McNair Scholars Journal

Volume 7 | Issue 1 Article 6

1-1-2003

Understanding Prehistoric Ceramic Technology from the Grand River Valley

Jeff Chivis
Grand Valley State University

Understanding Prehistoric Ceramic Technology from the Grand River Valley

Jeff Chivis
McNair Scholar

Janet G. Brashler, Ph.D.
Faculty Mentor

ABSTRACT

This research focused on understanding the production process of ceramic construction (technological choices of potters) during the Woodland Period in western Michigan. This ultimately provided information regarding choices not only pertaining to style but also to material choices and firing strategies of early societies. The research involved the replication of pottery sherds, which were then compared to a sample of Early Woodland, Middle Woodland, and Late Woodland sherds from sites in the Grand River valley by using petrographic analysis. These sherds were extracted from the Prison Farm (20IA58), Norton Mounds (20KT1), Spoonville (20OT1), and the Converse Mounds sites (20KT2). Technological changes were recorded and analyzed for a small sample of Woodland sherds from these sites that dated between 700 B.C. and A.D. 1000.

Introduction

Ceramics are important in archaeology because they convey information about site chronology (dates of occupation), site function, and relationships with other archaeological sites and regions. In addition, ceramics display information about production, consumption, and distribution practices of the people who made them (Chilton, 1998). The concept of technological style focuses on the relationship between techniques of ceramic production and society. Technological style concentrates on the sequence and use of pottery, as well as its appearance or what it suggests about a culture. The focus is on the makers and users of the ceramics, which provides a glimpse into social relations (Chilton, 1999; Chilton, 1998).

This paper examines Early, Middle, and Late Woodland ceramic collections from the Prison Farm (20IA58), Norton Mounds (20KT1), Spoonville (20OT1), and Converse Mounds (20KT2) sites in western Michigan (Figure 1). The purpose of this study was to define the production process of ceramics during the Woodland period in Michigan (800 B.C to A.D. 1650) and to identify technological choices of potters and how these changed over time. The first objective of this research was to describe the local clays and tempers so that they could be compared to archaeological samples from sites where importation and exchange has been suggested.

The testing of hypotheses concerning material choices through time was another objective of this study. Elizabeth S. Chilton (1998) stated that, "Quartz…is not an optimal inclusion type for cooking pots; it expands much more quickly than clay and can lead to crack initiation" (p. 149). Thus, it can be assumed that potters would eventually select clays that would have a lower percentage of quartz and there would be a declining percentage of quartz in pottery over time. Another hypothesis that was tested involved temper size over time. It has been suggested that temper size declines as time goes on (Brashler, personal communication, June 18, 2003). Since larger temper sizes are undesirable for firing because they can lead to cracks and poor ceramic quality, it would make sense that the potters would learn to use smaller pieces of temper in their pottery.

Previous analysis (Brashler, Laidler, & Martin, 1998; Brashler, 1991) suggests that there are significant technological differences between Early, Middle, and Late Woodland ceramics that can be identified in the region. Research involving stylistic differentiation and Instrumental Neutron Activation Analysis (INAA) has been initiated, but technological analyses proposed here will incorporate and refine previous preliminary work. Previous research has focused mostly on qualitative stylistic changes between Early, Middle, and Late Woodland ceramics (Chilton, 1998; Garland & Beld, 1999; Kingsley, 1990; Kingsley, 1999). There have also been studies conducted on imported or trade vessels during the Middle Woodland. It has been suggested that most of the vessels in western Michigan during the Middle Woodland period were influenced, traded, or imported from Illinois based on similar qualitative characteristics (Kingsley, 1990; Kingsley, 1999). Unlike most of the previous research, this research focused on technological data and will ultimately be integrated with ongoing stylistic and INAA analyses.

Figure 1. *Map of Archaeological Sites in Western Michigan*

Background

The Early Woodland period spans from approximately 800 B.C. to 200 B.C. (Fitting, 1975). The Early Woodland period in Michigan represents a transition from a foraging society to one that incorporated the cultivation of plants. It is also characterized by the introduction of squash and sunflower, which coincides with the use of the earliest pottery and the construction of burial mounds (Garland & Beld, 1999). Although many sites may lack pottery, Marion Thick pottery, Kramer points, and coil cordmarked pottery are the trademarks of this period. Other early forms of pottery that are believed to have been constructed during the latter part of the Early Woodland period include Shiawassee Ware and Mushroom Cordmarked pottery (Garland & Beld).

The Middle Woodland period refers to when most of eastern North America was dominated by the Hopewellian culture, between 200 B.C. and A.D. 400 (Fitting, 1975). The Middle Woodland era in Michigan reflects strong patterns of elaborate burial mounds (especially in Southern Michigan) and the importance of fishing (Fitting; Kingsley, 1999). This time period depicts several different settings of cultural development. The categories, *Southern Michigan* and

Northern Michigan, are used to clarify the Middle Woodland era in Michigan. In Southern Michigan, Hopewellian expressions are divided into two distinct regional traditions and several temporal phases (Kingsley, 1999). Southern Michigan consists of the “Norton Tradition,” which is used to signify Hopewell expressions in western Michigan and the Grand River Valley. However, it has been suggested that Havana and perhaps Ohio Hopewellian people actually moved and settled into western Michigan (Kingsley, 1990; Kingsley, 1999). Norton Tradition ceramics and associated “authentic Illinois” Havana Ware at the Norton Mounds site and other types of ceramics present in this region, such as Michigan copies of Havana Ware, appear to be imitations of original Illinois Havana Ware (Kingsley, 1999). Havana Ware, Western Basin Ware, Crockery Ware, Hacklander Ware, and Norton Ware are all representative of Middle Woodland pottery styles in Michigan (Kingsley, 1999).

