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Title:	Neutron Activation Analysis of Pottery from Pinson Mounds and Nearby Sites in Western Tennessee: Local Production vs. Long-Distance Importation
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NEUTRON ACTIVATION ANALYSIS OF POTTERY FROM PINSON MOUNDS AND NEARBY SITES IN WESTERN TENNESSEE: LOCAL PRODUCTION VS. LONG-DISTANCE IMPORTATION

Robert C. Mainfort, Jr., James W. Cogswell, Michael J. O'Brien, Hector Neff, and Michael D. Glascock

ABSTRACT

Investigations at Pinson Mounds, a large Middle Woodland ceremonial center in western Tennessee, recovered considerable quantities of stylistically nonlocal pottery. Neutron activation analysis was conducted at the Missouri University Research Reactor on 114 pottery samples from the site, using 40 pottery samples from sites near Pinson Mounds as a locally produced compositional baseline. This study indicates that all analyzed pottery from Pinson Mounds was produced locally; no evidence was found for long-distance importation of pottery.

During the Middle Woodland period (ca. 200 B.C.–A.D. 400), a number of nonlocal materials (e.g., copper, galena, marine shell, mica) and artifacts (e.g., bicymbal copper earspools, copper panpipes) circulated throughout eastern North America (see Seeman 1979 for a summary). It is therefore not surprising that stylistically nonlocal ceramics also occur at Hopewellian sites within this large region (e.g., Prufer 1968). Although chemical-composition studies have confirmed nonlocal origins for certain Hopewell exotica (e.g., Goad 1979), ceramic identification at Middle Woodland sites has been largely at the less definitive, macroscopic level (e.g., Kellar 1979).

This study addresses the question of stylistically nonlocal Middle Woodland pottery by focusing on the assemblage from Pinson Mounds, the largest Middle Woodland site in the Southeast. Located approximately 20 km south of Jackson, Tennessee (Fig. 1), the site includes at least 12 mounds, a geometric earthen enclosure, and associated ritual activity loci within an approximately 160-ha area above the floodplain of the South Fork of the Forked Deer River (Mainfort 1986, 1988). Among the earthworks are five large platform mounds, ranging in height from 2.5 to 22 m, of Middle Woodland age. Over 40 radiocarbon determinations (including multiple assays for all intensively investigated localities) demonstrate that primary use of the site, including construction of all of the large mounds and the enclosure, occurred between about 100 B.C. and A.D. 350 (Mainfort 1988;

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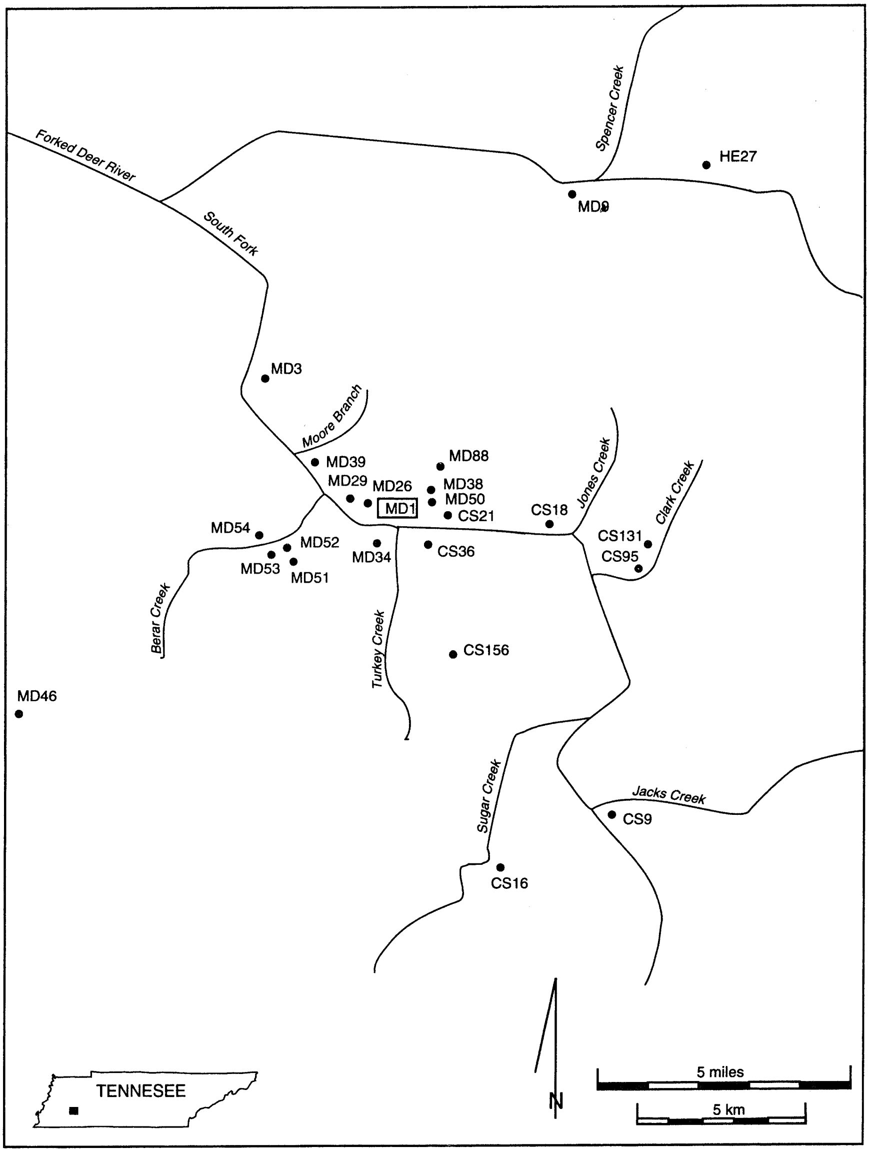

Figure 1. Location of Pinson Mounds (MD1) and nearby sites used in this study.

Mainfort and Walling 1992).

Excavations at the site have yielded numerous examples of pottery sherds that exhibit surface treatments and temper (paste inclusions) not observed in collections from presumably contemporary sites in the vicinity of Pinson Mounds (Mainfort 1986, 1988). Examples include Early Swift Creek Complicated

Stamped, McLeod Simple Stamped, Larto Red, Marksville Incised, Marksville Stamped, sand-tempered check stamped, and limestone-tempered wares (Fig. 2). In contrast, habitation sites near Pinson Mounds typically produce sand-tempered (or sandy-textured) cordmarked, fabric-marked, and plain-surfaced sherds. At Pinson Mounds, most, if not all, sherds with nonlocal surface decoration have been interpreted as imports from various areas (northern Georgia, the Mobile Bay region, and the Lower Mississippi Valley). In the case of limestone-tempered wares, nonlocal production was considered a certainty, because the nearest limestone outcrop is located nearly 100 km east of the site in the Tennessee River valley (Miller 1974; Russell and Parks 1975); moreover, limestone has not been observed in surface sediments in the vicinity of the site (e.g., Brown et al. 1978). Although macroscopic examination provides a basis for hypothesizing nonlocal origins for a subset of the Pinson Mounds ceramic assemblage, the technical analyses necessary to address the hypothesis conclusively were not undertaken until recently.

