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Instrumental Neutron Activation Analysis (INAA) of Shell-Tempered Ceramics in the Ancestral Caddo Region: Rethinking Methods

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ABSTRACT

The geochemical analysis of shell-tempered ceramics in the ancestral Caddo region has been a matter of confusion since the mid-1990s. While Caddo archaeologists have long perceived most or all of the shell-tempered ceramics in East Texas to have originated from two different areas within the Red River basin, the geochemical data and interpretations remain inconsistent with that idea. This poster takes another look at this dataset, and considers an approach that was initially put forth by MURR, and then seemingly abandoned. Using only the geochemical data from shell-tempered sherds, we take a closer look at the contributions of calcium (Ca), strontium (Sr), sodium (Na), and manganese (Mn), and illustrate the spatial and temporal consistencies that can be used to establish and expand arguments for the trade and/or exchange of shell-tempered ceramics from multiple locations in the Red River basin.

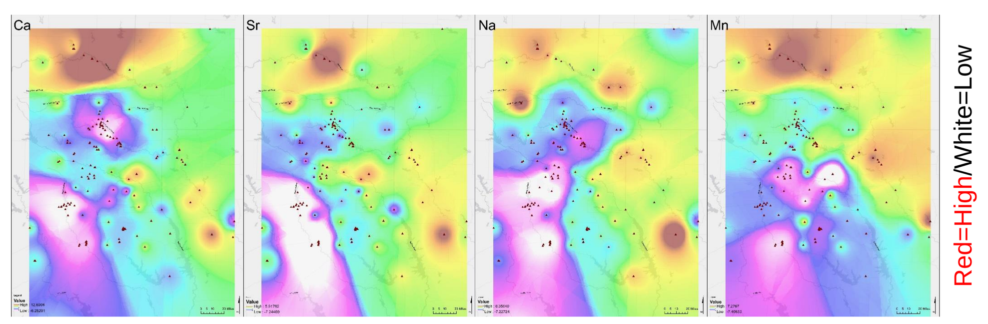
CADDO INAA AND SHELL TEMPER

Perttula et al. (2012) have shown from stylistic and technological analyses of ceramic assemblages across the southern Caddo area that the principal—if not exclusive—manufacture and use of shell-tempered Caddo pottery in prehistoric and early historic times is confined to three areas: (1) the middle Red River (between Oklahoma and Texas), (2) below the Great Bend of the Red River in northwest Louisiana, and (3) in the Ouachita River basin in southwest Arkansas. Thus, the occurrence of plain, red-slipped, and decorated shell-tempered ceramics in Caddo ceramic assemblages outside of these three regions should constitute some of the most compelling evidence for the trade and/or exchange of ceramics from one sub-region to another, but only if the provenance of these sherds can be reliably and consistently identified. We examine the question of ceramic provenance employing the Caddo INAA data base (n=1308 sherds at present) by exploring the geochemical findings from a significant sample of shell-tempered ceramic vessels, primarily due to the limited production of shell-tempered Caddo ceramics within few areas, their identification, employing geochemical data, outside of those production areas constitutes evidence of interaction with Caddo groups residing in neighboring and distant parts of the ancestral Caddo territory.

OBJECTIVE

We use the INAA data for 88 shell-tempered Caddo sherds from 26 Caddo sites to explore whether the geochemical contribution of shell temper inclusions—identified as Ca, Mn, Na and Sr—can successfully discriminate between key production areas in the Red River basin known to differ on the basis of stylistic and technological analyses.