The Late Woodland time period extends from approximately A.D. 400 to the time of European contact at about 1650 A.D. It immediately precedes and is the base for the tribal societies that were encountered by the earliest European explorers (Holman & Brashler, 1999). There is evidence of seasonal migrations, regional adaptations, important kinship ties, and food storage. The association of ceramic styles with particular regions indicates regional adaptations. Different kinds of chert were used to preserve relationships with close kin, marriage partners, and other neighbors. These close kinship ties helped groups in times of food scarcity. Furthermore, ceramic styles were very similar, which suggests close relationships among potters and their groups (Holman & Brashler).

After A.D. 1000, chert was no longer given as gifts and boundaries between groups became more strictly enforced. Groups probably traded maize for game (Holman & Brashler, 1999). Earthworks and rock art also surfaced during this time period (Zurel, 1999). The major types of pottery present in the Late Woodland period in the study area are Allegan Ware, Spring Creek Ware, Bowerman Ware, Skegemog Ware, and Mackinac Ware (Holman & Brashler, 1999).

Methodology

This research involved the replication of pottery sherds to begin gaining an understanding of the production strategies and technological choices of Woodland Period potters. An experimental process was employed to control a variety of conditions. First, three different clay sources were chosen for the experimental test-tiles. One source, which was called the Baldwin clay, was taken approximately 20 feet underground from a construction site on Baldwin Street near Allendale, Michigan. Another clay source was taken from a streambed 300 meters from the Spoonville site near the Grand River in Nunica, Michigan. Interestingly, the name *Nunica* means “place of clay” in Anishnabek, the language of the Potawatomi and Ottawa Indians who inhabited the region historically. This was called the Spoonville clay. The third clay source, the Forest Hills Northern clay, was obtained from a streambed tributary to the Grand River east of Grand Rapids, Michigan.

After the clay sources were chosen, three different types of temper were selected to be included in some of the test-tiles. Temper refers to a material, either mineral or organic, that is intentionally added to a clay source to improve its working, drying, or firing properties (Rice, 1987; Shepard, 1956). The three types of temper that were chosen for this study included mica schist, gabbro, and granite. Each rock was grinded and crushed into smaller pieces and then put into separate cups. The cups that included the mica schist and gabbro temper all contained roughly 30 milliliters of temper. Meanwhile, the granite-tempered cups had about 50 milliliters of temper, except for one cup, which only had about 45 milliliters. The overall weight of the temper (in grams) was written on the outside of each cup.

Next, the clay was prepared before it was made into test-tiles. The clay was deposited into a graduated bucket with water. The amount of clay and water was recorded so the process would be easy to replicate in order to make more clay. When the correct mixture of water and clay was achieved, the clay was wedged to reduce the size and number of air pockets. Then, the wedged clay was made into test-tiles by using a 10 cm x 10 cm, 3.5 inch thick template. For each clay source, four test-tiles did not include temper while six test-tiles did include temper. Of the six tempered test-tiles, two contained the mica schist temper, two others had gabbro, and the final two included granite temper. Thus, each clay source had ten test-tiles, four without temper and six with temper for a total number of thirty experimental test-tiles. After the test-tiles were made, tick marks were put onto the back of each test-tile to measure the shrinkage after firing.

The firing of the test-tiles was conducted next. Two separate types of kilns were used: one for oxidation and one for reduction. Oxidation refers to a firing atmosphere that is characterized by an abundance of free oxygen, while reduction refers to an atmosphere in which oxygen is removed from substances or materials (Druc & Velde, 1999; Rice, 1987). For each clay, two untempered test-tiles were fired in an oxidized environment, while the other two untempered test-tiles were fired in a reduced environment. The other six tempered test-tiles were all fired using oxidation. The test-tiles were also fired at two different temperatures: 650 and 900 degrees Celsius.

After the firing of the test-tiles, the amount of shrinkage and Munsell color changes were measured and recorded for each test-tile. Then, parts of each test-tile were cut off and sent to Spectrum Petrographics, Inc. to get them thin-sectioned. Thin sections are approximately 0.03 mm thick (Rice, 1987). The petrographic point counting technique developed by Stoltman (1989, 1991) was used to compare these thin sections with thin sections of ceramics from the selected Woodland sites in western Michigan. Point counting provides a way to measure relationships between matrix and temper in different samples. In addition, qualitative data on the minerals in each rock and a number of other categories of data were recorded. For example, some of the categories were percentage coarse fraction to percentage fine fraction ratio, fine fraction, coarse fraction, optical activity, sorting, grain-size, angularity, and homogeneity. At least one hundred points were counted for each thin section, and the points were recorded on an ordinal scale according to the type and size of each mineral under 100X power. Anything smaller than .0625 mm was recorded as clay "matrix." All other minerals were recorded based on these size categories: very fine sand (.0625-.125 mm), fine sand (.125-.25 mm), medium sand (.25-.50 mm), coarse sand (.50-1.0 mm), very coarse sand (1.0-2.0 mm), granule (2.0-4.0 mm), and pebble (4.0-64.0 mm). Once these data were recorded, a temper size index and quartz-sand size index were computed. (See Stoltman, 1991, p. 108-109 for this formula.) Finally, ternary diagrams comparing percent quartz sand, percent temper, and percent matrix were constructed for the sample of archaeological ceramics and experimental test-tiles. Pie charts were also constructed to compare the components of each clay source and the archaeological samples.

