-Convex	Chevron
391-011	0	0	None	None	56.3	8.3	7.3	Bi-wedge-shaped	Biconvex Asymmetrical	Oblique Subparallel
411-016	0	0	None	Burned		8		Indeterminate	Biconvex Symmetrical	Indeterminate
591-017	0	0	None	Burned		5.5	4	Tapered Base/Tip	Biconvex Symmetrical	Subparallel
591-018	0	0	None	Burned				Indeterminate	Indeterminate	Indeterminate
632-016	0	0	None	None				Indeterminate	Biconvex Symmetrical	Indeterminate
689-021	100	0	None	None				Indeterminate	Biconvex Symmetrical	Indeterminate
1205-010	75	0	None	None	62.7	6.1	7.2	Tapered Base/Tip	Biconvex Symmetrical	Oblique Subparallel
1206-010	0	0	None	None	40.7	8	3.9	Wedge Base, Flat	Biconvex Symmetrical	Chevron
1213-010	0	0	None	Burned		6.7		Indeterminate	Biconvex Symmetrical	Oblique Subparallel
1216-010	0	0	None	Burned	37.3		2.3	Indeterminate	Indeterminate	Indeterminate

Table O-25. Gower Point Data Continued

Cat. No.	Edge Roundin g	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notc h Depth h (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle
11-005-013	Absent			Indeterminate	Indeterminate			2.5		9.2	
29-010	Absent			Indeterminate	Indeterminate						
50-013	Absent		15.3	Straight	Straight	16.7	2.1	1.9	7.8	7.5	103
62-014	Present		17.2	Straight	Straight	19.5	3.4		10.1		77
86-019	Absent		15.8	Indeterminate	Indeterminate		2.6		10.8		73
86-020	Absent		22.3	Straight	Straight	24.8	3.9	4.1	9.8	8.8	42
153-028	Present		17.5	Indeterminate	Indeterminate	19.5	2.2	2.2	7.9	8	115
154-020	Absent			Indeterminate	Indeterminate						
192-011	Absent		14.2	Straight	Incurvate		2.2	2.7	9.9	10.6	44
215-019	Present			Indeterminate	Indeterminate						
215-020	Present		17.5	Indeterminate	Indeterminate	19.3		2.5		9	68
215-021	Absent			Indeterminate	Indeterminate						
228-014	Present	28.9	18.8	Indeterminate	Straight	21.1		2.2		8.3	53
254-014	Present	28.7	14.5	Straight	Excurvate	18.8	1.4	2.8	8.7	5.7	57
255-030	Absent	32.4	14.7	Straight	Excurvate	20.4	3.2	3.6	9	8.1	71
289-021	Present		15.5	Straight	Straight	21.4	2.3	3.7	10	13.3	76
289-022	Present		14.1	Indeterminate	Indeterminate	16.4	2.7	2.1	8	6.8	76
289-023	Absent		14.5	Indeterminate	Indeterminate						
332-011	Present		11.7	Straight	Excurvate						66
333-022	Present	27.2	14.7	Straight	Straight		1.3	1.9	9.6	9.8	90
345-026	Absent			Indeterminate	Indeterminate						
345-027	Present	45.9	18.3	Excurvate	Excurvate	25.4	5.3	4.8	10.1	9.7	46
391-011	Absent	45.3	14.5	Excurvate	Straight	20.2	1.6	2.3	6.6	7.8	70
411-016	Absent		14.6	Indeterminate	Indeterminate	19.1	3.4	3.4	8.3	8.2	67
591-017	Absent		18	Straight	Straight		1.9		9.3		78
591-018	Absent			Indeterminate	Indeterminate						
632-016	Present			Indeterminate	Indeterminate						
689-021	Present			Indeterminate	Indeterminate						
1205-010	Absent	46.4	18.1	Excurvate	Excurvate	22.6					52
1206-010	Present	31.7	13.3	Excurvate	Straight	17.9	1.5	1.4	5.6	5.1	52
1213-010	Absent		18.9	Indeterminate	Straight	23.2	1.8	2.2	7.1	7.5	54
1216-010	Absent	25.6	15.7	Incurvate	Straight	21.9	2.8	3.4	7.7	7	56

Table O-25. Gower Point Data Continued

Cat. No.	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
11-005-013	72	Curved	18.5	14.6	17.6	4.9	5.9	8.5	FALSE	FALSE
29-010		Curved		12.8	20	3.8	4.7	6.9	FALSE	FALSE
50-013	78	Curved	15.4	12.9		4.6	7		FALSE	FALSE
62-014		Curved	15.7			4	5.6		FALSE	FALSE
86-019		Curved	13.6			5.2	4.7		FALSE	FALSE
86-020	59	Curved	13.9	14.5	19.5	3.5	5.8	7.1	FALSE	TRUE
153-028	67	Curved	14.8	14.6	17.8	3.9	5.9		FALSE	FALSE
154-020		Expanding				3.9	6.7		FALSE	FALSE
192-011	41	Curved	14	13.5	17.6	4.3	4	7.3	FALSE	TRUE
215-019		Curved	14.7	15	16.9	5.5	6.2	9.1	FALSE	FALSE
215-020	62	Indeterminate		13.4		5.8			FALSE	FALSE
215-021		Curved					5.2		FALSE	TRUE
228-014	71	Curved	14.6	15.1		4	8.2		FALSE	FALSE
254-014	73	Expanding	11.4	12.8		3.5	5		FALSE	FALSE
255-030	61	Curved	11.8	13.3	16.9	5	5.8	7.8	FALSE	FALSE
289-021	68	Curved	19	14.6	19.1	5.3	7.5	10.4	FALSE	FALSE
289-022	80	Curved	12.9	12	19	5.3	5.1	10.1	FALSE	FALSE
289-023		Indeterminate				5.4			FALSE	FALSE
332-011		Indeterminate							FALSE	FALSE
333-022	90	Curved	12.5	13.2	17.4	4.1	4.9	9.1	FALSE	TRUE
345-026		Curved					5.8		FALSE	FALSE
345-027	43	Curved	12.5	14.3	18	5	6.1	8.1	FALSE	FALSE
391-011	73	Curved	11	15.3	17.7	3.7	6.2	9.1	TRUE	FALSE
411-016	68	Curved	13.1	11.6	16.7	4.4	3.7	8.9	FALSE	FALSE
591-017		Curved	11.1	15.5	18.6	5.1	5.9	10.4	FALSE	FALSE
591-018		Curved		10.9	20.7	5.4	4.5	11.2	FALSE	FALSE
632-016		Curved			19.1	5.8	6.3	11.5	FALSE	FALSE
689-021		Curved			19.8	5.3	3.1	10.9	FALSE	FALSE
1205-010		Curved	16.3	14.9					FALSE	FALSE
1206-010	65	Curved	9	12.9	13.9	5.7	3.5	6.8	FALSE	FALSE
1213-010	41	Curved	16.6	15.8		5.9	6.3		FALSE	TRUE
1216-010	46	Curved	11.7	12.9			3.7		FALSE	FALSE

Table O-26. Martidale Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharp Type	Preform	Shape	Raw Material	Texture
7-010	N99,E50	70-80	Complete	Use	Absent	None	Biface	Triangular	Chert	Fine
9-014	N99,E50	90	Proximal	Manufacture	Present	None	Biface	Triangular	Chert	Fine
9-015	N99,E50	80-90	Proximal	Use	Absent	Indeterminate	Indeterminate	Indeterminate	Chert	Fine
19-014	N99,E51	90-100	Proximal	Indeterminate	Absent	None	Biface	Indeterminate	Chert	Fine
39-015	N99,E53	90-100	Complete	Use	Absent	Break Compensation	Biface	Triangular	Chert	Fine
40-013	N99,E53	100-110	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
77-013	N99,E56	120-130	Complete	Use	Absent	None	Biface	Lanceolate	Chert	Fine
141-021	N100,E55	110-120	Medial	Use	Absent	None	Biface	Triangular	Chert	Fine
154-021	N100,E56	110-120	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
216-010	N101,E53	100-110	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
230-013	N101,E54	120-130	Proximal	Use	Present	None	Biface	Triangular	Chert	Fine
268-021	N102,E47	80-90	Complete	Use	Absent	Indeterminate	Biface	Triangular	Chert	Fine
268-022	N102,E47	80-90	Proximal	Use	Absent	Break Compensation	Biface	Indeterminate	Chert	Fine
311-013	N102,E53	90-100	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
346-024	N102,E56	110-120	Proximal	Use	Absent	Break Compensation	Biface	Indeterminate	Chert	Fine
347-014	N102,E56	120-130	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
591-019	N107,E53	50-60	Complete	Unbroken	Absent	None	Biface	Triangular	Chert	Fine
658-018	N108,E53	50-60	Complete	Use	Absent	None	Biface	Lanceolate	Chert	Fine
658-017	N108,E53	50-60	Proximal	Use	Absent	None	Indeterminate	Indeterminate	Chert	Fine
730-013	N109,E54	40-50	Complete	Unbroken	Absent	Alternate Beveled Unifacial	Biface	Triangular	Chert	Fine
854-010*	N118,E73	40-50	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
1201-010*	TRENCH 1	Buried	Complete	Use	Absent	Break Compensation	Biface	Triangular	Chert	Fine

Table O-26. Martidale Point Data Continued

Cat. No.	Percent Patination	Percent Cortex	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Flaking Pattern	Edge Rounding
7-010	25	0	None	52.4	7.2	10.8	Wedged Base, Flat	Biconvex Symmetrical	Chevron	Present
9-014	0	0	None		7.9	14.3	Tapered Base/Tip	Plano-Convex	Oblique Subparallel	Present
9-015	0	0	Burned				Indeterminate	Indeterminate	Indeterminate	Present
19-014	0	0	None		5.1		Indeterminate	Indeterminate	Indeterminate	Absent
39-015	0	0	Burned	47.4	7.2	10.8	Tapered Base/Tip	Biconvex Symmetrical	Oblique Subparallel	Present
40-013	0	0	Heat-Treated		6.2	6.7	Flat	Biconvex Symmetrical	Chevron	Present
77-013	0	0	None	57.8	6.6	10.8	Wedged Base, Flat	Biconvex Symmetrical	Oblique Subparallel	Present
141-021	0	0	Burned		8.3		Tapered Base/Tip	Biconvex Asymmetrical	Oblique Subparallel	Absent
154-021	0	0	None				Indeterminate	Indeterminate	Indeterminate	Present
216-010	0	0	None				Indeterminate	Biconvex Symmetrical	Indeterminate	Present
230-013	0	0	None		6.9	8	Flat	Biconvex Symmetrical	Indeterminate	Absent
268-021	0	0	Indeterminate	34.8	7.6	6.4	Tapered Base/Tip	Biconvex Symmetrical	Subparallel	Absent
268-022	0	0	Heat-Treated		6.5		Indeterminate	Biconvex Symmetrical	Oblique Parallel	Absent
311-013	100	0	None				Indeterminate	Biconvex Symmetrical	Indeterminate	Present
346-024	0	0	None		7.1		Indeterminate	Biconvex Symmetrical	Oblique Subparallel	Absent
347-014	0	0	None		6.6		Indeterminate	Biconvex Symmetrical	Oblique Subparallel	Present
591-019	0	0	None	55.8	6.6	8.8	Tapered Base/Tip	Biconvex Symmetrical	Chevron	Absent
658-018	0	0	None	55.2	6.6	8.5	Wedged Base, Flat	Plano-Convex	Subparallel	Present
658-017	0	0	None				Indeterminate	Indeterminate	Indeterminate	Absent
730-013	0	0	None	39.3	7.1	6	Tapered Base/Tip	Biconvex Symmetrical	Chevron	Present
854-010*	25	0	Heat-Treated		8.6		Indeterminate	Biconvex Symmetrical	Chevron	Absent
1201-010*	0	0	Heat-Treated	48.7	6.6	10	Tapered Base/Tip	Biconvex Symmetrical	Chevron	Absent

Table O-26. Martidale Point Data Continued

Cat. No.	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle
7-010	37.6	28.2	Excurvate	Straight		5.1		12.4		55
9-014			Excurvate	Indeterminate	32.9	7.7	5.4	8.4	9.2	46
9-015			Indeterminate	Indeterminate						
19-014			Indeterminate	Indeterminate						55
39-015	34.5	30	Excurvate	Straight	33.2	7.2	7.3	10.1	12.3	32
40-013		25.8	Straight	Straight	30	6.1	6.9	9.6	8.9	38
77-013	47.2	27.8	Excurvate	Excurvate	30	5.2		8.5		44
141-021		31.8	Straight	Straight	37.6		8.9		15.9	
154-021			Indeterminate	Indeterminate						
216-010			Indeterminate	Indeterminate						
230-013		30.8	Straight	Straight	34	8.1	8	10.2	8.7	51
268-021	23.3	23	Excurvate	Excurvate	24.2	3.4	4.1	9.1	9.8	57
268-022			Indeterminate	Indeterminate			9.5		7.8	
311-013			Indeterminate	Indeterminate						
346-024			Indeterminate	Straight			5.8		11.6	
347-014			Indeterminate	Indeterminate						
591-019	43	27.1	Straight	Recurvate	28.9	4.2	5.9	11.4	10.2	51
658-018	44.5	22	Straight	Straight	25.8	5.6		9.6		49
658-017			Indeterminate	Indeterminate						
730-013	24.5	19.1	Incurvate	Incurvate	27	5.4	5.3	14.1	15.5	55
854-010*		35.9	Excurvate	Excurvate	36.3	3.4	4.2	8	7.1	50
1201-010*	36.1		Excurvate	Indeterminate		9		9.3		45