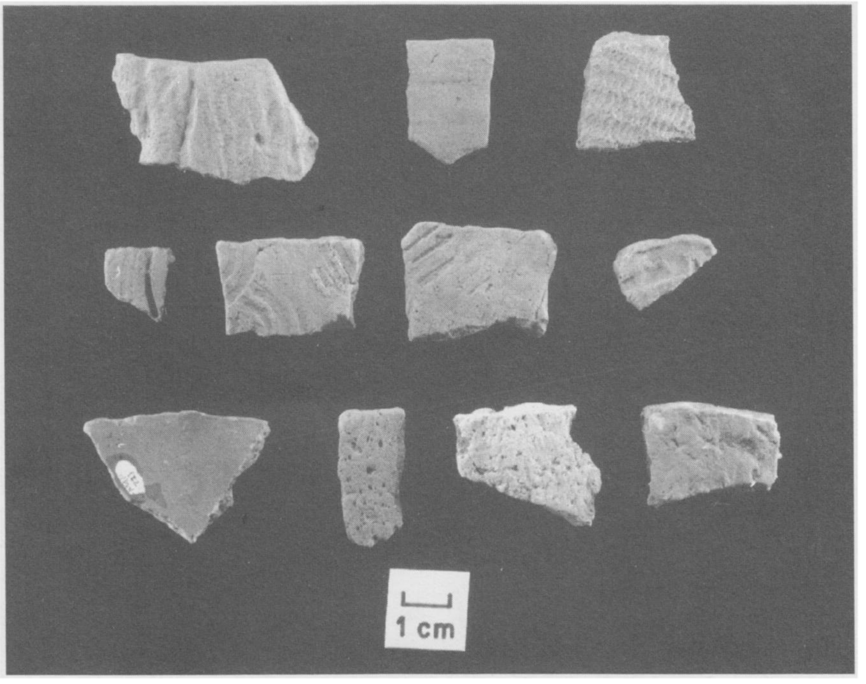

Figure 2. Selected examples of ceramics from the Pinson Mounds site. Upper row: Furrs Cordmarked (PM-0089), Baldwin Plain (PM-0066), Saltillo Fabric Impressed (PM-0076); middle row: Marksville Stamped (PM-0084), Swift Creek Complicated Stamped (PM-0013), McCleod Simple Stamped (PM-0061), sand-tempered checked stamped (PM-0119); bottom row: Larto Red (showing red-filmed interior; PM-0068), limestone temper plain (PM-0071), limestone temper cordmarked (PM-0067), grit temper cordmarked (PM-0060).

Research Questions and Data Set

This project had three main goals:

(1) *To determine if multiple compositional groups can be identified in neutron activation analysis (NAA) data from Pinson Mounds and vicinity.* Since the surface treatments of certain ceramics in the Pinson Mounds assemblage hint strongly that they were manufactured hundreds of miles from the site, it follows that the chemical signatures of these ceramics should differ significantly from those of locally produced wares. The presence of only a single compositional group would suggest the use of one clay source or several sources that are chemically indistinguishable.

(2) *To determine if pottery hypothesized to be locally and nonlocally manufactured corresponds to distinct compositional groups.* Since the geographic distribution of some of the stylistically nonlocal ceramics is known, the specific regions from which the pottery is hypothesized to derive should mirror the compositional groups revealed by NAA. Several pottery types offer the best potential in this regard. Early Swift Creek Complicated Stamped is especially characteristic of northern and southern Georgia, but is extremely rare in the upper and central Tombigbee drainage, which lies between Pinson Mounds and the presumed source area. Likewise, McCleod Simple Stamped is typical of sites in the Mobile Bay region, but becomes increasingly rare to the north and west. Finally, limestone-tempered wares are relatively common in the western portion of the Tennessee River valley, but rarely occur in the west Tennessee interior.

(3) *To relate the composition of clays in the Pinson Mounds area to archaeological samples.* Although unsystematic surveys have been conducted intermittently for a number of years, no clay sources have yet been identified within or immediately adjacent to the site. Several samples were obtained from clay deposits associated with historic stoneware potteries located several miles west of Pinson Mounds (Smith and Rogers 1979), as well as two other localities identified by Whitlach (1940). Empirical demonstration that certain pottery was "locally produced" requires identification of compositional similarities between local clays and ceramic specimens.

This study was conducted in two phases. In a pilot project, 39 sherds and one fired-clay sample from Pinson Mounds, six sherds from sites near Pinson Mounds, and five source-clay samples were submitted to the Missouri University Research Reactor (MURR) for neutron-activation analysis (see Cogswell et al. 1993 and 1995 for details on methods). Based on the results of this analysis, an additional 119 samples were analyzed, bringing the final total to 170. This included 117 sherds (including a baked-clay object fragment) and three fired-clay samples from Pinson Mounds, 39 sherds from 20 roughly contemporary sites within a 20-km radius of Pinson Mounds (Fig. 1), five source-clay samples, and six Swift Creek Complicated Stamped sherds from three sites in northern and southern Georgia (two sherds each from 9MU104, Leake [9BR2], and Hartford [9PU1]).

Examples of virtually every stylistically nonlocal type represented at Pinson Mounds were selected for analysis in addition to ceramic material from a variety of contexts within the site. Pinson Mounds proveniences represented include the Duck's Nest Sector (n=25), the Twin Mounds (n=18), various localities within or immediately adjacent to the geometric enclosure (n=11), the Cochran (40MD23) site area (n=10), Ozier Mound (n=9), and the Twin Mounds Sector (n=9). Stylistically nonlocal ceramic types include Swift Creek Complicated Stamped (n=5), McCleod Simple Stamped (n=2), check-stamped wares (n=6), limestone-tempered wares (n=2), sand/clay-tempered burnished wares (n=2), and Marksville Stamped (n=2).

Sample preparation, irradiation protocol, and statistical analysis were conducted using standard MURR procedures outlined by Glascock (1992).

Compositional Analysis

An average-linkage cluster analysis using mean Euclidean distance (not shown) and Mahalanobis-distance calculations using principal components analysis (PCA) of the variance-covariance matrix of the entire data set clearly differentiated the Georgia ceramic samples ($p < .05$) from the Tennessee samples, including the Swift Creek Complicated Stamped sherds from Pinson Mounds. Mahalanobis-distance calculations of group membership probabilities ($p < .05$) indicate that the raw-clay source samples, the fired-clay samples (PMO097 and 98), two Furrs Cordmarked samples (PMO021 and 22; these are called Group 1 due to their compositional distinctiveness), and PMO140 (an untyped, clay- and sand-tempered, fabric-marked sherd) also have low probabilities of membership in the main Tennessee data set. Because outliers can affect the results of multivariate analyses by causing samples to appear more similar when compared to the outliers, a second PCA was run after deleting these samples and further discussion of our results is based on this amended data set (Fig. 3).

Extensive use of Mahalanobis-distance calculations led to the refinement of the three main Pinson Mounds compositional groups, 3A, 3B, and 4 (Table 1; see also Table 2 for summary statistics on major compositional groups). Sixteen samples had high Mahalanobis probabilities for membership in both 3A and 3B. A biplot of principal components 1 and 2 (Fig. 4; see Baxter 1992 and Neff 1994) showed that Group 3B is differentiated from 3A primarily by relative enrichment of manganese and to a lesser extent by enrichment of sodium and barium (Fig. 4). A bivariate plot of logged manganese vs. sodium concentrations (Fig. 5) supports this hypothesis. Manganese and barium are potentially mobile elements that have been implicated in postdepositional contamination of Late Woodland pottery from southeastern Missouri (Cogswell et al. 1995; evidence concerning postdepositional contamination by sodium was inconclusive in that study), so it is possible that differential effects of diagenesis produced the 3A/3B separation. Although comparison of group affiliation with excavation depth or recovery from feature fill was inconclusive, 22 of the 41 Group 3B sherds were surface finds, but only 4 of the 50 Group 3A sherds were recovered from the surface. It is more probable that high concentrations of manganese and barium may represent a real