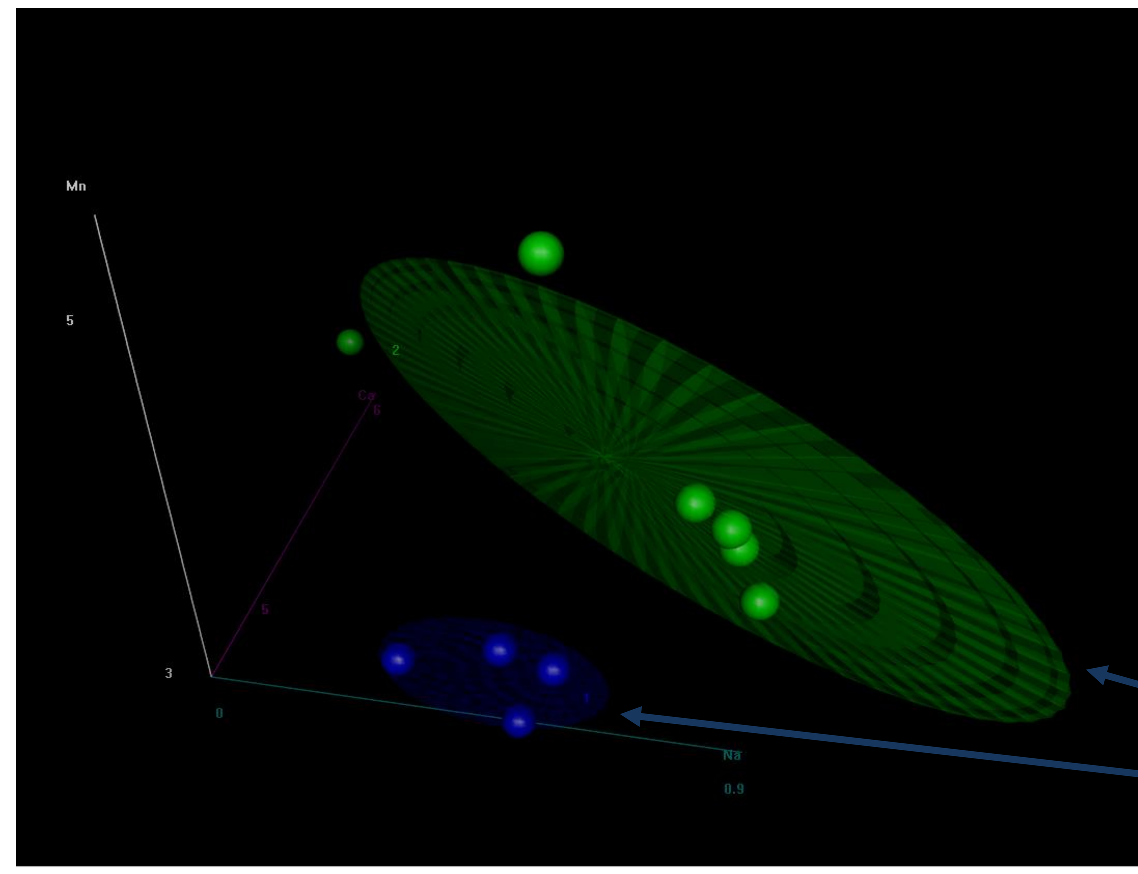
Site	River Basin	Sherd ID	Estimated Age/Age Range	Ca	Mn	Na	Sr
03LA001	Red	TKP958	A.D. 1450-1680	57168.92	267.31	2461.55	262.91
14CO331	Arkansas	TKP088	A.D. 1600-1720	229847.92	618.56	1450.12	634.75
14CO331	Arkansas	TKP094	A.D. 1600-1720	210020.52	590.58	1239.02	563.11
14CO385	Arkansas	TKP089	A.D. 1400-1700	236172.30	581.14	1438.88	575.54
14CO385	Arkansas	TKP090	A.D. 1400-1700	163080.41	610.52	1762.00	553.22
14CO385	Arkansas	TKP091	A.D. 1400-1700	170109.50	532.46	2785.15	909.96
14CO385	Arkansas	TKP092	A.D. 1400-1700	49680.29	865.43	2701.41	254.74
14CO385	Arkansas	TKP093	A.D. 1400-1700	5441.26	122.59	1526.71	67.19
16DS389	Red	TKP534	A.D. 1800	196794.50	499.71	2821.20	463.40
16NA016	Red	TKP613	A.D. 1720	4251.90	747.81	4912.40	77.60
16NA016	Red	TKP614	A.D. 1720	16747.30	686.39	6240.90	232.40
16NA016	Red	TKP615	A.D. 1720	3877.80	193.57	8287.30	79.80
16NA016	Red	TKP616	A.D. 1720	3322.80	965.30	5574.40	101.10
16NA016	Red	TKP617	A.D. 1720	5685.40	251.51	3093.20	49.80
16NA016	Red	TKP628	A.D. 1720	5253.60	657.80	6493.10	167.10
16NA016	Red	TKP629	A.D. 1720	6238.80	268.07	3446.20	112.70
16NA016	Red	TKP630	A.D. 1720	6812.70	290.96	3909.80	118.20
16NA016	Red	TKP631	A.D. 1720	8415.50	980.41	4261.30	188.60
16NA016	Red	TKP632	A.D. 1720	3863.40	536.61	3952.70	105.80
16NA016	Red	TKP633	A.D. 1720	8794.80	236.17	2632.70	131.40
16NA016	Red	TKP634	A.D. 1720	8429.60	524.32	3423.90	94.60
16NA016	Red	TKP637	A.D. 1720	48691.20	337.71	4215.40	290.10
16NA016	Red	TKP638	A.D. 1720	5313.90	233.12	4011.30	137.50
16NA016	Red	TKP639	A.D. 1720	48617.60	125.24	4202.40	261.50
16NA016	Red	TKP640	A.D. 1720	4412.00	274.34	5586.60	153.30
16NA544	Red	TKP341	18th Century	15213.50	645.60	2749.90	77.30
34CH112	Kiamichi	TKP456	A.D. 1300-1700	5944.70	309.86	2850.80	0.00
34CH113	Kiamichi	TKP463	A.D. 1300-1700	88827.00	304.38	2317.10	578.60
34CH113	Kiamichi	TKP471	A.D. 1300-1700	9755.80	776.51	4172.70	143.80
