

Source Analysis of Central Plains Tradition Pottery Using Neutron Activation Analysis: Feasibility and First Results

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We report the results of a study applying instrumental neutron activation analysis (NAA) to pottery from eight sites assigned to the western part of the Central Plains tradition (Upper Republican and Smoky Hill phases) and six components identified as High Plains Upper Republican. Our purpose is to test the feasibility of using NAA to trace interactions among people of the Central Plains tradition and between the Central Plains tradition people and their counterparts on the High Plains. Results of the statistical analysis, which was performed using the chemical data for both newly sampled sites and previously studied sites (as reported by Cobry), suggest that NAA is a usable method for evaluating the movement of pottery for at least parts of the Central Plains tradition. Samples from four sites on Medicine Creek as well as the Albert Bell and LeBeau sites formed a single homogeneous group referred to as the Central Plains Reference Group. Samples from the other sites, however, formed distinct groups for each site and also reflected some interaction with their contemporaries. We discuss the implications of these results, some of the questions that remain, and the need for continued sampling.

Keywords: *Central Plains tradition, ceramics, neutron activation analysis, interaction*

PROBLEM DEFINITION

For as long as archaeologists have recognized the “cultures,” now usually designated phases, that collectively compose the Central Plains tradition, these phases often have been treated as if they represented distinct, discrete, bounded, small village-dwelling societies analogous to the tribes, or at least to self-identified bands within the tribes, of the historic period. Our on-going work with the

western part of the Central Plains tradition—the Smoky Hill and Upper Republican phases—is painting a different picture. As a basic point, we find that we must renounce the notion of small village organization in the Central Plains tradition and replace it with one of economically autonomous farmsteads spread along the major stream valleys. This is important because even if some adjacent farmsteads were contemporaneous, we

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have no evidence for a village level of sociopolitical organization on the central Plains at this time. As we begin to build a new concept of Central Plains tradition social organization, the scale, degree of localization, and nature of interactions among members of the communities (and it is the *members* of the communities, not the communities per se, that interact) are topics of considerable interest.

The area of the western Central Plains tradition, i.e., the portion of northern Kansas and southern Nebraska from about the Blue River valley in northeast Kansas west to the Medicine Creek locality in southwest Nebraska, is an area that exhibits a strong ecological gradient. The notable variation in precipitation, vegetation, and faunal resources within this region is cross-cut by the valleys of trunk streams—the Smoky Hill, Saline, Solomon, and Republican rivers—that rise on the High Plains or Colorado Piedmont and flow in rather straight and parallel courses to the east. Each river valley provides a series of closely-spaced linear environments composed of the stream itself; the stream banks; timber belts that line the streams, if discontinuously; the prairie-covered stream terraces; and the uplands separating the rivers. Throughout the western Central Plains tradition, the farmsteads were small, usually rectangular, lodges spread along the front edges of the terraces in the main river valleys or the valleys of their larger tributaries. The most productive zones of the river valleys were the river meander belts, the stream banks, and the timber belts lining the river edges. Each farmstead's immediate catchment, therefore, contained most of the full diversity of resources on which the people of the Central Plains tradition depended for food and raw materials. Only two classes of resources would have required a walk of more than a kilometer or so to procure. One of these was the larger fauna, such as bison—an animal not always extensively used by western Central Plains tradition people. The other was, in most places, chert and other rock and mineral raw materials, potentially including suitable pottery clay.

Despite the lack of actual villages, we have no doubt that farmsteads were linked by notions of community. In the face of the strong ecological gradient, however, the degree of localization

of these communities appears variable. Precipitation in the lower valleys of the main streams of the central Plains, of course, varied from year to year, but it is likely that it did not often drop to such low levels that crops failed or resulted in severely reduced yields, and, if it did, it is not likely that it did so over runs of years. In this area, where resource yields were reasonably stable, communities may have been strongly localized, with farmsteads within a given valley comprising dispersed communities that, among other functions, maintained and reinforced exclusive claims to and access to its resources. Yet in the absence of actual village organization, farmsteads within valleys may have interacted primarily with their neighbors for several kilometers in each direction, resulting in “fuzzy” and probably continually shifting community “boundaries.”