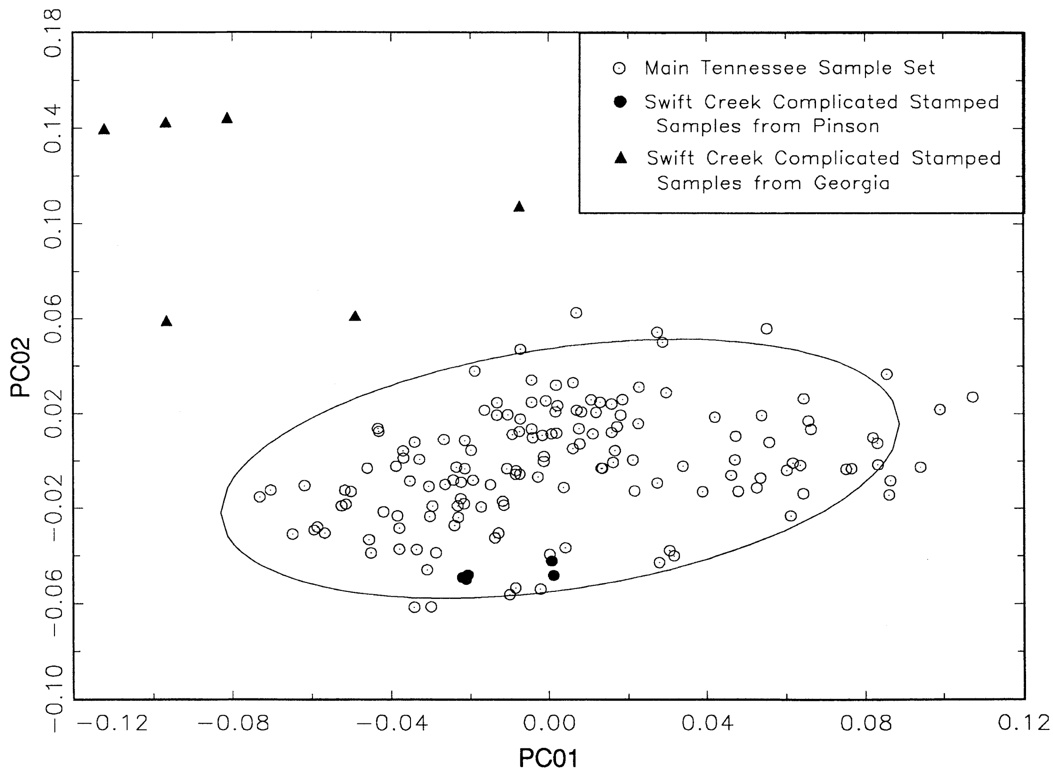

Figure 3. Plot of principal components 1 and 2 based on the variance-covariance matrix of the project data set with outliers removed. Ellipse represents 90% confidence level. Note separation of Swift Creek Complicated Stamped sherds from Georgia and those from Tennessee.

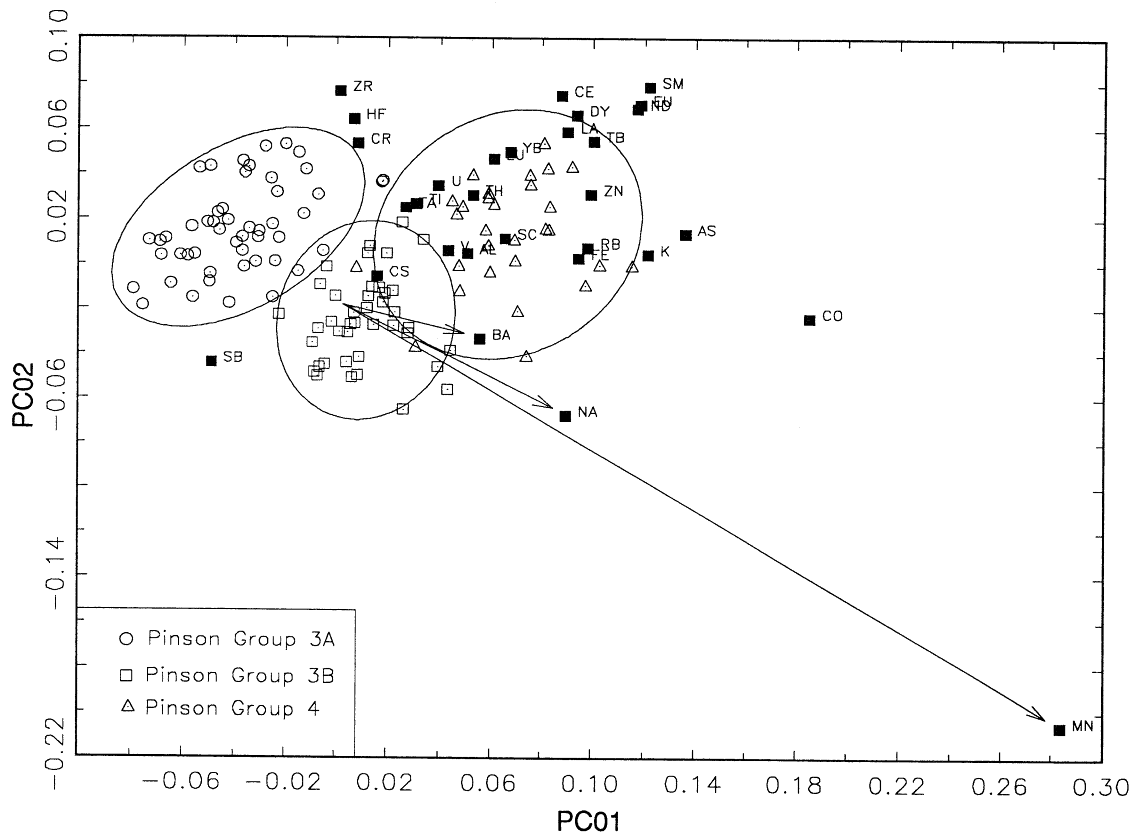

Figure 4. RQ-mode plot of principal components 1 and 2 based on the variance-covariance matrix of the project data set after removing compositional outliers discussed in the text. Ellipses represent 90% confidence levels.

Table 1. Compositional Groups in the Pinson Mounds Data Set and Descriptive Information.*

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
Pinson Group 1							
PMO021	40MD1	Ducks Nest Sector	Furrs Cordmarked #3	quartz	darks	mica	
PMO022	40MD1	Ducks Nest Sector	Furrs Cordmarked #1	darks	quartz	mica	
Pinson Group 3A							
PMO007	40MD29		Furrs Cordmarked	fine quartz		darks	
PMO013	40MD1	Ducks Nest Sector	Swift Creek CS	quartz		mica	
PMO014	40MD1	Ducks Nest Sector	Swift Creek CS	quartz		mica	
PMO015	40MD1	Ducks Nest Sector	Swift Creek CS	quartz		mica	
PMO016	40MD1	Ducks Nest Sector	Swift Creek CS	quartz		mica	
PMO019	40MD1	Ducks Nest Sector	Furrs Cordmarked #12	quartz		mica	
PMO025	40MD1	Ducks Nest	Furrs Cordmarked	quartz	darks		
PMO027	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	darks		
PMO029	40MD1	Mound 14 Sector	Furrs Cordmarked	quartz	darks		
PMO035	40MD1	Sauls Mound	Furrs Cordmarked	quartz		mica	
PMO039	40MD1	ridge into seedling bed	Saltillo Fabric Impressed	quartz	darks		
PMO045	40MD1	field w. of nursery area	Baldwin Plain	quartz	darks		
PMO051	40MD1	Ozier Mound	Furrs Cordmarked	fine quartz	fine darks		
PMO054	40MD1	Ozier Mound	Furrs Cordmarked	quartz	darks		
PMO056	40MD1	Ozier Mound	sand temper check stamped	quartz	darks		
PMO065	40MD1	Ducks Nest Sector	Furrs Cordmarked #13	quartz		darks	
PMO070	40MD1	Ducks Nest Sector	Baldwin Plain #5	quartz	limonite?	darks	
PMO073	40MD1	Mound 10	Swift Creek CS	quartz		darks	different paste than PMO013-016
PMO074	40MD1	Mound 12-stratum 5A	baked clay object	quartz	limonite?	darks	
PMO076	40MD1	Mound 12-stratum 5B	Saltillo Fabric Impressed	quartz	darks	limonite?	
PMO077	40MD1	Mound 12-stratum 5B	sand/clay temper FM	quartz		darks	
PMO078	40MD1	Mound 12-stratum 5B	sand/clay temper FM	quartz	limonite?	darks	
PMO080	40MD1	Mound 31	Furrs Cordmarked	fine quartz		darks	
PMO082	40MD1	Mound 31	Furrs Cordmarked	quartz		darks	
PMO084	40MD1	Mound 31	Marksville Stamped	quartz	limonite?		
PMO085	40MD1	Mound 15	Furrs Cordmarked	quartz			

Table 1. Continued.

