APPENDIX G

POLLEN AND PHYTOLITH ANALYSIS FOR SITE 41KR621, TEXAS

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POLLEN AND PHYTOLITH ANALYSIS
FOR SITE 41KR621, TEXAS

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Paleo Research Institute Technical Report 05-54

Prepared For

SWCA Environmental Consultants
Austin, Texas

November 2005
INTRODUCTION

Site 41KR621 is located within the boundaries of a proposed right-of-way extension along Spur 98 in Kerrville, Texas. Situated on the southern approach of Spur 98 to the Guadalupe River, this multi-component, Mid to Late Holocene prehistoric site covers the entire highway right-of-way from the base of an upland toeslope at the southern terminus to the scarp of a terrace above the river. Soil matrix samples from several features at the site were examined for pollen and phytoliths, as were samples from a stratigraphic column from units CT 3 and CS 3. Pollen and phytolith analyses are used to provide a backdrop of information concerning local vegetation and the paleoenvironment, as well as information concerning plant resources available to and utilized by the prehistoric occupants of site 41KR621, which is believed to have experienced Early, Middle and Late Archaic occupations.

METHODS

Pollen

A chemical extraction technique based on flotation is the standard preparation technique used in this laboratory for the removal of the pollen from the large volume of sand, silt, and clay with which they are mixed. This particular process was developed for extraction of pollen from soils where preservation has been less than ideal and pollen density is lower than in peat.

Hydrochloric acid (10%) was used to remove calcium carbonates present in the soil, after which the samples were screened through 150 micron mesh. The samples were rinsed until neutral by adding water, letting the samples stand for 2 hours, then pouring off the supernatant. A small quantity of sodium hexametaphosphate was added to each sample once it reached neutrality, then the samples were allowed to settle according to Stoke's Law in settling columns. This process was repeated with EDTA. These steps remove clay prior to heavy liquid separation. Next the samples are freeze dried. Sodium polytungstate (density 2.1) was used for the flotation process. The samples were mixed with sodium polytungstate and centrifuged at 1500 rpm for 10 minutes to separate organic from inorganic remains. The supernatant containing pollen and organic remains is decanted. Sodium polytungstate is again added to the inorganic fraction to repeat the separation process. The supernatant is decanted into the same tube as the supernatant from the first separation. This supernatant is then centrifuged at 1500 rpm for 10 minutes to allow any silica remaining to be separated from the organics. Following this, the supernatant is decanted into a 50 ml conical tube and diluted with distilled water. These samples are centrifuged at 3000 rpm to concentrate the organic fraction in the bottom of the tube. After rinsing the pollen-rich organic fraction obtained by this separation, all samples received a short (20-30 minute) treatment in hot hydrofluoric acid to remove any remaining inorganic particles. The samples were then acetolated for 3-5 minutes to remove any extraneous organic matter.

A light microscope was used to count the pollen to a total of approximately 50 to 100 pollen grains at a magnification of 500x. Pollen preservation in these samples varied from good to poor. Comparative reference material collected at the Intermountain Herbarium at Utah State University and the University of Colorado Herbarium was used to identify the pollen to the family, genus, and species level, where possible.
Pollen aggregates were recorded during identification of the pollen. Aggregates are clumps of a single type of pollen, and may be interpreted to represent pollen dispersal over short distances, or the introduction of portions of the plant represented into an archaeological setting. Aggregates were included in the pollen counts as single grains, as is customary. The presence of aggregates is noted by an "A" next to the pollen frequency on the pollen diagram. Pollen diagrams are produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum. Pollen concentrations are calculated in Tilia using the quantity of sample processed (cc), the quantity of exotics (spores) added to the sample, the quantity of exotics counted, and the total pollen counted and expressed as pollen per ml of sediment.

Indeterminate pollen includes pollen grains that are folded, mutilated, and otherwise distorted beyond recognition. These grains are included in the total pollen count, as they are part of the pollen record.

Pollen analysis also includes identification of starch granules to general categories. Starch granules are a plant's mechanism for storing carbohydrates. Starches are found in numerous seeds, as well as in starchy roots and tubers. The primary categories of starches include: with or without visible hila, hilum centric or eccentric, hila patterns (dot, cracked, elongated), and shape of starch (angular, ellipse, circular, eccentric). Some of these starch categories are typical of specific plants, while others are more common and tend to occur in many different types of plants.

Quantities of charcoal were estimated during the pollen count. Charcoal ratios represented on the pollen diagram reflect the number of charcoal particles encountered per pollen grain. In other words, if charcoal is represented as a value of 200, then 200 charcoal particles were observed for each pollen grain observed.

**Phytoliths**

Extraction of phytoliths from these sediments also was based on heavy liquid floatation. Sodium hypochlorite (bleach) was first used to destroy the organic fraction from 50 ml of sediment. Once this reaction was complete, the samples were rinsed to remove the bleach. If the samples contained calcium carbonates, they were reacted with hydrochloric acid, then the samples were rinsed until neutral. A small quantity of sodium hexametaphosphate was added to each sample once it reached neutrality, then the samples were allowed to settle according to Stoke’s Law in settling columns. This process was repeated with EDTA. These steps remove clay prior to heavy liquid separation. Next the samples are freeze dried. The dried silts and sands were then mixed with sodium polytungstate (density 2.3) and centrifuged to separate the phytoliths, which will float, from the other silica, which will not. This separation did not provide clean phytolith slides, rather, the samples still retained too much of the silt resident in the sediments. Therefore, another heavy liquid was selected to provide a better separation between silt and phytoliths. A mixture of potassium iodide and cadmium iodide was mixed to a density of 2.3, then used to repeat the heavy liquid separation. This provided a much better separation and made identifying and counting phytoliths much easier, since they were visible, rather than being contained in a matrix of silt particles. Phytoliths in these samples included only opal phytoliths. No calcium oxalate crystals, which are formed by *Opuntia* (prickly pear cactus) and other plants including *Yucca*, were observed. The samples are then rinsed with distilled water, then alcohols to remove the water. After several alcohol rinses, the samples are
mounted in cinnamaldehyde for counting with a light microscope at a magnification of 500x. Phytolith diagrams are produced using Tilia, which was developed by Dr. Eric Grimm of the Illinois State Museum for diagraming pollen.

**PHYTOLITH REVIEW**

Phytoliths are silica bodies produced by plants when soluble silica in the ground water is absorbed by the roots and carried up to the plant via the vascular system. Evaporation and metabolism of this water result in precipitation of the silica in and around the cellular walls. Opal phytoliths, which are distinct and decay-resistant plant remains, are deposited in the soil as the plant or plant parts die and break down. They are, however, subject to mechanical breakage and erosion and deterioration in high pH soils. Phytoliths are usually directly introduced into the soils in which the plants decay. Transportation of phytoliths occurs primarily by animal consumption, man's gathering of plants, or by erosion or transportation of the soil by wind, water, or ice.

Grass short-cell phytoliths are typically divided into festucoid, chloridoid, and panicoid or bilobate (including cross and polylobate) forms. In addition, buliforms, trichomes, and elongate forms represent other grass cells. Smooth elongate phytoliths are of no aid in interpreting either paleoenvironmental conditions or the subsistence record because they are produced by all grasses. Phytoliths tabulated to represent "total phytoliths" include all grass forms, as well as phytoliths produced by other plants. Non-plant bodies are recorded and calculated by dividing the number of each type recovered by the "total phytoliths".

The festucoid class of phytoliths is ascribed primarily to the Subfamily Pooideae and occur most abundantly in cool, moist climates. However, Brown (1984) notes that festucoid phytoliths are produced in small quantity by nearly all grasses. Therefore, while they are typically phytoliths produced by the Subfamily Pooideae, they are not exclusive to this subfamily. Chloridoid phytoliths are found primarily in the Subfamily Chloridoideae, a warm-season grass that grows in arid to semi-arid areas and requires less available soil moisture. In North America, chloridoid grasses are the most abundant in the southwestern United States (Gould and Shaw 1983:120). Bilobates and polylobates are produced mainly by panicoid grasses, although a few of the festucoid grasses also produce these forms. Panicoid phytoliths occur in warm-season or tall grasses that frequently thrive in humid conditions. Twiss (1987:181) also notes that some members of the Subfamily Chloridoideae produce both bilobate (panicoid) and festucoid phytoliths. "According to Gould and Shaw (1983, p. 110) more than 97% of the native US grass species (1,026 of 1,053) are divided equally among three subfamilies Pooideae, Chloridoideae, and Panicoideae" (Twiss 1987:181).

Buliform phytoliths are produced by grasses in response to wet conditions (Rovner, Irwin, January 1991, personal communication) and are to be expected in wet habitats of floodplains and other places. Trichomes represent silicified hairs produced either on the glumes (the papery coverings that surround grass seeds) or on other parts of the grass.