Farther west, the situation may have been somewhat different. Here, resource yields probably were not so stable and, moreover, runs of bad years probably did occur, potentially making continuous occupation of farmsteads precarious. In fact, as is well-known, elements of the distinctive material culture complex of this westernmost Central Plains tradition phase, what is often called the Upper Republican phase, are found on the High Plains in situations without lodges and without evidence of agriculture. Recent assessments of the relations among the westernmost lodge sites, such as those in the Medicine Creek valley, and the High Plains sites (Roper 2007; Scheiber 2006) suggest these are all the same people who, when conditions were favorable, occupied lodges and tended crops (and of course consumed other local resources) but, when conditions were less favorable, became mobile hunter-gatherers moving through a region where bison were abundant. Communities on this part of the central Plains were not localized and interaction probably was more fluid and situational.

We have several means of evaluating the utility of this conception of Central Plains tradition organization. One is detailed ceramic style analysis. This has been initiated and will be continuing over the coming years. A second approach is the use of chemistry-based approaches, such as neutron activation analysis (NAA) to study the movement of pots and, by extension, people through

the region.

NAA has been proven as an effective analytical tool to characterize the chemical composition of prehistoric pottery and to relate sherds to their sources through their chemical composition (Glascock 1992; Neff 1992). Given the chemical complexity of clay and temper materials, sensitive and precise measures of compositional elements are required to discriminate between production-source areas. The relation is, however, empirical and its sensitivity in any given region must be established through analysis of carefully selected samples. In this study, therefore, we report the results of a pilot study that tests the feasibility of using NAA to trace the interactions among people of the Central Plains tradition and between these people and their counterparts on the High Plains. Our basic strategy is to select materials from sites in most of the major river valleys forming the upper Kansas River basin, and to sample the valleys at several points along their east-west course. Our basic research question is whether pots appear to have moved west-to-east along drainages, which is consistent with the organizational model sketched above and with the results to date of the style analysis. Alternatively, interactions could have occurred across drainages in more of a north-south direction, as implied by the traditional taxonomies assigning the central Kansas sites to the Smoky Hill phase (regardless of which valley they lie in) and the western Kansas/southwestern Nebraska sites assigned to the Upper Republican phase (regardless of which valley they lie in).

MATERIALS AND METHODS

This is not the first study of material in the broad set of sites we are considering. A recent

study by Anne Cobry (1999; see also Cobry and Roper 2002) analyzed sherds from two Upper Republican sites in the Medicine Creek locality—a lithic work area at 25FT30 and House 5 at 25FT39—and from three sites on the High Plains of northeast Colorado and southeast Wyoming—Donovan (5LO204), Seven Mile Point (48LA304), and Gurney Peak Butte (48LA305). Cobry also analyzed clay samples from four separate sampling points in the Medicine Creek locality. Three of these were from B horizons of soils formed on the surface of the T-1. The fourth was obtained from an outcrop of weathered Pierre shale just below Medicine Creek Dam. Other clay-source samples included in Cobry’s analysis were taken near the Donovan site in northeast Colorado, from alluvial context near Muddy and Lodge Pole creeks, both near Seven Mile Point in southwest Wyoming; from Pine Bluffs Volcanic Ash, also near Seven Mile Point; and from Gurney Peak Butte, also in southwest Wyoming (Figure 1).

Cobry’s (1999; see also Cobry and Roper 2002) results suggested that some of the High Plains pots apparently were coming from Medicine Creek, but that some were made of clays from different sources that were not identified. Con-