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
PMO091	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz		darks	
PMO093	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	limonite	darks	
PMO094	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	limonite	darks	
PMO095	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	limonite	darks	
PMO096	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	limonite	darks	
PMO099	40MD1	Mound 14	Furrs Cordmarked	fine quartz		darks	fired white
PMO100	40MD1	Mound 14 sector	Furrs Cordmarked	fine quartz		darks	
PMO104	40MD1	Mound 30	sand temper eroded	quartz		darks	
PMO111	40MD1	Mound 29	sand/clay temper CM?	quartz	clay	darks	
PMO113	40MD1	Mound 6	clay temper incised	chert?	quartz	darks	
PMO114	40MD1	Mound 6	Basin Bayou Incised?	quartz	limonite	darks	
PMO118	40MD1	Mound 6	sand temper check stamped	quartz		darks	
PMO119	40MD1	Mound 6	sand temper check stamped	quartz		darks	
PMO122	40MD1	Mound 6	sand temper check stamped	large quartz		darks	
PMO123	40MD1	Mound 6	Saltillo Fabric Impressed	quartz		darks	
PMO124	40MD1	Mound 6	Marksville Stamped?	fine quartz		darks	
PMO127	40MD1	Mound 6	sand/clay temper FM	sand	limonite		
PMO128	40MD1	Mound 6	Furrs Cordmarked	quartz		darks	
PMO129	40MD1	Mound 6	Furrs Cordmarked	quartz	limonite	darks	
PMO130	40MD1	Mound 6	sand/clay temper CM	sand	limonite	darks	
PMO137	40MD26		Saltillo Fabric Impressed	quartz		darks	
PMO139	40MD26		sand/clay temper CM	quartz	limonite	darks	
PMO142	40MD30		Furrs Cordmarked	quartz	limonite	darks	
PMO148	40CS16		MCCM, *var.* Tishomingo	quartz		darks	
Pinson Group 3B							
PMO006	40MD1	Twin Mounds Sector	burned clay	N/A			
PMO008	40CS95-D		Saltillo Fabric Impressed	quartz	darks	mica	
PMO011	40MD50		Furrs Cordmarked	quartz	mica	darks	
PMO012B	40CS131		sand temper eroded	quartz	darks		
PMO017	40MD1	Ducks Nest Sector	sand/clay temper burnished	quartz	clay	darks	017 and 018 are different vessels

Table 1. Continued.

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
PMO018	40MD1	Ducks Nest Sector	sand/clay temper burnished	quartz	darks	clay	
PMO024	40MD1	Ducks Nest Sector	Furrs Cordmarked #4	quartz	darks		
PMO047	40MD1	Mound 14 Sector	Baytown Plain, *var.* Tishomingo	clay	quartz	darks	
PMO049	40MD23	ext. into seedling bed	Furrs Cordmarked	fine quartz	darks		
PMO058	40MD1	Ozier Mound	sand/clay check stamped	clay	quartz	darks	
PMO061	40MD1	Ducks Nest Sector	McCleod SS #1	quartz	darks		
PMO062	40MD1	Ducks Nest Sector	McCleod SS #1	quartz	darks	leached ls?	
PMO064	40MD1	Ducks Nest Sector	Saltillo Fabric Impressed #3	quartz	darks	limonite	
PMO068	40MD1	Ducks Nest Sector	Larto Red #2	clay		quartz	
PMO069	40MD1	Ducks Nest Sector	sand/clay temper FM #1	clay	quartz	darks	
PMO075	40MD1	Mound 12-stratum 5B	sand/clay temper FM	quartz	limonite?	darks	
PMO081	40MD1	Mound 31	sand temper eroded	quartz	mica	darks	
PMO083	40MD1	Mound 31	Furrs Cordmarked	quartz	limonite?	darks	
PMO087	40MD23	general surface	sand/clay temper FM	clay	quartz		
PMO102	40MD1	Mound 30	sand temper eroded	quartz		darks	
PMO105	40MD1	enclosure	Furrs Cordmarked	quartz	darks	limonite	
PMO108	40MD1	enclosure embankment	sand temper eroded	quartz	limonite	darks	
PMO109	40MD1	enclosure embankment	Baytown Plain	quartz	limonite	darks	
PMO120	40MD1	Mound 6	Furrs Cordmarked	quartz		darks	
PMO132	40MD3		sand temper eroded	grass? voids	quartz	darks	fiber tempered?
PMO134	40MD3		Withers FM, *var.* Cypress Cr.	quartz		darks	
PMO136	40MD46		sand/clay temper eroded	quartz		darks	2 clays, poorly mixed?
PMO138	40MD26		sand/clay temper FM	quartz	clay	darks	
PMO143	40CS156		sand/clay temper FM	quartz		darks	
PMO144	40CS21		sand/clay temper FM	quartz		darks	
PMO146	40CS36		sand/clay temper FM	quartz		darks	
PMO150	40CS16		sand temper eroded	quartz		darks	
PMO151	40CS9		sand/clay temper FM	quartz		darks	
PMO153	40CS9		sand/clay temper CM	quartz	clay	darks	
PMO157	40MD8		Madison paste eroded	clay	quartz	darks	

Table 1. Continued.

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
PMO158	40MD8		Madison paste eroded	quartz	limonite	darks	
PMO160	40MDA90		Tishomingo paste eroded	fine quartz	clay	darks	
PMO161	40MDA90		Tishomingo paste eroded	quartz	clay	darks	
PMO162	40MDA90		Tishomingo paste eroded	clay	quartz	darks	
PMO163	40MDA90		MCCM, *var.* Tishomingo	quartz	limonite	darks	
Pinson Group 4							
PMO009	40CS18		Furrs Cordmarked	fine quartz	fine darks		
PMO012A	40CS131		Furrs Cordmarked	fine quartz	darks	mica	
PMO020	40MD1	Ducks Nest Sector	Furrs Cordmarked #14	fine quartz	darks	mica	
PMO023	40MD1	Ducks Nest Sector	Furrs Cordmarked #6	mica	fine darks	fine quartz	
PMO026	40MD1	Ducks Nest	Furrs Cordmarked	fine quartz	darks	mica	
PMO030	40MD1	Mound 14 Sector	Furrs Cordmarked	fine quartz	mica	clay	
PMO032	40MD1	nature trail	Furrs Cordmarked	fine quartz	mica	darks	
PMO042	40MD1	west of Mound 17	Furrs Cordmarked	darks	mica	fine quartz	
PMO044	40MD1	extension of 40MD23	Saltillo Fabric Impressed	darks	mica	fine quartz	
PMO046	40MD23	east edge	Saltillo Fabric Impressed	darks	fine quartz	mica	
PMO050	40MD23	general surface	Furrs Cordmarked	fine quartz	mica	darks	
PMO052	40MD1	Ozier Mound	Saltillo Fabric Impressed	quartz	limonite	darks	
PMO055	40MD1	Ozier Mound	podal support	darks	quartz		
PMO059	40MD1	Ozier Mound	sand temper check stamped	quartz	limonite	darks	
PMO066	40MD1	Ducks Nest Sector	Baldwin Plain #1	fine quartz	fine darks	fine limonite	
PMO067	40MD1	Ducks Nest Sector	limestone temper CM	leached ls			
PMO071	40MD1	Ducks Nest Sector	limestone temper PL #1	leached ls	quartz	darks	
PMO088	40MD23	general surface	sand/clay temper FM	darks	mica	quartz	
PMO089	40MD1	west of Mound 17	Baldwin Plain	darks	mica	quartz	
PMO092	40MD1	Twin Mounds Sector	sand/clay temper CM	mica	fine quartz	fine darks	
PMO107	40MD1	enclosure	Baldwin Plain	mica	fine quartz	fine darks	
PMO112	40MD1	Mound 29	sand temper eroded	mica	fine quartz	fine darks	
PMO121	40MD1	Mound 6	Furrs Cordmarked	mica	fine quartz	fine darks	

Table 1. Continued.

