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Title:	Neutron-Activation Analysis of Campbell Appliquéd Pottery from Southeastern Missouri and Western Tennessee: Implications for Late Mississippian Intersite Relations.
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Neutron-Activation Analysis of Campbell Appliquéd Pottery from Southeastern Missouri and Western Tennessee: Implications for Late Mississippian Intersite Relations

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Abstract. *The pottery type Campbell Appliquéd is a late Mississippian-period (post–A.D. 1400) marker for archaeological sites in southeastern Missouri. Recent discoveries of Campbell Appliquéd sherds in western Tennessee have raised the question of whether production centers of Campbell Appliquéd were geographically limited or were dispersed across the central Mississippi River valley area. Stylistic and metric analyses of Campbell Appliquéd sherds and vessels have not demonstrated consistent interassemblage variation. Neutron-activation analysis of 67 sherds from sites in southeastern Missouri and western Tennessee, conducted at the Missouri University Research Reactor, indicates that the pottery forms a single compositional group. Analysis of five fired-clay (daub) samples and 16 raw-clay samples from near the Missouri sites shows that the daub samples are compositionally distinct from the pottery samples and that 14 of the raw-clay samples are compositionally similar to the pottery samples but cannot be differentiated by soil series. Chemical similarity between previously analyzed Woodland-period pottery from Missouri's Eastern Lowlands and Mississippian pottery analyzed for this project suggests that the entire modern alluvial valley of the Mississippi River from its confluence with the Ohio River to its confluence with the Arkansas River may constitute a single compositional source.*

The explication of trade in artifacts among Late Mississippian peoples in the central Mississippi River valley has long been a subject of archaeological discussion. Archaeological evidence for trade often is predicated on discovering physical-chemical similarities of artifacts and plotting their spatial distribution. One empirical method for measuring physical-chemical attributes is compositional analysis, whereby local vs. nonlocal artifacts can be discerned by determining and interpreting the chemical composition of artifacts and raw materials. This study analyzed the composition of a pottery type known as Campbell Appliquéd to determine whether (a) production centers could be discerned and (b) if intersite exchange could be established using chemical differences in the paste employed to manufacture the pottery.

Campbell Appliquéd vessels are shell tempered, usually including large-sized particles that give the pastes a coarse texture. The distinguishing decorative feature of the type is the presence of thin clay strips applied vertically or near-vertically from the lip to the shoulder of a vessel. Generally, the strips are large and unnotched (e.g., Figure 1, top row), but occasionally they are small and notched (e.g., Figure 1, bottom three rows). Campbell Appliquéd is always a minority type at sites. Campbell Appliquéd at the Campbell site, in Pemiscot County, Missouri, accounted for 12 percent of the assemblage, but recovery was biased toward collection of decorated sherds (Chapman and Anderson 1955; O'Brien 1994). Campbell Appliquéd from other sites in Pemiscot County amounts to between 5 and 10 percent of the recovered assemblage (O'Brien 1994). There is little reason to doubt that Campbell Appliquéd appeared late in the prehistoric record of the central Mississippi River valley. The type never occurs in assemblages that have been dated prior to A.D. 1400, and it does occur on sites in Pemiscot County, Missouri, that, through crossdating with other assemblages, contain late-Mississippian-period pottery markers. These markers include Nodena Red-and-White, Hollywood White-Slipped, Walls Engraved, and Ranch Incised. Several of the sites also contain European metal items and glass trade beads (O'Brien 1994), which places at least portions of the occupations into or near the second half of the sixteenth century.

Until recently, Campbell Appliquéd pottery had been found only in southern Pemiscot County, Missouri, and northern Mississippi County, Arkansas.[1] However, recent testing at 40LK4, near Reelfoot Lake in Lake County, Tennessee, produced a ceramic assemblage of 2,190 sherds, including 108 Campbell Appliquéd sherds (Lawrence and Mainfort 1992) (Figure 2). Other artifacts recovered from that site include an abundance of shell-tempered plain wares, 29 characteristic late Mississippian decorated sherds, 89 Campbell punctated sherds that are probably portions of Campbell Appliquéd vessels, snub-nosed scrapers, large triangular and Nodena points (other late markers), an unidentified iron artifact, and a rolled-brass tinkler cone or bead. Two radiocarbon assays from a feature containing Campbell Appliquéd produced uncorrected dates of 260 ± 40 B.P. (TX-7784) and 229 ± 40 B.P. (TX-7785).

In Pemiscot County, Missouri, nine sites have produced Campbell Appliquéd: Campbell (23PM5), Holland (23PM2), Dorrah (23PM11), Cagle Lake (23PM13), McCoy (23PM21), Murphy (23PM43), Brooks (23PM56), Berry (23PM59), and Denton Mounds (23PM549) (O'Brien 1994) (Figure 3). Visual and metric observations indicate no consistent interassemblage variation in vessel shape or size. In other words, vessels from one site are similar to those from any other.

Campbell Appliquéd pottery thus is a good candidate for examining artifact trade in the central Mississippi River valley using compositional analysis (e.g., Dunnell and Jackson 1992). Its low assemblage frequency allows that a modest analyzed sample should be representative (e.g., 10 sherds analyzed from 40LK4 represent 9 percent of the recovered sample), it is recognizable as a type but has not been differentiable using finer stylistic criteria, and it has a limited time range.

Research Questions

Three questions guided our approach to the study of Campbell Appliquéd pottery:

1. *What is the relation of Campbell Appliquéd to daub and nearby clay sources?* Part of the problem involved with finding "locally produced" pottery is that without comparison of pottery composition to raw-material composition, a locally produced pottery baseline is an assumption, not an empirically developed conclusion. The preponderance of common pottery types such as Mississippi Plain at a site leads one to believe that this pottery was locally produced, but again, this is an inference. All of the pottery might have been imported, the common as well as the exotic "types." Daub has a high probability of being locally derived because of the great volume of clay that was apparently required for house construction. The raw clays are known to be local because we procured them ourselves, but it must be demonstrated that they are from the same sources employed by prehistoric potters. An additional problem is that raw clays do not share the same compositional history as pottery that has experienced effects of manufacture, use, and burial. These factors must be considered when comparing the chemical signature of clay to pottery.