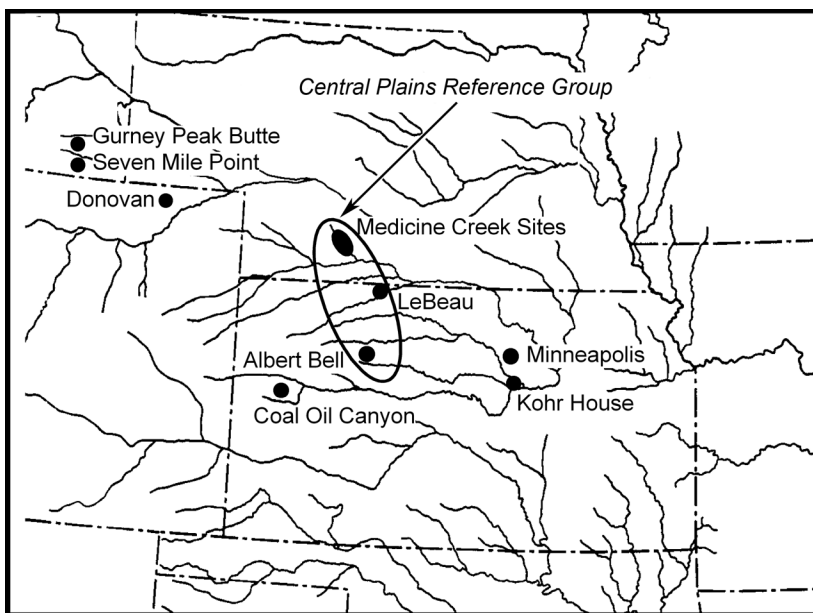


Figure 1. Sites from which pottery samples were obtained and of the Central Plains Reference Group (see text for details of how this group is formed).

versely, it also appeared that some of the pots from one of the Medicine Creek sites, House 5 at 25FT39, might have been produced from clays derived from sources other than the Medicine Creek valley, implying importation of pots and not clays, but it could not be determined where those pots might have come from. These results were and are credible, particularly given that the excavated material from the 25FT39 lodge includes large quantities of western lithic raw materials, especially Flattop Butte chalcedony.

The study reported here sought to expand the sampling and analysis of pottery to the east, overlapping Cobry's study area along the western edge of our sampling area (Figure 1). Thus, we selected samples of 10 to 30 sherds from each of seven lodge sites in four river valleys. We expanded the sampling of the apparently diverse Medicine Creek valley by selecting sherds from two additional sites, a midden associated with Houses 1 and 4 on 25FT22 and what is thought to be a plowed-down house on 25FT167. We also included sherds from the LeBeau site (14NT301) located in the valley of Prairie Dog Creek. Both Prairie Dog Creek and Medicine Creek are tributaries of the Republican River. Moving south, we selected material from two sites in the Solomon River drainage. The westernmost of these two is Albert Bell (14SD305), an Upper Republican site in the valley of Museum Creek, a tributary of the South Fork of the Solomon River. The Albert Bell site is situated at the western edge of the Central Plains tradition and located due south of the Medicine Creek valley site group. From farther downstream in the Solomon River valley, we selected samples from Minneapolis (14OT5), an important Smoky Hill phase site. From a short distance south of the Minneapolis site—in the lower valley of the Smoky Hill River—we sampled the ceramics from the Kohr House #1 (14SA414).

Finally, we included pottery from the Coal-Oil Canyon site (14LO1/401). Coal-Oil Canyon is not a lodge/agriculture site, but it is not exactly like others of the reported Upper Republican sites on the High Plains. The 1950s excavations at Coal-Oil Canyon (Bowman 1960) resulted in the recovery of a large quantity of pottery that can be accommodated by Central Plains tradition pottery typologies. However, our recent re-examination

of the numerous rim sherds indicates that the assemblage is very diverse, with decorative similarities to vessels from Medicine Creek valley, Solomon River drainage, and Smoky Hill River valley sites. Coal-Oil Canyon is beyond the western limits of the horticultural farmstead sites (that limit is at about 100° W longitude) and is functionally distinct from them. It is near historic trails and seemingly represents a place used repeatedly for short, perhaps transitory, occupation. Our purpose in including samples from this site was to help confirm whether this key western Kansas site, uniquely situated near trails, is indeed at a crossroads, or whether it better fits with other Smoky Hill River valley sites. To address this question, we sampled as best we could across the range of variation to see if that variation is the result of pots moving to the site from different areas or if this locality was used largely by the people of one community.

Roper (2006:111–112) summarizes the characteristics of Central Plains tradition pottery. Overall, this pottery usually is grit- or sand-tempered. Vessels are globular to sub-globular with direct flaring or collared rims. Decoration, when present, and except in rare instances, is confined to the rim and/or lip. Exteriors are predominantly cord-roughened. The High Plains material from beyond the area of the lodge sites is consistent with this general description. Shell-tempered pottery occurs in sites of the eastern part of the Central Plains tradition and is represented in small proportion as far west as the Minneapolis site. Shell-tempered pottery was not considered in this study. All sherds used for this study were grit- or sand-tempered body sherds.

In addition to the pottery samples, five samples from clay sources in the Albert Bell site vicinity were analyzed and compared against the sherds from that site to determine if they were locally manufactured. Two of these samples came from a playa in native rangeland 14.5 km southwest of the site. One came from a pit that was hand-excavated to obtain a sample from a Bkt horizon on a small terrace just south of the site. Another was taken from a small slack-water area in the Museum Creek channel. The final sample is from slack-water in an unnamed, slow-moving tributary of the Solomon River 1.9 km northeast

of the site. It is believed that these clay sources would have been accessible to prehistoric potters from Albert Bell.