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
PMO125	40MD1	Mound 6	Withers FM, *var.* Cypress Cr.	v. fine quartz	v. fine darks		untempered?
PMO126	40MD1	Mound 6	sand/clay check stamped	clay, mica	fine quartz	clay	
PMO135	40MD46		sand/clay temper eroded	quartz	clay	darks	
PMO141	40MD34B		sand/clay temper eroded	quartz		darks	
PMO147	40CS18		sand temper eroded	mica	quartz	darks	
PMO154	40HE27		sand/clay temper CM	fine quartz	clay	mica	
PMO155	40MD88		Saltillo Fabric Impressed	mica	quartz	darks	
Georgia Samples							
PMO164	9MU104		Swift Creek CS	cr. quartz			more angular than above samples
PMO165	9MU104		Swift Creek CS	cr. quartz		darks	
PMO166	9BR2		Swift Creek CS	cr. quartz		darks	
PMO167	9BR2		Swift Creek CS	fine crushed quartz		darks	
PMO168	9PU1		Swift Creek CS	cr. quartz		darks	
PMO169	9PU1		Swift Creek CS	cr. quartz	darks		
Outliers and Unassigned Samples							
• *Raw-clay Samples*							
PMO001	40MD54		clay sample	N/A			
PMO002	40MD51-53 area		clay sample	N/A			
PMO003	40MD51-52 area		clay sample	N/A			
PMO004	2 miles north of Five Points		clay sample	N/A			
PMO005	Mount Pinson		clay sample	N/A			
• *Fired-clay Samples*							
PMO097	40MD1	Mound 14 sector	fired clay	fine quartz		darks	silty
PMO098	40MD1	Mound 14 sector	fired clay	sand		darks	silty
• *Unassigned Samples-Transitional Between Groups 3A and 3B*							
PMO028	40MD1	Twin Mounds Sector	Furrs Cordmarked	quartz	darks		

Table 1. Continued.

Sample ID	*Site*	*Area*	*Type*	*Primary*	*Secondary*	*Trace*	*Comments*
PMO033	40MD1	Sauls Mound	Tishomingo paste eroded	quartz	clay	darks	
PMO036	40MD1	Mound 17	Tishomingo paste eroded	clay	quartz	darks	
PMO037	40MD1	west of nursery office	Furrs Cordmarked	quartz	darks		
PMO040	40MD1	Mound 21	Furrs Cordmarked w/bone	quartz	bone?		
PMO041	40MD1	Mound 17	Withers Fabric Marked	clay	quartz	darks	
PMO043	40MD23		Furrs Cordmarked	quartz	darks		
PMO053	40MD1	Ozier Mound	Furrs Cordmarked	quartz	darks		
PMO057	40MD1	Ozier Mound	Basin Bayou Incised?	quartz	darks	clay	
PMO072	40MD1	Ducks Nest Sector	Furrs Cordmarked #13	quartz		darks	
PMO079	40MD1	Mound 12-stratum 5B	Furrs Cordmarked	quartz		darks	
PMO090	40MD1	Ducks Nest	Furrs Cordmarked	quartz			
PMO115	40MD1	Mound 6	Baytown Plain	quartz	limonite	darks	
PMO116	40MD1	Mound 6	Furrs Cordmarked	quartz	clay	darks	
PMO145	40CS36		sand/clay temper FM	quartz		darks	
PMO156	40MD8		Furrs Cordmarked	fine sand		darks	
• *Unassigned*							
PMO010	40CS156		sand temper eroded	clay/grog	darks	quartz	
PMO031	40MD1	ravine NW of enclosure	Furrs Cordmarked	quartz	darks	mica	
PMO034	40MD1	south of nursery pond	shell temper eroded	shell		mica	
PMO038	40MD1	west of nursery office	Furrs Cordmarked	clay	quartz	darks	
PMO048	40MD23		Withers FM, *var.* Craig's Landing	clay		quartz	
PMO060	40MD1	Ducks Nest Sector	grit temper CM	large quartz		darks	
PMO086	40MD23		sand/clay temper FM	quartz	clay	darks	
PMO101	40MD1	Mound 14 sector	Furrs Cordmarked	quartz	mica	darks	
PMO103	40MD1	Mound 30	sand/clay temper FM	grog	quartz	darks	
PMO106	40MD1	enclosure	sand/clay temper FM	leached ls?	quartz	darks	
PMO110	40MD1	enclosure embankment	sand/clay temper FM	clay	quartz	limonite	
PMO117	40MD1	Mound 6	Furrs Cordmarked	quartz	limonite	darks	

Table 1. Continued.

Sample ID	Site	Area	Type	Primary	Secondary	Trace	Comments
PMO131	40MD3		Furrs Cordmarked	quartz		darks	
PMO133	40MD3		sand temper eroded	quartz		darks	
PMO140	40MD38		sand/clay temper FM	quartz		darks	
PMO149	40CS16		Furrs Cordmarked	quartz	mica	darks	
PMO152	40CS9		sand/clay temper FM	quartz	clay	darks	
PMO159	40MD8		MCCM, *var.* Bells Road	fine quartz	darks		

*Typological designations were made by the senior author prior to the start of the NAA project; see Mainfort and Chapman (1994) for further discussion. Individual vessels identified in the Ducks Nest Sector are listed by vessel number (see Mainfort 1986). The following abbreviations are used in this table with reference to ceramic types: CM=cordmarked; FM=fabric marked; CS=complicated stamped; SS=single stamped; MCCM=Mulberry Creek Cordmarked. Other abbreviations used: ls=limestone; cr=crushed.

Table 2. Element Means and Standard Deviations for Major Compositional Groups in the Pinson Analysis.

	Group 1		*Group 3A*		*Group 3B*		*Group 4*		*Georgia Samples*	
Element	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Al	75235.71	1706.45	66072.80	10015.21	76765.24	17637.74	92787.44	10911.35	102992.69	22287.56
As	63.91	2.71	5.66	2.30	7.57	1.68	13.93	5.44	2.34	.48
Ba	1214.09	82.31	922.63	654.96	1132.19	1744.11	1066.92	499.77	1027.88	834.86
Ca	2218.82	339.68	1248.32	905.87	2371.17	1287.76	2844.78	1094.71	25724.90	18083.48
Ce	239.34	15.82	78.01	23.02	75.18	16.52	122.62	43.60	26.94	15.72
Co	13.27	.50	4.00	1.15	7.08	2.85	13.40	6.83	14.44	5.31
Cr	280.99	7.11	147.48	38.21	137.25	56.32	139.68	28.05	158.26	88.25
Cs	2.40	.09	2.84	.64	3.24	1.38	3.24	.56	1.60	.66
Dy	11.17	.21	5.11	1.38	75.82	448.34	8.10	1.79	2.95	1.21
Eu	3.85	.13	1.15	.28	1.21	.27	2.20	.72	.72	.29

Table 2. Continued.