2. *Are multiple compositional groups of Campbell Appliquéd present?* If so, (a) do compositional groups correspond to geographic location, and (b) are multiple compositional groups present at a given site? If only one compositional group of Campbell Appliquéd can be discerned, then there are insufficient data to decide

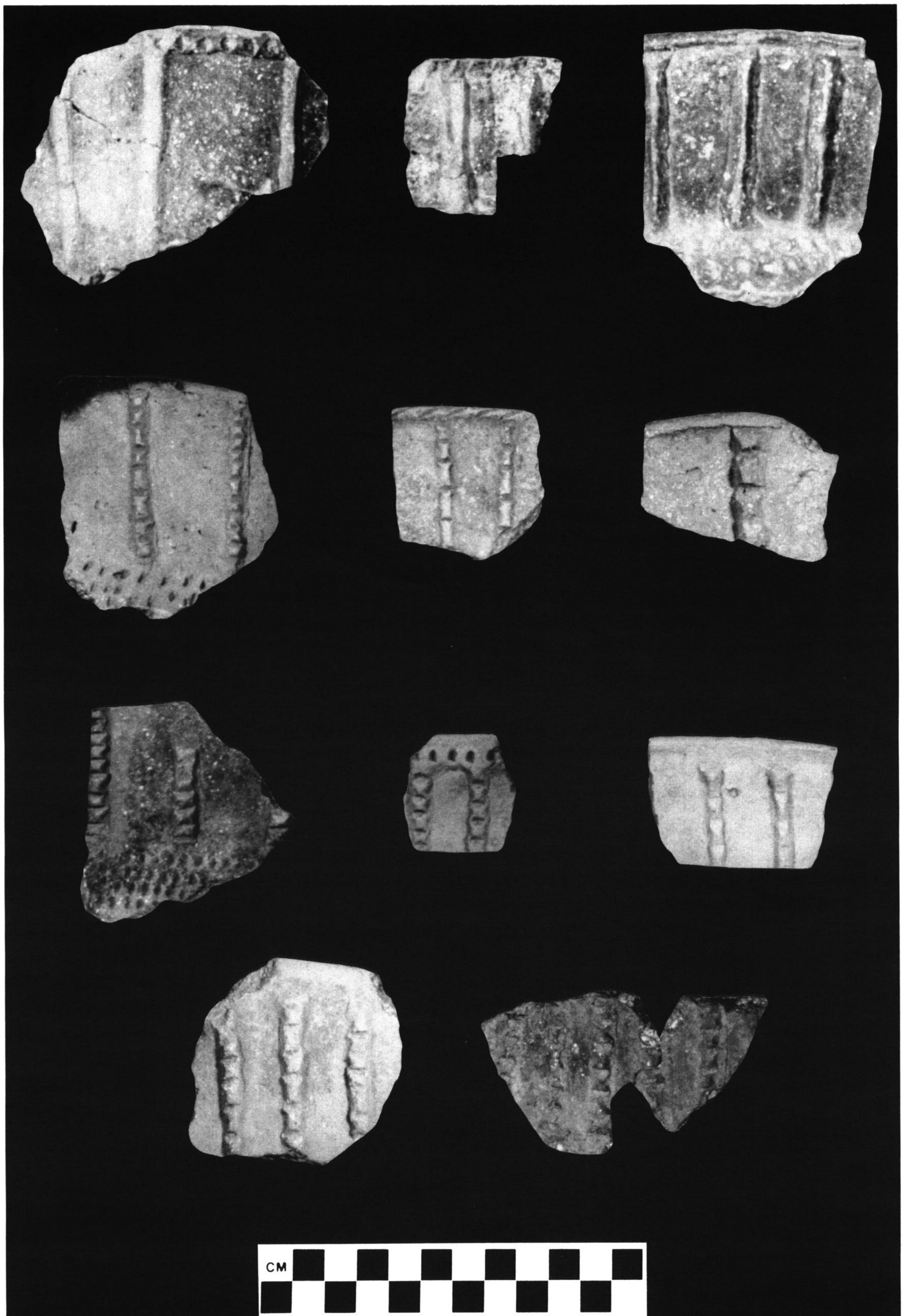

Figure 1. Examples of Campbell Appliquéd rim sherds from Campbell. Top row, plain appliqués; bottom three rows, notched appliqués.