34Mc52	Mountain Fork	TKP950	A.D. 1300-1700	632.59	318.64	4281.60	0.00
34Mc57	Mountain Fork	TKP936	A.D. 1300-1500	1561.64	22.36	993.19	0.00
34Mc760	Red	TKP475	A.D. 1300-1500	7818.10	3259.81	628.00	0.00
34Mc760	Red	TKP476	A.D. 1300-1500	7112.80	1036.44	1421.60	89.90
34Mc760	Red	TKP477	A.D. 1300-1500	41916.20	555.76	896.00	382.50
34Mc760	Red	TKP478	A.D. 1300-1500	136347.00	1801.84	2031.70	632.20
34Mc760	Red	TKP479	A.D. 1300-1500	6396.70	1484.27	766.20	0.00
34Mc8	Glover	TKP914	A.D. 1300-1500	14454.68	2038.82	1866.41	144.28
34Mc8	Glover	TKP917	A.D. 1300-1500	224026.52	613.22	876.70	376.15
34Mc8	Glover	TKP918	A.D. 1300-1500	18890.55	1353.83	1337.74	178.74
34Mc8	Glover	TKP924	A.D. 1300-1500	1320.91	113.49	274.88	0.00
34Mc8	Glover	TKP928	A.D. 1300-1500	6045.19	289.14	2249.73	118.06
34Mc8	Glover	TKP929	A.D. 1300-1500	11702.68	473.02	1181.64	183.26
34Mc8	Glover	TKP930	A.D. 1300-1500	1892.72	344.29	388.66	0.00
41BW003	Red	TKP570	A.D. 1500-1700	6540.70	381.95	2983.70	104.50
41BW512	Red	TKP231	A.D. 1700-1750	11514.40	283.63	3043.50	127.80
41BW512	Red	TKP234	A.D. 1700-1750	6933.60	311.76	2333.70	84.60
41CP239	Cypress	TKP133	A.D. 1550-1680	4611.30	1137.29	1077.10	0.00
41CP304	Cypress	TKP109	A.D. 1430-1680	1290.00	407.54	1931.70	0.00
41HP106	Sulphur	TKP015	A.D. 1300-1450	76339.20	680.53	5264.30	274.70
41HP237	Sabine	TKP880	A.D. 1500-1680	210870.90	415.63	1145.20	538.57
41HS015	Sabine	SWC146	A.D. 1430-1650	35080.80	297.08	1893.90	251.82
41HS015	Sabine	SWC152	A.D. 1430-1650	62145.30	232.12	1677.30	275.86
41HS015	Sabine	SWC211	A.D. 1430-1650	72262.90	295.85	3559.80	287.05
41RK003	Sabine	TKP559	A.D. 1700	7072.90	884.11	1224.80	99.30
41RK003	Sabine	TKP560	A.D. 1700	6606.60	1349.76	2890.00	147.10
41RR011	Red	TKP076	A.D. 1300-1500	172869.00	779.22	363.70	374.50
41RR016	Red	TKP053	A.D. 1300-1500	193665.60	549.77	2534.10	451.20
41RR016	Red	TKP055	A.D. 1300-1600	145543.00	71.84	509.40	485.40
41RR016	Red	TKP056	A.D. 1300-1600	154175.30	456.22	3045.50	407.60