Element	Group 1		Group 3A		Group 3B		Group 4		Georgia Samples	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Fe	112843.65	632.49	32255.39	10712.34	42143.36	10457.52	56130.70	12590.49	31469.34	5180.98
Hf	9.66	.04	16.54	5.05	13.32	4.04	15.24	2.83	5.60	3.07
K	16395.23	545.44	7919.12	1833.43	10590.64	3021.75	17757.55	3315.23	7183.44	2047.54
La	90.21	7.05	37.78	8.84	37.67	6.86	58.83	16.25	13.17	5.47
Lu	.69	.00	.49	.10	.48	.06	0.64	.09	.34	.09
Mn	216.46	1.65	102.60	43.29	526.09	397.56	510.36	368.62	358.10	226.08
Na	678.05	23.63	670.41	266.14	1310.72	1086.73	1027.02	244.87	6895.90	3225.91
Nd	101.60	2.14	31.90	7.97	34.61	8.96	61.77	25.99	14.67	5.89
Ni	68.68	.00	30.77	19.95	41.55	17.19	55.68	18.41	63.76	24.30
Rb	83.63	6.43	44.11	10.64	53.49	14.21	84.15	15.72	39.45	17.04
Sb	1.81	.17	.43	.10	.45	.13	0.35	.16	.20	.06
Sc	17.27	.32	10.91	1.63	13.59	3.08	16.34	1.57	23.58	7.95
Sm	19.43	.77	6.48	1.69	6.64	1.45	12.28	3.65	2.83	.91
Sr	43.68	.00	42.52	35.90	61.79	19.48	57.32	15.40	73.50	22.04
Ta	1.06	.05	1.26	.19	1.23	.15	1.44	.19	.90	.37
Tb	1.80	.02	.94	.28	.97	.29	1.46	.32	.70	.23
Th	20.35	.07	12.14	2.38	12.93	2.27	15.71	1.63	7.09	3.23
Ti	4270.35	34.84	5033.74	739.68	5099.46	658.21	5915.29	807.21	3652.70	2387.72
U	7.33	.23	3.47	.63	3.46	.60	4.32	1.18	2.28	1.05
V	367.53	3.89	103.07	19.02	124.43	41.85	134.33	15.88	131.90	41.90
Yb	4.99	.29	3.64	.77	3.56	.52	4.87	.84	1.79	.69
Zn	101.08	5.89	56.61	16.10	59.35	28.41	102.26	28.57	64.90	19.39
Zr	288.16	4.97	419.87	151.23	319.20	118.41	367.20	84.17	138.93	60.37

Note: All values are in parts per million. Ca, Ni, and Sr had significant amounts of missing values in all groups.

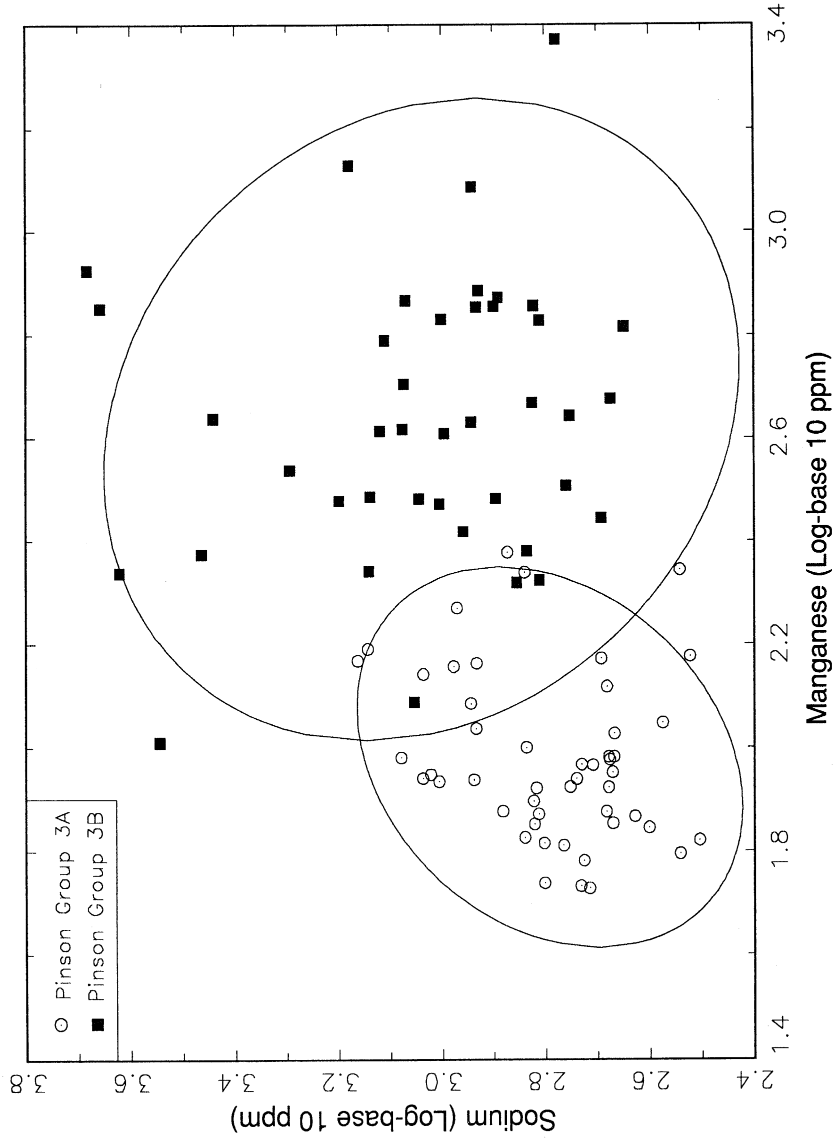

Figure 5. Plot of $\log_{10}$ concentrations of manganese vs. sodium, groups 3A and 3B.

compositional difference in clay sources. Possible explanations for the affiliation of these samples are: (a) that there are different sediment horizons or raw materials having different proportions of elements in the same deposit and groups 3A and 3B represent recognizable extremes; (b) that the intermediate samples were produced from a naturally occurring mixture of two discrete raw materials, perhaps located downstream from two clay sources; or (c) that prehistoric potters mixed distinct materials, i.e., clays and/or temper, to produce the compositionally intermediate samples.

Group 4 is differentiated from groups 3A and 3B by its relative enrichment in rare-earth elements and to a lesser extent in some transition metals (Fig. 5). A plot of $\log_{10}$ concentrations of the rare-earth elements samarium vs. europium (Fig. 6) separates Group 4 from 3A and 3B, though with some overlap. Because rare earths are often concentrated in clays, this group separation may reflect a fine- vs. coarse-paste distinction in the samples. Supporting evidence for this paste distinction is presented in the mineralogical analysis below. Thus, Group 4 samples are considered to be fine-paste variants of locally derived clays rather than representing nonlocal pottery imports to the Pinson area.

In the first analysis of 50 samples, the Swift Creek Complicated Stamped samples (PMO013-016) and one Furrs Cordmarked sample (PMO019) were posited to form a separate compositional group, Group 2 (Cogswell et al. 1993). With the perspective of additional samples in the data set, Group 2 now is a subset of Group 3A.[1]

Several additional pottery samples were originally believed to be nonlocal imports because of their limestone temper (PMO067 and 071) or paste characteristics (PMO060, the only grit-tempered sample submitted). Cluster analysis did not identify any of these samples as compositional outliers. Mahalanobis-distance-based classification resulted in a low membership probability for PMO060 in any of the PCA-derived reference groups, but the other potential nonlocal specimens were assignable to reference groups of presumed local origin.

Samples from local, non-Pinson sites were found in compositional groups 3A, 3B, and 4, with the bulk of samples in Group 3B (Table 3). Samples from 40MDA90 (n=4) all were in compositional Group 4; the three samples from 40CS9 all were in Group 3B and the two samples from 40CS18 were in Group 4. With these exceptions, which may reflect sample size, our inability to link archaeological provenance with compositional groups suggests that locally produced pottery was a readily transported commodity in the Pinson area during the Middle Woodland period. Pottery from all three main compositional groups occurs not only at Pinson Mounds, but also at many nearby sites. Other studies have demonstrated the transport of locally produced pottery during the Middle Woodland and Late Woodland–Early Mississippian periods (e.g., Neff et al. 1995).