Table O-26. Martidale Point Data Continued

Cat. No.	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
7-010		Expanding	14.8	18.6		5.4	3.9	11	FALSE	FALSE
9-014	50	Expanding	10.7	17.6	24.7	5.1	2.2	12	FALSE	FALSE
9-015		Expanding			24.5		3	7	FALSE	FALSE
19-014		Indeterminate		16.9	20.8	4.2	1.2		FALSE	FALSE
39-015	29	Expanding	12.9	18.3	22.3	4.8	2.4	6.9	FALSE	TRUE
40-013	29	Expanding	11.5	18	23.1	4.3	2.1	9.5	FALSE	FALSE
77-013		Expanding	10.6	18.4	22.3	4.1	1.6	10	FALSE	TRUE
141-021	35	Expanding	15.8	18.8		3.3	3.3		TRUE	FALSE
154-021		Expanding			24.8	3.9	1.8	9	FALSE	FALSE
216-010		Expanding			23.4	4.9	3.1	11.8	FALSE	FALSE
230-013	38	Expanding	11.8	17.4	25.6	5	2.9	14.4	FALSE	FALSE
268-021	49	Expanding	11.5	17	22.8	4	2.4	10.2	FALSE	TRUE
268-022	23	Expanding	11.6	16.8	21.4	4.1	3.1	14.5	FALSE	FALSE
311-013		Expanding	12.4	18.6	27.8	5	2.9	3.2	FALSE	TRUE
346-024	39	Expanding	14.8	18.6	24.7	4.8	3.6	11.5	FALSE	FALSE
347-014		Expanding	10.3	16.7	21.7	4.8	3.1	13.4	FALSE	FALSE
591-019	37	Expanding	12.8	18.1	24.1	4.8	2.9	8.5	TRUE	FALSE
658-018		Expanding	10.7	15.1	22.4	5.5	1.7	7.6	FALSE	FALSE
658-017		Expanding	11.5	13.3	18	3.5	2	7.3	FALSE	FALSE
730-013	51	Expanding	14.8	17	25.2	5.8	3	10	FALSE	FALSE
854-010*	25	Expanding	10.7	16.9	18.4	4.6	1.9	7.6	FALSE	TRUE
1201-010*		Expanding	12.6	17.9	24.9	4.8	3.9	11.5	FALSE	FALSE

* Not from Early Archaic Component

Table O-27. Bandy Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Preform	Shape	Raw Material	Texture
116-020	N100,E53	80-90	Proximal	Indeterminate	Absent	None	Biface	Triangular	Chert	Fine
142-011	N100,E55	120-130	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
334-022	N102,E55	140-150	Complete	Unbroken	Absent	None	Biface	Triangular	Chert	Fine
346-010	N102,E56	110-120	Proximal	Use	Absent	Indeterminate	Biface	Indeterminate	Chert	Fine
346-022	N102,E56	110-120	Complete	Unbroken	Absent	None	Biface	Triangular	Chert	Fine
347-013	N102,E56	120-130	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
390-010	N103,E55	110-120	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
400-011	N103,E56	70-80	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
439-010	N105,E50	80-90	Proximal	Manufacture	Present	Break Compensation	Biface	Indeterminate	Chert	Fine
531-018	N106,E54	90-100	Complete	Unbroken	Absent	None	Biface	Triangular	Chert	Fine
563-017	N107,E49	40-50	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
599-015	N107,E54	90-100	Complete	Use	Absent	None	Biface	Triangular	Chert	Fine
645-012	N108,E51	50-60	Medial	Use	Absent	Indeterminate	Indeterminate	Indeterminate	Chert	Fine
651-011	N108,E52	50-6	Complete	Unbroken	Absent	Beveled Unifacial	Biface	Triangular	Chert	Fine
689-020	N109,E48	40-50	Proximal	Use	Absent	Indeterminate	Biface	Indeterminate	Chert	Fine
694-017	N109,E49	40-50	Complete	Use	Absent	None	Biface	Triangular	Chert	Fine
713-016	N109,E51	46	Complete	Unbroken	Absent	Indeterminate	Biface	Triangular	Chert	Fine
719-010	N109,E52	50-60	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
735-011	N109,E55	40-50	Medial	Thermal/Crenated	Absent	Indeterminate	Indeterminate	Indeterminate	Chert	Fine
746-014	N110,E50	40-50	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
1204-010*	Block B	Surface	Proximal	Use	Absent	Indeterminate	Biface	Indeterminate	Chert	Fine

Table O-27. Bandy Point Data Continued

Cat. No.	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section
116-020	0	0	None	Burned			4.4		Indeterminate	Biconvex Symmetrical
142-011	0	0	None	Burned			6.8		Tapered Base/Tip	Biconvex Symmetrical
334-022	0	0	None	None	37.3		4.4	2.9	Wedged Base, Flat	Biconvex Asymmetrical
346-010	0	0	None	Heat-Treated					Indeterminate	Biconvex Symmetrical
346-022	0	0	None	None	31.8		4.1	2.5	Flat	Biconvex Symmetrical
347-013	0	0	None	None			4.9		Indeterminate	Biconvex Symmetrical
390-010	0	0	None	None			4		Flat	Biconvex Symmetrical
400-011	0	0	None	None			4.6		Flat	Biconvex Symmetrical
439-010	0	0	None	None			5.6		Indeterminate	Biconvex Symmetrical
531-018	0	0	None	None	39.6		4.8	5.3	Flat	Biconvex Symmetrical
563-017	0	0	None	None			5		Indeterminate	Biconvex Symmetrical
599-015	100	0	None	Burned	30.8		3.4	2.1	Flat	Biconvex Symmetrical
645-012	0	0	None	None					Indeterminate	Indeterminate
651-011	0	0	None	None	40.7		4.8	5.3	Flat	Biconvex Symmetrical
689-020	0	0	None	Burned			4.6		Flat	Biconvex Symmetrical
694-017	0	0	None	Heat-Treated	40.5		4.9	4	Wedged Base, Flat	Biconvex Symmetrical
713-016	0	0	None	Heat-Treated	55.8		4.5	5	Tapered Base/Tip	Biconvex Symmetrical
719-010	0	0	None	None			4.7		Indeterminate	Biconvex Symmetrical
735-011	0	0	None	Burned					Indeterminate	Indeterminate
746-014	0	0	None	None			4.8		Flat	Biconvex Symmetrical
1204-010*	0	0	None	Heat-Treated					Indeterminate	Biconvex Symmetrical

Table O-27. Bandy Point Data Continued

Cat. No.	Flaking Pattern	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)
116-020	Random	Absent			Indeterminate	Indeterminate		7.9	7.4	4.3
142-011	Chevron	Absent		30.8	Straight	Straight				
334-022	Parallel	Absent	28.3	21.5	Straight	Straight			6	
346-010	Indeterminate	Absent			Indeterminate	Indeterminate				
346-022	Subparallel	Present	26.4	19.4	Straight	Straight	26.1	4.5	4.6	3.6
347-013	Oblique Subparallel	Absent			Indeterminate	Indeterminate		6.6	7.9	
390-010	Parallel	Present		21.2	Indeterminate	Indeterminate	34.5	6.1	6.2	7.3
400-011	Chevron	Present		29.5	Indeterminate	Indeterminate		5.3	7.2	3.7
439-010	Indeterminate	Present			Indeterminate	Indeterminate		6.8		12.1
531-018	Chevron	Absent	32.3	30.2	Straight	Straight	40.2	7.3	7	5.9
563-017	Indeterminate	Present			Indeterminate	Indeterminate		6.3		10.3
599-015	Indeterminate	Present	24.5	22.9	Straight	Straight		6.4		6.1
645-012	Indeterminate	Absent			Indeterminate	Indeterminate				
651-011	Chevron	Present	30.9	27.2	Excurvate	Excurvate	35.2	9.1	8.6	7.6
689-020	Parallel	Absent		27	Straight	Incurvate	34.9	8.4	6.3	8
694-017	Chevron	Present	31.6	24.4	Straight	Straight			6.8	
713-016	Oblique Subparallel	Present	46.9	25.5	Straight	Straight	36.7	7.6	7.9	5.7
719-010	Indeterminate	Present			Indeterminate	Indeterminate			7.9	
735-011	Indeterminate	Absent			Indeterminate	Indeterminate				
746-014	Chevron	Present		28.9	Indeterminate	Straight	37.9	8.2	9.1	6.6
1204-010*	Indeterminate	Absent			Indeterminate	Indeterminate	26.5	4.2	4.5	5.5

Table O-27. Bandy Point Data Continued

Cat. No.	Right Notch Width (mm)	Left Notch Angle (mm)	Right Notch Angle (mm)	Stem Shape	Stem Length (mm)	Stem Dist Width (mm)	Stem Prox Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
116-020	4.1	38	40	Expanding	8.2	13.2	19.2	2.6	1.4	8.4	FALSE	TRUE
142-011		46	32	Expanding	10.8	14.3	18.5	4.8	0.7	12.1	FALSE	TRUE
334-022	7.9		31	Expanding	9	13.1	15.6	3.8	1.3	11	TRUE	FALSE
346-010				Expanding			17	3.4	0.9	7.6	FALSE	FALSE
346-022	5.6	46	25	Expanding	5.4	13.3	15.8	2.4	0.6	4.4	FALSE	FALSE
347-013	4.8		19	Expanding	7.6	14.6	15.4	3.2	0.6	5.3	FALSE	TRUE
390-010	4.3	31	25	Expanding	7	11.7	13.8	3.3	0.9	4.7	FALSE	FALSE
400-011		21		Expanding	7.6	13.4	16.7	2.7	1.4	6.2	FALSE	TRUE
439-010		51		Expanding	10.3	11.5	16.4	2.9	2.9	10.1	FALSE	FALSE
531-018	5.8	37	28	Expanding	7.3	14	16.5	3.2	1.9	7.3	FALSE	FALSE
563-017		32		Expanding	8.1	12.3	15.1	3.5	1.9	7.8	FALSE	FALSE
599-015		31	36	Expanding	6.3	13.6	16.5	2.4	1.3	10.1	FALSE	FALSE
645-012				Indeterminate							FALSE	FALSE
651-011	8	34	33	Expanding	9.8	11.6	15.3	3.4	1	8.9	FALSE	FALSE
689-020	8.4	38	26	Expanding	9.3	13.7	17.1	3.4	2.4	10.5	FALSE	FALSE
694-017	7		19	Expanding	8.9	14.4	17	3.5	1.9	12.9	FALSE	FALSE
713-016	4.9	14	26	Expanding	8.9	12.1	14.9	3.7	1.1	8.2	TRUE	FALSE
719-010	5.5		19	Expanding	8.5			3.2	0.9	5.6	FALSE	TRUE
735-011				Indeterminate							FALSE	FALSE
746-014	6.8	26	24	Expanding	8.2	13.9	15.5	2.9	1.5	13.2	FALSE	FALSE
1204-010*	3.8	35	41	Expanding	6.2	11.5	13.6	3.6	0.7	6.5	FALSE	FALSE

* From the surface of Block B

Table O-28. Group 1 Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Preform	Shape	Raw Material
141-020	N100,E55	110-120	Proximal	Use	Absent	Beveled Unifacial	Biface	Triangular	Chert
193-018	N101,E51	80-90	Proximal	Thermal/Crenated	Absent	None	Biface	Triangular	Chert
334-023	N102,E55	140-150	Complete	Unbroken	Absent	None	Biface	Triangular	Chert
486-010	N105,E56	60-70	Proximal	Use	Absent	Indeterminate	Indeterminate	Indeterminate	Chert
599-016	N107,E54	90-100	Complete	Use	Absent	Indeterminate	Biface	Triangular	Chert
599-017	N107,E54	90-100	Complete	Use	Absent	Break Compensation	Biface	Triangular	Chert
628-012	N108,E48	40-50	Proximal	Use	Absent	Alternate Beveled Unifacial	Biface	Triangular	Chert
665-016	N108,E54	50-60	Proximal	Thermal/Crenated	Absent	Indeterminate	Indeterminate	Triangular	Chert
670-005-011	N108,E55	49	Complete	Unbroken	Absent	Indeterminate	Flake	Triangular	Chert
670-013	N108,E55	40-50	Proximal	Use	Absent	Indeterminate	Biface	Indeterminate	Chert
671-011	N108,E55	50-60	Proximal	Use	Absent	None	Biface	Triangular	Chert
694-018	N109,E49	40-50	Proximal	Use	Absent	None	Biface	Lanceolate	Chert
717-012	N109,E52	30-40	Proximal	Use	Absent	Indeterminate	Indeterminate	Indeterminate	Chert
1202-010	BT WALL	51	Proximal	Use	Absent	Alternate Beveled Unifacial	Biface	Lanceolate	Chert
1203-010	BT 2		Proximal	Use	Absent	None	Biface	Indeterminate	Chert

Cat. No.	Texture	Percent Patination	Percent Cortex	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section
141-020	Fine	0	0	None			9.3		Indeterminate	Biconvex Symmetrical
193-018	Fine	0	0	Burned			6.6		Indeterminate	Biconvex Symmetrical
334-023	Fine	0	0	None	42		7.7	6.7	Tapered Base/Tip	Biconvex Symmetrical
486-010	Fine	0	0	Indeterminate					Indeterminate	Indeterminate
599-016	Fine	75	0	None	40.2		7.5	7.9	Tapered Base/Tip	Biconvex Symmetrical
599-017	Fine	0	0	Indeterminate	62.1		8.4	15.2	Tapered Base/Tip	Biconvex Symmetrical
628-012	Fine	0	0	None			8.3	11.1	Tapered Base/Tip	Biconvex Asymmetrical
665-016	Fine	0	0	Burned				4.2	Indeterminate	Biconvex Symmetrical
670-005-011	Fine	0	0	None	60.1		7.3	11.8	Tapered Base/Tip	Plano-Convex
670-013	Fine	0	0	Indeterminate					Indeterminate	Biconvex Symmetrical
671-011	Fine	25	0	None			8		Indeterminate	Biconvex Symmetrical
694-018	Fine	0	0	Heat-Treated			7.5		Indeterminate	Biconvex Symmetrical
717-012	Fine	0	0	None					Indeterminate	Indeterminate
1202-010	Fine	0	0	None			7.1	8	Flat	Biconvex Symmetrical
1203-010	Fine	0	0	None			6.2		Indeterminate	Plano-Convex