Diatoms and sponge spicules also frequently occur in samples. Sponge spicules represent microscopic fresh water sponges. Diatoms are single-celled algae with a siliceous cell wall. They grow in a wide range of aerophilous habitats, including on wet plants and rocks,
in damp soils, marshes, wetlands, mudflats, and all types of standing and flowing aquatic habitats. Their silica cells often are preserved in sedimentary deposits. Because individual taxa have specific requirements and preferences with respect to water chemistry, hydrologic conditions, and substrate characteristics, the presence (and subsequent identification to the species level) of diatoms in paleoenvironmental context can provide information about the nature of the local environment. These data, coupled with input about local geology, hydrology, soil characteristics, pollen, and phytoliths, provide evidence of the paleoenvironmental setting. In the context of phytolith samples we note the presence of diatoms, but do not identify them beyond the split of “long” and “round” or centric forms. Round diatoms often indicate wet conditions, while at least some of the long diatoms are cosmopolitan, occurring nearly everywhere. Both diatoms and sponge spicules can be transported with sediment. As an illustration, recovery of sponge spicules in upland soils is noted to accompany loess deposits derived from floodplains in Illinois (Jones and Beavers 1963).

**ETHNOBOTANIC REVIEW**

It is a commonly accepted practice in archaeological studies to reference ethnological (historic) plant uses as indicators of possible or even probable plant uses in prehistoric times. It gives evidence of the exploitation, in historic times, of numerous plants, both by broad categories, such as greens, seeds, roots, and tubers, etc. and by specific example, i.e., seeds parched and ground into meal which was formed into cakes and fried in grease. Repetitive evidence of the exploitation of resources indicates a widespread utilization and strengthens the possibility that the same or similar resources were used in prehistoric times. Ethnographic sources do document that with some plants the historic use was developed and carried from the past. A plant with medicinal qualities very likely was discovered in prehistoric times and the usage persisted into historic times. There is, however, likely to have been a loss of knowledge concerning the utilization of plant resources as cultures moved from subsistence to agricultural economies and/or were introduced to European foods during the historic period. The ethnobotanic literature serves only as a guide indicating that the potential for utilization existed in prehistoric times—not as conclusive evidence that the resources were used. Pollen and macrofloral remains, when compared with the material culture (artifacts and features) recovered by the archaeologists, become indicators of use. Pollen analysis identified remains of plants that might have been important food items for the various occupants of this site. These plants will be discussed in the following paragraphs in order to provide an ethnobotanic background for discussing the remains.

*Carya* (Hickory)

Hickory (*Carya* sp.) are noted to be tall, common trees of rich, open woods and bottomlands. The nuts are recorded as the most important nut used by Indians of North America at the time of contact (Reidhead 1981:189). Several species of hickory are sweet and edible, although some are bitter. The nuts usually were harvested in the fall when the outer husks dried and split, and before competing animals harvested them all. Nuts were commonly shelled by crushing, often using two rocks. Native groups in the eastern United States are noted to have placed shelled nuts in boiling water. Most of the shell fragments would sink to the
bottom, while the nutmeats would float or be held in suspension. The nutmeats then could be skimmmed off and either used immediately or dried for storage. Hickory nuts are high in fat and provide protein, carbohydrates, iron, phosphorous, potassium, trace minerals, and vitamins A and C. Their high fat content makes them vulnerable to rancidity. Many ethnographic sources suggest that hickory nut oil and "milk" were the desired product. The pulverized nuts were placed in slowly boiling water for a long period of time. The oil from the nutmeats (hickory butter) would separate and float to the surface where it was skimmed off and stored for later usage. The rest of the nutmeats would dissolve into a milky fluid (hickory milk) that was drunk or used as stock for soup. Hickory sap can be used like maple sap. Leaves and green hulls yield tan, brown, and blackish dyes. Most species of Carya are found in the southeastern United States, with some species reaching parts of the Midwest.

**Prosopis (Mesquite)**

*Prosopis* (mesquite) is a xerophytic shrub or small tree. The pods of both *P. juliflora* (honey mesquite) and *P. pubescens* (screwpod mesquite) were utilized for food. The pods are sweet (*P. juliflora* pods are noted to contain about 25% sugar), and they were eaten fresh, boiled, or fermented to make a mild alcoholic drink. The pods also were dried and ground into flour. Pods boiled in water yield molasses. Pottery paddles and cradleboards also were made from mesquite wood. The gum was applied to sores and wounds, or boiled in water to make an eyewash, candy, pottery paint, or hair dye. The bark was used for tanning and dying. Mesquite wood burns slowly, with an intense heat, and burns down to a long-lasting bed of coals (Burlage, 1968 #57:105){Kearney, 1960 #261:402}{Loughmiller, 1994 #304:135}{Peattie, 1953 #398:561'-563}{Sweet, 1976 #496:24}.

**Quercus (Oak)**

*Quercus* (oak) are deciduous or evergreen shrubs to large trees, and the various species are widespread throughout the United States. All species of *Quercus* produce edible acorns, although the presence of tannin results in varying degrees of bitterness. White oak acorns generally are less bitter than black oak (including red oak) acorns. *Quercus virginiana* (live oak) is noted to have sweet, palatable acorns. Acorns were gathered, shelled, roasted, and ground into a meal. The ground meal often was leached with water in various ways to remove any bitter taste. Wood ashes could be used like lye in the leaching process. The ground meal was used alone or mixed with cornmeal to make mush, thicken soup, or make breads and cakes. Acorn meal also could be mixed with meat or animal fat. Oak wood was used for a variety of utilitarian purposes including making bows, arrows, rabbitsticks, digging sticks, clubs, and other utensils. Oak wood is strong and hard, and it was valued as firewood because a large piece of oak would burn slowly all night long. Oak bark was the principal source of tanning materials (Burlage 1968:79; Elmore 1976:23; Gallagher 1977:113; Harrington 1967:239-241; Kirk 1975:104-106; Vines 1960:162).

**Apiaceae (Umbel Family)**

Members of the Apiaceae family, including but not limited to *Cymopterus, Lomatium,* and *Pseudocymopterus,* are noted to have been used by many Native American groups. The roots, stems, and leaves of these plants may be used for food, seasoning, and medicine (Harrington
1967; Kindscher 1987; Kirk 1975). *Cicuta* (water-hemlock) is noted to be poisonous, but medicinal uses are reported, including as a contraceptive. The eskimos are reported to eat the leaves. All species of *Lomatium* (biscuitroot, prairie parsley) are edible. The young leaves and greens may be eaten in the spring. *Lomatium* produces an edible root that has been widely used on the Plains. The roots may be eaten raw, cooked, or peeled, dried, and ground into a flour. The small seeds also can be parched and ground into a flour (Kindscher 1987:147-178; Kirk 1975:123).

**Brassicaceae (Mustard family)**

Several members of the Brassicaceae (mustard family), such as *Descurainia* (tansy-mustard) and *Lepidium* (pepperweed) are noted to have been exploited for their greens and seeds. Leaves can be eaten fresh or cooked as potherbs. Indians often baked fresh young *Descurainia* leaves in firepits lined with stones. Alternating layers of leaves and hot rocks were used to create a type of steamer. The plants were steamed for about thirty minutes then used right away or dried for later use (Harrington 1964:308). The parched and ground seeds were used to thicken or flavor soup and to make pinole (meal). Brassicaceae seeds ripen in early summer (Harrington 1967; Kirk 1975; Moerman 1986).

**Celtis (Hackberry)**

All species of *Celtis* produce edible berry-like drupes that can be eaten raw or dried. The berries of *C. laevigata* are typically orange-red and ripen in September or October. The wood is close-grained, soft, heavy, but not strong. This tree is found throughout the southeastern states, ranging west into central and west Texas, southern Oklahoma, southern New Mexico, and northeast Mexico. It is a small tree, seldom growing over 25 feet high, and can be found growing along streamsides, in moist soil, on rocky bluffs, alongside of draws, in washes, and in the deep gorges of Texas mountains (Angell 1981:80-82; Gould 1962:36; Peattie 1953:465-466; Petrides and Petrides 1992:171).