Results

One result of this initial research is that two of the clay sources that were chosen for the experimental test-tiles appear to be very similar while one clay source was very different from the other two. First of all, the average shrinkage of the Forest Hills Northern (FHN) and Spoonville clay sources was very similar and the Baldwin clay was much different (Table 1). The untempered FHN clay had a mean shrinkage of 0.7 cm while the tempered FHN clay had an average shrinkage of 0.64 cm. Similarly, the untempered Spoonville clay had an average shrinkage of 0.625 cm and the tempered test-tiles had an average shrinkage of 0.617 cm. On the other hand, the untempered Baldwin clay source had an average shrinkage of zero cm while the tempered Baldwin clay had a mean shrinkage of 0.2 cm.

Table 1. *Mean Shrinkage of Experimental Clay Sources*

	Baldwin Clay	Forest Hills Northern Clay	Spoonville Clay
Untempered Test-tiles	0 cm	0.7 cm	0.625 cm
Tempered Test-tiles	0.2 cm	0.64 cm	0.617 cm

Figure 2 illustrates attributes of the untempered and tempered Baldwin clay. It is important to notice the percent matrix and percent quartz for the Baldwin clay. For both the untempered and tempered clays, there was roughly 73-76% matrix, while the percent quartz ranged roughly from 17-18%. When compared to Figure 3 and Figure 4, it is obvious how different the Baldwin clay source is from the other two. The Forest Hills Northern and Spoonville clays have a much higher percentage of matrix and a much lower percentage of quartz. The untempered Forest Hills Northern and Spoonville clays have approximately 95-97% matrix while the tempered test-tiles have about 88-92% matrix. Furthermore, the percent quartz for the untempered and tempered Forest Hills Northern and Spoonville clays were only about one to four percent. It is important to remember that the Baldwin clay came from 20 feet below the ground in a pond excavation while the other two, more similar clays came from streambed contexts. This most likely accounts for the differences between the Baldwin clay and the Forest Hills Northern and Spoonville clays. It should also be noted that the Forest Hills Northern and Spoonville clays seemed to fire better than the Baldwin clay.