SAMPLE PREPARATION AND IRRADIATION

Sample preparation and analysis were conducted at the University of Missouri Research Reactor Center (MURR). The pottery samples were prepared for INAA using standard MURR procedures (Glascock 1992; Neff 1992, 2000). Fragments of about 1–2 cm were removed from each sample and the surfaces were abraded using a silicon carbide burr to remove any materials adhering to the surface, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research. Clay samples were fired in a furnace to 700 degrees Celsius for one hour.

Portions of approximately 150 mg of powder were weighed into small polyvials used for short irradiations at MURR. At the same time, 200 mg of each sample were weighed into the high-purity quartz vials used for long irradiations. Along with the unknown samples, reference standards of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay.

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation entails irradiation of each sample for five seconds by a neutron flux of $8 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$. The 720-second count yields gamma spectra containing peaks for short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples encapsulated in quartz vials are subjected to a 24-hour irradiation at a neutron flux of $5 \times 10^{13} \text{ n cm}^{-2} \text{ s}^{-1}$.

This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 2,000 seconds (the “middle count”) on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- to four-week decay, a final count of 9,000 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

STATISTICAL ANALYSIS OF THE CHEMICAL DATA

The analyses produced elemental concentration values for 32 or 33 elements in most of the analyzed samples. Data for As, Ni, Sb, and Tb were not considered during the statistical analysis of data given that these elements generally have poor analytical precision. As is customary in ceramic provenance studies at MURR, parts-per-million data were converted to base-10 logarithms. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as iron, and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more “normal” distribution for many trace elements.

Data were examined using principal components analysis (PCA) and through inspection of bivariate plots (see Baxter 1992; Bieber et al. 1976; Bishop and Neff 1989; Neff 1994, 2000, 2002; and Neff et al. 2006 for detailed discussions of various statistical approaches commonly used in NAA studies of pottery). Samples were assigned to groups based on patterning observed in PCA and bivariate space. Mahalanobis distance probabilities were used to evaluate the statistical validity of the proposed group structure. Use of Mahalanobis distances usually results in a subset

of specimens that cannot confidently be assigned to any group. As Neff et al. (2006) indicate, these specimens may be statistical outliers from one of the defined groups, may represent different pottery production practices or diagenic anomalies, or they may pertain to sources sampled so sparsely that they cannot be recognized as distinct groups. In the current study, specimens were left unassigned if they were marginal to all groups or if including a specimen in the group to which it apparently belonged obscured distinctions between groups that were otherwise well discriminated. Although unassigned specimens are problematic, the approach taken herein is similar to that taken by most NAA laboratories and serves to minimize incorrect group assignments by leaving marginal specimens unassigned (Neff et al. 2006). Ideally, additional analyses of pottery will permit classification of the unassigned specimens.

RESULTS

The current study reports on the analyses of the 87 artifact and 13 source clay samples newly submitted for this study and the data generated for the 56 sherds and 11 source clay samples reported in Cobry’s earlier study, thus producing a truly regional feasibility study.

Analysis of pottery

Eight compositional groups were identified in the current study. Cobry (1999; Cobry and Roper 2002) identified two compositional groups, Medicine Creek 1 and 2, from pottery produced at sites along Medicine Creek. The analysis of additional Medicine Creek pottery samples as well as analysis of samples from the Albert Bell, LeBeau, and Coal-Oil Canyon sites has necessitated reevaluation of the distinctiveness of these two groups. With the increased sample, groups designated Medicine Creek 1 and Medicine Creek 2 are no longer considered distinct. Instead, the two groups are combined with all pottery from the Albert Bell and LeBeau sites, and the vast majority of pottery from the Medicine Creek

sites and renamed the “Central Plains Reference Group,” which contains 70 pottery specimens (see Figure 1 for the spatial extent of this reference group). Other compositional groups are formed from pottery samples from the Seven Mile Point, Kohr House #1, Minneapolis, Coal-Oil Canyon, and Donovan sites. Pottery from Donovan site levels 1 and 4 each formed distinct groups. These results corroborate the intuitive notion that pottery was manufactured locally from nearby clays. Twenty-two pottery samples are unassigned.