**Cheno-ams**

Cheno-ams are a group of plants that include *Chenopodium* (goosefoot) and *Amaranthus* (pigweed). These plants were exploited for both their greens (cooked as potherbs) and seeds. The seeds were ground and used to make a variety of mushes and cakes. The seeds are usually noted to have been parched prior to grinding. The greens are most tender in the spring when young but can be used at any time. *Chenopodium* seeds are about equal to corn in the number of calories they contain, but have significantly more protein and fat (Asch 1978:307). The cooked greens contain more than three times as much calcium as cooked spinach and also have more vitamin A and C (Watt and Merrill 1963:37, 59)” (Kindscher 1987:82). Young *Amaranthus* leaves contain significant amounts of protein, calcium, phosphorus, potassium, vitamin A, and vitamin C (Kindscher 1987:22; Watt and Merrill 1963:6). *Chenopodium* and *Amaranthus* are both weedy annuals that are commonly found in ecologically disturbed habitats (Burlage 1968:2-3, 29-31; Kindscher 1987:18-22, 79-83; Kirk 1975:56, 63; Sweet 1976:48).
Chenopodium and Amaranthus also were used medicinally. Chenopodium leaves were eaten to treat stomachaches and to prevent scurvy. Leaf poultices were applied to burns and swellings, and a tea made from the whole plant was used to treat diarrhea. A leaf decoction was used as a bath for rheumatism. Oil of Chenopodium is obtained from C. ambrosioides (wormseed goosefoot), which is a good cure for intestinal worms. Amaranthus poultices were used to reduce swellings and to soothe aching teeth. A leaf tea was used to stop bleeding and to treat dysentery, ulcers, diarrhea, mouth sores, sore throats, and hoarseness (Angier 1978:33-35; Foster and Duke 1990:216; Harris 1972:58; Kirk 1975:57; Krochmal and Krochmal 1973:34-35, 66-67; Sweet 1976:48).

Lamiaceae (Mint Family)

Members of the Lamiaceae (mint) family are characterized by square stems and hairlike oil glands on the surfaces of the leaves and stems (McGee 1984:204). Mints have been well-known from ancient times as foods, flavorings, scents, and medicines. Members of the mint family are especially well-known carminative herbs that aid in the expulsion of gas from the intestinal tract. The seeds of Agastache (giant hyssop, nettle-leafed horsemint) can be eaten raw or cooked. A tea made from the leaves and flowers was used as a carminative, a diaphoretic (to induce sweating), and a mild sedative. Hedeoma (false-pennyroyal) contains volatile oils and can be rubbed on the skin to repel mosquitoes and other biting insects. A tea made from the whole plant is noted to be "an excellent diaphoretic in the first stages of a cold when a fever is present" (Moore 1979:122). Moldavica parviflora (dragonhead) seeds were ground into a flour. Mentha (wild mint, field mint) plants are good sources of vitamins A and C. Leaves can be eaten fresh, or dried and used as a flavoring, or to make a tea. Wild mint leaves contain menthol and are useful for treating upset stomach. Poliomintha (rosemary mint) flowers can be used for seasoning, and the plant can be eaten raw, boiled, or dried. Prunella has been used as a medicine to treat a variety of ailments. A dried leaf tea can be used as a gargle for sore throats and gums, upset stomach, and mild dysentery. The fresh plant can be used as a poultice for scrapes and bruises. Crushed leaves are astringent and anti-inflammatory for bites and scratches. The plant contains ursolic acid, a compound that has diuretic and antitumor qualities. Salvia (sage) contains volatile oils and is noted to have strong antimicrobial qualities. The tea will decrease secretions and was used to wean infants. A cold tea is noted to be a "good stomach tonic" (Moore 1979:144), while lukewarm tea is bacteriostatic and astringent and is useful for treating sore throats and as a skin wash. Stachys palustris (betony, hedge nettle) and Lycopus (bugleweed) produce edible tubers that can be eaten raw, roasted, or boiled. The young plants might have been cooked as potherbs. Stachys is used as a general-purpose, anti-inflammatory medicine to treat sore throats, urethritis, cystitis, joint inflammations, and migraine headaches. A wash or a poultice can be used for sores and wounds. Lycopus preparations have been used to treat coughs and are also believed to have diuretic, hemostatic, and mildly sedative effects. Scutellaria (skullcap) is noted to be "a sure treatment for almost any nervous system malfunction of a mild or chronic nature" (Moore 1979:147). This plant contains scutellarin, a flavonoid compound with sedative and antispasmodic qualities (Kirk 1975:78-86, 244; Moore 1979; Peterson 1977; Tilford 1997).
Malvaceae (Mallow Family)

Several members of the Malvaceae family are noted to have been utilized ethnographically. Harrington (1967:317) notes that *Malva* (cheese-weed) greens have been exploited both as a potherb and as a raw salad green. The green, immature fruits also are a flavorful snack that may been consumed raw. The entire plant also may be collected, dried, and used to make tea. Both *Malva* and *Sphaeralcea* are considered to be weedy plants, growing in disturbed ground.

Poaceae (Grass Family)

Members of the Poaceae (grass) family have been widely used as a food resource. Grass grains were normally parched and ground into a meal to make various mushes and cakes. Young shoots and leaves were cooked as greens. Grass also is reported to have been used as a floor covering. Some species of grass were used medicinally. *Andropogon glomeratus* (bushy bluestem) was used by the Catawba Indians to treat backache. *Hordeum jubatum* (foxtail barley) is used as an eye medicine. A decoction of *Oryza sativa* (rice) is used in fevers and inflammatory infections of the stomach, lungs, and kidneys. Paiute Indians gave sugar from *Phragmites communis* (common reed) to people with pneumonia. This plant also has been used as a diuretic, depurient, and an emetic. Grass seeds ripen from spring to fall, depending on the species, providing a long-term available resource (Burlage 1968:81-85; Chamberlin 1964:372; Harrington 1967:322).

DISCUSSION

Located in the right-of-way of the southern approach of Spur 98, site 41KR621 is situated along the bank of the Guadalupe River. The site is at the base of an upland colluvial toeslope and the floodplain of the river. Observed vegetation near the site varies from ash-juniper lowland forests, netleaf hackberry-plateau live oak floodplain woodlands, and upland plateau live oak savannah. Modern vegetation includes cedar elm, juniper, and shrubs growing along fence lines.

In all, thirty-three pollen and phytolith samples (Table 1) were collected at site 41KR621. Sample 43 was recovered from Feature 5 during the testing phase. Twenty-two samples represent fill from features identified at the site during the data recovery phase, while the remaining ten samples were collected stratigraphically in ten centimeter increments from levels two through eleven in the fill of a burned rock midden in units CT 3 and CS 3.

The main elements of the pollen record include *Quercus* and High-spine Asteraceae (Figure 1, Table 2), which usually occur as co-dominants. *Quercus* pollen reflects oak growing in the floodplain woodlands and on the upland plateau. High-spine Asteraceae pollen represents a variety of members of the sunflower family that grow as understory plants in open areas. Smaller quantities of *Cirsium* and Low-spine Asteraceae pollen reflect local thistle and members of a small group of plants within the sunflower family that includes ragweed, sumpweed, and cocklebur. All of these plants are weedy and grow in disturbed sediments. Recovery of *Cirsium* and Low-spine Asteraceae pollen regularly throughout this record suggest
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Feature No.</th>
<th>Elevation Below Datum</th>
<th>Provenience/Description</th>
<th>Analysis</th>
</tr>
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<td>98.20-98.10</td>
<td>Column sample from CT 3 CS 3, Level 2</td>
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<td>98.10-98.00</td>
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<td>98.00-97.90</td>
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<td>97.90-97.80</td>
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<td>97.80-97.70</td>
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<td>97.70-97.60</td>
<td>Column sample from CT 3 CS 3, Level 7</td>
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<td>97.30-97.20</td>
<td>Column sample from CT 3 CS 3, Level 11</td>
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<td>43</td>
<td>5</td>
<td>96.95-96.90</td>
<td>60N 50E (Testing Phase); Fill from burned rock layer of tabular limestone block with a semi-circle of burned rock cobbles</td>
<td>Pollen Phytolith</td>
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<td>13</td>
<td>97.60-97.50</td>
<td>Fill from burned rock layer of ring-like structure of FCR</td>
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<td>1027N 1068E/NE portion of quad; 1024N 1068E/SE portion of quad; Fill from burned rock layer of FCR scatter</td>
<td>Pollen Phytolith</td>
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<td>Feature No.</td>
<td>Elevation Below Datum</td>
<td>Provenience/Description</td>
<td>Analysis</td>
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</tr>
<tr>
<td>P-5</td>
<td>20</td>
<td>97.30-97.20</td>
<td>1033N 1058E; Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-6</td>
<td>21</td>
<td>97.20-97.10</td>
<td>1031N 1068N; Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-7</td>
<td>22</td>
<td></td>
<td>Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-10</td>
<td>24</td>
<td>97.00</td>
<td>Fill from burned rock layer of small, circular FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-11</td>
<td>25</td>
<td>97.00</td>
<td>1034.30N 1057.40E; Fill from burned rock layer of large, dense FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-13</td>
<td>26</td>
<td>97.04</td>
<td>1036.94N 1058.20E; Fill from burned rock layer of possible hearth</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-14</td>
<td>27</td>
<td>97.01-96.90</td>
<td>Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-15</td>
<td>28</td>
<td>97.80-97.70</td>
<td>Fill from burned rock layer of amorphous FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-17</td>
<td>31</td>
<td>97.70-97.60</td>
<td>Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-24</td>
<td>33</td>
<td>97.55-97.50</td>
<td>1020.99N 1044.50E; Fill from …</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-32</td>
<td>34</td>
<td>97.52</td>
<td>SW quad Fill from burned rock layer of amorphous FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-33</td>
<td>35</td>
<td>97.50-97.40</td>
<td>Fill from burned rock layer of FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>Sample No.</td>
<td>Feature No.</td>
<td>Elevation Below Datum</td>
<td>Provenience/ Description</td>
<td>Analysis</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-----------------------</td>
<td>--------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>P-34</td>
<td>36</td>
<td>98.00</td>
<td>1015.40N 1038.85E; Fill from burned rock layer of FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-35</td>
<td>37</td>
<td></td>
<td>Fill from burned rock layer of FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
<tr>
<td>P-36</td>
<td>38</td>
<td></td>
<td>Fill from burned rock layer of small FCR cluster</td>
<td>Pollen Phytolith</td>
</tr>
</tbody>
</table>
FIGURE 1. POLLEN DIAGRAM FROM SITE 41KR621.
TABLE 2 (Continued)