Mineralogical Analysis

We inspected all samples under a binocular microscope (20–40x) and recorded

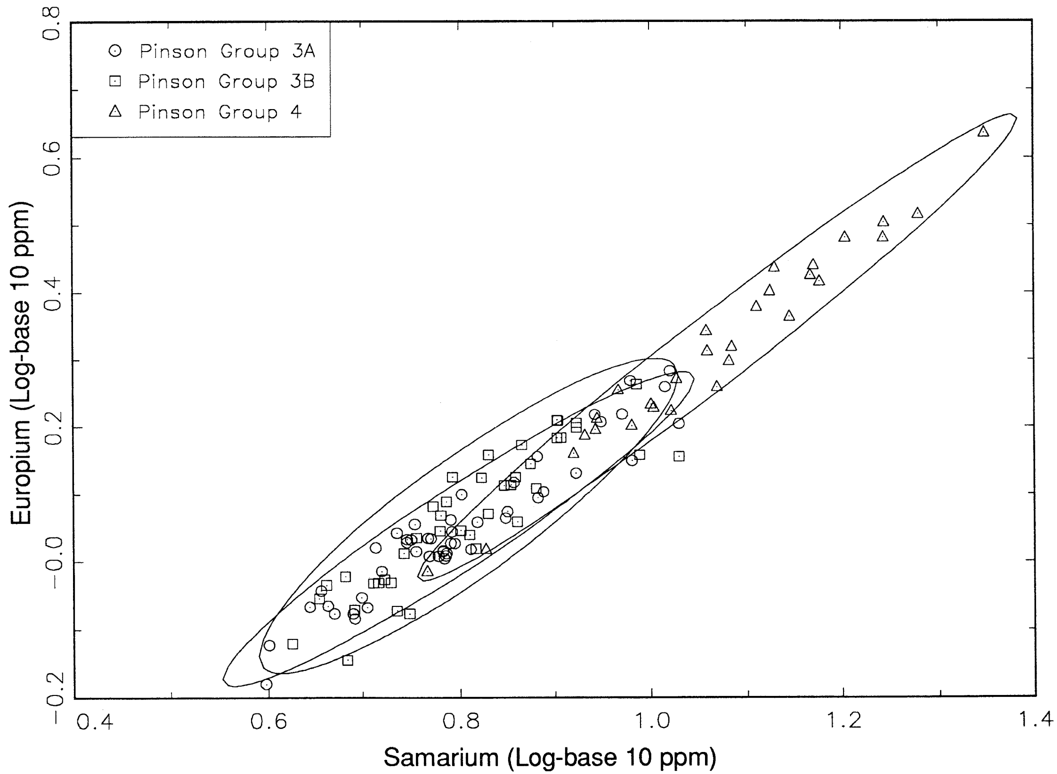

Figure 6. Plot of $\log_{10}$ concentrations of samarium vs. europium in Pinson groups 3A, 3B, and 4. Ellipses represent 90% confidence levels. Note the superposition of Group 3A and 3B samples, and that the Group 4 samples continue in the same axis of variation as the 3A and 3B samples.

Table 3. Non-Pinson Sites and Compositional Groups.

Site	*No. of Samples*	*Group*				*Unassigned*
		3A	*3B*	*4*	*3A-3B*	
40CS9	3		3			
40CS16	3	1	1		1	
40CS18	2			2		
40CS21	1		1			
40CS36	2		1		1	
40CS95-D	1		1			
40CS131	2		1	1		
40CS156	2		1			1
40HE27	1			1		
40MD3	4		2		1	1
40MD8	4		2		1	1
40MD26	3	2	1			
40MD29	1	1				
40MD30	1	1				
40MD34B	1			1		
40MD38	1					1
40MD46	2		1	1		
40MD50	1		1			
40MD88	1		1			
40MDA90	4		4			
Total	40	5	21	6	4	4

observations on temper constituents. The Swift Creek Complicated Stamped sherds submitted in the first phase of the project probably derive from only one or two vessels (Mainfort 1986) and are now considered to be a subset of Group 3A. These samples also are a recognizable subgroup on mineralogical grounds, having mostly quartz sand with traces of mica as inclusions. The additional Swift Creek Complicated Stamped sample from Pinson (PMO073) does not share the quartz/mica temper profile. Group 4 samples generally have finer temper than do samples from either Group 3A or 3B. This supports the chemical evidence cited above that the separation of Group 4 from 3A and 3B is based primarily on paste texture.

Internal Structure of the Pinson Data Set

The compositional homogeneity noted above is reflected in a lack of strong spatial variability within the Pinson Mounds site. With the exception of the small (n=2) compositional Group 1, none of the identified compositional groups is exclusively associated with specific ceramic surface treatments or specific proveniences within the site. A few intrasite spatial trends are worth noting, although it probably is unwise to attribute great significance to these. Of the 18 sherds from Pinson Mound 6 (the Twin Mounds), 11 are assigned to Group 3A, one to Group 3B, and three to Group 4; two specimens fall within the Group 3A/

3B transitional group, and one is unassigned. Four of the six specimens associated with the deposits beneath Pinson Mound 12 are assigned to Group 3A; these include three fabric-marked sherds and a baked-clay object fragment. Check-stamped specimens are most strongly represented in Group 3A (n=4), including three sherds from Pinson Mound 6. Fabric-marked specimens are present in all compositional groups, but only in Group 3B do they outnumber (n=10) cordmarked sherds. Of the sampled localities within the Pinson Mounds site, the Duck's Nest Sector provided the largest number of sherds used in this study (n=25); these sherds are relatively evenly distributed among the three main compositional groups.

Relationship of Pinson Samples to Regional Characterization of Pottery from the Southeast

A recent paper by Steponaitis et al. (1996) presented results of a long-term compositional analysis of pottery from the southeastern United States. Four regional compositional groups—northern, southern, eastern, and western—were identified in the data set. Of particular relevance to this study is the interstitial geographic position of Pinson Mounds to the northern, southern, and western groups. In order to effect comparability of the two data sets, ten elements—Al, Ca, Dy, Mn, Nd, Ni, Sr, Ti, V, and Zr—were eliminated from the Pinson data set.[2] PCA of the combined, $\log_{10}$-transformed data set showed that Pinson Mounds pottery is compositionally distinct from the regional reference groups (Fig. 7) and is relatively low in sodium, a trait shared with the northern reference group (Steponaitis et al. 1996:7). The Pinson samples are correspondingly enriched by hafnium and chromium. While the significance of chromium is unclear at present, the high loading of hafnium may reflect a relatively higher amount of sand and silt in the Pinson pottery (Blackman 1992). The Pinson Mounds samples are geographically intermediate between the northern and southern reference groups; actual affiliation with the eastern reference group as the source of Pinson pottery is unlikely. Commensurate with its geographic position, the Pinson-area samples show similarities with the northern reference group (low sodium values) and southern reference group (overall, but low, similarity). Note that the Steponaitis et al. data set was corrected for (shell) temper effects and thus reflects relatively undiluted clay provenances; the Pinson samples were not corrected for temper effects. Until the effect of sand, grit, and limestone tempers on the Pinson samples are quantified, no definitive assessment of membership affiliation with the regional groups can be made.[3]

Conclusions

A major purpose of this investigation was to determine if pottery was imported to Pinson Mounds from distant locations. Of the 154 pottery samples analyzed, all samples submitted from Pinson Mounds and nearby sites are probably of local origin. The three possible exceptions, PMO021, 022, and 140, are ar-