Table O-28. Group 1 Point Data Continued

Cat. No.	Flaking Pattern	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)	Left Notch Depth (mm)	Right Notch Depth (mm)
141-020	Indeterminate	Present		27.4	Indeterminate	Indeterminate	31.3	4.4	6.4
193-018	Indeterminate	Present		21.5	Indeterminate	Indeterminate	28.9	5.1	4.5
334-023	Chevron	Absent	29.6	27.1	Straight	Straight	32.1	6.4	6.2
486-010	Indeterminate	Absent			Indeterminate	Indeterminate			
599-016	Chevron	Present	27.3	24.1	Straight	Straight		6.5	
599-017	Chevron	Present	44.3	32.6	Excurvate	Excurvate	34.2	7.7	7.2
628-012	Oblique Parallel	Absent		28.4	Straight	Straight	32.5	5.2	
665-016	Subparallel	Absent		20.2	Straight	Straight	25.8	3.2	5.2
670-005-011	Random	Present	45	27.4	Recurvate	Straight	31.7	6.3	5.5
670-013	Indeterminate	Present			Indeterminate	Indeterminate			
671-011	Random	Present		34.9	Straight	Straight	39.4	6.8	7.2
694-018	Subparallel	Present		29.9	Straight	Excurvate	30.4	5.6	5
717-012	Indeterminate	Present			Indeterminate	Indeterminate			
1202-010	Subparallel	Present		19.5	Straight	Straight	29.8		4.6
1203-010	Oblique Subparallel	Present		30.1	Straight	Indeterminate	34	7.8	7.3

Cat. No.	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Micro-wear	NAA
141-020	12.6	60	38	Expanding	15.1	16.3	20.5	4.9	4.7	FALSE	FALSE
193-018	13.6	43	39	Expanding	15.9	19.7	24.3	3.5	5.9	FALSE	FALSE
334-023	8.9	54	24	Expanding	12.4	17.4	22.3	6.2	2.8	FALSE	FALSE
486-010				Expanding			19.8	4	3.4	FALSE	FALSE
599-016		53	39	Expanding	12.9	16.8	23	4.4	2.4	FALSE	FALSE
599-017	18	25	20	Expanding	17.8	19	20.7	5.9	4.2	TRUE	FALSE
628-012		46	24	Expanding	15.2	17.7		6.3	4.5	FALSE	FALSE
665-016	9.2	68	48	Expanding	14.2	14.3	19	4.3	1.9	FALSE	FALSE
670-005-011	10.8	30	30	Expanding	15.1	18.1	21.3	4.7	4.7	TRUE	FALSE
670-013				Expanding			22	4.2	4.7	FALSE	TRUE
671-011	12.3	62	56	Expanding	15	19.1	24.5	3.9	1.4	FALSE	TRUE
694-018	8.6	43	42	Expanding	12.6	18.1	21.8	5.4	3.4	FALSE	FALSE
717-012				Expanding			23.9	4.2	6.9	FALSE	FALSE
1202-010	9.6		33	Expanding	10.2	21.5	23.6	6	4.1	FALSE	FALSE
1203-010	13.7	33	28	Expanding	15.6	19.3	24.1	3.9	3.5	FALSE	TRUE

Table O-29. Baker Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Preform	Shape	Edge Rounding
28-014	N99,E52	80-90	Complete	Unbroken	Absent	None	Biface	Lanceolate	Present
28-013	N99,E52	80-90	Proximal	Indeterminate	Absent	None	Biface	Indeterminate	Present
95-018	N100,E51	80-90	Proximal	Use	Absent	Indeterminate	Biface	Indeterminate	Absent
117-021	N100,E53	90-100	Indeterminate	Use	Absent	None	Biface	Indeterminate	Absent
140-024	N100,E55	100-110	Proximal	Indeterminate	Absent	None	Flake	Lanceolate	Absent
229-019	N101,E54	110-120	Proximal	Use	Absent	Break Compensation	Biface	Indeterminate	Absent
346-023	N102,E56	110-120	Proximal	Use	Absent	Break Compensation	Biface	Lanceolate	Present
402-011	N103,E56	90-100	Proximal	Use	Absent	None	Biface	Triangular	Present
431-010	N105,E47	70-80	Complete	Unbroken	Absent	Break Compensation	Biface	Triangular	Present
462-015	N105,E53	47	Proximal	Use	Absent	None	Biface	Lanceolate	Present
569-013	N107,E50	40-50	Complete	Unbroken	Absent	Break Compensation	Biface	Triangular	Present
653-012*	N108,E53	0-10	Proximal	Use	Absent	Beveled Unifacial	Biface	Indeterminate	Absent

Cat. No.	Raw Material	Texture	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)
28-014	Chert	Fine	0	0	None	None	47.2		6.5
28-013	Chert	Fine	0	0	None	Burned			6.2
95-018	Chert	Fine	0	0	None	None			
117-021	Chert	Fine	0	0	None	None	50.9		
140-024	Chert	Fine	0	0	None	None	57		7.5
229-019	Chert	Fine	0	0	None	None			6.8
346-023	Chert	Fine	0	0	None	None			6.5
402-011	Chert	Fine	0	0	None	None			7.2
431-010	Chert	Fine	0	0	None	None	43.3		6.1
462-015	Chert	Fine	0	0	None	Heat-Treated			5.9
569-013	Chert	Fine	0	0	None	None	35.7		7.5
653-012*	Chert	Fine	0	0	None	None			7

Table O-29. Baker Point Data Continued

Cat. No.	Wt. (g)	Long X-Section	Trans X-Section	Flaking Pattern	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Shoulder Width (mm)
28-014	4.8	Tapered Base/Tip	Plano-Convex	Oblique Parallel	36.3	18.2	Straight	Straight	21
28-013		Indeterminate	Biconvex Symmetrical	Subparallel		18.9	Indeterminate	Excurvate	
95-018		Indeterminate	Biconvex Symmetrical	Indeterminate			Indeterminate	Indeterminate	
117-021		Tapered Base/Tip	Biconvex Symmetrical	Indeterminate	36		Excurvate	Indeterminate	
140-024	7.6	Wedge Base, Thick Body	Biconvex Symmetrical	Parallel	45.2	18.9	Straight	Straight	21.8
229-019		Indeterminate	Biconvex Symmetrical	Oblique Parallel		18.9	Straight	Indeterminate	
346-023	5.7	Tapered Base	Biconvex Symmetrical	Oblique Subparallel		17.9	Straight	Excurvate	21.6
402-011		Tapered Base/Tip	Biconvex Symmetrical	Subparallel		16.1	Straight	Straight	21.1
431-010	3.4	Tapered Base/Tip	Biconvex Symmetrical	Subparallel	29.4	16.5	Straight	Straight	21
462-015	5.7	Wedge Base, Flat	Biconvex Symmetrical	Oblique Subparallel			Straight	Straight	23.2
569-013	4.8	Bi-wedge-shaped	Biconvex Symmetrical	Subparallel	23.1	18.5	Straight	Excurvate	22.3
653-012*		Indeterminate	Biconvex Symmetrical	Oblique Subparallel		20.2	Indeterminate	Indeterminate	

Cat. No.	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)
28-014	1.9	2.2	7.3	7.1	62	46	Curved	10.9	15.8
28-013		1.9		11.4		63	Expanding	16.4	
95-018							Curved	17.3	13.7
117-021							Expanding	12.9	
140-024		4.8		12.2		25	Straight	11.8	15.2
229-019						38	Expanding	11.7	16.2
346-023	3.3	3.4	11.8	13.2	38	49	Expanding	13.6	13.5
402-011	2.2		8.5		49		Curved	14.2	12.9
431-010	3.5	1.8	9.8	8.7	57	49	Expanding	13.9	15.5
462-015	2.9	4	9.1	9.7	36	31	Straight	13.3	14.6
569-013	2.3	2.5	7.5	8.4	51	42	Expanding	12.6	16.1
653-012*		3.1		9.4		37	Curved	13.5	15.2

Table O-29. Baker Point Data Continued

Cat. No.	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
28-014	16.9	4	5	8.6	FALSE	FALSE
28-013	16.6	4.5	6.1	11	FALSE	FALSE
95-018	16.4	4.4	5.5	7.9	FALSE	FALSE
117-021			5.8		FALSE	TRUE
140-024		4	6.8		TRUE	FALSE
229-019		5.4	8.1		FALSE	FALSE
346-023	14.9	4.2	3.9	8.3	FALSE	FALSE
402-011		3.2	7		FALSE	TRUE
431-010	18.5	4.1	5.8	7.9	FALSE	FALSE
462-015	15.3	2.6	4.9	8.5	FALSE	TRUE
569-013	18.3	7	5	6.7	FALSE	FALSE
653-012*	16	5.7	5.3	8	FALSE	FALSE

* From Toyah component

Table O-30. Merrell Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Preform	Shape	Raw Material	Texture
117-020	N100,E53	90-100	Complete	Unbroken	Absent	Indeterminate	Biface	Triangular	Chert	Fine
157-011*	N101,E47	10-20	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
203-014	N101,E52	80-90	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
299-014	N102,E52	80-90	Proximal	Use	Absent	None	Biface	Triangular	Chert	Fine
345-028	N102,E56	100-110	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
463-021	N105,E53	50-60								
479-013	N105,E55	60-70	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
523-022	N106,E53	60-70	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
523-025	N106,E53	60-70	Proximal	Use	Absent	Break Compensation	Biface	Indeterminate	Chert	Fine
584-015	N107,E52	50-60	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
615-020	N107,E56	53	Complete	Use	Absent	Break Compensation	Biface	Lanceolate	Chert	Fine
658-016	N108,E53	50-60	Complete	Unbroken	Absent	Indeterminate	Biface	Triangular	Chert	Fine

Cat. No.	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Flaking Pattern
117-020	0	0	None	None	44.2	6.4	4.9	Tapered Base/Tip	Biconvex Symmetrical	Chevron
157-011*	0	0	None	Burned		6.4		Indeterminate	Biconvex Symmetrical	Indeterminate
203-014	0	0	None	None		6.6	5.2	Wedge Base, Flat	Biconvex Symmetrical	Subparallel
299-014	0	0	None	None		5.9		Wedge Base, Flat	Biconvex Symmetrical	Oblique Subparallel
345-028	0	0	None	None		8		Wedge Base, Thick Body	Biconvex Symmetrical	Oblique Subparallel
463-021										
479-013	0	0	None	None		7.3	5.1	Tapered Base/Tip	Biconvex Symmetrical	Oblique Parallel
523-022	0	0	None	Burned		7.2		Indeterminate	Biconvex Symmetrical	Indeterminate
523-025	0	0	None	Heat-Treated		6.6	4.7	Indeterminate	Plano-Convex	Subparallel
584-015	0	0	None	Burned		5.7		Indeterminate	Plano-Convex	Indeterminate
615-020	50	0	None	None	56.6	8.1	9.5	Bi-wedge-shaped	Biconvex Symmetrical	Subparallel
658-016	100	0	None	None	41.1	7.3	5.4	Tapered Base/Tip	Biconvex Symmetrical	Chevron

Table O-30. Merrell Point Data Continued

Cat. No.	Edge Rounding	Blade Length (mm)	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle
117-020	Absent	29.3	16.8	Straight	Straight	4.7	5.4	11.5	8.5	37
157-011*	Absent			Indeterminate	Indeterminate	3.3		8.7		90
203-014	Present		18.4	Straight	Straight	2.2	2.7	7.9	8.7	76
299-014	Present		17.3	Straight	Straight	5.5	5.3	8.5	8.5	68
345-028	Absent		17.7	Straight	Straight	3.3	2	9.6	6.2	41
463-021										
479-013	Absent		17.1	Straight	Straight	3.1	3.1	8.4	8.1	61
523-022	Absent		17.3	Indeterminate	Indeterminate	3	3.2	8.1	8.9	109
523-025	Absent		17.6	Indeterminate	Straight	4.2	3.1	7.5	8.3	66
584-015	Absent		14	Indeterminate	Indeterminate	3.4	1.7	6.7	7.6	66
615-020	Absent	43	18.8	Straight	Straight	3.1	1.6	9.4	8.4	60
658-016	Present	28	16.7	Straight	Straight	3.3	3.7	7.3	11.8	77

Cat. No.	Right Notch Angle	Stem Shape	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
117-020	55	Curved	14.9	15.3	20.2	4.3	6	7.7	FALSE	FALSE
157-011*	90	Curved	17.7	15	23.7	3.7	5.4	6.7	FALSE	TRUE
203-014	78	Expanding	14.3	15.5	20.9	5.4	6.5	8.2	FALSE	FALSE
299-014	67	Curved	13.9	11.4	20.7	4.7	3.9	8.6	FALSE	TRUE
345-028	70	Expanding		13.7		3.1			FALSE	TRUE
463-021									FALSE	FALSE
479-013	65	Expanding	11.7	15.6	21.3	4.5	5.9	11.8	FALSE	FALSE
523-022	80	Expanding	15.3	13.6	19.4	5.5	4.5	8.7	FALSE	FALSE
523-025	113	Expanding	14.9	15.7	22.2	5.2	5.8	10.5	FALSE	FALSE
584-015	79	Expanding	13	12.9	18.1	3.5	5.1	10.1	FALSE	FALSE
615-020	58	Expanding	13.6	15.1		4.1	3.9	9.1	FALSE	TRUE
658-016	64	Expanding	13.1	14.8	20.1	4.4	5.3	7	FALSE	FALSE

* Found in Toyah Component

Table O-31. Group 2 Point Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Preform	Shape	Raw Material	Texture
215-018	N101,E53	90-100	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
283-014	N102,E51	33	Complete	Use	Absent	Beveled Unifacial	Biface	Lanceolate	Chert	Fine
324-016*	N102,E55	50	Proximal	Use	Absent	None	Biface	Indeterminate	Chert	Fine
370-010	N103,E51	40.5	Proximal	Use	Absent	None	Biface	Lanceolate	Chert	Fine
412-011	N104,E47	80-90	Proximal	Use	Absent	Indeterminate	Biface	Lanceolate	Chert	Fine
412-010	N104,E47	80-90	Complete	Unbroken	Absent	None	Biface	Lanceolate	Chert	Fine
523-021	N106,E53	80	Complete	Unbroken	Absent	Beveled Bifacial	Biface	Triangular	Chert	Fine

Cat. No.	Percent Patination	Percent Cortex	Heating	Length (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Flaking Pattern	Edge Rounding
215-018	25	0	None		5.6	4.4	Flat	Biconvex Symmetrical	Subparallel	Present
283-014	0	0	Burned	61.3	7.6	13.4	Wedge Base, Flat	Biconvex Symmetrical	Random	Absent
324-016*	0	0	Heat-Treated		5.9		Indeterminate	Biconvex Symmetrical	Chevron	Absent
370-010	0	0	None		6.1		Flat	Biconvex Symmetrical	Subparallel	Present
412-011	0	0	None		8.5		Tapered Base/Tip	Biconvex Symmetrical	Oblique Subparallel	Absent
412-010	0	0	None	74.5	7	13.4	Wedge Base, Flat	Biconvex Asymmetrical	Chevron	Absent
523-021	0	0	None	49.7	5.5	5.6	Wedge Base, Flat	Plano-Convex	Chevron	Absent