41RR016	Red	TKP057	A.D. 1300-1600	36680.90	226.62	534.60	108.30
41RR016	Red	TKP058	A.D. 1300-1600	130879.80	1142.58	1376.80	449.50
41RR016	Red	TKP059	A.D. 1300-1600	199949.80	1402.63	2392.80	545.60
41RR016	Red	TKP061	A.D. 1300-1600	158065.20	329.54	2520.50	515.20
41RR016	Red	TKP062	A.D. 1300-1600	176591.80	266.25	3436.00	466.10
41RR016	Red	TKP063	A.D. 1500-1700	24332.40	498.03	2137.20	124.10
41RR016	Red	TKP065	A.D. 1300-1450	183968.80	406.73	2295.50	445.50
41RR016	Red	TKP066	A.D. 1300-1450	222337.40	818.95	1177.50	449.90
41RR016	Red	TKP067	A.D. 1500-1700	10607.00	799.56	4123.10	106.70
41RR016	Red	TKP068	A.D. 1300-1450	144291.60	176.25	4314.30	369.00
41RR016	Red	TKP069	A.D. 1300-1450	230893.10	448.61	140.90	391.70
41RR016	Red	TKP070	A.D. 1300-1450	165573.10	428.51	2573.40	416.60
41RR016	Red	TKP071	A.D. 1500-1700	136973.10	652.38	4436.30	393.80
41RR016	Red	TKP072	A.D. 1300-1450	200829.20	479.09	3731.30	485.60
41RR204	Red	TKP041	A.D. 1300-1500	221762.50	397.88	2434.20	591.30
41RR204	Red	TKP042	A.D. 1300-1500	253792.10	648.15	1018.30	639.70
41RR204	Red	TKP043	A.D. 1300-1500	229177.60	1007.36	1599.20	611.70
41RR204	Red	TKP044	A.D. 1300-1500	196095.70	1471.60	2788.20	490.30
41RR204	Red	TKP045	A.D. 1300-1500	214458.90	764.14	1556.80	556.60
41RR204	Red	TKP046	A.D. 1300-1500	212208.20	673.57	4484.90	567.30
41RR204	Red	TKP047	A.D. 1300-1500	229243.00	1736.77	11527.10	640.30
41RR204	Red	TKP048	A.D. 1300-1500	216693.00	749.28	1544.50	536.10
41RR204	Red	TKP049	A.D. 1300-1500	198963.40	764.41	2238.50	560.50
41RR204	Red	TKP050	A.D. 1300-1500	233489.80	655.47	2424.90	514.50
41TT653	Sulphur	EHA086	A.D. 1430-1680	253377.80	983.89	0.00	599.50
41TT769	Sulphur	TKP535	A.D. 1500	53728.20	1208.11	4032.60	201.30
41TT769	Sulphur	TKP562	A.D. 1500	153700.40	660.37	3615.00	242.50
41TT769	Sulphur	TKP563	A.D. 1500	137671.90	1918.95	46.90	407.70
41WD524	Sabine	TKP311	A.D. 1430-1680	5506.40	810.09	4120.80	0.00