Figure 2. *Baldwin Clay Attributes*

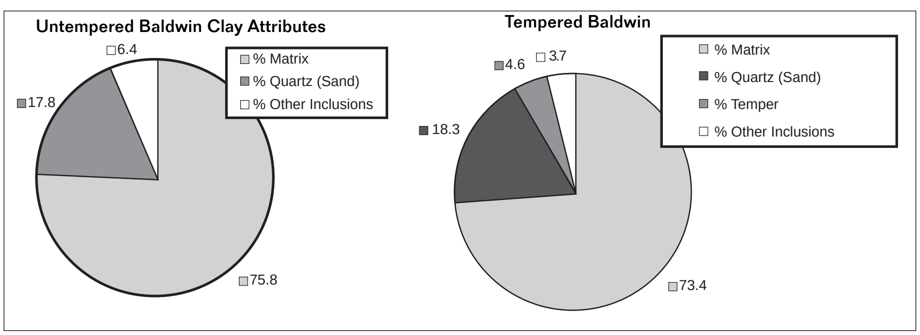


Figure 3. *Forest Hills Northern Clay Attributes*

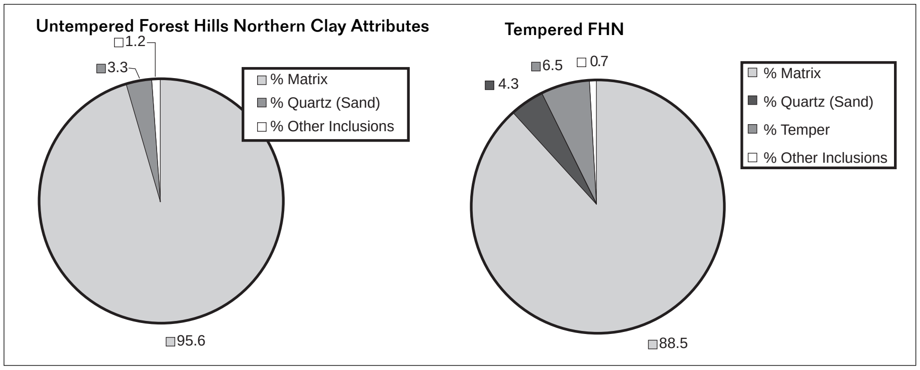


Figure 4. *Spoonville Clay Attributes*

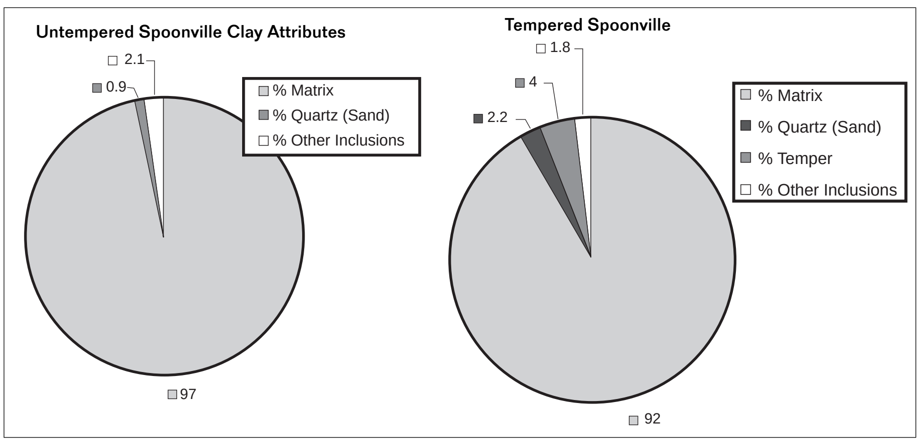
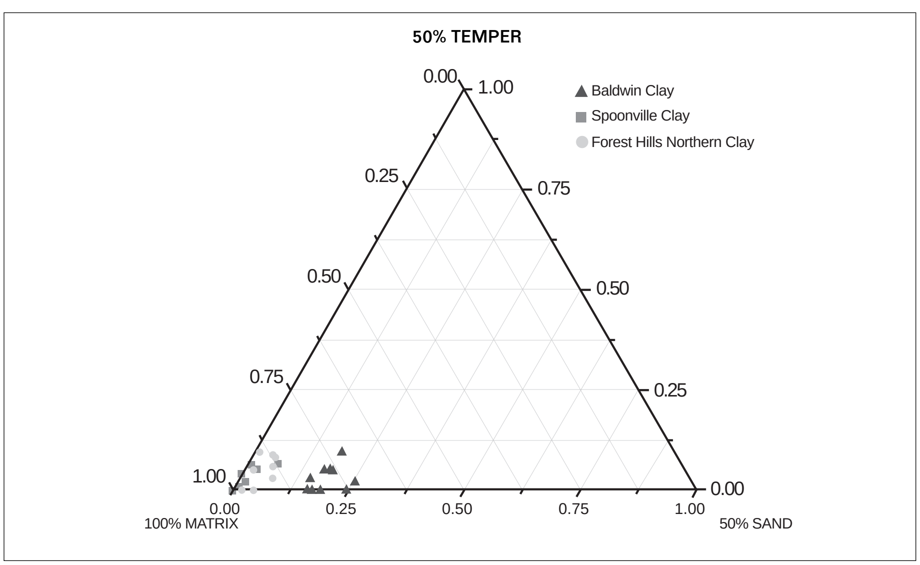


Figure 5. *Ternary Diagram of Clay/Raw Material Attributes*



Once the attributes of the clay sources were investigated, they were compared to archaeological samples from the sites in western Michigan by using ternary diagrams. Figure 5 demonstrates the previously mentioned differences between the Baldwin clay and the Forest Hills Northern and Spoonville clays. Once again, the similarities between the Forest Hills Northern and Spoonville clays are demonstrated by the overlapping of the points. The points representing Baldwin clay are clearly separate from the other two.

Figure 6 displays the same data as Figure 5 but the archaeological samples are added according to the site where they were found. Interestingly, the samples from the Spoonville site did not match the grouping from the Spoonville clay source. There is no apparent patterning according to site location. All samples are mostly well scattered. The Prison Farm samples are the most closely patterned but even these have a couple outliers. However, it appears that most of the points from the archaeological sites occur between the 75-87.5% matrix, 0-12.5% quartz sand, and the 10.5-24% temper ranges.

Figure 7 reveals the archaeological sample attributes based on types. Some of the types used, such as Norton Ware, Hopewell Ware, and the *Other* category, were introduced by Kingsley (1990). To gear the types more toward this research, Early Woodland (EW), Early Late Woodland, Hacklander, and Sister Creeks Ware were added. In this graph, instead of plotting all test-tiles being plotted, only tempered test-tiles were averaged and plotted because all archaeological samples, except one, were tempered. One interesting point is that two of the Early Woodland sherds lay as outliers with more percent quartz sand, which makes sense according to the hypothesis that the percent quartz sand would decrease as time went on. However, there are three Early Woodland sherds that lie within the major grouping, which are mostly Middle Woodland sherds. Additionally, the Early Late Woodland sherds pattern nicely together but even these group with a number of the Middle Woodland sherds. Lastly, it is interesting to note that the plotted point labeled *Other* is a limestone-tempered sherd, which was probably imported from Illinois. Limestone-tempered pottery is representative of classic Hopewell Ware that has been imported from Illinois (Kingsley, 1990), but limestone temper also occurs in Hopewell series ceramics from Ohio (Prufer, 1968).

When comparing the test-tile attributes to the archaeological sample, Figures 8-11 illustrate the differences and similarities. Interestingly, when compared to Figures 2-4 of the clay sources, the archaeological samples all have a much higher percentage of temper. For example, the Norton Mounds, Converse Mounds, and Spoonville sites all have about 11% temper while the Prison Farm sample has about 13%. Also, they all have a higher percentage of quartz sand. The lowest percent of quartz sand (4.8%) is from the Prison Farm sample. Spoonville site has 9.2%; Converse Mounds has 13.9%; and Norton Mounds has 15.3% quartz sand. These are all higher percent quartz than the clay sources have. The higher percentages of quartz in the archaeological samples can be attributed to predominance of granitic rock use as temper based on the mineralogical observations. Furthermore, when first analyzing these data, it can be easy to make a mistake and say that because of the percent matrix of between 70 and 79, the archaeological samples are most like the Baldwin clay. However, when examined more closely, one realizes that the much higher percentages of temper account for the lower percentages of matrix and the higher percentages of quartz. As was the case for the experimental clay sources, the more temper that was added, the more it added to the percent quartz. Thus, if the percent temper is subtracted from these pie charts, the percent matrix, quartz,