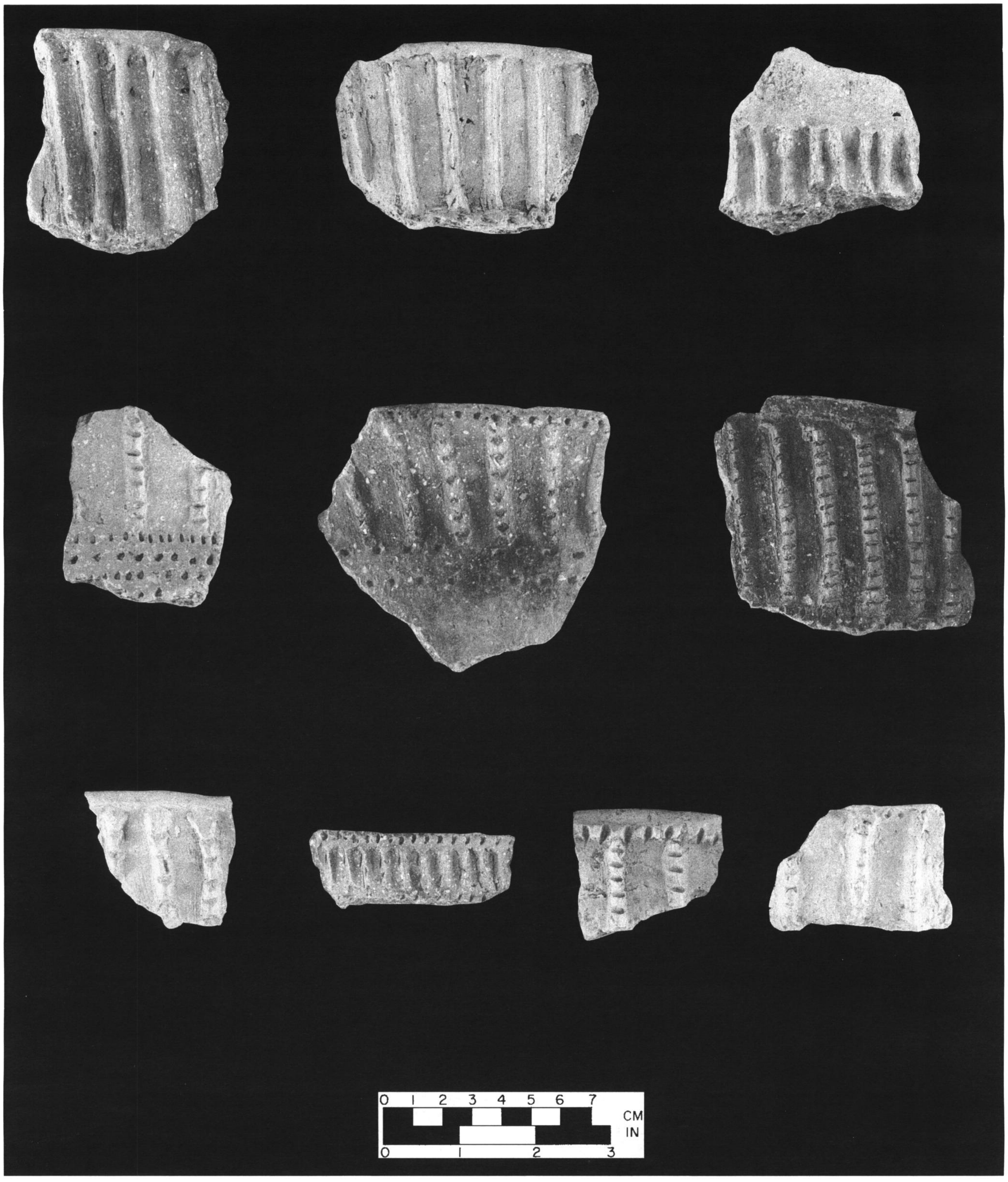

Figure 2. Examples of Campbell Appliquéd rim sherds from 40LK4, Lake County, Tennessee. Top row, plain appliqués; bottom two rows, notched appliqués.

if there is only one localized source of clay used to produce Campbell Appliquéd from which the pottery was produced and traded into surrounding areas. Alternatively, the source of clay may be so geographically large that chemical data alone could not determine if Campbell Appliquéd had been produced at each site or traded among sites.

3. *Can clay sources within the modern Mississippi River meander belt be differentiated chemically?* Saucier (1974) established five meander-belt systems; the most re-

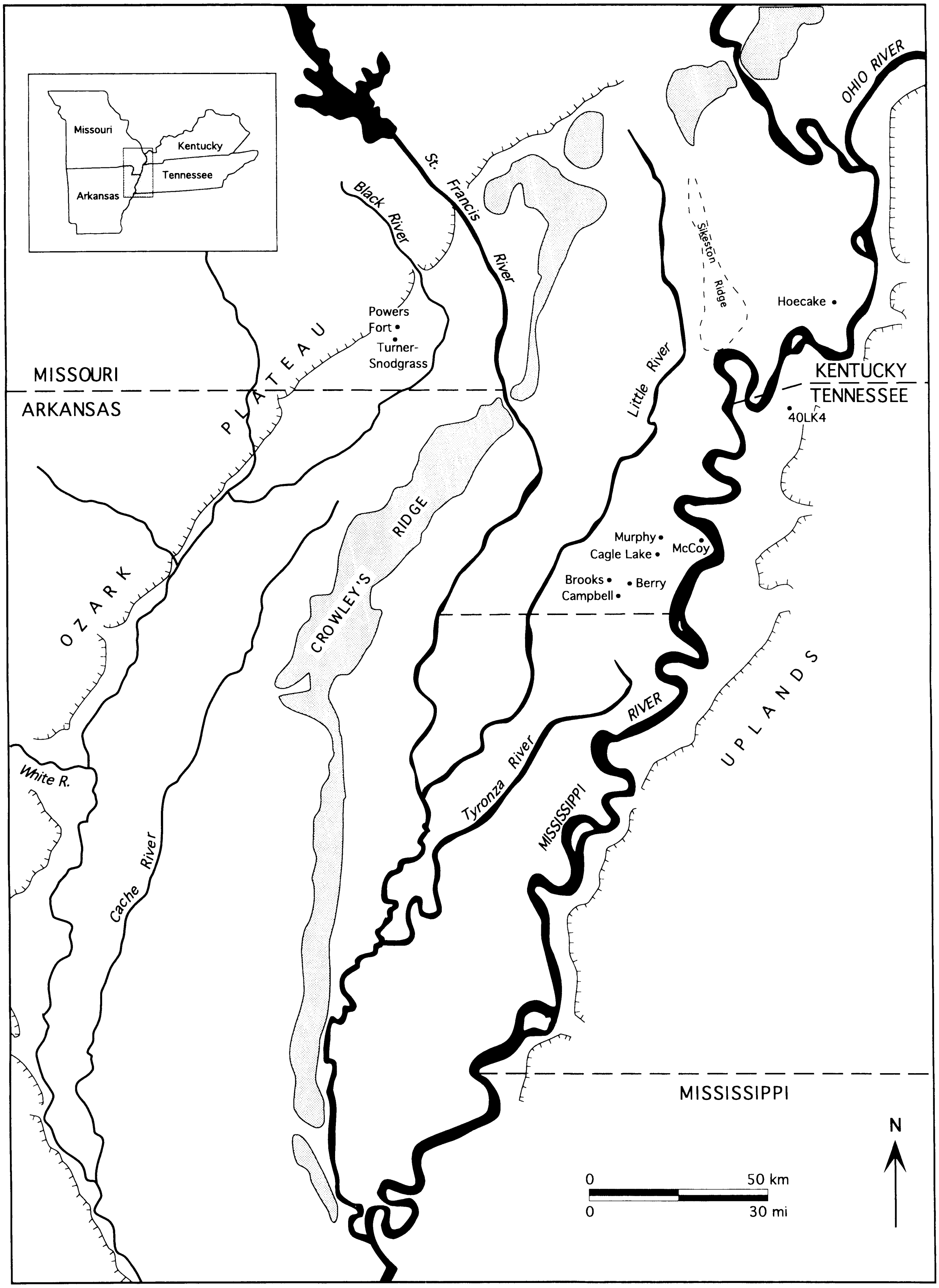

Figure 3. Map of the central Mississippi River valley showing locations of sites from which pottery and/or daub was analyzed.

Table 1. Type and Provenance of Analyzed Samples.

	Site						
Sample Type	Berry	Brooks	Cagle Lake	Campbell	McCoy	Murphy	40LK4
Campbell Appliquéd, notched strips		2	5	5	2		
Campbell Appliquéd, plain strips	1		4	1	2		
Campbell Appliquéd, arcades with notched strips		1	1	2			
Campbell Appliquéd, arcades with plain strips	1		1	1	2		
Campbell Appliquéd, arcades with bun-shaped strips			1	1	1		
Campbell Appliquéd, indeterminate pattern		1	4				10
Campbell Incised				5			
Parkin Punctated				8			
Ranch Incised				5			
Daub			2		2	1	
Raw-clay samples							
Portageville soil series	1	2	3	2	3		
Hayti soil series			4			1	

Note: Clays are identified by nearest relevant site.

cent, Belt 5, began about 2,000 years ago and is the only one exposed in the study area. Additionally, clays have been accreting in the flood plain as part of normal flooding. If clays can be differentiated, then there is potential for recognizing discrete pottery sources; if clays cannot be differentiated, then the entire Meander Belt 5 in effect would be a single source. This would make chemical discrimination of any pottery produced from its clays difficult if not impossible.