Cat. No.	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Left Notch Depth (mm)	Right Notch Depth (mm)	Left Notch Width (mm)	Right Notch Width (mm)	Left Notch Angle	Right Notch Angle	Stem Shape
215-018	20.2	Straight	Excavate					62	31	Expanding
283-014	27.3	Excavate	Incurvate		6.9		5.7		49	Expanding
324-016*	25.5	Straight	Straight	7		4.5		43	29	Expanding
370-010	27.7	Straight	Straight	7.4		5.4		33		Expanding
412-011	25	Straight	Straight	9.5		9.1		33		Expanding
412-010	33	Straight	Straight	9.2	11.5	10.4	7.5	35	35	Expanding
523-021	21	Straight	Straight	10.6	10.9	7.4	7.4	37	32	Expanding

Table O-31. Group 2 Point Data Continued

Cat. No.	Stem Length (mm)	Distal Stem Width (mm)	Proximal Stem Width (mm)	Stem Thick (mm)	Base Depth (mm)	Base Notch Width (mm)	Micro-wear	NAA
215-018	9.1	9.5		4.9	1.8		FALSE	FALSE
283-014	12.9	20.2	29.3	3.9	4.1	19	TRUE	FALSE
324-016*	9.5	16.3	21.3	4.6	2.6	10.6	FALSE	TRUE
370-010	11.5	17.7	24.1	5.8	2.8	15.5	FALSE	FALSE
412-011	12.1	14	20.3	4	3.1	12.6	FALSE	TRUE
412-010	10.6	14.4	20.4	4.9	4.1	13.6	TRUE	FALSE
523-021	10.5	13.4	20.6	4.8	2	13.4	FALSE	FALSE

* From Toyah Component

Table O-32. Carrizo Point Data

Cat. No.	Unit	Depth (cmbd)	Feature No.	Condition	Break Type	Rejuvenation Scar	Resharpener Type	Raw Material	Texture	Percent Patination
213-012	N101,E53	70-80		Distal	Use	refits with #650-16	None	chert	Fine	100
391-010	N103,E55	120-130		Proximal	Use	Absent	None	Chert	Fine	0
650-016	N108,E52	40-50		Complete	Unbroken	Absent	None	Chert	Fine	100
670-005-012	N108,E55	49	23	Proximal	Use	Present	Break Compensation	Chert	Fine	0

Cat. No.	Percent Cortex	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Long X-Section	Trans X-Section	Preform	Shape
213-012	0	None								
391-010	0	Heat-Treated			6.8	12.4	Tapered Base/Tip	Biconvex Symmetrical	Biface	Lanceolate
650-016	0	None	70	27.9	7.7	13.6	Wedge Base, Flat	Plano-Convex	Flake	Lanceolate
670-005-012	0	None			7		Tapered Base/Tip	Biconvex Symmetrical	Biface	Lanceolate

Cat. No.	Flaking Pattern	Edge Rounding	Blade Width (mm)	Left Lateral Edge	Right Lateral Edge	Base Depth (mm)	Base Notch Width (mm)	NAA
213-012								FALSE
391-010	Oblique Parallel	Present	36.5	Straight	Straight	8.9	18.4	TRUE
650-016	Subparallel	Absent	27.7	Excurvate	Straight	6.1	6.2	TRUE
670-005-012	Subparallel	Absent	20.4	Indeterminate	Excurvate	4	8.2	TRUE

Table O-33. EA Biface Data

Cat. No.	8-026	8-027	8-030	8-029	8-028	18-023	18-026	18-022	18-025
Unit	N99,E50	N99,E50	N99,E50	N99,E50	N99,E50	N99,E51	N99,E51	N99,E51	N99,E51
Depth (cm)	70-80	70-80	77	70-80	70-80	80-90	85.5	80-90	84
Biface Stage	Middle	Middle	Late	Middle	Late	Early	Late	Middle	Late
Condition	Proximal	Distal	Distal	Complete	Proximal	Distal	Proximal	Proximal	Medial
Break Type	Indeterminate	Indeterminate	Use	Unbroken	Use	Manufacture	Use	Use	Use
Preform	Biface	Biface	Flake	Biface	Flake	Flake	Flake	Biface	Biface
Shape	Ovate	Indeterminate	Indeterminate	Ovate	Indeterminate	Ovate	Ovate	Indeterminate	Triangular
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Beveled Unifacial	None	None	None	None	Indeterminate	Indeterminate	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Coarse	Fine	Fine	Fine	Fine	Fine
Percent Patination	25	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	Burned	None	None	None	None	Heat-Treated	None	Burned	None
Length (mm)				124.3			75.2		
Width (mm)	46.2	38.3	39.2	44	44.5	35.7	40.3	42.5	30
Thick (mm)	19.6	19	7.8	26	12.3	14.8	11.2	18.5	10
Wt. (g)	61			135.2		31.6	32		16.5
Long X-Section	Indeterminate	Indeterminate	Flat	Bi-wedge-shaped	Indeterminate	Tapered Base	Tapered Base/Tip	Indeterminate	Flat
Trans X-Section	Biconvex Asymmetrical	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Random	Random	Oblique Subparallel	Random	Flake Blank Remnant	Random	Collateral	Random	Random
Edge Rounding	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent
Left Lateral Edge	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Straight	Excurvate	Indeterminate	Straight
Right Lateral Edge	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Excurvate	Straight	Indeterminate	Straight
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	18-027	19-016	19-015	28-010	28-011	29-018	38-011	39-010	39-016
Unit	N99,E51	N99,E51	N99,E51	N99,E52	N99,E52	N99,E52	N99,E53	N99,E53	N99,E53
Depth (cm)	90	90-100	90-100	80-90	80-90	90-100	80-90	90-100	90-100
Biface Stage	Early	Indeterminate	Late	Indeterminate	Early	Late	Indeterminate	Early	Late
Condition	Complete	Medial	Proximal	Medial	Complete	Complete	Indeterminate	Distal	Distal
Break Type	Unbroken	Thermal/ Crenated	Use	Indeterminate	Unbroken	Unbroken	Indeterminate	Use	Use
Preform	Biface	Indeterminate	Indeterminate	Biface	Biface	Flake	Indeterminate	Flake	Biface
Shape	Ovate	Indeterminate	Indeterminate	Indeterminate	Ovate	Ovate	Indeterminate	Indeterminate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Indeterminate	None	Indeterminate	None	Beveled Unifacial	Indeterminate	Indeterminate	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	25	0	0	0	0	50	0
Percent Cortex	0	0	50	0	0	0	0	50	0
Cortex Type	None	None	Pebble/ Cobble	None	None	None	None	Pebble/ Cobble	None
Heating	None	Burned	None	Indeterminate	Heat-Treated	None	None	None	Indeterminate
Length (mm)	128.4				95.5	54.5			
Width (mm)	84.7		53.9	42.6	66.4	29.9		38.8	
Thick (mm)	33.7	6.4	9.1	13.2	26.7	9.2		9.7	6.2
Wt. (g)	391.3				147.7	14.3			
Long X-Section	Tapered Base/Tip	Indeterminate	Flat	Indeterminate	Bi-wedge-shaped	Wedge Base, Flat	Indeterminate	Indeterminate	Indeterminate
Trans X-Section	Biconvex Asymmetrical	Indeterminate	Biconvex Symmetrical	Plano-Convex	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Random	Indeterminate	Oblique Subparallel	Indeterminate	Random	Oblique Subparallel	Indeterminate	Subparallel	Random
Edge Rounding	Absent	Absent	Present	Absent	Absent	Present	Present	Absent	Present
Left Lateral Edge	Excurvate	Indeterminate	Indeterminate	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Indeterminate
Right Lateral Edge	Excurvate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	49-011	49-012	50-016	50-014	50-015	61-016	61-015	62-010	75-015
Unit	N99,E54	N99,E54	N99,E54	N99,E54	N99,E54	N99,E55	N99,E55	N99,E55	N99,E56
Depth (cm)	90-100	90-100	100-110	100-110	100-110	90-100	90-100	100-110	100-110
Biface Stage	Late	Late	Indeterminate	Late	Middle	Early	Late	Indeterminate	Late
Condition	Distal	Complete	Proximal	Proximal	Distal	Complete	Distal	Indeterminate	Indeterminate
Break Type	Use	Unbroken	Thermal/ Crenated	Use	Indeterminate	Unbroken	Use	Indeterminate	Indeterminate
Preform	Flake	Biface	Indeterminate	Flake	Biface	Flake	Flake	Indeterminate	Flake
Shape	Teardrop	Lanceolate	Indeterminate	Lanceolate	Indeterminate	Lanceolate	Indeterminate	Indeterminate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Beveled Unifacial	None	Indeterminate	None	None	None	Indeterminate	Indeterminate	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	25	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	None	Burned	Burned	Burned	None	None	Burned	None
Length (mm)		110.2				65.2			
Width (mm)		43		22.3	11.2	26.4			
Thick (mm)	6.8	17.4		6.8		11.4	4.7		9.2
Wt. (g)		76.5				14.8			
Long X-Section	Flat	Tapered Base/Tip	Indeterminate	Flat	Indeterminate	Tapered Base/Tip	Flat	Indeterminate	Indeterminate
Trans X-Section	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex
Flaking Pattern	Oblique Parallel	Parallel	Indeterminate	Oblique Subparallel	Indeterminate	Random	Indeterminate	Indeterminate	Indeterminate
Edge Rounding	Absent	Present	Absent	Present	Absent	Absent	Absent	Present	Present
Left Lateral Edge	Excurvate	Straight	Indeterminate	Straight	Indeterminate	Straight	Excurvate	Indeterminate	Indeterminate
Right Lateral Edge	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate	Excurvate	Indeterminate	Indeterminate	Indeterminate
Micro-wear	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	75-016	77-016	85-012	85-020	85-019	86-011	86-021	86-010	94-013
Unit	N99,E56	N99,E56	N100,E50	N100,E50	N100,E50	N100,E50	N100,E50	N100,E50	N100,E51
Depth (cm)	100-110	120-130	70-80	70-80	70-80	80-90	80-90	80-90	70-80
Biface Stage	Middle	Late	Late	Late	Early	Indeterminate	Late	Early	Late
Condition	Indeterminate	Proximal	Medial	Distal	Proximal	Medial	Distal	Complete	Proximal
Break Type	Indeterminate	Use	Use	Manufacture	Indeterminate	Thermal/ Crenated	Manufacture	Unbroken	Indeterminate
Preform	Biface	Flake	Biface	Flake	Biface	Indeterminate	Flake	Flake	Flake
Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Ovate	Bipointed	Indeterminate
Rejuvenation Scar	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	None	None	Indeterminate	Beveled Unifacial	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	50	0	75	0	75
Percent Cortex	0	0	0	0	0	0	0	25	0
Cortex Type	None	None	None	None	Pebble/ Cobble	None	None	Pebble/Cobble	None
Heating	None	None	None	Heat-Treated	None	Burned	Burned	None	None
Length (mm)								67.7	
Width (mm)	32.4	39	8.5	21.1	46.7		23.6	34.1	
Thick (mm)	17.7	8.7		7.5		6.2	4.6	19.1	10
Wt. (g)		25.5						35	
Long X-Section	Indeterminate	Flat	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flat	Tapered Base/Tip	Indeterminate
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical	Biconvex Asymmetrical	Plano-Convex
Flaking Pattern	Random	Random	Random	Oblique Parallel	Flake Blank Remnant	Indeterminate	Oblique Parallel	Flake Blank Remnant	Oblique Subparallel
Edge Rounding	Absent	Absent	Present	Present	Present	Present	Present	Absent	Present
Left Lateral Edge	Straight	Straight	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate
Right Lateral Edge	Excurvate	Indeterminate	Excurvate	Excurvate	Indeterminate	Indeterminate	Excurvate	Excurvate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	95-017	95-013	105-017	106-016	116-018	116-019	117-024	117-017	117-022
Unit	N100,E51	N100,E51	N100,E52	N100,E52	N100,E53	N100,E53	N100,E53	N100,E53	N100,E53
Depth (cm)	80-90	80-90	80-90	90-100	80-90	80-90	90-100	90-100	90-100
Biface Stage	Late	Indeterminate	Middle	Late	Indeterminate	Late		Middle	
Condition	Distal	Medial	Medial	Distal	Medial	Complete		Medial	
Break Type	Use	Indeterminate	Indeterminate	Use	Thermal/ Crenated	Unbroken		Indeterminate	
Preform	Flake	Indeterminate	Biface	Flake	Indeterminate	Flake		Biface	
Shape	Indeterminate	Indeterminate	Indeterminate	Ovate	Indeterminate	Lanceolate		Indeterminate	
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent		Absent	
Resharpener Type	Indeterminate	Indeterminate	None	Beveled Unifacial	Indeterminate	None		Indeterminate	
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert		Chert	
Texture	Fine	Fine	Fine	Fine	Fine	Fine		Fine	
Percent Patination	0	0	0	75	0	0		0	
Percent Cortex	0	0	0	0	0	0		0	
Cortex Type	None	None	None	None	None	None		None	
Heating	None	None	None	None	Burned	None		None	
Length (mm)						65.4			
Width (mm)				37.9		21.3			
Thick (mm)	4.6		16.3	7.2		9.2		14.2	
Wt. (g)						14			
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Flat	Indeterminate	Tapered Base/Tip		Indeterminate	
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex		Biconvex Symmetrical	
Flaking Pattern	Collateral	Indeterminate	Random	Flake Blank Remnant	Indeterminate	Collateral		Random	
Edge Rounding	Present	Present	Absent	Present	Present	Absent		Absent	
Left Lateral Edge	Indeterminate	Indeterminate	Excurvate	Straight	Indeterminate	Straight		Excurvate	
Right Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Straight		Indeterminate	
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	117-023	129-010	139-018	140-022	142-012	152-016	152-015	152-017	154-024
Unit	N100,E53	N100,E54	N100,E55	N100,E55	N100,E55	N100,E56	N100,E56	N100,E56	N100,E56
Depth (cm)	90-100	110-120	90-100	100-110	120-130	90-100	90-100	90-100	110-120
Biface Stage	Late	Late	Late	Late	Middle	Late	Late	refit to 162-16	Late
Condition	Proximal	Distal	Distal	Proximal	Complete	Proximal	Medial		Complete
Break Type	Indeterminate	Use	Use	Manufacture	Unbroken	Thermal/Crenated	Indeterminate		Unbroken
Preform	Biface	Flake	Flake	Flake	Biface	Biface	Indeterminate		Biface
Shape	Lanceolate	Triangular	Triangular	Indeterminate	Ovate	Teardrop	Indeterminate		Triangular
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent		Absent
Resharpener Type	None	None	None	None	None	None	Break Compensation		None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert		Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine		Fine
Percent Patination	0	0	25	0	0	0	0		0
Percent Cortex	0	0	0	0	0	0	25		0
Cortex Type	None	None	None	None	None	None	Pebble/Cobble		None
Heating	None	None	None	None	None	Burned	None		None
Length (mm)					90				78
Width (mm)	25		33.1		42.9	28.6			44.6
Thick (mm)	8.8		5.4	5.8	19.2	9.3	7.6		16.1
Wt. (g)			6.1		65.5	13.3			55.4
Long X-Section	Tapered Base/Tip	Indeterminate	Flat	Indeterminate	Tapered Base/Tip	Bi-wedge-shaped	Indeterminate		Wedge Base, Thick Body
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate		Biconvex Symmetrical
Flaking Pattern	Oblique Subparallel	Flake Blank Remnant	Oblique Parallel	Oblique Parallel	Random	Subparallel	Indeterminate		Parallel
Edge Rounding	Absent	Absent	Present	Present	Absent	Present	Present		Present
Left Lateral Edge	Straight	Straight	Straight	Indeterminate	Excurvate	Straight	Indeterminate		Excurvate
Right Lateral Edge	Straight	Straight	Straight	Indeterminate	Incurvate	Excurvate	Indeterminate		Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	165-015	184-017	193-020	193-017	202-012	202-011	203-013	203-015	204-017
Unit	N101,E47	N101,E50	N101,E51	N101,E51	N101,E52	N101,E52	N101,E52	N101,E52	N101,E52
Depth (cm)	80-90	80-90	80-90	80-90	70-80	70-80	80-90	80-90	90-100
Biface Stage	Late	Late	Late	Late	Late	Late	Late	Late	Late
Condition	Medial	Distal	Medial	Indeterminate	Proximal	Distal	Medial	Complete	Complete
Break Type	Use	Indeterminate	Use	Thermal/ Crenated	Use	Use	Thermal/ Crenated	Unbroken	Unbroken
Preform	Biface	Flake	Flake	Indeterminate	Flake	Biface	Indeterminate	Flake	Biface
Shape	Lanceolate	Indeterminate	Indeterminate	Indeterminate	Ovate	Triangular	Indeterminate	Lanceolate	Teardrop
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Beveled Unifacial	Beveled Unifacial	Indeterminate	Indeterminate	Alternate Beveled Unifacial	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	75	0	0	0	0	0	100	0
Percent Cortex	0	25	0	0	25	0	0	25	0
Cortex Type	None	Pebble /Cobble	None	None	Pebble/ Cobble	None	None	Pebble/ Cobble	None
Heating	None	Heat-Treated	None	Burned	None	None	Burned	None	None
Length (mm)								79.8	57.5
Width (mm)	19.5	30.6			39.3	36.6		22.4	36.8
Thick (mm)	9.2	7.5	6.7		8.8	8.6		8.9	12.2
Wt. (g)	9.2					14.6		15.1	22.1
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flat	Wedge Base, Flat
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex	Biconvex Symmetrical	Indeterminate	Plano-Convex	Biconvex Asymmetrical
Flaking Pattern	Oblique Parallel	Collateral	Flake Blank Remnant	Indeterminate	Flake Blank Remnant	Chevron	Indeterminate	Random	Chevron
Edge Rounding	Absent	Present	Absent	Absent	Present	Absent	Absent	Absent	Present
Left Lateral Edge	Straight	Straight	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Straight	Excurvate
Right Lateral Edge	Straight	Excurvate	Straight	Indeterminate	Indeterminate	Excurvate	Indeterminate	Straight	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	205-010	215-010	215-023	215-022	216-011	229-015	242-015	242-013	255-032
Unit	N101,E52	N101,E53	N101,E53	N101,E53	N101,E53	N101,E54	N101,E55	N101,E55	N101,E56
Depth (cm)	100-110	90-100	90-100	90-100	100-110	110-120	110-120	110-120	110-120
Biface Stage	Late	Early	Late	Late	Late	Late	Late	Late	Late
Condition	Distal	Complete	Medial	Indeterminate	Distal	Indeterminate	Complete	Distal	Distal
Break Type	Indeterminate	Unbroken	Indeterminate	Use	Use	Use	Unbroken	Thermal/ Crenated	Use
Preform	Biface	Biface	Flake	Biface	Flake	Flake	Biface	Flake	Biface
Shape	Teardrop	Irregular	Indeterminate	Indeterminate	Triangular	Indeterminate	Ovate	Triangular	Ovate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	Indeterminate	Indeterminate	None	Indeterminate	None	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	Indeterminate	None	Burned	None
Length (mm)	70.6	83.7					74.3		
Width (mm)	46.6	51.3			29		37	27.1	54.6
Thick (mm)	9.6	16.4	6.7	7.7	9.1		17.1	8.2	9.5
Wt. (g)		57.2			9.7		40.3		29.2
Long X-Section	Tapered Base/Tip	Bi-wedge-shaped	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip	Indeterminate	Flat
Trans X-Section	Biconvex Symmetrical	Biconvex Asymmetrical	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Parallel	Random	Random	Indeterminate	Chevron	Indeterminate	Random	Subparallel	Chevron
Edge Rounding	Absent	Absent	Absent	Present	Present	Present	Present	Absent	Present
Left Lateral Edge	Excurvate	Excurvate	Indeterminate	Indeterminate	Straight	Straight	Excurvate	Straight	Excurvate
Right Lateral Edge	Excurvate	Excurvate	Indeterminate	Indeterminate	Straight	Straight	Straight	Straight	Excurvate
Micro-wear	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	205-010	215-010	215-023	215-022	216-011	229-015	242-015	242-013	255-032