**TABLE 2**
POLLEN TYPES OBSERVED IN SAMPLES FROM SITE 41KR621

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARBOREAL POLLEN:</strong></td>
<td></td>
</tr>
<tr>
<td><em>Alnus</em></td>
<td>Alder</td>
</tr>
<tr>
<td><em>Carya</em></td>
<td>Hickory, Pecan</td>
</tr>
<tr>
<td><em>Juniperus</em></td>
<td>Juniper</td>
</tr>
<tr>
<td><em>Pinus</em></td>
<td>Pine</td>
</tr>
<tr>
<td><em>Prosopis</em></td>
<td>Mesquite</td>
</tr>
<tr>
<td><em>Quercus</em></td>
<td>Oak</td>
</tr>
<tr>
<td><em>Ulmus</em></td>
<td>Elm</td>
</tr>
<tr>
<td><strong>NON-ARBOREAL POLLEN:</strong></td>
<td></td>
</tr>
<tr>
<td><em>Apiaceae</em></td>
<td>Parsley/Carrot family</td>
</tr>
<tr>
<td><em>Asteraceae:</em></td>
<td>Sunflower family</td>
</tr>
<tr>
<td><em>Artemisia</em></td>
<td>Sagebrush</td>
</tr>
<tr>
<td><em>Cirsium</em></td>
<td>Thistle</td>
</tr>
<tr>
<td>Low-spine</td>
<td>Includes ragweed, cocklebur, sumpweed</td>
</tr>
<tr>
<td>High-spine</td>
<td>Includes aster, rabbitbrush, snakeweeds, sunflower, etc.</td>
</tr>
<tr>
<td><em>Liguliflorae</em></td>
<td>Chicory tribe, includes dandelion and chicory</td>
</tr>
<tr>
<td><em>Boerhaavia</em></td>
<td>Spiderling</td>
</tr>
<tr>
<td><em>Brassicaceae</em></td>
<td>Mustard family</td>
</tr>
<tr>
<td><em>Caryophyllaceae</em></td>
<td>Pink family</td>
</tr>
<tr>
<td><em>Celtis</em></td>
<td>Hackberry</td>
</tr>
<tr>
<td>Cheno-am</td>
<td>Includes the goosefoot family and amaranth</td>
</tr>
<tr>
<td><em>Sarcobatus</em></td>
<td>Greasewood</td>
</tr>
<tr>
<td><em>Ephedra nevadensis</em>-type (includes <em>E. clokeyi</em>, <em>E. coryi</em>, <em>E. funera</em>, <em>E. viridis</em>, <em>E. californica</em>, <em>E. nevadensis</em>, and <em>E. aspera</em>)</td>
<td>Ephedra, Jointfir, Mormon tea</td>
</tr>
<tr>
<td><em>Eriogonum</em></td>
<td>Wild buckwheat</td>
</tr>
<tr>
<td>Scientific Name</td>
<td>Common Name</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>Euphorbia</strong></td>
<td>Spurge</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Bean or Legume family</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Mint family</td>
</tr>
<tr>
<td>Malvaceae:</td>
<td>Mallow family</td>
</tr>
<tr>
<td><em>Malva</em></td>
<td>Mallow</td>
</tr>
<tr>
<td>Sphaeralcea</td>
<td>Globe mallow</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Evening primrose family</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Grass family</td>
</tr>
<tr>
<td>Polygalaceae</td>
<td>Milkwort family</td>
</tr>
<tr>
<td>Rhamnaceae</td>
<td>Buckthorn family</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>Rose family</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Potato/Tomato family</td>
</tr>
<tr>
<td><em>Tacca</em></td>
<td>Bat flower</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>Too badly deteriorated to identify</td>
</tr>
<tr>
<td><strong>STARCHES:</strong></td>
<td></td>
</tr>
<tr>
<td>Eccentric hilum</td>
<td>Root starch</td>
</tr>
<tr>
<td>Linear hilum</td>
<td>Legume family or <em>Hordeum/Elymus</em> (little barley grass seeds/wild rye seeds)</td>
</tr>
<tr>
<td><strong>SPORES:</strong></td>
<td></td>
</tr>
<tr>
<td>Trilete</td>
<td>Fern</td>
</tr>
</tbody>
</table>
the presence of weedy plants including thistle and ragweed or related plants. This type of a
signature is a strong indication of mixing with post-occupational deposits, since disturbed
sediments support a variety of weedy plants. Liguliflorae pollen is also noted in most samples.
Members of the chicory tribe of the sunflower family are usually weedy in their growth habits,
preferring to colonize disturbed sediments. Recovery of Liguliflorae pollen supports an
interpretation that these samples contain post-occupational debris.

Brassicaceae pollen might reflect either an economic resource or weedy plants growing
in disturbed sediments. Weedy plants growing in abandoned features might provide resources
for people using other features in the area. Cheno-am pollen represents plants in the goosefoot
family, including the highly valued goosefoot, which has been exploited for both its greens and
seeds, and the genus *Amaranthus* (amaranth), a closely related plant of another family that was
also valued for its greens and seeds. Both goosefoot and amaranth also are weedy plants,
preferring to grow in disturbed sediments. Like members of the mustard family these plants
might have grown in abandoned features and provided handy resources for exploitation by
people making and using new features in the area. Variability in Cheno-am pollen frequency is
fairly low in these samples, making interpretation of use or processing of Cheno-ams in
individual features very difficult. *Malva* is another weedy plant that has edible seeds. It is
possible that mallow or cheese-weed was part of a weedy plant complex that grew in disturbed
sediments of abandoned features and also were exploited by occupants of the site.

Poaceae is another regular member of the pollen record, reflecting grasses growing at
the site. Grasses are expected as part of the native vegetation in this area, and as such, they
are interpreted to primarily represent local vegetation. Variation in the quantities of Poaceae
pollen are relatively small, making interpretation of use or processing of grasses very difficult
from the pollen record alone. Recovery of starches or elevated quantities of trichomes in the
phytolith record are used to indicate the likelihood of processing grasses in individual features.

The phytolith record exhibits several main components. In samples with poor
preservation, buliforms and elongates (Figure 2) dominate the record. Buliforms are large cells
that silicify in grasses. Their bulk assists in their preservation. As opal silica forms begin to
dissolve, which they do most readily in sediments that have a moderately high to high pH and
also experience alternating wet and dry conditions, the smaller forms are more likely to dissolve
prior to the large forms. When a record is dominated by buliforms and elongates, it is likely that
many (or most) of the grass short cells have been dissolved and the silica put into solution in
the ground water, for uptake by the next generation of phytoliths. It is interesting to note that
conditions in Feature 1, the burned rock midden, appear to be significantly different than those
in most other features. Grass short cells are far more abundant in the samples from Feature 1
than in most other features. To identify changes in populations of grass, it is most valuable to
compare the total quantities of festucoid, chloridoid, and panicoid grasses to each other,
ignoring the remainder of the phytolith data base.

**Feature 1**

Feature 1 is a large, 18x18 m, burned rock midden buried by colluvium. Profiling of the
midden indicated multiple use events. Preliminary radiocarbon dates suggests that it was first
used around 3,740 B.P. and last used around 1,000 BP, although this estimate was refined by a
radiocarbon age of 4220 ± 40 BP reported for the “final level of Burned Rock Midden” (Boone
Law, personal communication, June 28, 2005), which provides a basal date. The midden
FIGURE 2. PHYTOLITH DIAGRAM FROM SITE 41KR621.
deposit is composed of fire-cracked limestone, and is approximately 1.0-1.2 meters deep. A “20x20 cm column sample” (Boone Law, personal communication, June 28, 2005), was excavated vertically through Feature 1, and ten samples were collected for pollen and phytolith analysis.