In order to address these questions, 88 samples, consisting of 67 pottery samples from six sites, five fired-clay (daub) samples from three sites, and 16 raw-clay samples from 12 argillaceous soils near the six Missouri sites were submitted to the Missouri University Research Reactor (MURR) for neutron-activation analysis (NAA) (Table 1). Sample preparation, irradiation, counting, and data analysis were performed according to standard MURR procedures (Glascock 1992). Corrections for shell-temper dilution effects were also employed on the pottery (Neff et al. 1992a, 1992b; Steponaitis and Blackman 1981; Steponaitis et al. 1988).

Results

The Relation of Daub to Pottery Samples. Five daub samples were submitted for analysis (Table 1). Principal-components analysis showed that all five daub samples were compositionally distinct from all analyzed pottery samples (Figure 4). Daub is depleted in most elements and is correspondingly enriched in only hafnium and zirconium. This differentiation indicates that daub samples contain higher amounts of silt as evidenced by the enrichment of hafnium and zirconium (Blackman 1992; Neff et al. 1992a). Hafnium and zirconium can substitute for each other in the mineral zircon, a common mineral that is resistant to degradation below silt-sized particles. The presence of hafnium and zirconium in clays inferentially reflects concentrations of zircon grains and therefore of silt. Elements not analyzed by NAA also contributed to the daub/pottery dichotomy. The most likely unanalyzed elements were silicon and oxygen in the form of quartz sand. The pottery samples all exhibited very low amounts of sand in their pastes; the daub samples were noticeably coarser textured and sandier.

Analysis of the daub samples also provided evidence of relative lack of postdepositional effects on compositional analysis, at least for this research area. The daub samples were deposited in the same soil as the pottery at each site (and presumably were similarly treated after excavation) and thus received the same potential postdepositional contamination. If the daub samples had the same compositional characterization as the pottery, there would have been the possibility that although the daub originally was from a clay source that was compositionally different from the pottery-clay source(s), burial in the same soil for approximately 400 years had overwhelmed the original distinctiveness of the sources. This possibility was ruled out because the daub samples are compositionally different from the pottery samples. Whatever postdepositional changes occurred, they were not sufficient to overwhelm the distinctiveness of the pottery and daub.

Comparison of Raw Clays to Daub and Pottery. Sixteen clay samples procured from 12 locations in Pemiscot County, Missouri (Table 1), were submitted for NAA. Sample preparation for these samples included homogenization, forming into a test tile, and firing to 700°C for one hour in an oxidizing (air) atmosphere.

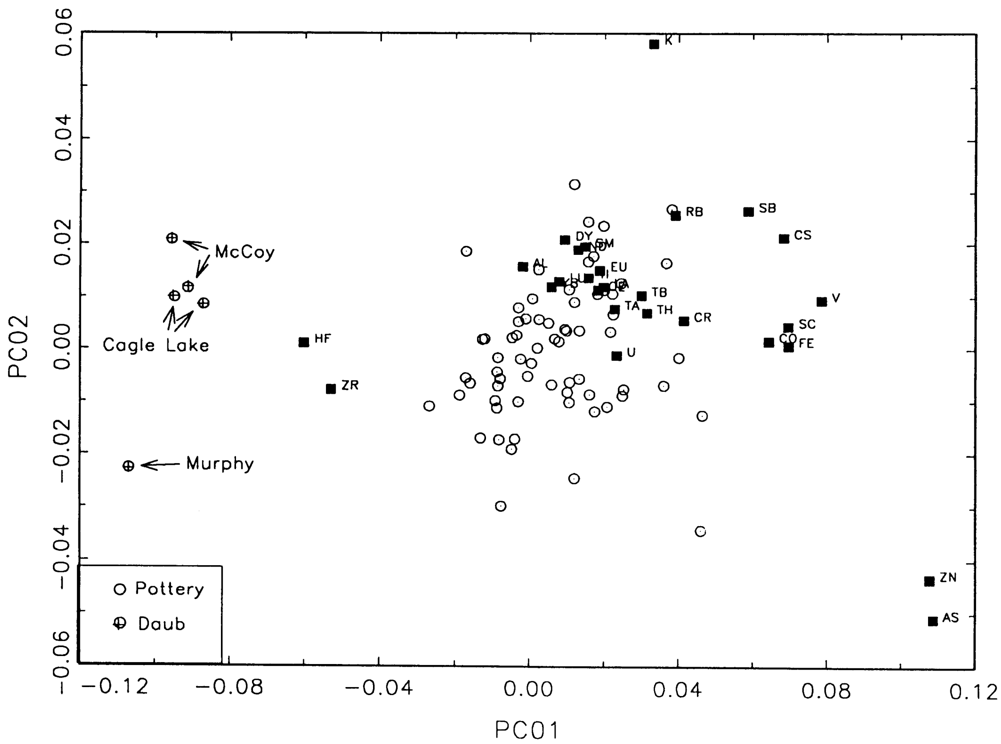

Figure 4. RQ-mode plot of principal components 1 and 2, based on the chemical composition of pottery and daub samples from Cagle Lake and McCoy (pottery and daub), Murphy (daub), and Berry, Brooks, Campbell, and 40LK4 (pottery). Provenience of daub samples are indicated. Note separation of daub samples from pottery samples.

The samples came from Portageville- and Hayti-series clay soils (Brown 1971) that were close to the sampled archaeological sites. Of the 16 clay samples submitted for NAA, 14 have chemical compositions that are highly similar to the pottery samples (Figure 5). Principal-components analysis showed these clays to be differentiated from pottery primarily by enrichment in aluminum, a feature that was confirmed by inspection of bivariate plots of logged element concentrations. Because aluminum is a primary constituent of clay minerals, enrichment in aluminum is not surprising. Simply put, the clay samples have more clay in them than do the pottery samples.

Two raw-clay samples are compositionally distinct from the other clays and are most similar to daub. The sample MOB073 was noted to be silty when procured but had fair workability when wet. The other sample, MOB085, had thin sand lenses interspersed in the field sample. Homogenization of this sample resulted in a sandier texture than the other clay samples exhibited. When preparing test tiles, however, sample MOB085 was considered to have wet properties and fired strength that were commensurate with the 14 clays mentioned above. Both samples plotted low on principal component 1, the dimension representing paste texture. This observation suggests that Mississippian potters undoubtedly selected clays for specific purposes (daub vs. pottery manufacture) and that subtle paste distinctions (e.g., slight sandiness) were employed when selecting among clays for pottery manufacture.

