QUALITATIVE PETROGRAPHIC ANALYSIS OF SELECTED CERAMIC SHERDS FROM TWO PREHISTORIC SITES IN TENNESSEE

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ABSTRACT—This article summarizes the results of petrographic analysis conducted on prehistoric ceramic sherds collected from two archaeological sites located in geologically and physiographically dissimilar regions of Tennessee. The results, based on the identification, abundance, and geometric relationship of included mineral grains, evince differences in the provenance of the raw material (geologic differences) as well as in the method of manufacture (anthropogenic differences).

Petrographic microscopy is commonly used by geologists to identify the mineral components in a rock and in the subsequent identification of the rock itself. A translucent slice of rock or mineral (i.e., a thin section) is mounted on a glass microscope slide and viewed in polarized light where distinguishing optical properties can be observed (Phillips, 1971; Kerr, 1977). This study applies these same principles and techniques to the investigation of the mineral inclusions found within the tempering matrix of selected fragments of prehistoric, clay-fired pottery (Danson and Wallace, 1956; Shotton and Hendry, 1979; O'Malley, 1981; Garrett, 1986; Ferring and Pertulla, 1987; Stoltman, 1989, 1991, 1996, 2001). Petrographic analysis can be employed to effectively answer questions concerning the classification, function, manufacturing methods, and exchange of prehistoric ceramics (Stoltman, 2001).

A total of seven samples collected from two geologically and physiographically distinct regions of Tennessee (Fig. 1) were examined: three sherds from site 40WM01 located in the Central Basin physiographic province, and four from site 40PK27 located in the Unaka Mountains physiographic province (Miller, 1974). Site 40WM01 is described as a palisaded Mississippian village site (ca. 800 B.P.) that includes at least one mound feature. It is located in Williamson County along the Little Harpeth River, approximately 20 miles south of Nashville. Site 40PK27 is primarily a middle Woodland habitation site (ca. 1800 B.P.) located in Polk County along the Hiwassee River in the extreme southeastern corner of the state.

METHODS

Each sample sherd was cut to fit on a glass microscope slide measuring 27 by 46 mm. The inner, concave side of the trimmed sherds was ground flat and polished manually using wetted carborundum grit (220 and 600 mesh) against a plate glass surface. Following this same procedure, one side of the glass slide was ground (frosted) in order to enhance the adhesive bond between the glass and the sherd. The sherd was then affixed to the slide using a two-part epoxy resin. No attempt was made to impregnate these samples. After a setting time of approximately 15 minutes, the samples were mechanically ground to a thickness between 0.04 and 0.03 mm. The final polishing was performed manually using the 600-mesh carborundum grit. The completed thin sections were examined with a petrographic (polarizing) microscope for the purpose of identifying constituent sand-size (2 to 0.0625 mm) and silt-size (0.0625 to 0.0039 mm) single and compound mineral grains and assessing their relative abundance and degree of sorting. Because of their extremely small size, clay-size particles (< 0.0039 mm), the principal matrix constituent, are not individually identifiable using standard optical microscopy. This is the principal limiting factor of ceramic petrography.

DESCRIPTIONS

The following three descriptions are for those sherds collected from site 40WM01 located within the Central Basin physiographic province of Tennessee (Miller, 1974). This region of the state is underlain by Ordovician carbonates (Wilson, 1962; Miller, 1974). Previous investigations employing scanning electron microscopy, neutron activation analysis, and X-ray diffraction have identified illite as the predominant clay type found in the Central Basin (Nieheisel and Weaver, 1965; Steponaitis et al., 1996). Illite, specifically a group of clay minerals that are abundant in sedimentary rocks, is intermediate in composition between muscovite and montmorillonite (Deer et al., 1966).

Sample 40WM01-1—The sherd from which this thin section was made was initially described, in hand sample, as having a plain (non-decorated) outer surface tempered with finely crushed freshwater mollusk shell. Petrographic analysis revealed a surprising abundance of feldspar grains, representing > 50% of the identifiable single mineral grains (Fig. 2). Feldspar is not a common constituent of the limestones and shales that underlie the Central Basin and suggests an extralocal origin for this particular vessel. Patchy extinction displayed by some of the feldspar grains may be indicative of the potassium-rich feldspar, microcline ($KAlSi_3O_8$). A possible source for clays with this particular mineral assemblage would be an area underlain by arkosic (feldspar-rich) sandstone.