The three lowest levels, represented by samples 31, 30, and 29, are associated with a mid-Holocene occupation (approximately 4,500 to 6,000 BP), while the remaining samples appear to represent a Late Holocene (approximately 1,000 to 3,700 BP) occupation. In general the samples from Feature 1 are co-dominated by *Quercus* and High-spine Asteraceae pollen, representing local oaks and members of the sunflower family. Pollen that occurs regularly in small quantities throughout the samples includes *Juniperus*, *Pinus*, *Cirsium*, Low-spine Asteraceae, Liguliflorae, Cheno-am, *Eriogonum*, *Malva*, Poaceae, and Rosaceae, representing local juniper or cedar, pine, thistle, members of the sunflower family including ragweed/sumpweed and members of the chicory tribe, cheno-ams (members of the goosefoot family and also amaranth), wild buckwheat, mallow, grasses, and members of the rose family.

The three lowest samples from the midden, representing the mid-Holocene occupation, exhibit slightly more *Quercus* pollen than do most of the samples from the Late Holocene, suggesting slightly more oak growing in the vicinity at the time of the earlier occupation. Whether the acorns were exploited or not, they appear to have been an abundant resource in the vicinity of this site. *Carya* (hickory, pecan) pollen is observed occasionally in both time periods, indicating the presence of hickory or pecan in the area and its availability for exploitation.

Brassicaceae pollen occurs more abundantly in the Late Holocene samples than in the mid-Holocene samples, suggesting that this resource, although present in both time periods, was more abundant and perhaps more used during the Late Holocene occupation. Both the seeds and greens of plants in the mustard family are edible and often processed. Members of the mustard family also are weedy plants, growing in disturbed areas. Their presence in these samples might reflect growth of the weedy plants in the disturbed sediments of the midden or might reflect discard of plants processed.

Fabaceae pollen is noted in the mid-Holocene and early Late Holocene samples, indicating the presence of members of the legume family in the local vegetation. *Prosopis* pollen was noted in one sample from the mid-Holocene occupation and other members of the legume family could not be identified to genus, but were noted to be present. At this level of identification, the *Prosopis* pollen, which indicates the presence of mesquite in the local vegetation, can be interpreted as representing an economically important resource. The remainder of the Fabaceae pollen might represent only members of the local vegetation, not exploitation of edible or medicinal resources.

*Malva* pollen is present as a regular component of many of the midden samples associated with both cultural occupations. Cheese-weed or mallow is a common weedy plant that has edible seeds and greens. Recovery of this pollen might represent either growth of weedy plants in the disturbed sediments of the midden, or exploitation of a readily available resource.

Apiaceae pollen is present only in one sample from the Late Holocene occupation and might reflect either food processing activities or growth of a weedy member of the umbel family.
in the disturbed midden deposits. Lamiaceae pollen also is present only in one sample from the Late Holocene portion of the midden. It might reflect local growth of a weedy member of the mint family or perhaps use and discard of an economically important member of the mint family, many of which were prized for their medicinal properties.

Quantities of charcoal vary between the mid-Holocene and Late Holocene use of this midden, with larger quantities associated with the Late Holocene use.

The phytolith record from Feature 1 is dominated by chloridoid grass short cells, representing short grasses that tolerate hot summer temperatures and relatively dry soil conditions. Festucoid grass short cells are fairly abundant, indicating a good population of cool season grasses — those grasses that grow and thrive in the cooler months of the growing season. Brome grasses are part of this category and are the most likely to be represented by the “trapezoid sinuate (crenate)” forms. Lastly, the panicoid or tall grass phytoliths form a measured portion of the record. Tall grasses grow best on the floodplains during the summer, benefitting from both the hot summers and added moisture of the floodplains. The three lowest samples, attributed to the mid-Holocene occupation, exhibit moderately large quantities of festucoid grass short cells and the largest quantity of panicoid grass short cells, suggesting that this was a moister interval than later during the Late Holocene occupation — at least from the perspective of the grasses. Samples 27, 28, and 30 yield very similar ratios of festucoid, chloridoid, and panicoid phytoliths, indicating similar conditions. Sample 31 exhibits more festucoid phytoliths than the others, indicating that a greater portion of the grass population was comprised of cool season grasses than at other times. Sample 29 yielded the greatest proportion of panicoid grass cells compared to other grass short cells, indicating that the time period represented by this sample was perhaps the warmest and wettest. Samples 18, 19, and 23, in the upper portion of the midden, yielded the most overwhelming quantities of chloridoid grass short cells, representing the driest interval that supported the greatest proportion of short grasses. The remainder of the samples yielded a signature between the two extremes. Trichomes varied between approximately 2% and less than 10% of the phytoliths present. The variability is fairly small and tends to run between approximately 5% and 10%. This suggests that the trichomes present represent grasses growing in the area, not processing grass seeds to remove or concentrate the glumes that surround the seeds.

**Feature 5**

Feature 5, represented by pollen and phytolith sample 43, consisted of a large tabular limestone block situated within a semi-circle of burned rock cobbles. Sample 43 was collected from amid the burned rock layer. This feature is reported to represent a Late Holocene occupation between approximately 4,000 and 6,000 BP (Boone Law, personal communication, June 28, 2005) This feature should be associated with either a Late Holocene occupation (1,700 to 4,000 BP) or an occupation between approximately 4,000 and 6,000 BP, which is usually assigned to the mid-Holocene. The pollen record is very similar to that in the samples from the burned rock midden (Feature 1). This sample contains small quantities of *Carya*, Apiaceae, and Brassicaceae pollen that might reflect economic activity. In addition, both eccentric and linear hilum starches were observed, suggesting the possibility that roots (perhaps of a member of the Apiaceae family) and perhaps a legume were processed in this feature. The linear hilum starch might represent either a member of the legume family or perhaps a *Hordeum/Elymus*-type grass seed starch. Although the description of the feature
suggests use for heat treating chert, recovery of these starches suggests that this feature was used to process foods that included roots and seeds.

The phytolith record from this feature exhibits severe dissolution on the surface of the buliforms, elongates, and other phytoliths. The record is heavily dominated by buliforms, although some chloridoid and festucoid phytoliths also are present. The ratio of festucoid to chloridoid phytoliths indicates relatively wet conditions, or at least a good population of cool season grasses, which might reflect water retention in this feature when it was filling with post-occupational sediments. Recovery of a small quantity of sponge spicules is consistent with this interpretation.

**Feature 12**

Feature 12 consisted of a small cluster of fire-cracked rock assigned to the mid-Holocene occupation of the site (approximately 4,500 to 6,000 BP). Pollen and phytolith sample P-1 was recovered from the burned rock layer. The pollen record was very similar to that of other samples examined from this site. It provides a signature of local vegetation and no obvious evidence of exploitation of plants known to have economic value either through recovery of larger than average pollen frequencies or starches.

The phytolith record exhibits dissolution, but not as severe as in other samples. Grass short cells also are present and the ratio of these phytoliths indicates moderate conditions similar to those noted in sample 25 in the upper portion of the Feature 1 midden.

**Feature 13**

Feature 13, represented by pollen and phytolith sample P-16, is a ring-like cluster of fire-cracked limestone assigned to the mid-Holocene occupation of the site (4,500 to 6,000 BP). A radiocarbon age of 4950 ± 40 BP is reported for this feature. Soil discoloration was observed near the center of the feature, which also exhibited the densest concentration of burned rock. Dense concentrations of black charcoal were observed near the feature base. Sample P-16 was collected from the burned rock layer. The pollen record is very similar to that of other samples examined from this site with few exceptions. A small quantity of *Celtis* pollen indicates the presence of hackberry in the local vegetation, and hence, availability of these fruits for exploitation. No starches were observed in this sample. This sample exhibited the largest quantity of charcoal examined from this site, which is consistent with the description the feature having dense concentrations of charcoal. Recovery of a pollen sample within a dense charcoal layer usually suggests that pollen present is the result of post-occupational intrusion of pollen into a matrix that represents fuel burned in the feature. Hence, it is likely that this sample represents local vegetation after the feature was used.

This phytolith record exhibits a moderate amount of dissolution and a large quantity of chloridoid short cells. The ratio of grass short cells (chloridoid, festucoid, and panicoid phytoliths) is very similar to that noted in sample 23 from the upper portion of the Feature 1 midden, indicating relatively dry conditions. The moderately dry conditions apparent in the feature suggest that this feature did not hold much water while the fill accumulated and grasses grew in the post-occupational fill.
**Feature 14**

Feature 14 has been interpreted as a burned rock hearth feature also used during the mid-Holocene (approximately 4,500 to 6,000 BP). In addition, a radiocarbon age of $6570 \pm 50$ BP is reported for this feature. Consisting of a dense, circular cluster of fire-cracked limestone, the feature is represented by pollen and phytolith sample P-2. The sample was collected from the burned rock layer. The pollen record for Feature 14 exhibits one of the largest quantities of *Quercus* pollen observed at this site. A full spectrum of pollen was recovered in this sample, so it is not possible to interpret the fill as belonging to a single season of use. Recovery of small quantities of Brassicaceae and *Celtis* pollen indicate local presence of members of the mustard family and hackberry that might have been processed in this feature. Because Feature 14 was discovered at a depth similar to that of Feature 26 (represented by sample P-13), the archaeologist requested that we compare these two records for similarity. Radiocarbon ages returned for Feature 14 (cal BC 5620 to 5470) and Feature 26 (cal BC 5200 to 5180) indicate that they do not overlap in age and the pollen records are not particularly similar to one another, at least not any more than to other samples examined from this site.