Analysis of Pottery Samples. Considering only pottery samples, principal-components analysis suggests that compositional variation in the pottery data set is quite low and that it is consistent with derivation from a single clay "source." The geographic extent of this source is one of the questions that must be addressed.

Not all of the pottery submitted in this phase of the project was Campbell Appliquéd. When pottery samples from the Campbell site were being selected, a subsidiary research question arose: *Was there compositional variation among late-Mississippian pottery types?* Pottery from the Campbell site submitted for analysis was selected from four types: Campbell Appliquéd ($n = 10$), Campbell Incised ($n = 5$), Parkin Punctated ($n = 8$), and Ranch Incised ($n = 5$) (Chapman and Anderson 1955; O'Brien 1994; Phillips 1970) (Figure 6). Principal-components analysis (Figure 7) and cluster analyses were run on only the Campbell-site pottery and compared to typological groups. No correspondence was observed between typological group and chemical composition. Thus, for the Campbell site at least, all sampled pottery presumably came from the same raw-material source.

Inspection of bivariate plots using combinations of the first nine principal components failed to identify any separation of the data set into compositional sub-

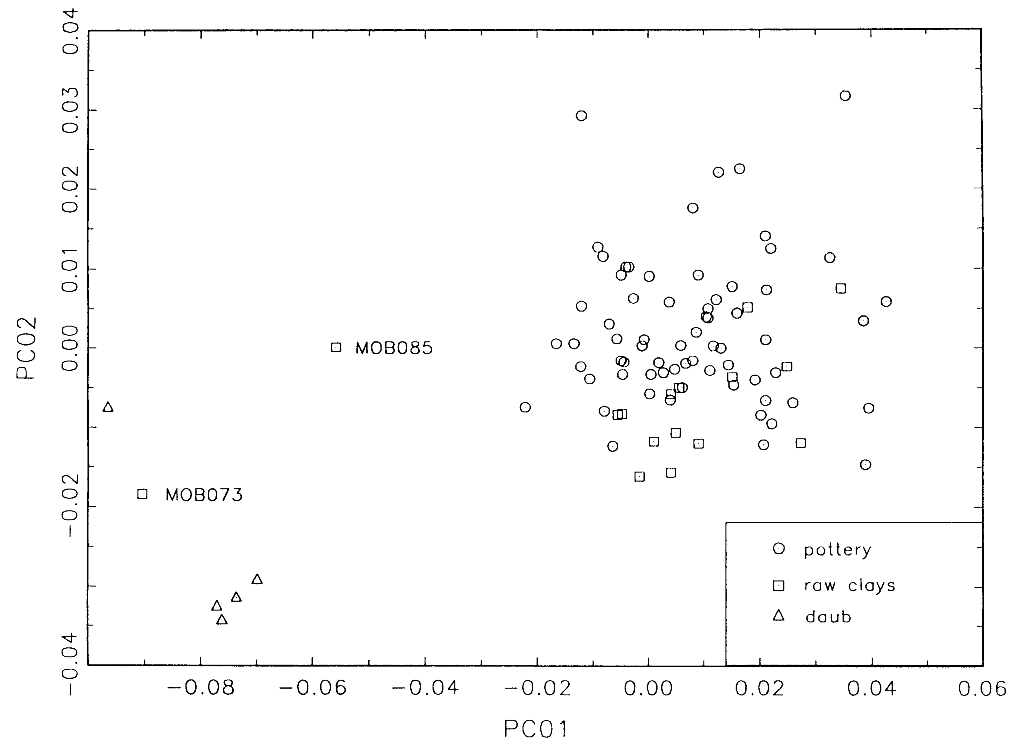

Figure 5. Plot of principal components 1 and 2, based on the chemical composition of pottery, daub, and raw-clay samples from Cagle Lake and McCoy (pottery and daub), Murphy (daub), and Berry, Brooks, Campbell, and 40LK4 (pottery). Clay was procured from deposits near Berry, Brooks, Cagle Lake, Campbell, McCoy, and Murphy. The two clay samples discussed in the text, MOB073 and 085, are indicated. Note that except for those two samples, the clays fall within the range shown by pottery samples.

groups that would correspond to provenience (see Figure 8 for an example). In other words, pottery from Tennessee could not be differentiated from pottery from southeastern Missouri, and pottery from southeastern Missouri could not be differentiated by site. This lack of patterned compositional variation was supported by average-link cluster analyses (not shown) as well as by bivariate plots of log-transformed concentrations of the highly loaded elements. We used Mahalanobis-distance calculations to verify this lack of differentiation. Using the largest provenience-based group, i.e., all pottery from the Campbell site, sample-membership probabilities for the group were calculated using the first nine principal components. The remaining pottery samples were grouped by site, and the probabilities of each of these groups to membership in the Campbell site group were calculated. All but one sherd from the Campbell site have greater than one percent probability of membership with that group, but 33 of the 39 sherds from the other sites also have greater than one percent probability of membership in the Campbell site group. Similar results occurred when pottery from the Cagle Lake site—the second-largest provenience group—was used as the reference group. Pottery from other sites had high probabilities of membership in the Cagle Lake group. These calculations support the conclusion that the pottery samples reflect a single group that cannot be differentiated by provenience.

Principal-components analysis and cluster analysis were also conducted on Campbell Appliquéd pottery using selected decorative attributes as the grouping method. Because of small sherd size and small sample size, only four decorative criteria could be identified among the southeastern Missouri appliquéd sherds, and no analyzed pottery from Tennessee was available for decoration analysis. Using the resulting 34-sherd subset, groups were formed based on presence or absence of arcades and whether the appliquéd strips were plain, notched, or abbreviated into a "bun" shape (Table 1 and Figures 1 and 9). No correlation of decorative group with chemical composition was obtained (Figure 10).

We next tried to develop groups solely on the basis of compositional data. Starting with a cluster analysis, two provisional compositional groups were posited. Membership probabilities based on Mahalanobis distance were calculated for these groups and the unclustered samples. Extensive efforts to refine and separate these groups using Mahalanobis distance calculations led to the result that the clustering is illusory; the data are best interpreted as a single group with statistical outliers.