Geographic distribution of elements associated with the inclusion of shell temper.

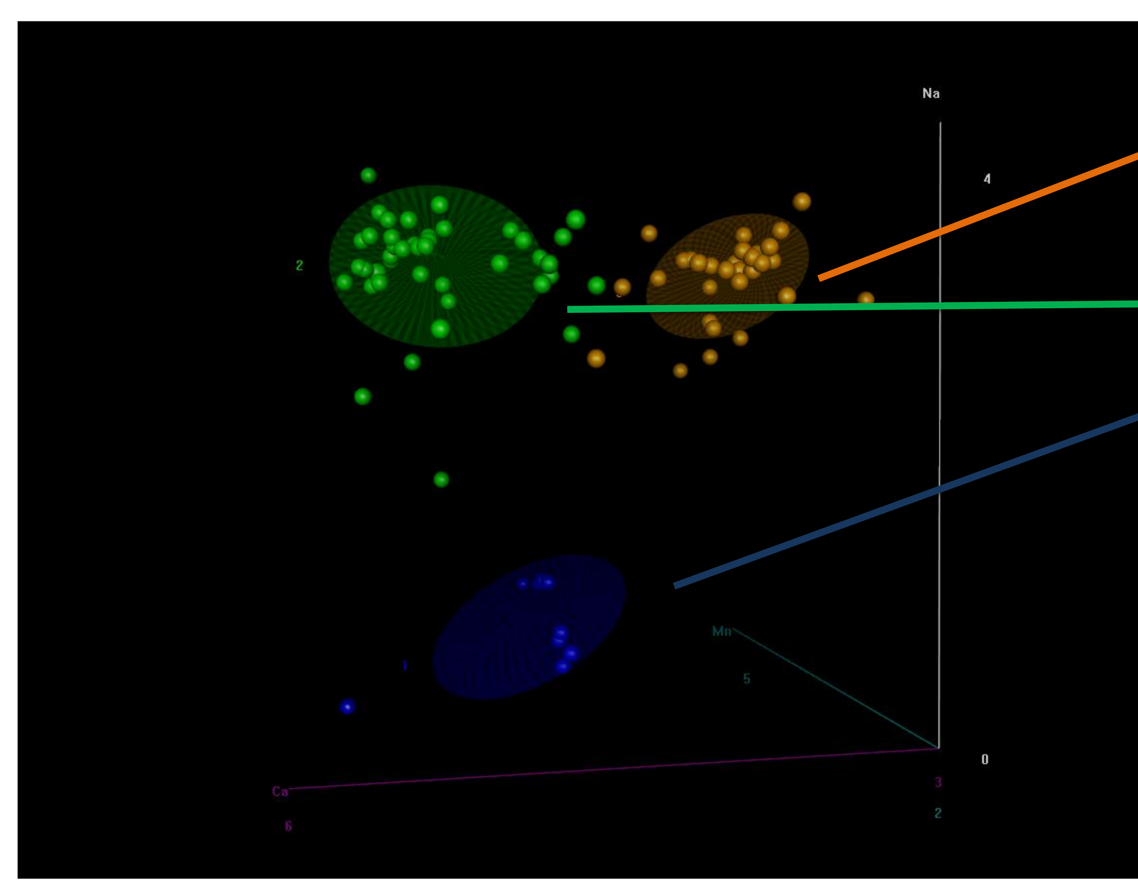
PROBLEMS WITH INTERPRETATION

The University of Missouri Research Reactor (MURR) has conducted INAA on Caddo ceramics for a number of years. Within the context of MURR's analyses of shell-tempered sherds from Caddo sites, none have been successfully assigned to specific provenances that correspond with the results from stylistic and technological analyses, with the exception of 16th and 17th century shell-tempered Caddo vessels from sites in south-central Kansas. MURR's analysis of shell-tempered ceramics from the Caddo INAA database mistakenly suggests that very distinctive shell-tempered ceramics were manufactured throughout East Texas and not traded and/or exchanged from one sub-region to another. Thus, shell-tempered sherds have lost their distinctive geochemical signature through MURR's protocol of removing calcium-related elements from statistical calculations of elemental proportions, group memberships, and probabilities of membership for sherds within specific East Texas geochemical groups. This has led to shell-tempered