The phytolith record, which exhibits a moderate dissolution signature, is dominated by buliforms and elongates. The remaining grass short cells, including chloridoid, festucoide, and panicoid forms, indicate moderate conditions, falling neither among the driest nor the wettest samples examined.

**Feature 15**

Feature 15 consisted of a small, circular scatter of fire-cracked limestone assigned to the mid-Holocene occupation of the site (approximately 4,500 to 6,000 BP). Pollen and phytolith sample P-3 was recovered from the burned rock layer of the feature. The pollen record exhibits a rather small quantity of *Quercus* pollen, reflecting local oak trees. Recovery of small quantities of Brassicaceae and *Celtis* pollen might reflect processing a member of the mustard family and hackberry, but definitely indicates the presence of these plants in the vicinity, and their availability for exploitation. Recovery of Low-spine Asteraceae aggregates suggests that ragweed, or a closely related plant, grew as a weedy plant in the post-occupational fill of this feature.

This phytolith sample exhibited evidence of dissolution on the large phytoliths, such as buliforms, which dominated the record. Although elongates were not abundant, they also exhibited pitting, which indicates dissolution. Only a few grass short cells were recovered. The ratio between them suggests relatively dry conditions, which is unusual, given the evidence for severe dissolution in this sample.

**Feature 16/17**

Feature 16/17, represented by pollen and phytolith sample P-22, consisted of an oval cluster of fire-cracked limestone, with the densest concentration of burned rock located near the center of the feature. This feature is associated with the mid-Holocene occupation (approximately 4,500 to 6,000 BP). A charcoal sample was collected from the base of Feature 16/17 and submitted for radiocarbon dating, but no date was available to us at this writing.
Sample P-22 was recovered from the burned rock layer. The pollen record includes a moderate quantity of *Quercus* pollen and small quantities of Brassicaceae and *Malva* pollen that might reflect exploitation of a member of the mustard family and mallow. Alternatively, these are weedy plants that might have been growing in the disturbed sediments accumulating in the feature after its abandonment.

The large phytoliths observed in this sample also exhibited severe pitting, which indicates dissolution. This record indicates dominance by cool season grasses, which might occur if the feature was in a shady area and if the feature collected water while it filled with post-occupational fill.

**Feature 18**

Feature 18 was a small cluster of fire-cracked limestone roughly circular in outline. Debitage was observed throughout the feature matrix, and use has been assigned to the mid-Holocene (approximately 4,500 to 6,000 BP). Pollen and phytolith sample P-4 was recovered from the burned rock layer. The pollen record is similar to others from this site and exhibits small quantities of Brassicaceae and *Celtis* pollen, documenting the presence and availability of these resources, if not their actual use.

The phytolith record experienced less dissolution than many others. The grass short cell record is good and not overwhelmed by buliforms. The ratio of grass short cells to one another is typical of the moister conditions noted for the mid-Holocene samples from the Feature 1 midden, although this signature does not indicate dominance by cool season grasses that some of the other features (such as Features 5, 16, 20, and 27) do.

**Feature 19**

Feature 19 consisted of a dense cluster of fire-cracked limestone with an amorphous shape. A radiocarbon age of 4120 \( \pm 40 \) BP was returned for the southern portion of this feature, while the northern portion returned a modern date. The two sections of this feature were dated independently because there was a difference in elevation between them. The pollen and phytolith samples are not labeled as to which portion of the feature they represent, so it is not possible to associate them beyond the association of the feature, which is believed to be of mid-Holocene (approximately 4,500 to 6,000 BP) age. Dense concentrations of burned rock were found in various locations, with the most discrete concentrations located on the eastern and western half of the feature. Feature 19 is represented by pollen and phytolith sample P-8, which was collected from amid the burned rock in the eastern side of the feature matrix. The pollen record is typical of others from this site with the exception that the quantity of *Malva* pollen is larger. This might reflect processing cheeseweed or growth of this weedy plant in the disturbed sediments after the feature was abandoned.

The phytolith record from this feature exhibited a moderately large amount of dissolution, but still contained grass short cells. The ratio of grass short cells to one another is similar to that exhibited by Features 28 and 36, as well as the base of the Feature 1 midden, indicating a slight dominance by cool season (festucoid) grasses.
Feature 20

Feature 20, represented by pollen and phytolith sample P-5, also consisted of a small circular cluster of fire-cracked rock. In cross-section, the feature exhibited a basin-like shape and its use has been assigned to the mid-Holocene (approximately 4,500 to 6,000 BP). The soil beneath the burned rock layer appeared slightly darker than the surrounding matrix. While screening soil from the feature, a charcoal fragment was recovered in the 1/8” screen and submitted for an AMS date. Martindale and Early Triangular points were recovered from the same level within the excavation unit. Sample P-5 was recovered from the burned rock layer. The pollen record is similar to other samples from this site and contains small quantities of Brassicaceae and Malva pollen, indicating that weedy plants of the mustard family and also cheeseweed were available for exploitation. It is likely that they formed part of the weedy complex of plants that grew in the disturbed sediments of the feature after its abandonment.

The phytolith record for this feature suffered from a large amount of dissolution. Few grass short cells remained, but festucoid short cells were most abundant, indicating that this feature might have been located in the shade and retained water while it filled with post-occupational sediments.

Feature 21

Feature 21, a small, discrete cluster of fire-cracked rock, is represented by pollen and phytolith sample P-6, which was recovered from the burned rock layer. A Gower point found immediately below feature suggests an Early Archaic cultural affiliation. Use of this feature has been assigned to the mid-Holocene (approximately 4,500 to 6,000 BP). The pollen record contains a very small quantity of Quercus pollen, offset by increases in Cirsium, Low-spine Asteraceae, and indeterminate pollen. This pollen signature is typical of one heavily influenced by a population of weedy plants that grew in the disturbed sediments as they filled the feature after its abandonment. The Brassicaceae pollen is slightly elevated in this sample, which might be the result of weedy members of the mustard family growing in the sediments after abandonment.

The phytolith record from this feature yielded surprisingly little evidence of dissolution. Instead, it showed a record dominated by chloridoid short cells, providing a signature indicating relatively dry conditions similar to those noted for the upper portion of the Feature 1 midden.

Feature 22

Feature 22, represented by pollen and phytolith sample P-7, is also a small, circular cluster of fire-cracked rock. Like so many others, this feature has been assigned to the mid-Holocene (approximately 4,500 to 6,000 BP). A radiocarbon age of 5280 ± 50 BP was returned on charcoal from this feature. Sample P-7 was collected from the burned rock layer. The pollen record is very similar to others from this site. Small quantities of Brassicaceae and Malva pollen probably represent weedy plants growing in the post-occupational sediments. Aggregates of Cirsium pollen, noted in the count, support this interpretation and suggest growth of thistle either in the post-occupational fill or very nearby.
The phytolith record is dominated by a combination of buliform and elongate forms, which exhibited some dissolution. Grass short cell phytoliths also are present, and examination of the ratio of grass short cells to one another provides a relatively dry signature, similar to that in the upper portion of the Feature 1 midden and also Features 21 and 15.

**Feature 24**

Feature 24 consisted of a small, discrete cluster of fire-cracked rock that appeared circular in outline. A Nolan point and an unfinished Early Triangular point recovered in the level immediately above the feature suggest a late Early or initial Middle Archaic period affiliation. Pollen and phytolith sample P-10 was collected from the burned rock within the general feature matrix. The pollen record is typical of many others from this site, with a few exceptions. Like others, this record includes small quantities of Brassicaceae and *Malva* pollen, which probably represent the presence of weedy plants growing in the post-occupational feature fill. Unlike other samples, this one exhibits a small quantity of *Ulmus* pollen, which represents elm, noted to be one of the trees that grows along fences today. *Ulmus* pollen is readily wind transported and if elm grew in the area during prehistoric times, it is expected to have contributed more heavily to the prehistoric record. It is likely that the *Ulmus* pollen recovered from this sample represents modern cedar elm growing along the fences whose pollen was introduced into this record.