The subgroup structure in the complete central and High Plains regional potsherd data set is visually portrayed in three bivariate plots (Figures 2–4; Speakman and Glascock 2004) and is summarized in Table 1. The table lists group membership based on Mahalanobis distance probabilities; these probabilities are based on the 29 elements retained for analysis. The group membership assignments listed in Table 1 confirm that the subgroup structure proposed herein is statistically viable, with the possible exception of the specimens from Coal-Oil Canyon that exceed one percent probability of membership in the Central Plains Reference Group. These specimens suggest that the chemical composition of the two

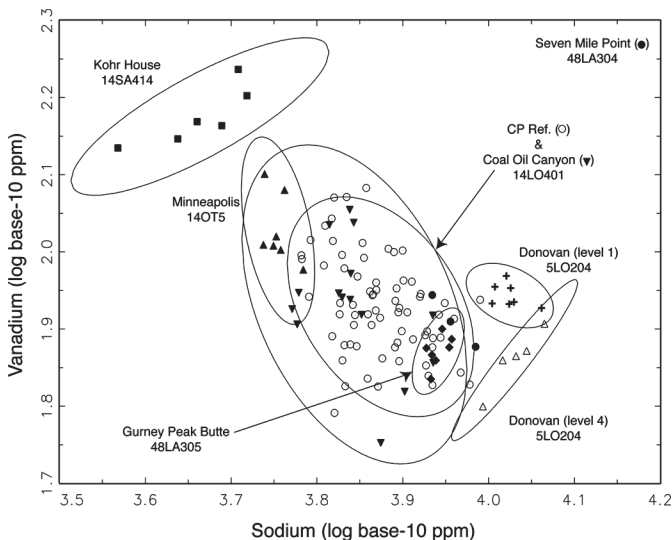


Figure 2. Bivariate plot of sodium and vanadium base-10 logged concentrations for pottery samples. In this projection the Kohr and Donovan groups (level 1 and level 4) are shown to be separate from all other groups. Ellipses represent 90% confidence interval. Unassigned samples are not plotted.

groups overlaps to some extent.

The group structure for Gurney Peak Butte, Seven Mile Point, and Donovan has not changed significantly with the analysis of additional samples. This is not unexpected given that all new samples were from either the eastern edge of the area covered by Cobry's samples or from sites even farther to the east and probably did not affect the grouping of those samples. A few samples were reassigned, but these reassignments do not affect the interpretations made by Cobry and Roper (2002). Of particular note here is that one sample from Coal-Oil Canyon (CPT051), which consistently groups with Donovan-1 pottery. However, this assignment is tenuous at best given that the small number of samples in the Donovan-1 group prohibits any rigorous statistical testing of the member in the group.

Results for the central Kansas lodge sites are of considerable interest. Seven of the nine samples analyzed from the Minneapolis site form a distinct compositional group. Six of the 10 samples from Kohr house also formed a distinct compositional group, one sample is unassigned, and three have a high probability of membership in the Central Plains Reference Group. Additional analyses of pottery from Minneapolis and adjacent sites would help to refine this group and would permit more rigorous statistical testing of the Minneapolis and Kohr groups. Given that a distinct group comprised of Kohr pottery was identified, the assignment of the three Kohr House samples to the Central Plains Reference Group potentially indicates a west-to-east movement of some pots to the lower Smoky Hill valley. Roper in fact has seen in collections from this area occasional sherds whose ceramic fabric macroscopically bears a strong resemblance to that from Medicine

Creek and other sites to the west. It is highly significant, however, that neither the Kohr site nor the Minneapolis site appears to have pottery from