Table O-33. EA Biface Data Continued

Cat. No.	255-012	268-017	268-025	268-023	268-024	268-027	278-011	278-010	278-028
Unit	N101,E56	N102,E47	N102,E47	N102,E47	N102,E47	N102,E47	N102,E50	N102,E50	N102,E50
Depth (cm)	110-120	80-90	80-90	80-90	80-90	80-90	80-90	80-90	80-90
Biface Stage	Indeterminate	Indeterminate	Late	Early	Late	Late	Late	Middle	refit to 278-11
Condition	Indeterminate	Medial	Distal	Proximal	Medial	Distal	Medial	Proximal	
Break Type	Indeterminate	Thermal/Crenated	Use	Thermal/Crenated	Thermal/Crenated	Use	Thermal/Crenated	Indeterminate	
Preform	Indeterminate	Biface	Biface	Biface	Flake	Biface	Biface	Biface	
Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Triangular	Lanceolate	Ovate	
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	
Resharpener Type	Indeterminate	None	None	Indeterminate	Indeterminate	None	None	None	
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	
Percent Patination	0	0	0	0	0	50	25	0	
Percent Cortex	0	0	0	0	0	0	0	0	
Cortex Type	None	None	None	None	None	None	None	None	
Heating	None	Burned	Burned	Burned	Burned	None	Burned	None	
Length (mm)								84.6	
Width (mm)				17.7			28.8		
Thick (mm)		14				8.8	9.6	14.1	
Wt. (g)							17.5		
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Wedge Base, Flat	Indeterminate	
Trans X-Section	Indeterminate	Plano-Convex	Biconvex Symmetrical	Indeterminate	Indeterminate	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	
Flaking Pattern	Indeterminate	Indeterminate	Oblique Subparallel	Indeterminate	Indeterminate	Subparallel	Indeterminate	Random	
Edge Rounding	Absent	Absent	Present	Absent	Absent	Present	Present	Absent	
Left Lateral Edge	Indeterminate	Indeterminate	Excurvate	Indeterminate	Straight	Excurvate	Straight	Indeterminate	
Right Lateral Edge	Indeterminate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Straight	Straight	Excurvate	
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	278-012	289-025	289-024	288-011	289-013	289-019	299-012	300-016	300-017
Unit	N102,E50	N102,E51	N102,E51	N102,E51	N102,E51	N102,E51	N102,E52	N102,E52	N102,E52
Depth (cm)	80-90	90-100	90-100	80-90	90-100	90-100	80-90	90-100	90-100
Biface Stage	Late	Late	Late	Late	Late	Middle	Late	Late	Late
Condition	Distal	Proximal	Medial	Medial	Distal	Complete	Medial	Distal	Complete
Break Type	Use	Use	Use	Indeterminate	Indeterminate	Unbroken	Thermal/ Crenated	Use	Thermal/ Crenated
Preform	Flake	Biface	Flake	Indeterminate	Biface	Biface	Flake	Flake	Indeterminate
Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Irregular	Indeterminate	Indeterminate	Ovate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Indeterminate	Indeterminate	Indeterminate	None	None	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	50	50	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	25	0	0	0	0
Cortex Type	None	None	None	None	Pebble/ Cobble	None	None	None	None
Heating	Burned	None	None	None	Indeterminate	None	Burned	None	Burned
Length (mm)						86.6			59
Width (mm)		40.1				52.6			33.8
Thick (mm)		8.2	6.1	6	7.6	18.2		4.3	7.7
Wt. (g)						80.5			12.7
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base	Indeterminate	Flat	Flat
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Chevron	Random	Subparallel	Subparallel	Flake Blank Remnant	Random	Subparallel	Oblique Subparallel	Random
Edge Rounding	Present	Absent	Present	Absent	Absent	Absent	Present	Absent	Absent
Left Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate
Right Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	300-018	312-018	312-014	323-019	333-024	333-021	333-023	333-025	334-017
Unit	N102,E52	N102,E53	N102,E53	N102,E54	N102,E55	N102,E55	N102,E55	N102,E55	N102,E55
Depth (cm)	90-100	100-110	100-110	120-130	130-140	130-140	130-140	130-140	140-150
Biface Stage	Late	Late	Late	Late	Late	Indeterminate	Late	Late	Late
Condition	Distal	Complete	Distal	Medial	Proximal	Indeterminate	Proximal	Medial	Medial
Break Type	Use	Unbroken	Thermal/ Crenated	Indeterminate	Use	Indeterminate	Use	Indeterminate	Indeterminate
Preform	Flake	Flake	Flake	Indeterminate	Flake	Indeterminate	Flake	Biface	Biface
Shape	Indeterminate	Teardrop	Indeterminate	Indeterminate	Lanceolate	Indeterminate	Lanceolate	Indeterminate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Beveled Unifacial	None	Indeterminate	None	None	Indeterminate	None	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	25	0	0	0	0	0	0	25
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	Heat-Treated	None	Burned	None	None	Burned	None	None	None
Length (mm)		73.5							
Width (mm)	50.3	45.8			25.7		23.8	42.1	
Thick (mm)	9.1	12.1		8.7	7.4		7.4	16.1	7.7
Wt. (g)	27.5	37.6							
Long X-Section	Flat	Wedge Base, Flat	Indeterminate	Indeterminate	Flat	Indeterminate	Flat	Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Asymmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Indeterminate	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical
Flaking Pattern	Random	Random	Indeterminate	Random	Subparallel	Indeterminate	Oblique Parallel	Random	Indeterminate
Edge Rounding	Present	Present	Absent	Present	Absent	Absent	Absent	Present	Absent
Left Lateral Edge	Excurvate	Excurvate	Indeterminate	Indeterminate	Straight	Indeterminate	Straight	Excurvate	Indeterminate
Right Lateral Edge	Excurvate	Excurvate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Straight	Indeterminate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	334-014	345-029	345-015	366-012	375-017	391-016	400-012	401-035	402-016
Unit	N102,E55	N102,E56	N102,E56	N103,E51	N103,E51	N103,E55	N103,E56	N103,E56	N103,E56
Depth (cm)	140-150	100-110	100-110	90-100	80-90	120-130	70-80	80-90	90-100
Biface Stage	Late	Late	Late	Late	Late	Late	Middle	Late	Middle
Condition	Proximal	Indeterminate	Proximal	Indeterminate	Distal	Proximal	Indeterminate	Complete	Complete
Break Type	Use	Indeterminate	Thermal/ Crenated	Indeterminate	Use	Indeterminate	Indeterminate	Unbroken	Unbroken
Preform	Indeterminate	Flake	Flake	Flake	Biface	Biface	Biface	Indeterminate	Biface
Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Lanceolate	Lanceolate	Indeterminate	Ovate	Ovate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	Indeterminate	None	None	None	None	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	50	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	Burned	None	Burned	None	None	None	Heat-Treated	None	None
Length (mm)								68.6	89.8
Width (mm)					28.4	36.1		32.8	37.8
Thick (mm)		7.9	5.9	5.6	8.7	9.2	13.1	10.2	16.2
Wt. (g)					8.7	21		20.6	53.2
Long X-Section	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip	Flat	Indeterminate	Wedge Base, Flat	Wedge Base, Thick Body
Trans X-Section	Plano-Convex	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Biconvex Asymmetrical	Biconvex Asymmetrical	Biconvex Asymmetrical
Flaking Pattern	Indeterminate	Subparallel	Indeterminate	Oblique Subparallel	Subparallel	Random	Collateral	Oblique Subparallel	Random
Edge Rounding	Absent	Absent	Present	Absent	Present	Present	Absent	Absent	Absent
Left Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Straight	Excurvate	Excurvate	Excurvate	Excurvate
Right Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate	Straight	Excurvate	Excurvate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	402-013	402-014	402-017	403-012	411-018	421-034	422-019	422-014	422-017
Unit	N103,E56	N103,E56	N103,E56	N103,E56	N104,E47	N104,E56	N104,E56	N104,E56	N104,E56
Depth (cm)	90-100	90-100	90-100	100-110	70-80	80-90	90-100	90-100	90-100
Biface Stage	Late	Late	refit to 403-12	Late	Late	Middle	Late	Late	Middle
Condition	Proximal	Proximal		Complete	Proximal	Complete	Proximal	Medial	Complete
Break Type	Indeterminate	Indeterminate		Unbroken	Thermal/ Crenated	Unbroken	Use	Thermal/ Crenated	Unbroken
Preform	Indeterminate	Biface		Flake	Indeterminate	Biface	Biface	Indeterminate	Biface
Shape	Indeterminate	Indeterminate		Ovate	Indeterminate	Ovate	Triangular	Indeterminate	Ovate
Rejuvenation Scar	Absent	Absent		Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Indeterminate		None	Indeterminate	None	None	Indeterminate	None
Raw Material	Chert	Chert		Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine		Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	25		0	0	25	25	0	25
Percent Cortex	0	0		0	0	0	0	0	0
Cortex Type	None	None		None	None	None	None	None	None
Heating	None	None		None	Burned	None	None	Burned	None
Length (mm)				83.1		66.6			54.1
Width (mm)	36.4	50.5		41.7		36.2	52.1		26.7
Thick (mm)	7.9	8.7		7.9	6.5	18.5	12.4		12.7
Wt. (g)				34.3		41.9	53.5		20.6
Long X-Section	Indeterminate	Indeterminate		Flat	Indeterminate	Tapered Base/Tip	Tapered Base/Tip	Indeterminate	Bi-wedge-shaped
Trans X-Section	Biconvex Symmetrical	Biconvex Symmetrical		Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical
Flaking Pattern	Oblique Subparallel	Indeterminate		Random	Indeterminate	Random	Random	Indeterminate	Random
Edge Rounding	Absent	Present		Present	Present	Absent	Absent	Present	Absent
Left Lateral Edge	Indeterminate	Indeterminate		Excurvate	Indeterminate	Excurvate	Straight	Excurvate	Excurvate
Right Lateral Edge	Indeterminate	Indeterminate		Excurvate	Indeterminate	Excurvate	Excurvate	Indeterminate	Straight
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	432-011	447-016	447-017	455-017	457-010	463-022	464-017	465-011	469-012
Unit	N105,E47	N105,E51	N105,E51	N105,E52	N105,E52	N105,E53	N105,E53	N105,E53	N105,E54
Depth (cm)	80-90	60-70	60-70	50-60	70-80	50-60	60-70	76	30-40
Biface Stage	Late	Late	Late	Late	Late	Late	Late	Late	Late
Condition	Proximal	Complete	Distal	Complete	Proximal	Complete	Complete	Proximal	Indeterminate
Break Type	Manufacture	Unbroken	Use	Use	Use	Use	Use	Indeterminate	Indeterminate
Preform	Biface	Flake	Biface	Flake	Biface	Flake	Flake	Flake	Flake
Shape	Indeterminate	Triangular	Indeterminate	Ovate	Indeterminate	Triangular	Ovate	Indeterminate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	None	None	None	None	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None	Heat-Treated
Length (mm)		51.6		60.3		33.9	59.1		
Width (mm)		31.4	34.4	34.3	23.7	33.8	33.4	42.5	
Thick (mm)	22.4	7.3	17.1	9.6	8.6	5.1	10.5	7.4	
Wt. (g)		10		21.3		6.5	23.6		
Long X-Section	Indeterminate	Flat	Indeterminate	Flat	Indeterminate	Flat	Wedge Base, Flat	Indeterminate	Indeterminate
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Asymmetrical	Biconvex Asymmetrical	Biconvex Asymmetrical	Plano-Convex	Plano-Convex
Flaking Pattern	Random	Chevron	Collateral	Random	Random	Chevron	Oblique Subparallel	Random	Indeterminate
Edge Rounding	Absent	Absent	Present	Absent	Absent	Absent	Absent	Present	Present
Left Lateral Edge	Indeterminate	Incurvate	Straight	Excurvate	Indeterminate	Straight	Excurvate	Indeterminate	Indeterminate
Right Lateral Edge	Indeterminate	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Excurvate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	470-013	472-013	500-012	502-017	508-013	515-023	516-015	521-014	523-024
Unit	N105,E54	N105,E54	N106,E50	N106,E50	N106,E51	N106,E52	N106,E52	N106,E53	N106,E53
Depth (cm)	40-50	70	40-50	60-70	50-60	50-60	60-70	40-50	60-70
Biface Stage	Late	Late	Late	Late	Middle	Middle	Middle	Late	Late
Condition	Distal	Complete	Distal	Proximal	Medial	Distal	Complete	Complete	Proximal
Break Type	Use	Unbroken	Use	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Unbroken	Indeterminate
Preform	Flake	Flake	Biface	Indeterminate	Biface	Biface	Flake	Indeterminate	Indeterminate
Shape	Indeterminate	Triangular	Indeterminate	Indeterminate	Indeterminate	Ovate	Ovate	Triangular	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	None	Indeterminate	Indeterminate	None	Break Compensation	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	25	25	50	0	0	0	0	0
Percent Cortex	50	0	0	0	0	0	0	0	0
Cortex Type	Pebble/Cobble	None	None	None	None	None		None	None
Heating	None	None	None	None	Burned	None	None	None	None
Length (mm)		58.9					81.5	65	
Width (mm)	30.7	36.5	38.8	46.2			50.6	33.3	
Thick (mm)	7.9	8.6	22.5	8.7	10.9	14	15.6	9.2	8.4
Wt. (g)		15.9					64.9	19.1	