Additional Analyses. We inspected each archaeolog-

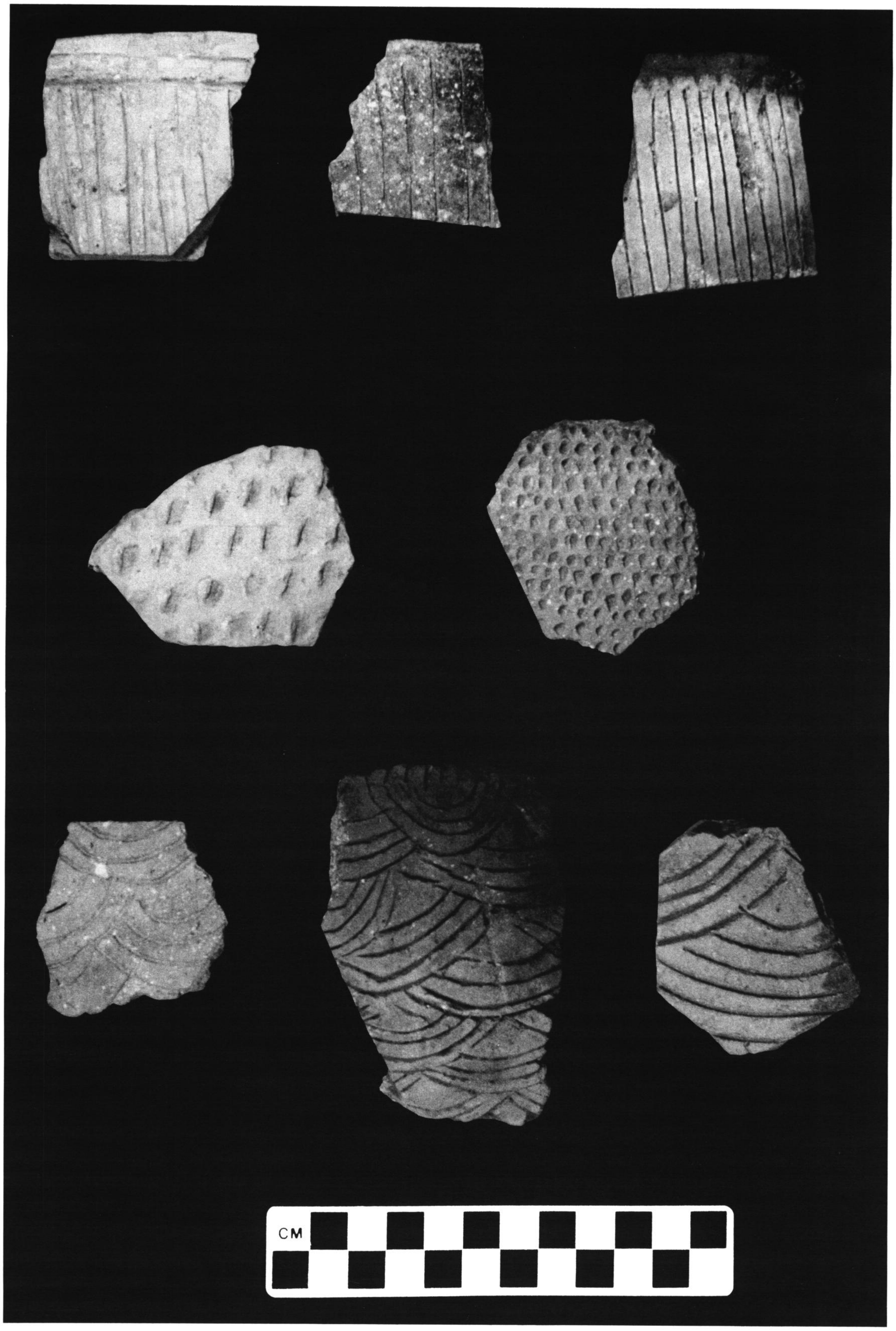

Figure 6. Examples of additional pottery from Campbell submitted for neutron-activation analysis. Top row, Campbell Incised; middle row, Parkin Punctated; bottom row, Ranch Incised.

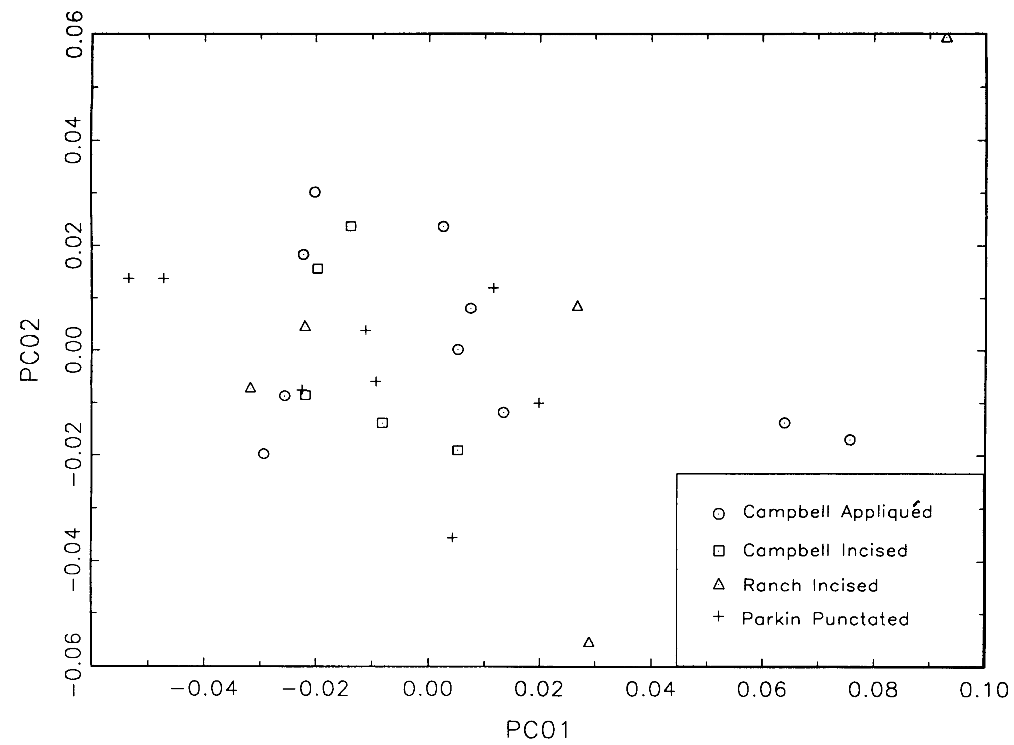

Figure 7. Plot of principal components 1 and 2, based on the chemical composition of pottery samples from Campbell. No compositional groupings are evident.

ical sample using a binocular microscope (20/40X) for more detailed information on temper. A four-level, ordinal system of measurement was employed: primary—the dominant temper type; secondary—temper that was present in a lesser amount than the primary temper but which was still a significant component of the paste; tertiary—temper that was observed occasionally in the paste; and trace—temper that was a rare component of the paste. No site-related pottery group had any temper that was internally