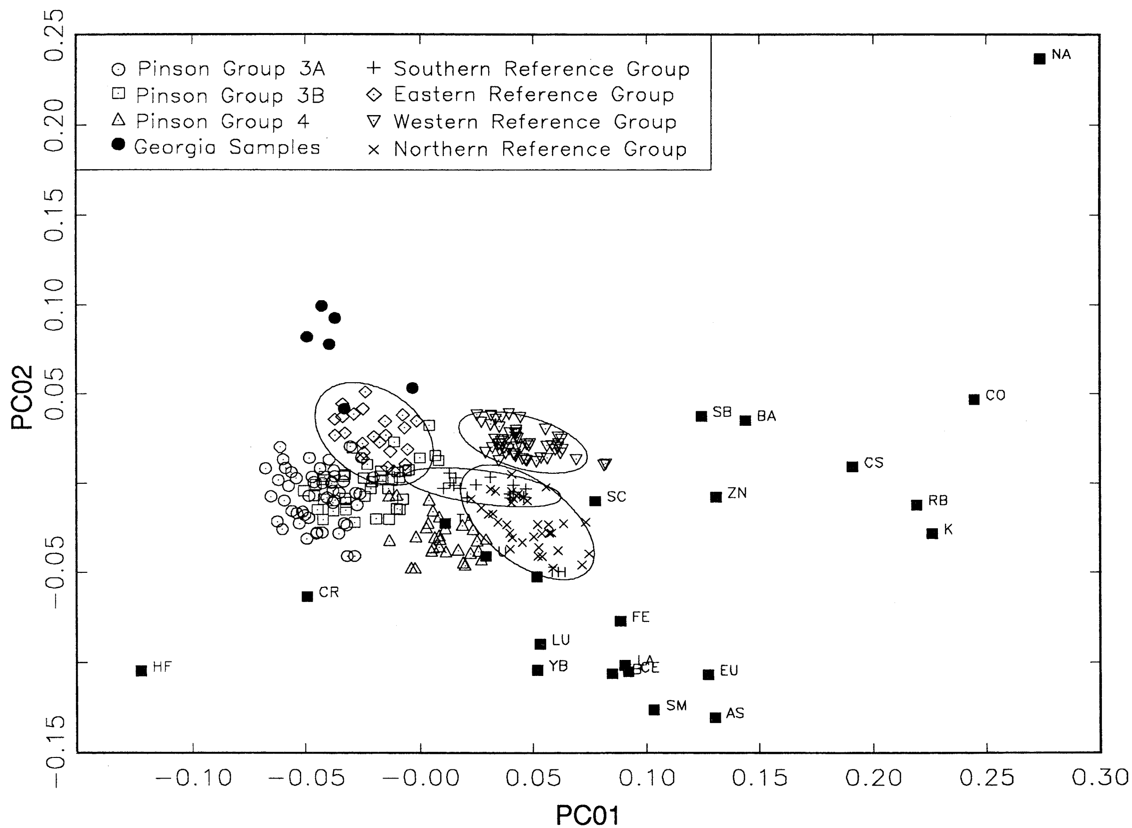

Figure 7. Plot of principal components 1 and 2 based on the variance-covariance matrix of the combined Pinson and regional reference group data set. Ellipses represent 90% confidence levels.

chaeological types common to the Pinson area. Probably none of the Pinson samples came from Georgia, which had been considered a possible source of Swift Creek Complicated Stamped pottery found at the site (Mainfort 1986, 1988).

Three main compositional groups have been identified in the Pinson data set. Two groups, 3A and 3B, can be differentiated possibly because of post-depositional factors. Alternatively, variation in source materials or in their exploitation might account for the Group 3A/3B differentiation. Differentiation of Group 4 from groups 3A and 3B might be based primarily on paste texture. The demonstrated mixture of compositional groups at Pinson and nearby sites argues for movement of vessels within local production areas.

Note that we have not determined what geographical range constitutes "local" for this study and only in one instance (with reference to the comparison of Pinson Swift Creek Complicated Stamped pottery samples to similarly decorated sherds from Georgia) have we implied what constitutes a long-distance import, i.e., "nonlocal" pottery. We instead rely on the "Provenience Postulate" (Weigand et al. 1977) for our inference of local pottery production, because none of the submitted raw-clay samples has a significant affiliation with the archaeological samples submitted. The intermixture of pottery from the three compositional groups at Pinson Mounds and nearby sites strongly argues for the pottery being locally produced. However, the limestone-tempered pottery samples posited to be from roughly 100 km east of Pinson were found to be compositionally local. In contrast, Carr and Komorowski (1995), using other techniques, infer that interlocal trade of ceramics was conducted within a 25-km radius of a Middle Woodland site in Ohio. A ceramic raw materials survey of the research area and further NAA may define source areas for the compositional groups presented in this study, as well as refining the geographic expanse of what is termed local in this report.

While the Pinson Mounds site is spatially extensive, construction and maintenance of the numerous earthworks cannot be attributed to a large residential population. Nor is there strong evidence for a sizable Middle Woodland population in the general vicinity of the site. Construction of the largest earthworks at Pinson Mounds has been attributed to joint efforts by a number of social groups, some from areas at considerable distances from the site. The presence of ceramics with nonlocal surface treatments at the site has been used to bolster this argument (Mainfort 1986, 1988).

The results of this study clearly demonstrate that none of the analyzed sherds with nonlocal surface treatments was manufactured from nonlocal clays. Rather, the vessels in question were produced at or near the Pinson Mounds site. How are we to account for these stylistically nonlocal vessels? One possibility is that past interpretations of what constitutes local and nonlocal surface treatments and decorative patterns are seriously flawed. While this may be true in a few specific instances, data from sites in the Pinson Mounds area, as well as the substantial ceramic assemblages from both mound complexes and domestic sites in the Tombigbee River drainage to the south and the Tennessee River drainage to the east and southeast (e.g., Bohannon 1972; Cotter and Corbett 1951; Jenkins 1981;

Webb and DeJarnette 1942), indicate that pottery typed as Swift Creek Complicated Stamped and McCleod Simple Stamped are not local variants. Likewise, limestone tempering is not characteristic of the west Tennessee interior; indeed, there are no local limestone deposits or sediments from which to obtain limestone.

An alternative interpretation is that individuals from different social groups, some located at great distances from Pinson Mounds, placed their own regionally distinct styles on pottery while participating with other groups in activities at the Pinson Mounds site (see also Smith 1965). This scenario is consistent with the interpretation offered by Milner and O'Shea (1995) of ceramics recovered from the Late Woodland-period Mikado Earthwork in Michigan. At Mikado, the ceramic assemblage is characterized by considerable stylistic diversity indicative of several distinct ceramic traditions, but the pottery was produced using local clays. Milner and O'Shea believe that this reflects use of Mikado and other northern Michigan earthen enclosures as rendezvous points constructed along social and ecological boundaries at which intergroup exchange was periodically conducted. Although we do not propose a similar function for the Pinson Mounds site, Mikado and Pinson Mounds have in common their use as special activity loci, and they have yielded similarly variable ceramic assemblages.

The results obtained by this study were unexpected. Pinson Mounds is the largest Middle Woodland site in the Southeast and, not surprisngly, a number of nonlocal materials have been found at the site (e.g., Mainfort 1988). Excavations at Pinson Mounds also have produced a large number of pottery sherds that exhibit nonlocal decorative attributes. Mainfort (1986, 1988) has previously suggested these sherds represent nonlocal vessels that were brought to Pinson Mounds by the societies that produced them, but neutron activation analysis has conclusively demonstrated that the sherds in question were produced locally. The cultural and behavioral mechanisms responsible for the presence of stylistically nonlocal but compositionally local sherds at Pinson Mounds may never be known, but it is clear that pottery and raw materials from the site and its surrounding area are worthy of further research.

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Notes

[1]We have not reconfigured our group numbering to conform to our "final" compositional groups for two reasons. First, a report on the preliminary analysis was circulated to researchers several years ago. Second, we want to convey how empirical findings may change based on an expanded data set.

[2]These elements subsequently have been added to the Steponaitis et al. (1996) data set.

[3]The data discussed in this paper are available on the Internet at http://www.missouri.edu/~murrwww/archdata.html.

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