The phytolith record for this feature was surprisingly similar to that in Feature 22. Evidence for dissolution was similar, as were frequencies of grass short cells. This sample yielded a slightly larger quantity of festucoid phytoliths, which indicate a ratio of grass short cells weighted slightly more towards the cool grasses, resulting in a signature of less dry conditions than noted in Feature 22.
Feature 25

Feature 25, a large, dense cluster of fire-cracked limestone, is represented by pollen and phytolith sample P-11. The sample was recovered from the burned rock layer. The recovery of Martindale and Gower Points indicate that the feature is most likely Early Archaic. Charcoal was also collected from the feature matrix for the purposes of radiocarbon dating. The pollen record is similar to many from this site. It exhibits Poaceae aggregates that might represent processing grass seeds. Alternatively, grasses growing in the feature fill might have dropped flowers that left these aggregates.

The phytolith record exhibits a moderate amount of dissolution and is dominated by buliforms and elongates. The ratio of grass short cells provides a signature of relatively wet conditions, similar to those at the beginning of the Feature 1 midden sequence and Features 36 and 19.

Feature 26

Feature 26 is a hearth-like pit consisting of a moderate amount of charcoal and a dense circular cluster of fire-cracked limestone. Pollen and phytolith sample P-13 was recovered from the burned rock layer. The pollen and phytolith record of feature 26 as compared to Feature 14 indicate a significant difference. The pollen record exhibits a smaller frequency of *Quercus* pollen, which is more similar to that observed in many features other than the signature in Feature 14. Although not significant in an environmental signal, the pollen record for Feature 26 exhibits small quantities of Apiaceae and Solanaceae pollen, as well as the far more common small quantities of Fabaceae and *Malva* pollen that probably represent weedy plants growing in the pits as post-occupational fill accumulated. Recovery of Apiaceae and Solanaceae pollen might reflect processing members of the umbel and nightshade families. Alternatively, since both of these families also include weedy plants, they might simply be part of the weedy plant complex growing in an abandoned, hearth-like pit as it filled.

The phytolith record from this feature exhibited a moderate amount of dissolution and an extremely large quantity of chloridoid phytoliths. Comparison of the quantities of chloridoid, festucoid, and panicoid phytoliths indicates that this sample represents very dry conditions, as it exhibits a signal even drier than samples 18 and 19, representing the upper portion of the Feature 1 midden column.

Feature 27

Feature 27 consisted of a small, dense cluster of fire-cracked limestone. No distinguishable shape or rock layering was observed in cross-section. There was also no discernable difference between soil from the feature matrix and surrounding soils. A Martindale point recovered 30 cm above feature 17 suggests an Early Archaic period cultural affiliation. Sample P-14 was collected from the burned rock layer for pollen and phytolith analysis. The pollen record from this feature is similar to many from this site. The quantity of *Quercus* pollen is slightly reduced and the quantity of High-spine Asteraceae pollen slightly elevated. In addition, small quantities of Brassicaceae, Fabaceae, and *Malva* pollen were recovered, indicating growth of weedy plants in the mustard and legume families, as well as mallow or
cheeseweed. Recovery of this pollen indicates that these weedy plants also were available for exploitation by people who used this or other nearby features.

The phytolith record from this feature exhibited a large amount of dissolution. The signature of the ratio of chloridoid, festucoid, and panicoid phytoliths indicates relatively wet conditions while the sediments accumulated in this feature. This might represent environmental conditions at this time, or an artificial microhabitat created by the basin of the feature holding water. Either way, the grass short cell record in this sample has a higher ratio of festucoid cells than most other records from this site, indicating growth of cool season grasses that thrive in the cool and generally moist growing conditions of spring and fall.

**Feature 28**

Pollen and phytolith sample P-15 was recovered from amid the burned rock of feature 28, an amorphous cluster of fire-cracked rock. Nolan and Bulverde points recovered from the same level indicate a Middle Archaic date for Feature 28. A radiocarbon age of 4980 ± 40 BP was returned for this feature. The pollen record exhibited an elevated *Quercus* pollen frequency, similar to that in Feature 14. In addition, the Cheno-am pollen frequency was very slightly elevated. This might reflect local growth of weedy plants or perhaps processing cheno-ams. Recovery of small quantities of Brassicaceae and *Celtis* pollen indicate that members of the mustard family and hackberry grew in the area.

The phytolith record from this feature exhibits evidence of moderate dissolution. The grass short cells remaining indicate relatively wet conditions that support cool season grasses, similar to those noted in the lower samples from the Feature 1 midden. This feature might have been located in the shade while it was filling with post-occupational sediments.

**Feature 31**

Feature 31 consisted of a small cluster of fire-cracked rock. No discernable difference between the feature matrix and surrounding soils was observed. Six debitage fragments were found within the feature matrix. Pollen and phytolith sample P-17 was collected from the burned rock layer. The pollen record exhibited a much smaller quantity of High-spine Asteraceae pollen, as well as few Liguliflorae pollen. Small quantities of both *Cirsium* and Low-spine Asteraceae were observed. Small quantities of Brassicaceae, Lamiaceae, and *Malva* were recorded, indicating the presence of weedy plants in the mustard and mint families, possibly cheese-weed or mallow. Alternatively, it is possible that some of these plants were processed in the feature. The nature of the fill (undifferentiated from the surrounding matrix) and similarity of this pollen record to others from this site argue for this sample representing post-occupational fill, as the others appear to.

The phytolith record for this feature also suffered severe dissolution, which is consistent with the presence of water in the feature. This grass short-cell ratio signature is similar to that exhibited in sample 29, collected in the upper portion of the mid-Holocene deposits of the Feature 1 midden and exhibiting a relatively wet signature within that feature. This signature falls within the middle of the range for wetness and is not as influenced by festucoid phytoliths as are samples from Features 28, 16, 5, 27, and 20.
Feature 33

Feature 33 might be a small, discrete cluster of fire-cracked rock, although the same description was provided for Features 24 and 33. This feature, apparently used during the mid-Holocene (approximately 4,000 to 6,000 BP) is represented by pollen and phytolith sample P-24. A radiocarbon age of 5440 ± 40 BP is reported for this feature. The pollen record is typical for this site and includes small quantities of Apiaceae and Malva pollen, indicating the presence of a member of the umbel family and cheese-weed in the local vegetation. The pollen record documents the presence of these plants and their availability for use by occupants of this site.

The phytolith record exhibits a moderately high level of dissolution, as well as some festucoid and chloridoid grass short cells. The ratio of these short cells provides a moderately wet signal, since quantities of cool season and short grasses were nearly equal. No evidence of panicoid (tall) grasses was recovered. The presence of sponge spicules in this sample is consistent with the presence of water, probably accumulating in the pit as it filled with post-occupational sediments.

Feature 34

Feature 34 was a poorly defined amorphous cluster of fire-cracked rock associated with a mid-Holocene (4,000 to 6,000 BP) occupation. A radiocarbon age of 4990 ± 50 was returned on charcoal from this feature. Although burned rock, charcoal, and faunal materials were widely dispersed throughout the excavation unit, the feature is defined by three distinct concentrations: A, B, and C. Pollen and phytolith sample P-32 was recovered from amid the burned rock in concentration B. The pollen record yielded a surprising dominance by Pinus pollen, which is very out of character for samples from this site. Nearly 60% of the pollen recorded in this sample is Pinus, compared to less than 5% in most other samples. Total pollen concentration also was anomalously high – over 12,000 pollen per ml of sediment. This pollen record appears to be the result of factors not influencing the accumulation of sediment and pollen in other features. It is probable that this sample was the recipient of spring pine pollen that accumulated on the temporary fill surface of the feature as it filled. Pine pollen can be noted as a “yellow dust” that accumulates in puddles of water during the late spring or early summer. This anomalous quantity of Pinus pollen is probably the result of this type of deposition. Other pollen types recovered in the sample are typical of those in other samples from this site.

The phytolith record was severely impacted by dissolution. Buliforms and elongates dominated the record, although evidence for grass short cells also was recovered. The ratio of grass short cells suggests relatively wet conditions that supported cool season grasses while the sediments accumulated – similar to those at the base of the Feature 1 midden. This is consistent with the interpretation of the pine pollen (above).

Feature 35

Pollen and phytolith sample P-33 was recovered from the burned rock layer in Feature 35, a cluster of fire-cracked rock. The feature appeared basin-shaped in cross-section and
circular in plan view. It is associated with a mid-Holocene occupation (4,000 to 6,000 BP). No charcoal was found in or around the feature. Feature 35 might be located directly below feature 13, suggesting an earlier occupation than that of feature 13. The pollen record was similar to many others at this site and included small quantities of Brassicaceae and Malva pollen, indicating local growth of weedy members of the mustard family and cheeseweed. These plants would have been valuable resources for occupants of the site. This is the only feature to contain Alnus pollen, reflecting the presence of alder trees growing along the Guadalupe River. Recovery (or absence) of Alnus pollen appears to be accidental and should not be interpreted to have significance other than marking the presence of occasional alder as part of the floodplain vegetation.