Figure 6. *Ternary Diagram of a Comparison between Clay Source Attributes and Archaeological Sample Attributes by Site*

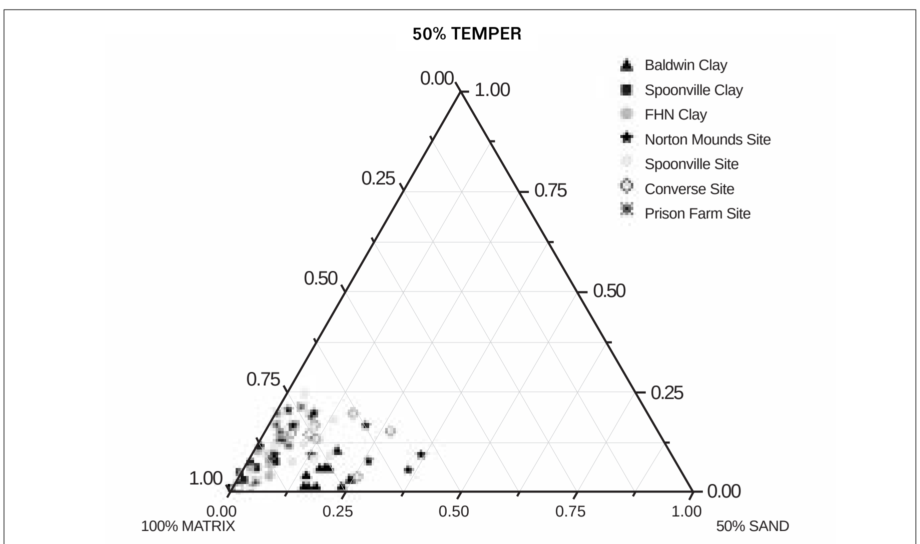


Figure 7. *Ternary Diagram of Archaeological Sample Attributes by Type*

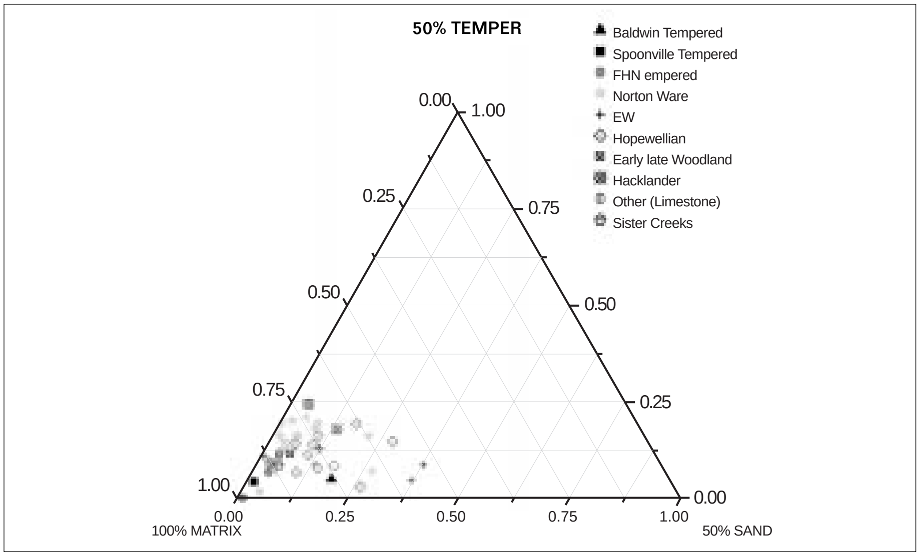


Figure 8. *Compositional Attributes of Norton Mounds Site Ceramics (Note: Includes both Early and Middle Woodland data).*

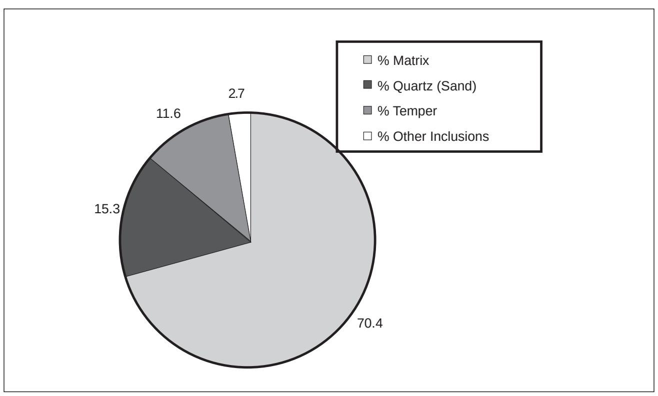


Figure 9. *Compositional Attributes of Converse Mounds Site Ceramics (Note: Includes both Early and Middle Woodland data).*