Overall, the section exhibits an orange-brown, birefringent tint, most likely the result of iron oxidation. A large, polymineralic, iron-oxidized grain (unidentified) was clearly visible near

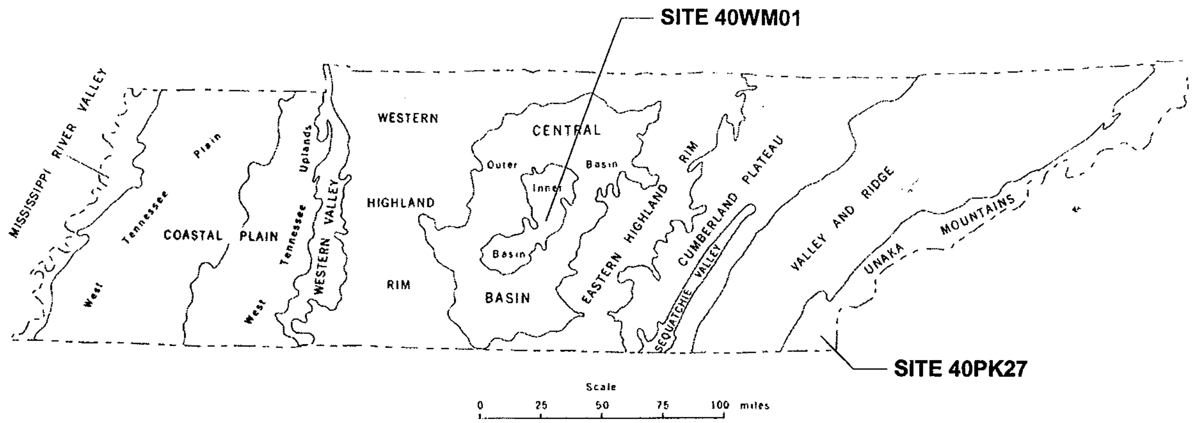

FIG. 1. Site locations plotted on "Generalized Physiographic Map of Tennessee" (from Miller, 1974).

the center of the slide. The higher interference colors observed were produced by the thicker quartz grains (> 30 microns). The presence of shell, characterized by fourth and fifth order interference colors indicative of the presence of calcium carbonate minerals, was not detected in this sample.

Sample 40WM01-2—This sherd was initially described as having a plain outer surface tempered with medium-size shell fragments. Quartz and feldspar were the predominant mineral grains identified within the clay matrix. The feldspar content was much lower in this sample. This sample contained a significant amount of opaque grains, likely hematite (Fe_3O_2). Again, shell fragments were not observed in the section.

Sample 40WM01-3—This sherd was initially described as having a non-decorated outer surface tempered with large fragments of crushed shell. Quartz and feldspar were the predominant mineral grains observed in this section. The percentage of feldspar in this sample fell somewhere between that contained in the two previous examples. Overall, this specimen is quite similar to Sample 40WM01–1 except for its lack of iron oxidation. No shell fragments were observed.

The following four descriptions are for sherds collected from site 40PK27 located within the Unaka Mountains physiographic province of Tennessee (Miller, 1974). In this region, the predominant clay mineral is kaolinite, a two-layer hydrous aluminosilicate mineral (Neiheisel and Weaver, 1967; Steponaitis et al., 1996)

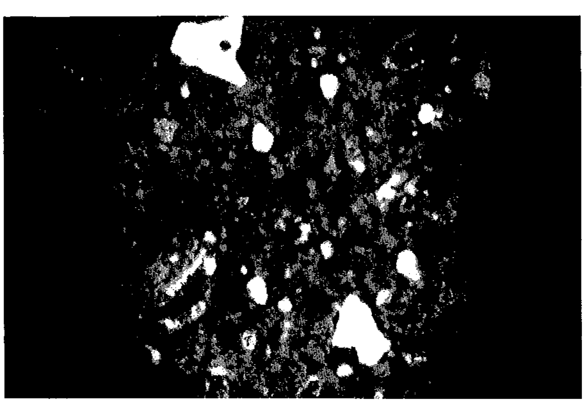

FIG. 2. Photomicrograph (cross polarized light) of sample 40WM01-1 showing feldspar and quartz grains in a ferruginous clay matrix (paste). The field of view at magnification 40× is 34 by 22 mm.