Long X-Section	Flat	Wedge Base, Flat	Indeterminate	Flat	Indeterminate	Indeterminate	Wedge Base, Thick Body	Flat	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Asymmetrical	Biconvex Asymmetrical	Plano-Convex	Indeterminate	Indeterminate	Biconvex Asymmetrical	Plano-Convex	Plano-Convex
Flaking Pattern	Flake Blank Remnant	Subparallel	Chevron	Random	Flake Blank Remnant	Random	Random	Subparallel	Random
Edge Rounding	Absent	Present	Absent	Absent	Absent	Absent	Present	Absent	Absent
Left Lateral Edge	Excurvate	Straight	Straight	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate
Right Lateral Edge	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Excurvate	Excurvate	Straight	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	523-023	530-018	530-016	531-020	539-016	539-017	546-010	552-017	563-019
Unit	N106,E53	N106,E54	N106,E54	N106,E54	N106,E55	N106,E55	N106,E56	N107,E47	N107,E49
Depth (cm)	60-70	80-90	80-90	90-100	60-70	60-70	40-50	40-50	40-50
Biface Stage	Late	Late	Middle	Late	Late	Late	Late	Late	Late
Condition	Complete	Proximal	Medial	Proximal	Medial	Distal	Proximal	Indeterminate	Complete
Break Type	Unbroken	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Use	Indeterminate	Use	Use
Preform	Biface	Indeterminate	Indeterminate	Indeterminate	Biface	Biface	Indeterminate	Biface	Flake
Shape	Triangular	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Triangular	Indeterminate	Indeterminate	Teardrop
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	Indeterminate	Indeterminate	Indeterminate	Indeterminate	None	Indeterminate	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	25	0	25	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None		None	None
Heating	None	None	Burned	None	None	None	None	None	None
Length (mm)	79.6								66.5
Width (mm)	35.3	40.9				49.8		62	35.4
Thick (mm)	16.1	7.9	8.2	9.2		9		14.5	7.8
Wt. (g)	40.2					42.2		76.6	19.1
Long X-Section	Wedge Base, Thick Body	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flat	Indeterminate	Indeterminate	Tapered Base/Tip
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate	Plano-Convex	Plano-Convex	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Random	Indeterminate	Indeterminate	Random	Oblique Parallel	Collateral	Random	Random	Random
Edge Rounding	Absent	Absent	Absent	Absent	Present	Present	Present	Present	Present
Left Lateral Edge	Straight	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate	Indeterminate	Indeterminate	Excurvate
Right Lateral Edge	Straight	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	563-018	570-010	577-013	590-015	591-021	591-024	598-014	598-013	606-011
Unit	N107,E49	N107,E50	N107,E51	N107,E53	N107,E53	N107,E53	N107,E54	N107,E54	N107,E55
Depth (cm)	40-50	50-60	50-60	40-50	50-60	50-60	80-90	80-90	50-60
Biface Stage	Middle	Middle	Late	Middle	Late	Middle	Late	Late	Late
Condition	Indeterminate	Complete	Proximal	Complete	Proximal	Complete	Indeterminate	Complete	Distal
Break Type	Indeterminate	Thermal/ Crenated	Indeterminate	Unbroken	Indeterminate	Unbroken	Indeterminate	Unbroken	Thermal/ Crenated
Preform	Biface	Biface	Indeterminate	Biface	Flake	Flake	Flake	Flake	Indeterminate
Shape	Indeterminate	Ovate	Indeterminate	Triangular	Lanceolate	Teardrop	Indeterminate	Ovate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	None	Indeterminate	None	None	None	None	Break Compensation	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	25	0	25	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	Burned	None	Burned	None	None	None	None	Burned
Length (mm)		89.1		61.6		53.3			
Width (mm)		63.7		35.1	21.6	22.9	35.6	31.9	
Thick (mm)	17.6	19.7	8.6	12.3	7.9	6.6	9	9	
Wt. (g)		94.8		24.7		8.1		15.2	
Long X-Section	Indeterminate	Bi-wedge-shaped	Indeterminate	Tapered Base/Tip	Flat	Wedge Base, Thick Body	Indeterminate	Tapered Base/Tip	Indeterminate
Trans X-Section	Indeterminate	Biconvex Symmetrical	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Biconvex Asymmetrical	Biconvex Asymmetrical	Biconvex Symmetrical	Biconvex Symmetrical
Flaking Pattern	Random	Indeterminate	Indeterminate	Indeterminate	Oblique Subparallel	Random	Collateral	Random	Indeterminate
Edge Rounding	Absent	Absent	Absent	Absent	Absent	Present	Present	Present	Absent
Left Lateral Edge	Indeterminate	Excurvate	Indeterminate	Straight	Straight	Excurvate	Indeterminate	Excurvate	Indeterminate
Right Lateral Edge	Indeterminate	Excurvate	Indeterminate	Excurvate	Straight	Excurvate	Indeterminate	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	615-017	615-018	615-016	622-020	622-021	623-011	627-012	628-015	638-014
Unit	N107,E56	N107,E56	N107,E56	N108,E47	N108,E47	N108,E47	N108,E48	N108,E48	N108,E50
Depth (cm)	50-60	50-60	50-60	40-50	40-50	50-60	30-40	40-50	47
Biface Stage	Middle	Middle	Late	Middle	Late	Late	Late	Late	Middle
Condition	Complete	Medial	Distal	Proximal	Proximal	Medial	Distal	Distal	Proximal
Break Type	Unbroken	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Use	Use	Use	Indeterminate
Preform	Flake	Biface	Flake	Biface	Biface	Flake	Indeterminate	Indeterminate	Biface
Shape	Teardrop	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Triangular	Indeterminate	Indeterminate	Quadrilateral
Rejuvenation Scar	Present	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	Indeterminate	None	None	Beveled Unifacial	None	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	25	0	25	0	25	0	100	0	0
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	None	None	None	None	None	None	None	None
Length (mm)	58.2	43.4							47.5
Width (mm)	33.3	77.5			29.1		35.4		44.6
Thick (mm)	10.4	18.1	7.7	11.4	8.5	4.1	8.2	7.1	14.9
Wt. (g)	20.6				12.9	1.8			
Long X-Section	Wedge Base, Thick Body	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Flat	Indeterminate	Indeterminate	Indeterminate
Trans X-Section	Biconvex Symmetrical	Biconvex Asymmetrical	Plano-Convex	Indeterminate	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Plano-Convex	Plano-Convex
Flaking Pattern	Random	Random	Random	Random	Oblique Subparallel	Oblique Parallel	Oblique Subparallel	Chevron	Random
Edge Rounding	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Left Lateral Edge	Straight	Excurvate	Indeterminate	Indeterminate	Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Right Lateral Edge	Excurvate	Excurvate	Excurvate	Indeterminate	Excurvate	Straight	Indeterminate	Indeterminate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	664-016	664-017	670-005-014	677-012	677-015	689-012	689-022	698-014	699-020
Unit	N108,E54	N108,E54	N108,E55	N108,E56	N108,E56	N109,E48	N109,E48	N109,E50	N109,E50
Depth (cm)	40-50	40-50	50	50-60	50-60	40-50	40-50	30-40	44
Biface Stage	Late	Middle	Middle	Late	Late	Late	Middle	Late	Late
Condition	Medial	Complete	Complete	Proximal	Distal	Proximal	Proximal	Medial	Proximal
Break Type	Use	Unbroken	Unbroken	Indeterminate	Indeterminate	Use	Indeterminate	Use	Use
Preform	Biface	Biface	Biface	Flake	Flake	Indeterminate	Biface	Biface	Biface
Shape	Indeterminate	Ovate	Ovate	Indeterminate	Indeterminate	Indeterminate	Lanceolate	Indeterminate	Teardrop
Rejuvenation Scar	Absent	Present	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None	Beveled Unifacial	Alternate Beveled Unifacial	Indeterminate	None	Indeterminate	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	100	100	50	25
Percent Cortex	0	0	0	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None	None	None	None
Heating	None	None	None	None	Heat-Treated	None	None	None	None
Length (mm)		83.7	78.3						
Width (mm)	52	35	60.1	35.3	36.3		35.7		
Thick (mm)	10.1	19.7	17.5	11.6	8.5	7.8	13.2	8.9	9.6
Wt. (g)		47.9	93.1		18.6		28.1		
Long X-Section	Indeterminate	Tapered Base/Tip	Tapered Base/Tip	Indeterminate	Wedge Base, Flat	Indeterminate	Bi-wedge-shaped	Indeterminate	Indeterminate
Trans X-Section	Biconvex Symmetrical	Plano-Convex	Biconvex Asymmetrical	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical
Flaking Pattern	Collateral	Random	Random	Random	Oblique Subparallel	Indeterminate	Collateral	Random	Random
Edge Rounding	Present	Absent	Absent	Present	Present	Absent	Present	Present	Present
Left Lateral Edge	Indeterminate	Excurvate	Excurvate	Excurvate	Excurvate	Indeterminate	Straight	Indeterminate	Excurvate
Right Lateral Edge	Indeterminate	Excurvate	Excurvate	Excurvate	Excurvate	Indeterminate	Straight	Excurvate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	699-018	699-019	705-012	718-013	724-024	725-013	725-012	729-011	734-010
Unit	N109,E50	N109,E50	N109,E51	N109,E52	N109,E53	N109,E53	N109,E53	N109,E54	N109,E55
Depth (cm)	40-50	43	70-80	40-50	40-50	50-65	50-65	30-40	25-52
Biface Stage	Late	Late	Middle		Late	Late	Late	Late	Late
Condition	Distal	Proximal	Proximal		Distal	Distal	Distal	Proximal	Proximal
Break Type	Indeterminate	Use	Indeterminate		Use	Use	Manufacture	Indeterminate	Thermal/ Crenated
Preform	Flake	Indeterminate	Biface		Flake	Flake	Biface	Flake	Biface
Shape	Indeterminate	Indeterminate	Indeterminate		Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Rejuvenation Scar	Absent	Absent	Absent		Absent	Absent	Absent	Absent	Absent
Resharpener Type	None	None	None		None	Indeterminate	None	Indeterminate	Indeterminate
Raw Material	Chert	Chert	Chert		Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine		Fine	Fine	Fine	Fine	Fine
Percent Patination	0	25	0		25	0	0	0	0
Percent Cortex	0	0	0		0	0	0	0	0
Cortex Type	None	None	None		None	None	None	None	None
Heating	None	None	None		None	None	None	None	Burned
Length (mm)									
Width (mm)		43.7	44.3						44.1
Thick (mm)	6.4	8.8	20.5		8.6		9	7.2	
Wt. (g)	6.4		66.6		21.3				
Long X-Section	Flat	Flat	Indeterminate		Flat	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical		Plano-Convex	Indeterminate	Biconvex Symmetrical	Plano-Convex	Biconvex Symmetrical
Flaking Pattern	Chevron	Random	Random		Chevron	Indeterminate	Subparallel	Indeterminate	Indeterminate
Edge Rounding	Absent	Present	Absent		Absent	Absent	Absent	Present	Present
Left Lateral Edge	Excurvate	Excurvate	Indeterminate		Excurvate	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Right Lateral Edge	Excurvate	Indeterminate	Excurvate		Excurvate	Indeterminate	Excurvate	Indeterminate	Indeterminate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	736-013	736-012	746-016	746-015	751-017	752-011	752-010	755-010	756-005-011
Unit	N109,E55	N109,E55	N110,E50	N110,E50	N110,E54	N110,E54	N110,E54	N110,E56	N110,E56
Depth (cm)	50-60	50-60	40-50	40-50	30-40	40-50	40-50	30-40	40-50
Biface Stage	Late	Late	Late	Late	Late	refit to 756-11	Late	Middle	Late
Condition	Medial	Proximal	Distal	Complete	Distal		Medial	Complete	Complete
Break Type	Use	Use	Use	Unbroken	Use		Manufacture	Unbroken	Indeterminate
Preform	Flake	Biface	Biface	Flake	Flake		Indeterminate	Biface	Flake
Shape	Indeterminate	Indeterminate	Indeterminate	Teardrop	Indeterminate		Ovate	Lanceolate	Ovate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent		Absent	Absent	Absent
Resharpener Type	Indeterminate	None	None	None	Indeterminate		Beveled Unifacial	None	Indeterminate
Raw Material	Chert	Chert	Chert	Chert	Chert		Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine		Fine	Fine	Fine
Percent Patination	0	75	50	75	0		0	0	0
Percent Cortex	0	0	0	0	0		0	0	0
Cortex Type	None	None	None	None	None		None	None	None
Heating	None	None	None	None	None		None	Burned	None
Length (mm)				75.1				74.8	47.7
Width (mm)		37.9	42.6	24.4			45.6	38.4	34.1
Thick (mm)	5.7	10.6	16.2	8.6	5.3		10.7	15.7	5.5
Wt. (g)			41.3	14				43.4	9.9
Long X-Section	Flat	Indeterminate	Indeterminate	Flat	Flat		Indeterminate	Tapered Base	Flat
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Plano-Convex	Plano-Convex		Biconvex Symmetrical	Biconvex Symmetrical	Biconvex Symmetrical
Flaking Pattern	Subparallel	Random	Collateral	Collateral	Chevron		Random	Indeterminate	Flake Blank Remnant
Edge Rounding	Absent	Absent	Present	Present	Absent		Present	Present	Absent
Left Lateral Edge	Indeterminate	Indeterminate	Excurvate	Recurvate	Excurvate		Excurvate	Straight	Excurvate
Right Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Excurvate	Excurvate		Excurvate	Excurvate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Table O-33. EA Biface Data Continued