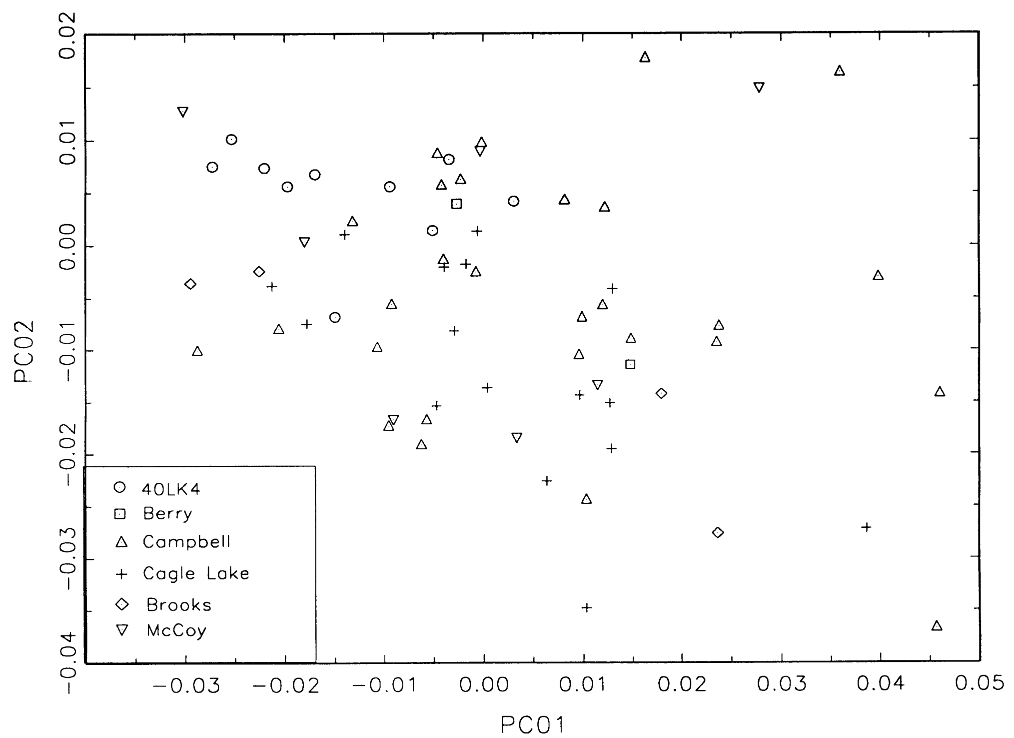

Figure 8. Plot of principal components 1 and 2, based on the chemical composition of pottery from 40LK4, Berry, Brooks, Cagle Lake, Campbell, and McCoy. No compositional groups are evident.

Figure 9. Examples of Campbell Appliquéd pottery with appliqués on arcades. Top row, plain appliqués; middle row, notched appliqués; bottom row, abbreviated bun-shaped appliqués.

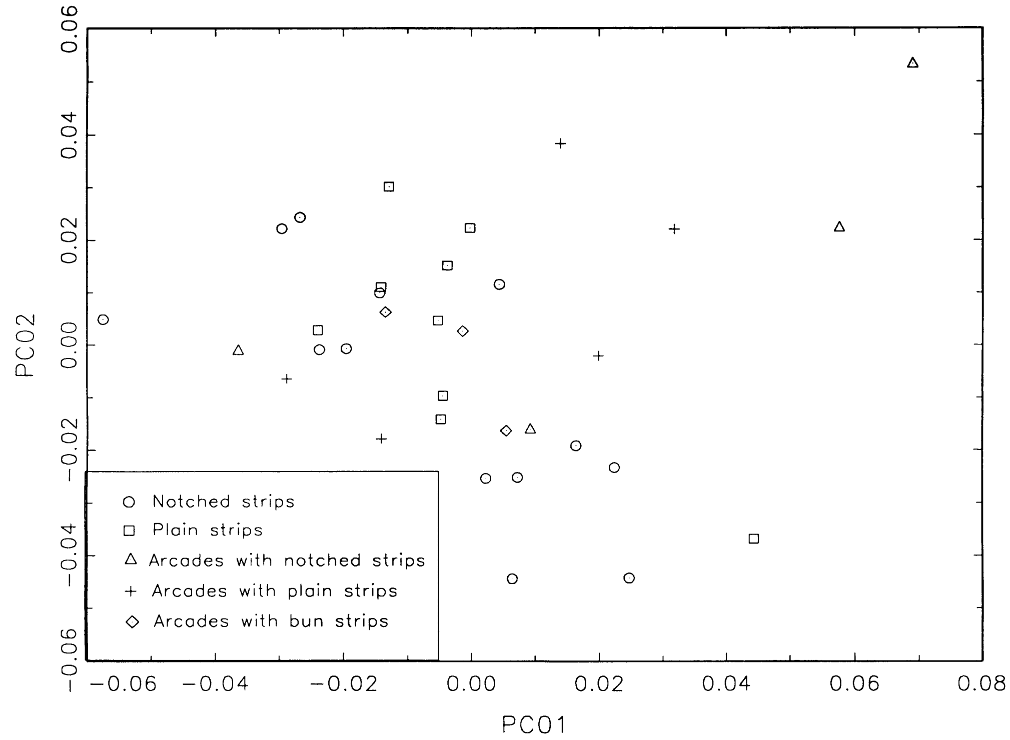

Figure 10. Plot of principal components 1 and 2, based on Campbell Appliquéd pottery from Berry, Brooks, Cagle Lake, Campbell, and McCoy. Pottery is identified by decorative attributes discussed in text and shown in Figures 1 and 9. No compositional groups are evident.

consistent and that could be used to discriminate that group from any other. Looking specifically at Campbell site pottery, no type-related group had any distinguishing temper characteristics. Daub samples were considerably sandier than pottery samples, which supports our daub/pottery distinction based on compositional analysis. Sand was coarser and mineralogically more diverse in daub samples than that exhib-