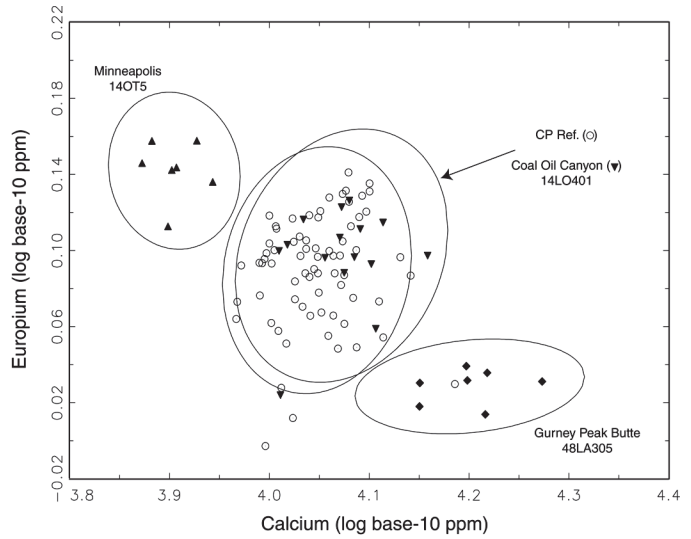


Figure 3. Bivariate plot of calcium and europium base-10 logged concentrations for pottery samples. In this projection Gurney Peak and Minneapolis Groups are shown to be separate from the CP Ref. and COC groups. Ellipses represent 90 percent confidence interval. Unassigned samples are not plotted.

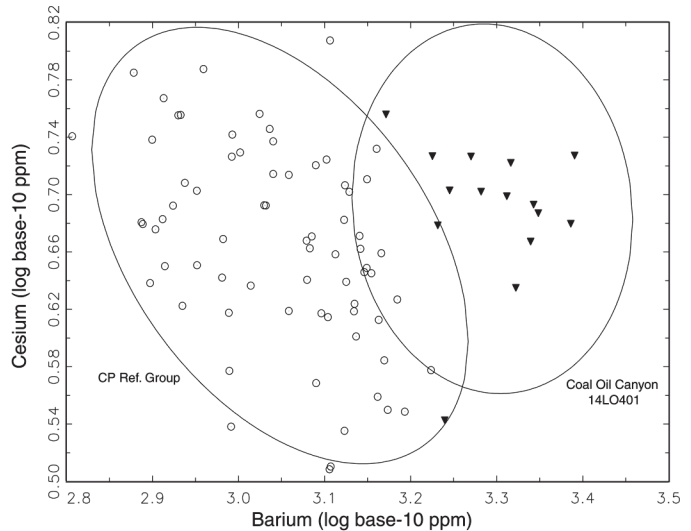


Figure 4. Bivariate plot of barium and cesium base-10 logged concentrations illustrating the best possible separation of the CP Ref. and COC groups. Ellipses represent 90 percent confidence interval. Unassigned samples are not plotted.

Table 1. Samples from Sites and Compositional Group Membership as Determined by Chemical Composition Acquired by Neutron Activation Analysis. Group Membership Is Based on Mahalanobis Distance Probabilities

Sites and Samples		Compositional Groups								
Sites	N	CPR ¹	SMP ²	GPB ³	D1 ⁴	D4 ⁵	COC ⁶	M ⁷	K ⁸	Unassigned
25FT22	10	10								
25FT30	10	9								1
25FT39	10	10								
25FT167	10	8								2
LeBeau	12	12								
Albert Bell	10	10								
SMP ²	13	7	3	1	1					1
GPB ³	10			6						4
D1 ⁴	5				5					
D4 ⁵	5				1	4				
DL9 ⁹	3									3
COC ⁶	26	1			1		15			9
M ⁷	9	1						7		1
K ⁸	10	3							6	1

1 Central Plains Reference Group, 2 Seven Mile Point, 3 Gurney Peak Butte, 4 Donovan 1, 5 Donovan 4, 6 Coal-Oil Canyon, 7 Minneapolis, 8 Kohr House #1, 9 Donovan Level 9.

the other site. This is consistent with our prediction of more interaction along than between river valleys. Considerable additional work will have to be done to strengthen this conclusion, including showing the contemporaneity of the two sites and increasing the sample size of analyzed sherds, but the results obtained here at least suggest that these sites can be differentiated by neutron activation analysis and that expanded sampling and analysis should be productive.

Of the 26 pottery samples analyzed from Coal-Oil Canyon, 15 are assigned to a new group: the Coal-Oil Canyon Group (COC). Of the other 10 samples, one is assigned to the Central Plains Reference Group, one sample is assigned to Donovan-1, and nine are unassigned. Pottery from the Coal-Oil Canyon Group is so similar to pottery assigned to the Central Plains Reference Group that barium appears to be the only element capable of discriminating between these two groups, and even then the separation is not unambiguous. A discriminant analysis failed to show a good separation for these groups and several specimens assigned to the Coal Oil-Canyon group exceed one percent probability of membership in the Central Plains Reference Group. It is possible that analysis of a larger sample of pottery from Coal-Oil Canyon would help to refine the COC group so that a statistically viable group (or groups)

could be defined. Given the high number of unassigned specimens, increased sampling might also aid in identification of additional COC subgroups.