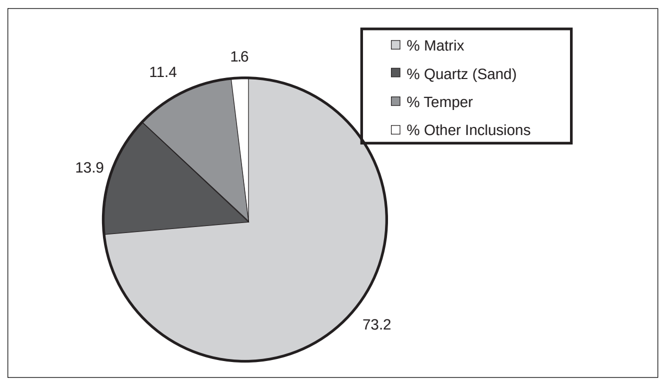


Figure 10. *Compositional Attributes of Prison Farm Site Ceramics (Note: Includes both Early and Middle Woodland data).*

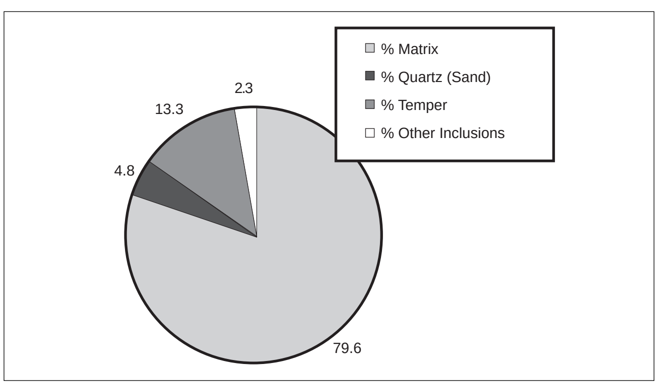
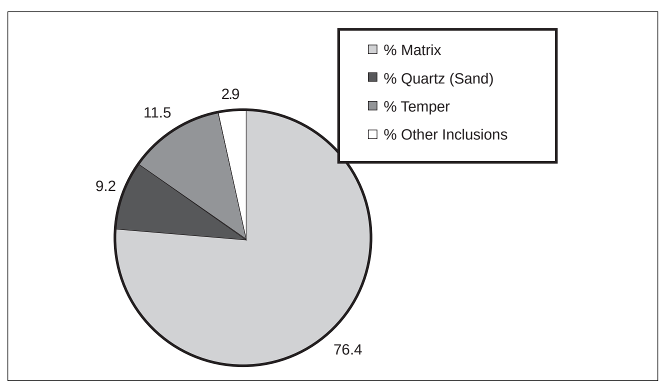


Figure 11. *Compositional Attributes of Spoonville Site Ceramics (Note: Includes both Early and Middle Woodland data).*



and temper would be approximately the same as the Forest Hills Northern and Spoonville clay sources.

Figure 12 provides support for the hypothesis that the percent quartz in pottery would decrease over time because potters would eventually learn that too much quartz is not desirable for firing because “Quartz… is not an optimal inclusion type for cooking pots; it expands much more quickly than clay and can lead to crack initiation” (Chilton, 1998, p. 149). The sample of eight Early Woodland sherds consisted of 14.5% quartz while the Middle Woodland sample of twenty-nine had a lower percentage of about 9.96% quartz. Meanwhile, quartz in the Late Woodland sample, though only based on two samples, decreased even more to about 5.05%. Thus, the petrographic analysis of these archaeological samples supports the hypothesis that potters may have reduced the percent quartz over time by selecting sources with less quartz and tempering with rock that has less quartz in it.

The other hypothesis that was tested was that temper size would decline over time due to potters learning how to use smaller pieces of temper in their pottery because larger pieces can lead to cracks. Figure 13 supports this hypothesis. While the sample of eight Early Woodland sherds had a temper size index of 3.954, the twenty-nine Middle Woodland sherds averaged a lower temper size index of 3.622. Meanwhile, the surprisingly high 3.797 temper size index of the Late Woodland sample may be attributed to the low sample size. It can be expected that with a larger sample size, this number would decrease, probably to a lower number than the Middle Woodland index.

Discussion

The first objective of this research was to describe the local clays and tempers so that they could be compared to archaeological samples. First of all, the average shrinkage of the Baldwin clay was much different from the similar Forest Hills Northern and Spoonville clays. It seems clear that the Baldwin clay source was much different from the Forest Hills Northern and Spoonville clays, which both had a much higher percentage of matrix and a much lower percentage of quartz. When comparing the clay sources to the archaeological samples, it was evident that the percent matrix, quartz, and temper of the archaeological samples were most similar to the Forest Hills Northern and Spoonville clay sources, rather than the Baldwin clay.

Previous research has suggested that there are significant technological differences between Early, Middle, and Late Woodland ceramics in Michigan. While most of the previous research has focused mostly on qualitative, stylistic changes between Early, Middle, and Late Woodland ceramics, this research has focused on technological data. This study examined a portion of the production process of ceramics during the Woodland period in Michigan, focusing on two key technological choices of potters (temper choice and clay composition). It appears that there are, in fact, significant differences in ceramic technology through time. Two hypotheses were tested.

The first one had to do with the assumption that potters would eventually select clays that would have a lower percentage of quartz and there would be a declining percentage of quartz in clays selected for pottery manufacture over time. This would be due to the fact that quartz is not the most favorable inclusion type because it can lead to cracks. The results of this study supported this hypothesis. The sample of Early Woodland sherds consisted of 14.5% quartz while the Middle Woodland sample had a lower percentage of about 9.959% quartz, and the Late Woodland sample decreased even more to about 5.05% quartz.