Cat. No.	756-011	763-011*	763-012*	765-011*	1013-010*	1141-016*
Unit	N110,E56	N109,E70	N109,E70	N109,E70	N126,E72	N131,E70
Depth (cm)	40-50	60-70	60-70	80-90	70-80	70-80
Biface Stage	Late	Late	Late	Late	Late	Middle
Condition	Distal	Indeterminate	Indeterminate	Proximal	Indeterminate	Complete
Break Type	Use	Thermal/Crenated	Thermal/Crenated	Use	Indeterminate	Indeterminate
Preform	Flake	Indeterminate	Indeterminate	Biface	Indeterminate	Biface
Shape	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Ovate
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent
Resharpener Type	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	None
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0
Percent Cortex	0	0	0	0	0	0
Cortex Type	None	None	None	None	None	None
Heating	None	Burned	Burned	None	None	None
Length (mm)						51.9
Width (mm)				36.1		28.4
Thick (mm)				11.6		12.8
Wt. (g)						18.4
Long X-Section	Flat	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Tapered Base/Tip
Trans X-Section	Plano-Convex	Biconvex Symmetrical	Biconvex Symmetrical	Biconvex Symmetrical	Indeterminate	Biconvex Symmetrical
Flaking Pattern	Indeterminate	Indeterminate	Random	Random	Indeterminate	Random
Edge Rounding	Absent	Absent	Absent	Absent	Absent	Absent
Left Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate
Right Lateral Edge	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Excurvate
Micro-wear	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
NAA	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

* Biface from Block B

Table O-34. Early Archaic Scraper Data

Cat. No.	Unit	Depth (cm)	Tool Subtype	Condition	Break Type	Rejuvenation Scar	Shape	Raw Material	Texture	Percent Patination
18-021	N99,E51	80-90	End-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	0
29-012	N99,E52	90-100	Side-Scraper	Complete		Absent	Round	Chert	Fine	0
50-010	N99,E54	100-110	Side-Scraper	Distal	Use	Absent	Indeterminate	Chert	Fine	0
62-011	N99,E55	100-110	Side-Scraper	Proximal	Indeterminate	Absent	Indeterminate	Chert	Fine	0
75-020	N99,E56	100-110	Side-Scraper	Indeterminate	Indeterminate	Absent	Indeterminate	Chert	Fine	0
95-011	N100,E51	80-90	Side-Scraper	Indeterminate	Indeterminate	Absent	Indeterminate	Chert	Fine	0
141-022	N100,E55	110-120	Side-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	0
152-013	N100,E56	90-100	Side/End Scraper	Distal	Indeterminate	Absent	Indeterminate	Chert	Fine	0
154-023	N100,E56	110-120	Side-Scraper	Proximal	Use	Absent	Indeterminate	Chert	Fine	0
240-013	N101,E55	90-100	Side-Scraper	Medial	Indeterminate	Absent	Indeterminate	Chert	Fine	0
290-014	N102,E51	100-110	Side-Scraper	Medial	Manufacture	Present	Indeterminate	Chert	Fine	25
300-010	N102,E52	90-100	End-Scraper	Complete	Unbroken	Absent	Teardrop	Chert	Fine	0
312-019	N102,E53	100-110	Side-Scraper	Complete		Absent	Lanceolate	Chert	Fine	0
323-020	N102,E54	130-140	Side/End Scraper	Complete		Absent	Ovate	Chert	Fine	0
333-020	N102,E55	130-140		Indeterminate	Thermal/Crenated	Absent	Indeterminate	Chert	Fine	0
346-025	N102,E56	110-120	End-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	0
392-016	N103,E55	130-140		Indeterminate	Thermal/Crenated	Absent	Indeterminate	Chert	Fine	0
401-034	N103,E56	80-90	Side-Scraper	Complete	Unbroken	Absent	Irregular	Chert	Fine	0
401-036	N103,E56	80-90	End-Scraper	Complete	Unbroken	Absent	Ovate	Chert	Fine	0
500-013	N106,E50	40-50	Side-Scraper	Proximal	Thermal/Crenated	Absent	Indeterminate	Chert	Fine	50
539-011	N106,E55	60-70	Side-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	0
627-013	N108,E48	30-40	End-Scraper	Complete	Unbroken	Absent	Triangular	Chert	Fine	0
704-010	N109,E51	60-70	End-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	25
734-011	N109,E55	25-52	Side-Scraper	Complete	Thermal/Crenated	Absent	Round	Chert	Fine	0
741-010	N109,E56	50-60	End-Scraper	Complete	Unbroken	Absent	Irregular	Chert	Fine	0
746-017	N110,E50	40-50	End-Scraper	Complete	Unbroken	Absent	Round	Chert	Fine	25
746-011	N110,E50	40-50	End-Scraper	Complete	Unbroken	Absent	Quadrilateral	Chert	Fine	25

Table O-34. Early Archaic Scraper Data Continued

Cat. No.	Percent Cortex	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	Edge Flaking	Edge Rounding	No. of Bits
18-021	50	Pebble/Cobble	None	43	58.3	14.6	42	Distal/Lateral	Present	1
29-012	0	None	None	47.4	54.7	9.4	24	Distal/Lateral	Absent	1
50-010	0	None	None			9		Distal/Lateral	Present	2
62-011	0	None	None		45.8	18.9		Proximal/ Lateral	Present	2
75-020	0	None	None		41.1	11.4		Lateral Only	Present	1
95-011	0	None	None		35	12.1		Lateral Only	Absent	2
141-022	25	Pebble/Cobble	None	51.7	68.2	24.5	72	Distal/Lateral	Present	2
152-013	25	Pebble/Cobble	None			12.4		Distal/Lateral	Present	3
154-023	0	None	None			7.1		Proximal/ Lateral	Present	2
240-013	0	None	None			5.4		Lateral Only	Present	1
290-014	0	None	None			7.8		Lateral Only	Present	1
300-010	0	None	Heat-Treated	72.1	46.4	6.1	22	Distal/Lateral	Present	3
312-019	0	None	None	58.7	32	11.6	27	Lateral Only	Absent	2
323-020	0	None	None	73.1	60.8	16.7	83	Distal/Lateral	Absent	3
333-020	0	None	Burned					Indeterminate	Absent	1
346-025	0	None	None	62.2	75.9	25.3	121	Indeterminate	Absent	1
392-016	0	None	Burned			8.2		Indeterminate	Absent	1
401-034	25	Pebble/Cobble	Burned	51.2	35.7	13.1	20	Distal/Lateral	Present	1
401-036	0	None	Indeterminate	87.9	41.5	26.5	96	Indeterminate	Absent	2
500-013	0	None	Burned	69	41	13.2	46	Lateral Only	Present	1
539-011	25	Pebble/Cobble	None	52.2	69.1	27.6	69	Distal/Lateral	Present	2
627-013	25	Pebble/Cobble	None	71	44.7	12	43	Distal/Lateral	Present	2
704-010	25	Pebble/Cobble	None	61	65.1	23.5	97	Distal	Present	1
734-011	0	None	Burned	54.3	49.5	20.2	53	Lateral Only	Absent	1
741-010	0	None	None	55	37	11.6	19	Distal	Absent	1
746-017	50	Pebble/Cobble	None	73.4	79.1	24.2	146	Distal	Absent	1
746-011	0	None	None	35.7	68.5	7.9	17	Distal/Lateral	Present	2

Table O-34. Early Archaic Scraper Data Continued

Cat. No.	Bit 1 Location	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)	Bit 1 Angle	Bit 2 Location	Bit 2 Shape	Bit 2 Retouch	Bit 2 Length (mm)
18-021	Lateral/Distal	Excurvate	Regular Continuous	88.1	6	65				
29-012	Lateral/Distal	Excurvate	Regular Continuous	62.4	7.7	66				
50-010	Lateral/Distal	Incurvate	Regular Continuous	24.9	5.7	68	Distal	Excurvate	Regular Continuous	25.3
62-011	Lateral/ Proximal	Excurvate	Regular Continuous	51.6	12.3	45	Lateral	Incurvate	Regular Continuous	33.7
75-020	Lateral	Recurvate	Regular Continuous	7.5	65					
95-011	Lateral	Straight	Regular Continuous	31.5	6.4	72	Lateral	Straight	Irregular Continuous	20.3
141-022	Lateral	Excurvate	Regular Continuous	30.6	6.3	72	Lateral/ Distal	Excurvate	Regular Continuous	24.4
152-013	Distal	Straight	Regular Continuous	17.5	5.4	79	Lateral	Excurvate	Regular Continuous	26.9
154-023	Lateral/ Proximal	Straight	Regular Continuous	35.9	4.4	57	Lateral	Straight	Irregular Continuous	25.1
240-013	Lateral	Straight	Regular Continuous	34.4	4.7	64				
290-014	Lateral	Excurvate	Regular Continuous	43.7	6.9	90				
300-010	Distal	Excurvate	Regular Continuous	19.7	4.5	60	Lateral	Excurvate	Irregular Discontinuous	53.9
312-019	Lateral/ Proximal	Straight	Regular Continuous	25.6	7.4	52	Lateral/ Distal	Straight	Regular Continuous	25.5
323-020	Lateral	Straight	Regular Continuous	18.9	1.9	71	Distal	Straight	Regular Continuous	42.1
333-020	Indeterminate	Excurvate	Irregular Continuous	22.3	2.8	69				
346-025	Indeterminate	Excurvate	Irregular Discontinuous	106	4.1	53				
392-016	Indeterminate	Excurvate	Regular Continuous	22.2	4.3	73				
401-034	Lateral/Distal	Excurvate	Regular Continuous	46.3	5	49				
401-036	Indeterminate	Excurvate	Irregular Continuous	45.4	4.6	56	Indeterminate	Straight	Regular Continuous	13.4
500-013	Lateral	Excurvate	Irregular Continuous	54.7	8	71				
539-011	Lateral/Distal	Excurvate	Regular Continuous	50.7	8.6	77	Lateral	Straight	Regular Discontinuous	30.7
627-013	Distal	Excurvate	Regular Continuous	61.3	7.4	59	Lateral	Straight	Regular Continuous	16.3
704-010	Distal	Excurvate	Regular Continuous	57.3	12.7	74				
734-011	Lateral	Excurvate	Regular Continuous	55	6.7	68				
741-010	Distal	Excurvate	Regular Continuous	27.7	5.4	40				
746-017	Distal	Excurvate	Irregular Continuous	128.6	11.5	81				
746-011	Distal	Excurvate	Regular Continuous	75.6	3.2	42	Lateral	Straight	Regular Continuous	21.1