Analysis of clay samples

For the earlier study by Cobry and Roper, investigators sampled clay sources from a T-1 source in the Medicine Creek locality. This clay source should have been accessible to prehistoric potters. Roper and some of her students previously had made and fired pots made from these clays and had added temper similar to that seen in prehistoric pots from the area. The vessel fabric macroscopically appeared very like Upper Republican pottery, both on the surface and on fresh breaks. Samples of weathered shale in the region were tested in similar fashion with poor results. It was difficult to produce vessels with thickness similar to that of Upper Republican pottery, and the clay body cracked extensively. Moreover, the vessel fabric did not look like that of Upper Republican pottery. Clay samples from near the Albert Bell site collected for the current study were selected based on presumed availability to prehistoric potters (terrace cut, stream bed, and playa) and their relatively high clay content.

Based on the available data, it appears that clay resources in this region exhibit similar ranges of variation across broad geographic areas. The

chemical similarity and the small number of pottery samples analyzed from the Albert Bell ($n = 10$) and LeBeau ($n = 12$) sites preclude the identification of distinct reference groups for the Medicine Creek, LeBeau, and Albert Bell sites and the evaluation of the movement or lack of movement of pots among these valleys.

In nearly all cases, our clay samples do not group with the pottery samples, and thus are not included in the principal components analysis of pottery samples. The mismatch between pottery and clay samples suggests that we have not sampled the sources that were used by prehistoric potters. Of the analyzed clay samples, the closest matches to the Central Plains Reference Group are those that were collected from a playa near the Albert Bell site. In general, most pottery from the Albert Bell and LeBeau sites is lower in aluminum than pottery from the Medicine Creek sites. Additionally, cesium, lutetium, and zirconium are generally higher in pottery from the LeBeau site suggesting a possible separation of this pottery from that represented at Albert Bell. Most of the pottery in this dataset is tempered with a high silica sand. When added to clays, the quartz in the sands effectively serves to dilute most other elements. The inclusion of possible sand tempers in the next stage of this study will permit us to "mathematically temper" the clay data so that clays can be more effectively compared to the pottery reference groups. Because of this, it seems likely that additional sampling of Albert Bell site pottery will show that the clay from the vicinity of the Albert Bell site best matches the pottery from this site. Also, we are optimistic that additional sampling of Albert Bell and LeBeau site pottery will lead to the identification of distinct compositional groups.

CONCLUSIONS

The results are notable on two fronts, one methodological and one substantive. Methodologically, the study shows that NAA is a viable method for chemically discriminating Central Plains tradition pottery and evaluating its movement through at least some parts of the Central Plains tradition. The chemical similarities between the Central Plains Reference Group and the Coal-Oil Canyon group present some difficulties. This division possibly could disappear with additional

sampling. Should this happen, it would be even more difficult than it currently is to evaluate movement between sites on the western edge of the Central Plains tradition and the High Plains sites. The chemical similarities between these two groups also make it difficult to determine how the ceramic assemblage at Coal-Oil Canyon came to be as it is. On the other hand, the lack of association of ten Coal-Oil Canyon sherds with the Coal-Oil Canyon Group may be an indication that the assemblage is as eclectic as it appears on stylistic grounds. More concretely at the present time, the chemical distinctness of the sites downstream on the Solomon and Smoky Hill rivers suggests that we can evaluate the directions of the interactions of people centered at these two sites. Sampling of more sites in this downstream area should tell us much about interactions among people in this area.

This project has been gratifying in that several new compositional groups have been identified and we now have a better understanding of the range of chemical variability in this area of the central Plains. Unfortunately, LeBeau, Albert Bell, and Medicine Creek sites form a single homogeneous group indicating that ceramic sourcing between sites within this area is difficult at this time, but perhaps not impossible. Petrography may provide a viable and comparable method for investigating provenance in this area. Analysis of additional samples from Coal-Oil Canyon and sites in western Kansas may help to resolve lingering questions about pottery from this area. Further clay source sampling and the analysis of tempering material may also help document the amount of variability expected among the localities and may even indicate whether we should expect to be able to differentiate geographically separate sites within this large group.