Another hypothesis that was tested was that temper size would decline over time because larger temper sizes are undesirable for firing and potters would learn to use smaller pieces of temper in their pottery. This study’s results supported this hypothesis as well. The Early Woodland sherds had a temper size index of 3.954, while the Middle Woodland sherds averaged a lower temper size index of 3.622. However, the surprisingly high 3.797 temper size index of the Late Woodland sample can be attributed to the low sample size of two. Once again, it can be anticipated that with a larger sample size, this number will decrease to a lower number than the Middle Woodland index.

This study included six, raw material sources (three clays and three tempers) and thirty-nine archaeological samples. A larger archaeological sample size from other sites in western Michigan needs to be included, especially a larger Early and Late Woodland sample, to more fully describe with confidence the production processes. Furthermore, due to limitations of time, this paper does not address issues such as firing conditions, construction techniques, and use and discard attributes of the ceramics described. More clay sources need to be studied to better understand the production process by comparing these to a sample of archaeological specimens. Higher level statistical analyses (Principle Component and Cluster Analyses) currently being explored should provide information on which samples are most similar to each other. However, the preliminary results suggest that additional samples and variables need to be considered. This project initiates a much larger study and advances our understanding of the technological choices of potters and production processes during the Woodland period in western Michigan.

Figure 12. *Bar Chart of Average Percent Quartz of Woodland Periods*

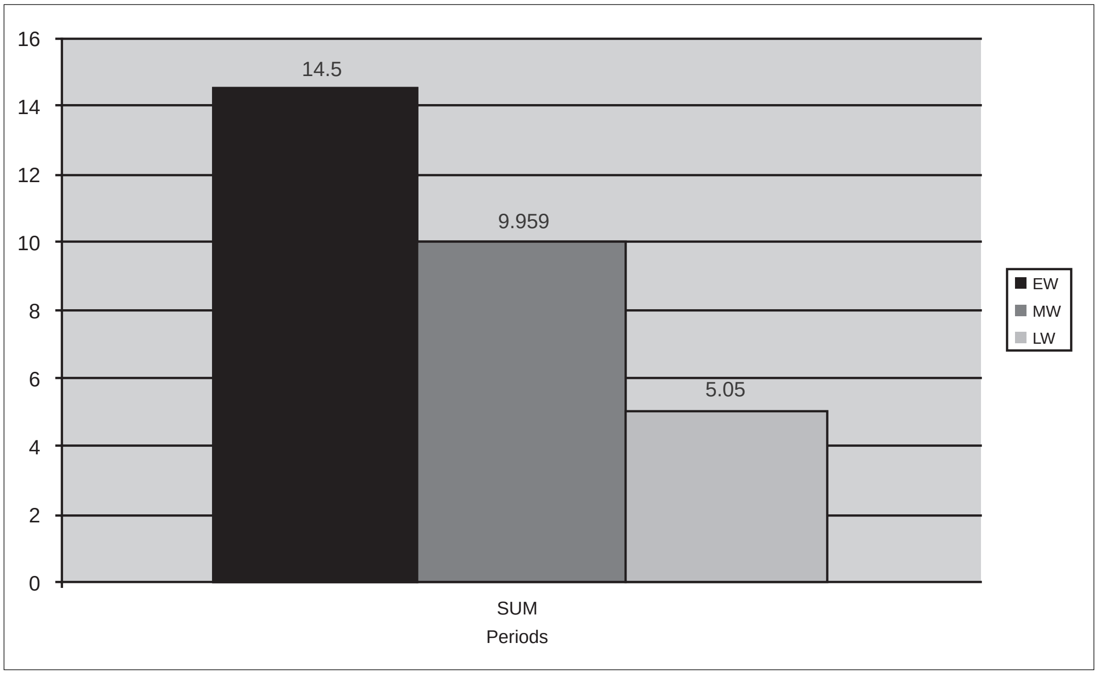
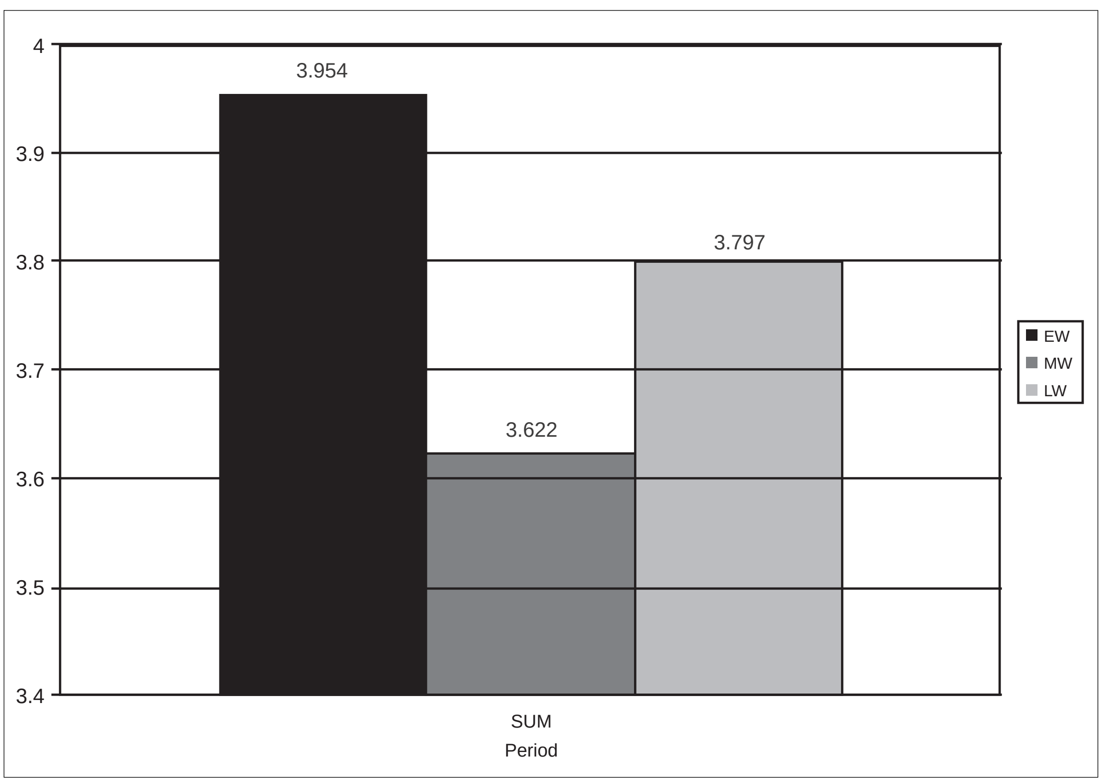