sherds becoming lost in the current geochemical groupings, rather than being identified as sherds from non-local vessels that might further discussions of inter-regional interaction, trade, and exchange.



METHODS

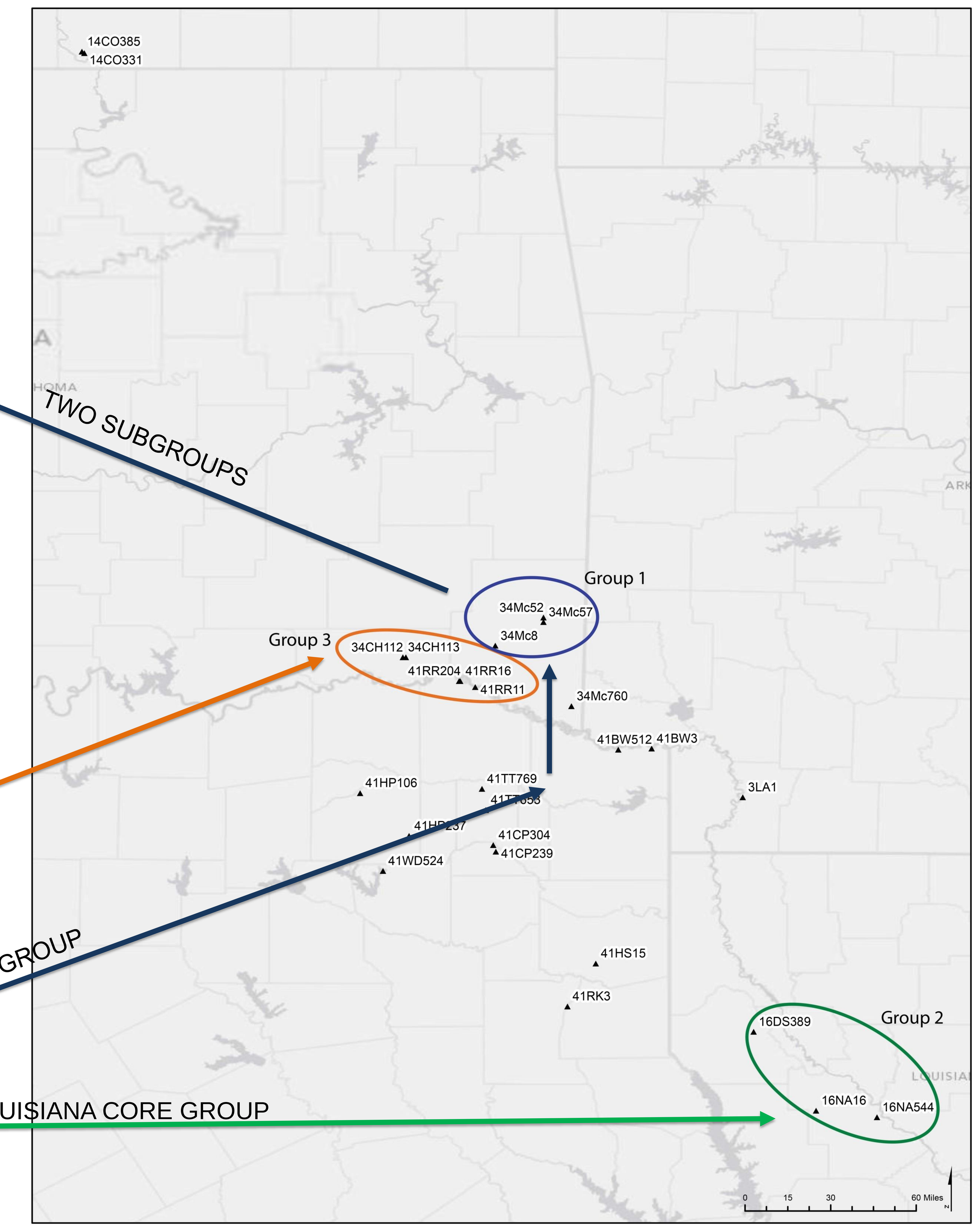
The standard calcium correction (see Steponaitis et al., 1996) was applied in version 3.0.1 of R (www.r-project.org), and the log-10 transformation calculated for each element, after a value of one was added to each sherd/element in the database, effectively replacing all missing values with a zero. Since we are concerned only with the contribution of shell temper to the ceramic paste for this endeavor, only those values associated with Ca, Mn, Na, and Sr—as identified by Cogswell et al. (1998)—were used in this analysis. We explored a range of cluster numbers from two to 15 using the NbClust package in R. Almost half of the methods (11) recommend three clusters. The next most recommended number of clusters was 15 (4 methods). The geochemical data were then analyzed using a kmeans cluster analysis wherein three chemical composition groups were identified, then illustrated in a 3D scatterplot.