Substantively, though, some movement of pottery is suggested by the data and some indications of the directionality of that movement are shown. The seven sherds of Central Plains Reference Group pottery at the Seven Mile Point site, the three at 14SA414 (Kohr House #1), and the one at Coal-Oil Canyon suggest general east-to-west or west-to-east movement of pottery from these clays. While seven sherds from the central Plains reference area are found on the High Plains

(Seven Mile Point), only one sherd from the Donovan 1 compositional groups was found further east, at Coal-Oil Canyon. This is noted by Cobry and Roper (2002), though with the data they had at hand they stated that Medicine Creek pottery was found on High Plains sites. The current analysis shows the clays and pottery found at Medicine Creek are compositionally similar over an area that extends minimally south to the Solomon River and, should the Coal-Oil Canyon Reference Group prove to be a part of this broader group, possibly to the Smoky Hill River. Further, we have already noted that the downstream sites (e.g., Minneapolis and Kohr) show west-to-east, but *not* north-south, movement of some pottery.

Finally, clay samples from the general vicinity of the Albert Bell site, taken from streambeds and from clay horizons buried in a terrace, showed no relation to the Central Plains Reference Group using Mahalanobis distance calculation with the exception of two samples taken from the B horizon of an upland playa. This is based on a very small sample but suggests that people on this part of the central Plains were using clays developed in playa soils rather than streambed or terrace deposits. Clay samples from the vicinity of Coal-Oil Canyon showed a low affinity toward the Central Plains Reference Group overall, but a sample from the B horizon of the upland Richfield silt loam, mixed with about 10 percent local sand showed a 2.09 percent probability of membership in the group.

Selecting clay samples for this type of study is speculative. Unlike stone sources, for which we often have evidence of prehistoric use of a source based on waste flakes, it is difficult to determine what sources were used to make pots and investigators must use intuitive notions of what clays might be best in a given region. Because there may be multiple sources of clay with differing parent materials in any given region, it may take many samples to come up with a match to the prehistoric pottery under study. Finally, unlike stone sources, clay sources may be severely affected by the passage of time. Streambed clays, for example, surely have been affected by intensive, machine-assisted agriculture of the twentieth century and subsequent erosion. Because of this, clay sampling is, in many cases, an attempt to discover

in a very general sense what types of sources (alluvial, weathered bedrock, or in the case of playas, aeolian) might have been used rather than trying to pinpoint specific sources. This is the approach we used here and it is apparent that we have not yet located the right type of source. Our results are interesting, though, in that the playa clay samples proved to have the closest relationship to the region's prehistoric pottery. Perhaps the aeolian nature of these clay deposits explains why the pottery from the broad Central Plains Reference Group area is chemically similar. Playas are common in the south-central United States in the mixed-grass and short-grass prairies that cover portions of western Texas, Oklahoma, Kansas, and Nebraska and the eastern portions of New Mexico and Colorado, and southeastern Wyoming (Smith 2003:6), and wetlands with similar soils are widely distributed.

We have no doubt that significant questions remain, that alternative scenarios must be evaluated by additional research, and that the sampling must be expanded. This study, however, shows that NAA is a feasible approach to the research problem. A priority will be determining if the apparent homogeneity of the Central Plains Reference Group is a result of the chemical similarity of available source clays or sufficient movement of people that the group actually is a composite of many geographically separated sources. It should also be determined if the Coal-Oil Canyon group similarly is a composite, for, on other grounds, we are not at all sure that the pottery found at this site actually was made there. Roper (2007) suggests that the people in the Medicine Creek-LeBeau-Albert Bell site area may be far more mobile than the presence of farmsteads and lodges might lead one to believe. We must therefore consider the possibility that people were moving around considerably and possibly exploiting many clay sources across the landscape, thus creating a large group that is impossible to differentiate. The distinctiveness of the groups from sites downstream (Kohr and Minneapolis) is consistent with indications, again on other grounds, that these people were considerably less mobile than their contemporaries to the west. The lack of interaction between these two sites is provocative, but must be supported by increased sampling from

both sites, sampling of additional sites in the vicinity of these two sites, and a demonstration that the two communities were contemporaneous. Sampling sites in other localities along the lower valleys of these rivers should also be indicative.

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67th Plains Conference, Norman, Oklahoma, Robert Brooks, Oklahoma Archeological Survey, University of Oklahoma, Norman, OK 73019, rbrooks@ou.edu, date pending.