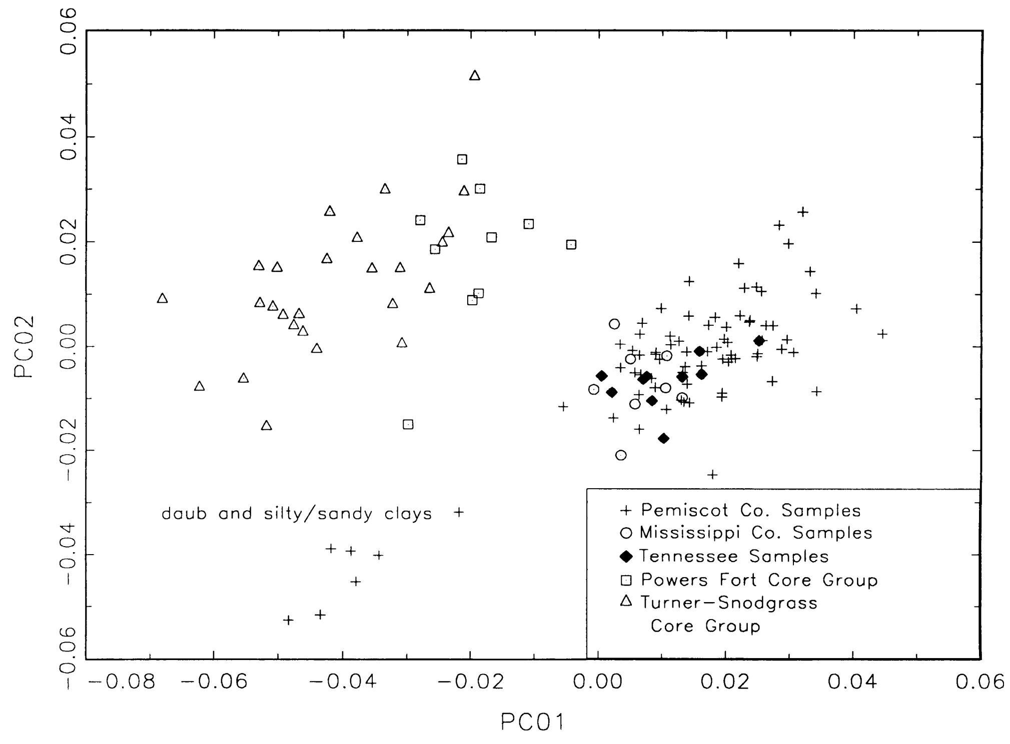

Figure 11. Plot of principal components 1 and 2 of entire data set with Powers Fort, Turner-Snodgrass, and Hoecake samples superimposed. Note clear separation of modern flood-plain samples from Western Lowland (Powers Fort and Turner-Snodgrass) samples.

ited in pottery samples. This is probably a result of a higher-energy depositional regime that deposited the silty clays used as daub.

The Relation of Sampled Materials to Pottery from Outside the Research Area. The entire data set from the project, including the five daub and 16 clay samples, was compared to pottery samples from Hoecake (23MI8) in the Cairo Lowland (Mississippi County, Missouri) and Powers Fort (23BU10) and Turner-Snodgrass (23BU21) in the Western Lowland (Butler County, Missouri). These samples were submitted as part of an ongoing project sponsored by the National Park Service to characterize compositional variation in the Ozark Uplands and the adjacent Western Lowland (Neff et al. 1992a, 1992b). Samples from Butler and Mississippi counties had been differentiated into two main clay-source groups: a Western Lowland reference group, which was subdivided into a Powers Fort core group and a Turner-Snodgrass core group; and a separate Eastern Lowland group, the Hoecake group.

Principal-components analysis of the combined data set differentiates the Western-Lowland groups from the Pemiscot County/Tennessee pottery but fails to differentiate the Hoecake group from the Pemiscot County/Tennessee pottery (Figure 11). (The five daub and the two silty/sandy raw-clay samples are also compositionally distinct.) Powers Fort pottery could be distinguished from Turner-Snodgrass pottery despite the sites being separated by only 6 km, but pottery from the Eastern Lowlands sites (Hoecake and Pemiscot County sites) could not be differentiated, despite a maximum intersite distance of approximately 75 km.

Compositional variation in the samples reflects the geographic separation and geologic history of the Western and Eastern Lowlands. Crowley's Ridge separates the Eastern Lowlands from the Western Lowland, the latter an area of relict braided-stream deposits of the Pleistocene-age Mississippi River. The modern (post–2000 B.P.) Mississippi River is responsible for the meander belts that deposited clays in the form of clay plugs and backswamp deposits of Meander Belt 5 in the Eastern Lowlands (O'Brien 1994; Saucier 1974). Large areas of the modern flood plain can be inundated simultaneously; clays deposited by such floods are thoroughly homogenized and are compositionally indistinguishable over large areas. No tributary is likely to add a significant amount of compositionally distinct sediment to the modern Mississippi River between the mouths of the Ohio River and the Arkansas River. Thus, with the possible exception of highly localized clays deposited by and along some tributaries, the vast clay deposits of the modern Mississippi River between the Ohio and Arkansas rivers may prove to be a single compositional source.

An alternative hypothesis is that the pottery sampled during this project is from a smaller, more discrete production area. Extensive trading dispersed the pottery (or the raw clay) from its source area to the archaeological sites sampled. We discount this small-source-area hypothesis partly on the nature of the depositional environment discussed above. More importantly, the clay-tempered, Late Woodland (Baytown) period sherds from Hoecake are compositionally indistinguishable from the late Mississippian-period pottery. In short, the Hoecake samples are from a location 75 km away from the Pemiscot County sites and are at least 500 years older than the late Mississippian pottery from those sites. It is highly unlikely that one discrete raw-clay source would have been monopolized for that length of time by potters living so far apart.

Conclusion

Extensive analysis of compositional data from 72 late Mississippian-period samples from the central Mississippi River valley failed to find any compositionally based pottery groupings. Samples from western Tennessee were indistinguishable from samples from Pemiscot County, Missouri. Pottery from Pemiscot County likewise was indistinguishable when grouped by site, by archaeological type, or by selected decorative attributes. When pottery samples from Butler and Mississippi counties, Missouri, were compared to samples from Pemiscot County and western Tennessee, the Butler County pottery was compositionally distinct, but the Mississippi County pottery was not. Daub samples were compositionally different from all pottery samples. Fourteen raw clays were compositionally similar to the analyzed pottery; two clays that were compositionally different had textural differences that would have been noticeable to prehistoric potters. The pottery samples are most reasonably interpreted as reflecting a single compositional group with statistical outliers. The most likely source for this pottery is the extensive, geologically modern Mississippi River backswamp-clay deposits. Determining the geographical extent of this raw material source has begun with the incorporation of samples from the Hoecake site and the sampling of clays in Pemiscot County. Expanding the data set to incorporate samples from downstream areas such as eastern Arkansas would be a profitable adjunct to subsequent phases of analysis.

Notes

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[1] Phillips et al. (1951) illustrate vessels from Cross County, Arkansas (Figure 97q), and Crittenden County, Arkansas (Figures 94m and 96i), that exhibit Campbell-like vertical appliqués. We have observed a Parkin Punctated *var. Castile* vessel from Chucalissa that is helmet shaped and exhibits appliquéd strips on the outflared rim.

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