*References available upon request.

RESULTS

The results of this analysis indicate that the use of Ca, Mn, Na, and Sr as a proxy for shell-tempered inclusions in Caddo sherds yields results consistent with recent stylistic and technological analyses of Caddo shell-tempered sherds, and point to geographically distinct production areas in several portions of the Red River basin. The NbClust function indicates that there are three groups present within the dataset, one in southeast Oklahoma, a second in the lower Red River basin in northwest Louisiana, and the third in middle Red River basin between southeast Oklahoma and east Texas. Sites that form the potential production areas include Clement (34Mc8), 34Mc52, and 34Mc57 for Group 1, 16DS389, Los Adaes (16NA16) and Point (16NA544) for Group 2, and Hugo Lake (34CH112), 34CH113, Dan Holdeman (41RR11), Roitsch/Sam Kaufman (41RR16), and Salt Well Slough (41RR204) for Group 3. Since previous studies (Cogswell et al., 1998; Peacock et al., 2007) have indicated the potential for successful demarcation of shell temper inclusions between different drainages using INAA and LA-ICP-MS data, the INAA data from the southeast Oklahoma production area was examined in more detail, since shell-tempered sherds in Group 1 are from Caddo sites in both the Glover (34Mc8) and Mountain Fork (34Mc52 and 34Mc57) drainages, which are in and immediately adjacent to the Ouachita Mountains. The geochemical results support findings from the Cogswell et al. (1998) and Peacock et al. (2007) studies, in that those elements associated with shell-temper inclusions can be successfully discriminated between these two drainages. In all, only two sherds (TKP924 and 930) from 34Mc8 (Glover) fall within sub-group 1 of Group 1; the other five—and the single sherd from 41TT653 (EHA086)—fall within sub-group 2 of Group 1. Sherds from 34Mc52 (TKP950) and 34Mc57 (34Mc936) both fall within sub-group 1 of Group 1.



CONCLUSIONS

The INAA data associated with Ca, Mn, Na, and Sr can be used as geochemical proxies to explore the potential contributions of shell-tempered inclusions in Caddo ceramics, pointing to an analytical avenue where significant gains can be made through a reanalysis of existing data. The results of this effort are consistent with recent stylistic and technological analysis of shell-tempered sherds from the Caddo region that has identified several distinct post-A.D. 1300 production areas, which differs considerably from the interpretation of previous analyses of shell-tempered ceramics in the Caddo INAA dataset. Our analysis of Caddo shell-tempered ceramic sherds points to a new method of analysis that may yield considerable gains with regard to the identification of areas of shell temper procurement and shell-tempered ceramic vessel production, as well as the provenance of shell-tempered sherds that are from sites not in any known production area.