Table O-34. Early Archaic Scraper Data Continued

Cat. No.	Bit 2 Thick (mm)	Bit 2 Angle	Bit 3 Location	Bit 3 Shape	Bit 3 Retouch	Bit 3 Length (mm)	Bit 3 Thick (mm)	Bit 3 Angle	Flake Size	Micro-wear	NAA
18-021									7	FALSE	FALSE
29-012									6	TRUE	TRUE
50-010	2.7	47								FALSE	FALSE
62-011	4	65								FALSE	FALSE
75-020										FALSE	FALSE
95-011	7.5	70								FALSE	FALSE
141-022	1.4	62							7	FALSE	FALSE
152-013	3	61	Lateral	Incurvate	Regular Continuous	8.4	3.1	78		FALSE	FALSE
154-023	4.4	66								FALSE	FALSE
240-013										FALSE	FALSE
290-014										FALSE	FALSE
300-010	0.8	50	Lateral	Excurvate	Irregular Discontinuous	41.2	1	49	8	FALSE	FALSE
312-019	4.3	60							7	TRUE	FALSE
323-020	2	46	Distal	Straight	Regular Continuous	35.7	3.6	70	8	TRUE	FALSE
333-020										FALSE	FALSE
346-025									8	TRUE	TRUE
392-016										FALSE	FALSE
401-034									6	FALSE	FALSE
401-036	3.5	58							10	TRUE	TRUE
500-013									7	FALSE	FALSE
539-011	1.2	52							7	FALSE	FALSE
627-013	2	59							8	TRUE	FALSE
704-010									7	FALSE	FALSE
734-011									6	FALSE	FALSE
741-010									6	FALSE	FALSE
746-017									9	FALSE	FALSE
746-011	2	51							8	FALSE	FALSE

Table O-35. Early Archaic Drill Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Rejuvenation Scar	Preform	Raw Material	Texture	Percent Patination	Percent Cortex
40-012	N99,E53	100-110	Distal	Use	Absent	Biface	Chert	Fine	0	0
63-016	N99,E55	110-120	Proximal	Use	Absent	Biface	Chert	Fine	25	0
95-016	N100,E51	80-90	Medial	Thermal/Crenated	Absent	Flake	Chert	Fine	0	0
183-021	N101,E50	70-80	Proximal	Use	Absent	Biface	Chert	Fine	0	0
242-014	N101,E55	110-120	Proximal	Use	Absent	Biface	Chert	Fine	0	0
277-014	N102,E50	70-80	Medial	Use	Absent	Flake	Chert	Fine	75	0
278-026	N102,E50	87	Complete	Unbroken	Absent	Flake	Chert	Fine	0	0
278-013	N102,E50	80-90	Distal	Indeterminate	Absent	Flake	Chert	Fine	0	0
289-020	N102,E51	90-100	Distal	Thermal/Crenated	Absent	Biface	Chert	Fine	0	0
343-013	N102,E56	80-90	Distal	Use	Absent	Biface	Chert	Fine	0	0
455-016	N105,E52	50-60	Complete	Unbroken	Absent	Flake	Chert	Fine	0	25
578-018	N107,E51	60-70	Medial	Use	Absent	Biface	Chert	Fine	25	0
670-005-015	N108,E55	48	Complete	Unbroken	Absent	Biface	Chert	Fine	0	0
688-013	N109,E48	30-40	Medial	Use	Absent	Biface	Chert	Fine	0	0
689-019	N109,E48	40-50	refit to 688-13	13						
693-011	N109,E49	30-40	Medial	Use	Absent	Indeterminate	Chert	Fine	75	0
735-012	N109,E55	40-50	Distal	Use	Absent	Biface	Chert	Fine	0	0

Cat. No.	Cortex Type	Heating	Length (mm)	Thick (mm)	Wt. (g)	Trans X-Section	Edge Rounding	Stem Shape	Stem Length (mm)	Micro-wear	NAA
40-012	None	Burned				Biconvex	Present	Indeterminate		FALSE	TRUE
63-016	None	None		6.9	8.5	Biconvex Asymmetrical	Present	Expanding	30.7	FALSE	TRUE
95-016	None	Burned		4.3		Plano-Convex	Absent	Expanding		FALSE	FALSE
183-021	None	None		7.6	6	Plano-Convex	Present	Expanding	20.4	FALSE	TRUE
242-014	None	None	57.2	21.4	35	Biconvex Asymmetrical	Absent	Expanding	39.7	FALSE	FALSE
277-014	None	None		7.7		Biconvex Asymmetrical	Present	Expanding		FALSE	FALSE
278-026	None	None	69	9.1	25	Plano-Convex	Present	Expanding	48.4	TRUE	FALSE
278-013	None	None		5.1		Plano-Convex	Present	Expanding		FALSE	FALSE
289-020	None	Burned		7.4		Biconvex Symmetrical	Present	Indeterminate		FALSE	FALSE
343-013	None	None				Biconvex Asymmetrical	Present	Indeterminate		TRUE	FALSE
455-016	Pebble/Cobble	None	48.1	8.5	8.3	Biconvex Symmetrical	Present	Straight	31.8	TRUE	FALSE
578-018	None	Burned		6.7		Biconvex Symmetrical	Present	Indeterminate		FALSE	FALSE
670-005-015	None	None	72.9	8.1	8	Biconvex Symmetrical	Present	Expanding	42.4	TRUE	FALSE
688-013	None	None		8.5		Biconvex Symmetrical	Absent	Expanding		FALSE	FALSE
689-019										FALSE	FALSE
693-011	None	None		6.5	5	Biconvex Symmetrical	Present	Expanding		FALSE	FALSE
735-012	None	None		5.3		Biconvex Symmetrical	Present	Indeterminate		FALSE	TRUE

Table O-36. EA Uniface Data

Cat. No.	Unit	Depth (cmbd)	Condition	Break Type	Shape	Edge Flaking	Edge Rounding	Rejuvenation Scar	Raw Material	Texture
84-010	N100,E50	60-70	Proximal	Use	Ovate	Lateral Only	Present	Absent	Chert	Fine
139-016	N100,E55	90-100	Indeterminate	Use	Indeterminate	Indeterminate	Absent	Absent	Chert	Fine
153-030	N100,E56	100-110	Proximal	Manufacture	Indeterminate	Lateral Only	Present	Absent	Chert	Fine
546-014	N106,E56	40-50	Complete	Unbroken	Teardrop	Proximal/Distal	Absent	Absent	Chert	Fine

Cat. No.	Percent Patination	Percent Cortex	Cortex Type	Heating	Length (mm)	Width (mm)	Thick (mm)	Wt. (g)	No. of Bits	Bit 1 Location
84-010	0	0	None	None		30.2	11.7	12.8	1	Lateral
139-016	0	25	Pebble/Cobble	None					1	Indeterminate
153-030	0	0	None	Burned		32.6	9.4		1	Lateral
546-014	0	0	None	None	88.4	51.1	16.6	67.4	3	Proximal

Cat. No.	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)	Bit Angle 1	Bit 2 Location	Bit 2 Retouch	Bit 2 Length (mm)	Bit 2 Thick (mm)	Bit 2 Angle
84-010	Straight	Regular Continuous	31.6	2.1	52					
139-016	Excurvate	Regular Continuous	20.5	6.4	78					
153-030	Straight	Regular Continuous	20.6	5.8	66					
546-014	Excurvate	Regular Continuous	32.3	5.3	51	Proximal	Regular Continuous	28.3	2.6	48

Cat. No.	Bit 3 Location	Bit 3 Shape	Bit 3 Retouch	Bit 3 Length (mm)	Bit 3 Angle	Flake Size	Micro-wear	NAA
84-010						5	FALSE	FALSE
139-016							FALSE	FALSE
153-030							FALSE	FALSE
546-014	Distal	Excurvate	Regular Continuous	53.9	50	10	TRUE	FALSE

Table O-37. Gouge Data

Cat. No.	Unit	Depth (cmbd)	Condition	Rejuvenation Scar	Shape	Raw Material	Texture	Percent Patination	Percent Cortex	Heating	Length (mm)
64-014	N99,E55	120-130	Complete	Absent	Quadralateral	Chert	Fine	0	50	None	62.3
346-011	N102,E56	110-120	Complete	Absent	Triangular	Chert	Fine	0	0	None	47.4
724-013	N109,E53	40-50	Complete	Absent	Indeterminate	Chert	Fine	0	0	None	58.7

Cat. No.	Width (mm)	Thick (mm)	Wt. (g)	Edge Flaking	Edge Rounding	No. of Bits	Bit 1 Location	Bit 1 Shape	Bit 1 Retouch	Bit 1 Length (mm)	Bit 1 Thick (mm)
64-014	49.9	14	51.7	Distal/Lateral	Absent	3	Lateral	Incurvate	Regular Continuous	29	2.8
346-011	44.8	13.3	34.6	Distal/Lateral	Present	2	Distal	Incurvate	Regular Continuous	48.3	7.3
724-013	39.2	19.2	39.6	Distal/Lateral	Absent	5	Distal	Excurvate	Regular Continuous	7.7	4.1

Cat. No.	Bit 1 Angle	Bit 2 Location	Bit 2 Shape	Bit 2 Retouch	Bit 2 Length (mm)	Bit 2 Thick (mm)	Bit 2 Angle	Bit 3 Location	Bit 3 Shape	Bit 3 Retouch	Bit 3 Length (mm)
64-014	64	Lateral	Excurvate	Regular Continuous	42.4	7.7	53	Distal	Recurvate	Regular Continuous	25.8
346-011	63	Lateral/ Distal	Excurvate	Regular Continuous	39.9	3.4	54				
724-013	50	Distal	Straight	Regular Continuous	31.2	2.6	67	Distal	Excurvate	Regular Continuous	7.5

Cat. No.	Bit 3 Thick (mm)	Bit 3 Angle	Flake Size	Micro-wear	NAA
64-014	10.1	70	7	FALSE	FALSE
346-011			7	TRUE	FALSE
724-013	3.1	66	6	TRUE	TRUE

Table O-38. Early Archaic Core Data

Cat. No.	29-019	139-019	203-005-016	323-021	421-033	455-014	455-015	530-021	531-019
Unit	N99,E52	N100,E55	N101,E52	N102,E54	N104,E56	N105,E52	N105,E52	N106,E54	N106,E54
Depth (cmbd)	98	90-100	91	130-140	80-90	50-60	50-60	80-90	90-100
Condition	Complete	Complete	Complete	Complete	Fragmented	Complete	Complete	Fragmented	Complete
Tool Type	Unifacial	Unifacial	Multi-Directional	Bifacial	Bifacial	Multi-Directional	Multi-Directional	Multi-Directional	Bifacial
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	25	0	0	0	0
Percent Cortex	75	50	0	50	0	25	0	0	75
Cortex Type	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	None	None	None	None	Pebble/Cobble
Heating	None	None	None	None	None	None	None	None	None
Length (mm)	84.6	124	72.7	135	84.7	81.8	67.1	40	95.7
Width (mm)	76	57.1	72	131	43.8	70.6	52.2	37.5	87.2
Thick (mm)	53.2	41.7	37.2	38	24.5	36	36	30.7	52.1
Wt. (g)	351	274	177	740	99.4	190	135	56.1	471

Table O-38. Early Archaic Core Data Continued

Cat. No.	538-010	539-018	584-017	598-015	638-013	64-012	650-019	658-020	665-015
Unit	N106,E55	N106,E55	N107,E52	N107,E54	N108,E50	N99,E55	N108,E52	N108,E53	N108,E54
Depth (cmbd)	50-60	60-70	50-60	80-90	40-50	120-130	40-50	50-60	50-60
Condition	Complete	Complete	Complete	Exhausted	Complete	Exhausted	Complete	Complete	Complete
Tool Type	Multi-Directional	Bifacial	Multi-Directional	Bifacial	Multi-Directional	Bifacial	Bifacial	Bifacial	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	0	0	0	0	0	0	0	0
Percent Cortex	25	25	25	0	50	0	50	75	25
Cortex Type	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble
Heating	None	None	None	None	None	None	None	None	None
Length (mm)	104	70.8	73.8	55.9	93.1	48.1	125	99	66.3
Width (mm)	83.4	65.6	57.3	38.1	83.3	40.2	114	78.6	64.5
Thick (mm)	58.1	28.4	34.6	26.7	48.1	15.1	48.4	50	38.2
Wt. (g)	380	104	145	68.8	491	27.2	913	501	154

Table O-38. Early Archaic Core Data Continued

Cat. No.	677-016	688-014	689-023	694-021	699-010	741-005-016	1013-014*
Unit	N108,E56	N109,E48	N109,E48	N109,E49	N109,E50	N109,E56	N126,E72
Depth (cmbd)	50-60	30-40	40-50	40-50	40-50	51	70-80
Condition	Complete	Complete	Complete	Complete	Complete	Complete	Complete
Tool Type	Bifacial	Multi-Directional	Bifacial	Bifacial	Multi-Directional	Bifacial	Multi-Directional
Rejuvenation Scar	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Raw Material	Chert	Chert	Chert	Chert	Chert	Chert	Chert
Texture	Fine	Fine	Fine	Fine	Fine	Fine	Fine
Percent Patination	0	75	50	0	25	0	50
Percent Cortex	0	50	25	25	25	0	0
Cortex Type	None	Tabular	Pebble/Cobble	Pebble/Cobble	Pebble/Cobble	None	None
Heating	None	None	None	None	None	None	None
Length (mm)	84.3	92.5	113	64.6	114	77.6	60.4
Width (mm)	65.1	84.1	104	57.8	105	61.1	44.9
Thick (mm)	25.7	45	54.3	46.6	60.4	23.8	36.7
Wt. (g)	179	354	591	215	752	102	87.2

* From Block B

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