Sample 40PK27-1—The sherd from which this thin section was made was initially described, in hand sample, as having a plain (non-decorated) outer surface tempered with limestone grit, primarily sand-size particles of crushed rock. Quartz and feldspar were the predominant mineral grains identified in this sample. Single (monomineralic) quartz grains accounted for more than half of the identifiable inclusions. Extremely high order interference colors displayed by some of the grains indicated the presence of carbonate minerals, i.e., the limestone tempering agent. The clay used in the manufacture of this vessel was very dark brown (non-birefringent, optically dense) suggesting a high concentration of organic material.

Sample 40PK27-2—This sherd was initially described as having a plain outer surface tempered with limestone grit. The clay used in the manufacture of this vessel was dark brown to black (non-birefringent, optically dense), again suggesting a high concentration of organic matter. This sample exhibits a large fine grain (clay) to coarse grain (sand and silt) ratio. Sand- and silt-size inclusions are observably scarce. The few grains that were examined displayed signs of particle segregation. The larger grains were concentrated in individual layers while the smaller grains tended to occur in roughly circular clusters. This type of particle arrangement would be difficult to justify from the random mixing of the clay paste and temper and quite possibly reflects a specialized manufacturing technique. The predominant minerals are quartz and feldspar; no carbonate minerals were identified in this section.

Sample 40PK27-3—This sherd was initially described as having a plain outer surface with micaceous sand as the tempering agent. Numerous single mineral grains were identifiable in this section. They consisted of quartz, feldspar (primarily plagioclase), muscovite mica, and kyanite. This mineral assemblage reflects the area's metasedimentary geology.

Sample 40PK27-4—This sherd also was described as having a plain outer surface tempered with micaceous sand. This section contained the largest concentration and variety of identifiable mineral grains; these included quartz, microcline and plagioclase feldspars, muscovite, and a large amount of kyanite (Fig. 3). The quartz/feldspar ratio was approximately 50/50. The mineral kyanite is indicative of a medium temperature/high pressure metamorphic terrane (Deer et al., 1966) and is, again, well representative of the geologic history of this region of southeastern Tennessee (Miller, 1974).

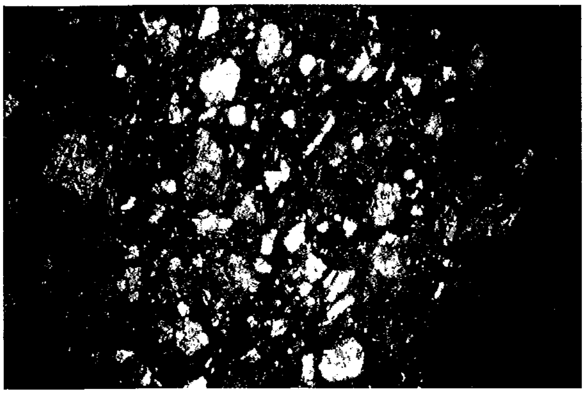

FIG. 3. Photomicrograph (cross polarized light) of sample 40PK27–4 showing monomineralic quartz, feldspar (microcline and plagioclase varieties), muscovite, and kyanite grains with polymineralic quartzite grains in a dark, organic-rich clay matrix (paste). The field of view at magnification 40× is 34 by 22 mm.

CONCLUSIONS

Petrographic analysis of prehistoric ceramics is a tremendously underutilized investigatory tool. It does far more than simply enhance megascopic (hand sample) descriptions. A qualitative approach, such as described in this paper, can provide valuable insights concerning raw material provenance (location of production) and methods of manufacture: geologic versus anthropogenic variations. Ceramic petrography benefits greatly from the fact that it is a quick, efficient, and economical investigatory tool. It has not been supplanted by newer and more expensive "high tech" procedures like neutron activation analysis, electron microbrobe analysis, X-ray fluorescence, or acid extraction techniques. The findings presented in this article attest to the value of thin section analysis of prehistoric ceramics and support its incorporation into the overall investigation strategy employed at Woodland and Mississippian period archaeological sites.

ACKNOWLEDGMENTS

I would like to thank S. S. Farrar, Dept. of Earth Sciences, Eastern Kentucky Univ., for his helpful comments.

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