The phytolith record is rather severely affected by dissolution and dominated by buliforms and elongates. Chloridoid forms are more abundant than festucoid forms in this sample, providing a signature of dry conditions fairly similar to those of the upper few samples from the Feature 1 midden.

**Feature 36**

Feature 36 was recorded as a small, discrete cluster of fire-cracked rock, associated with projectile points and bone and representing a late-Holocene (approximately 1,500 to 4,000 BP) occupation. Roughly circular in outline, the rocks appeared stacked in cross-section. No discernable difference was observed between the feature matrix and surrounding soil. Sample P-34 was collected from the burned rock layer for pollen and phytolith analysis. The pollen record is typical for this site, including the ubiquitous small quantity of Brassicaceae pollen, indicating the presence of weedy members of the mustard family that would have provided a valuable resource for people.

The phytolith record suffered from severe dissolution, which left only a few grass short cells. Recovery of these few grass short cells suggests relatively wet conditions in the pit, which is consistent with the extreme dissolution. It is likely that this pit accumulated water while it was filling with post-occupational fill and that the extra water put phytoliths into solution, resulting in this collection of large phytoliths exhibiting severe dissolution pits.

**Feature 37**

Feature 37, another small, discrete cluster of fire-cracked limestone, is represented by pollen and phytolith sample P-35. Fifty-five lithic flakes and five bone fragments were recovered from the feature matrix. Feature 37 is located directly below feature 36, suggesting a separate use-period for the two features. A La Jita dart point was collected 100 cm south of feature 37, indicating an early Middle Archaic or late Early Archaic age and assigning this feature to the mid-Holocene (approximately 4,000 to 6,000 BP) occupation. Charcoal recovered from the same level as Feature 27 yielded a radiocarbon age of 3830 ± 40 BP. Sample P-35 was recovered from the burned rock layer. The pollen record is typical for this site and contained a relatively large quantity of High-spine Asteraceae pollen. It did not, however, exhibit small quantities of Brassicaceae or Malva pollen and quantities of Liguliflorae and Cheno-am pollen were low. In contrast, this sample exhibited a moderately large quantity of Low-spine
Asteraceae pollen, reflecting weedy ragweed, sumpweed, or cocklebur. No evidence in the pollen record suggests plant processing.

The phytolith record exhibited moderately severe dissolution, although at least some grass short cells remained. The ratio of these grass short cells suggests moderately wet conditions, which is consistent with the evidence for dissolution. Once again, this feature appears to have held water when the post-occupational sediments accumulated, which facilitated dissolution of the phytoliths.

**Feature 38**

Feature 38, was recorded as a small cluster of fire-cracked limestone cobbles. No datable materials were recovered from Feature 38, but its proximity to the La Jita dart point recovered immediately south of Feature 37 suggests a similar occupation date. Therefore, this feature has been associated with a mid-Holocene (approximately 4,000 to 6,000 BP) occupation (Boone Law, personal communication, June 28, 2005). A radiocarbon age of 4560 ± 40 BP is reported on charcoal recovered from the same level as Feature 38. Pollen and phytolith sample P-36 was recovered from amid the burned rock. The pollen record is typical for this site. Recovery of aggregates of Low-spine Asteraceae pollen suggests growth of weedy members of this group of plants (ragweed, sumpweed, or cocklebur), probably in the fill of this feature as it accumulated. This, along with the presence of small quantities of Brassicaceae and *Malva* pollen, representing weedy members of the mustard family and cheeseweed, suggest accumulation of post-occupational fill between the rocks.

The phytolith record exhibits less dissolution than that in many of the other features from this site. A respectable amount of grass short cells were recovered, indicating relatively dry conditions, similar to those in the upper levels of the Feature 1 midden. This undoubtedly contributed to the preservation of grass short cells.

**SUMMARY AND CONCLUSIONS**

Examination of pollen and phytolith samples from numerous features at site 41KR621 in Kerrville County, Texas has yielded records of vegetation at the time these features filled. The features represent primarily mid-Holocene occupations (approximately 4,000 to 6,000 BP), although there is some evidence of late-Holocene occupations (approximately 1,700 to 4,000 BP). The samples appear to represent, primarily, post-occupational fill in the features or mixtures of occupational and post-occupational fill. Total pollen concentrations between approximately 1,000 and 12,000 pollen per ml of sediment were recovered from many features that had been burned. Many of the samples contained between 4,000 and 8,000 pollen per ml of sediment. This is a large pollen concentration for samples from burned rock features. Burned rock features appear not to have discrete fuel zones that can be identified as such in the field. Therefore, samples were collected from the burned rock matrix. Since the use of burned rock features is not well understood, it is difficult to formulate a sampling design that will consistently address the use of the features. Therefore, examination of these feature fill samples has been an exercise in determining what the fill represents and when the samples might reflect use of the features and when they might represent post-occupational fill. The
similarity in the pollen record through most of this record from 24 features suggests that the samples are heavily influenced by post-occupational fill. Recovery of starches from Feature 5, which contained fire-cracked chert, suggests that even if this feature was used to heat treat chert, it also was used to cook food that included roots and either a legume or grass seeds that are limited to little barley grass or wild rye. Starches were not recovered from other features.

Examination of the phytolith record provides information that helps to interpret the pollen records. Evidence for dissolution in the phytolith record, which varies from extreme to slight, appears to provide interpretations of the conditions under which the phytoliths survived or were dissolved. Conditions of dissolution suggest puddling of water, which is what happens at the base of features and in feature fill. Standing water in features apparently contributes to dissolution of the phytoliths in this area. The smaller, more gracile grass short cells are not expected to survive as well as the more robust bulliforms and slightly larger elongate forms. Therefore, when these larger forms dominate the record and exhibit evidence of dissolution pits on their surface, it is a clear indicator of the accumulation of water in pits. If this were a common condition in the sediments, rather than related to accumulation of water in pits, similar dissolution would have been observed in the stratigraphic samples collected from the Feature 1 midden. These samples were least affected by dissolution.

Plants that provide an economic base for people living in this area would have included at least *Prosopis* (mesquite), Apiaceae (umbel family), Brassicaceae (mustard family), *Celtis* (hackberry), Cheno-ams, Lamiaceae (mint family), *Malva* (cheeseweed), and Poaceae. Even though most of the samples appear to represent post-occupational fill, they still document the types of plants growing in the area and their availability to occupants of this area. Abandoned features would have provided disturbed sediments and good habitats for weedy plants that are economically valuable to people returning to the area. The more disturbed the landscape by previous occupations the more abundant valuable plant resources become. Gatherers valued many weedy plants for both their seeds and greens, available during different times of the year. Any means of concentrating these resources provided value to people living off the landscape.

There are some patterns of distribution to a few pollen types that, without more intimate knowledge of the features, landscape, and distribution of features on the landscape, cannot be interpreted. *Celtis* pollen was recovered in Features 5, 13, 14, 15, 18, 21, and 28. If there is a pattern here, it is not apparent from the information available. By contrast, *Malva* pollen is largely lacking from most of these features, with the exception of Feature 28.
REFERENCES CITED

Angell, Madeline  

Angier, Bradford  

Asch, David L.  

Brown, Dwight A.  

Burlage, Henry M.  
1968  *Index of Plants of Texas with Reputed Medicinal and Poisonous Properties.* Henry M. Burlage, Austin Texas.

Chamberlin, Ralph V.  

Elmore, Francis H.  

Foster, Steven and James A. Duke  

Gallagher, Marsha V.  

Gould, F. N. and R. B. Shaw  
1983  *Grass Systematics.* Texas A&M University Press, College Station.

Gould, F. W.  
1962  *Texas Plants: A Checklist and Ecological Summary.* Texas Agricultural Experiment Station. Submitted to M.P. 585.

Harrington, H. D.

Harrington, H. D.  
1967  *Edible Native Plants of the Rocky Mountains.* University of New Mexico Press, Albuquerque, New Mexico.

Harris, Ben Charles  

Jones, Robert L. and A. H. Beavers  

Kindscher, Kelly  
1987  *Edible Wild Plants of the Prairie.* University Press of Kansas, Lawrence, Kansas.

Kirk, Donald R.  

Krochmal, Arnold and Connie Krochmal  

McGee, Harold  

Moerman, Daniel E.  

Moore, Michael  
1979  *Medicinal Plants of the Mountain West.* The Museum of New Mexico Press, Santa Fe, New Mexico.

Peattie, Donald Culross  
1953  *A Natural History of Western Trees.* University of Nebraska Press, Lincoln, Nebraska.

Peterson, Lee A.  

Petrides, George A. and Olivia Petrides  

Reidhead, Van A.

Sweet, Muriel

Tilford, Gregory L.

Twiss, Page C.

Vines, Robert A.

Watt, Bernice K. and Annable L. Merrill