Figure 13. *Bar Chart of Temper Size over Time*



Acknowledgments
This research project required the assistance of many different people and sources. I would like to thank the Grand Valley State University Ronald E. McNair Scholars Program for funding this research. I would like to thank my mentor, Janet G. Brashler, Ph.D., for helping me this summer and for being my McNair mentor during the previous two summers. Also, Melissa Morison, Ph.D. of the Grand Valley State University Classics Department provided critical training in ceramic petrography; Soon Hong, Ph.D. of the Grand Valley State University Statistics Department helped to compute the initial principle component and cluster analyses; Steve Mattox, Ph.D. and Greg Wilson, Ph.D. of the Grand Valley State University Geology Department identified the rocks that we would eventually use as temper in the experimental test-tiles, and Daleene Menning, M.F.A of the Grand Valley State University ceramic studio assisted in the firing of our test-tiles.

References

Brashler, J. G. (1991). *Excavations at the Spoonville site: A new look at old data*. Paper presented at the Midwest Archaeological Conference, La Crosse, WI.

Brashler, J. G., & Morison, M. (2002). *Examination of ceramics using petrography in the Grand River Valley*. Presentation to the Wright L. Coffinberry Chapter, Michigan Archaeological Society.

Brashler, J. G., Matthew R., Laidler, M. R., & Martin, T. J. (1998). The Prison Farm site (20IA58): A Woodland occupation in the Grand River basin of Michigan. *Midcontinental Journal of Archaeology*, 23(2).

Chilton, E. S. (1998). The cultural origins of technical choice: Unraveling Algonquian and Iroquoian ceramic traditions in the northeast. In M. T. Stark (Ed.) *The Archaeology of Social Boundaries*. Washington, D.C. and London, England: Smithsonian Institution.

Chilton, E. S. (Ed.) (1999). *Material Meanings: Critical Approaches to the Interpretation of Material Culture*, Salt Lake City: University of Utah.

Druc, I. C., and Velde, B. (1999). *Archaeological ceramic materials: Origin and utilization*. Berlin Heidelberg: Springer-Verlag.

Fitting, J. E. (1975). *The archaeology of Michigan: A guide to the prehistory of the Great Lakes Region* (2nd ed.). (Bulletin No. 56). Bloomfield Hills, MI: Cranbrook Institute of Science.

Garland, E. B., & Beld, S. G. (1999). The early woodland: Ceramics, domesticated plants, and burial mounds foretell the shape of the future. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. Bloomfield Hills, MI: Cranbrook Institute of Science.

Holman, M. B., & Brashler, J. G. (1999). Economics, material culture, and trade in the late woodland lower peninsula of Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. Bloomfield Hills, MI: Cranbrook Institute of Science.

Kingsley, R. G. (1990). Rethinking Hopewell ceramic typology in Michigan. *The Michigan Archaeologist*, 36(3-4).

Kingsley, R. G. (1999). The middle woodland: A golden age of mound builders and fisherman. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. Bloomfield Hills, MI: Cranbrook Institute of Science.

Prufer, O. H. (1968). *Ohio Hopewell ceramics: An analysis of the extant collections*. (Anthropological Papers No. 33). Ann Arbor, MI: University of Michigan, Museum of Museum of Anthropology.

Rice, P. M. (1987). *Pottery analysis: A sourcebook*. Chicago: University of Chicago.

Shepard, A. O. (1956). *Ceramics for the archaeologist*. (Publication 609). Washington, D.C.: Carnegie Institution of Washington.

Stoltman, J. B. (1989). A quantitative approach to the petrographic analysis of ceramic thin sections. *American Antiquity*, 54(1).

Stoltman, J. B. (1991). Ceramic petrography as a technique for documenting cultural interaction: An example from the Upper Mississippi Valley. *American Antiquity*, 56(1).

Zurel, R. L. (1999). Earthwork enclosure sites in Michigan. In *Retrieving Michigan's buried past: The archaeology of the Great Lakes state*. Bloomfield Hills, MI: Cranbrook Institute of Science.

Zurel, R. L. (1999). Michigan's rock art. In *Retrieving Michigan's buried past: The archaeology of the Great Lakes state*. Bloomfield Hills, MI: Cranbrook Institute of Science.