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Effigy Mounds, Social Identity, and Ceramic Technology: Decorative Style, Clay Composition, and Petrography of Wisconsin Late Woodland Vessels

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EFFIGY MOUNDS, SOCIAL IDENTITY, AND CERAMIC TECHNOLOGY: DECORATIVE STYLE, CLAY COMPOSITION, AND PETROGRAPHY OF WISCONSIN LATE WOODLAND VESSELS

by

Jody A. Clauter

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ABSTRACT

EFFIGY MOUNDS, SOCIAL IDENTITY, AND CERAMIC TECHNOLOGY: DECORATIVE STYLE, CLAY COMPOSITION, AND PETROGRAPHY OF WISCONSIN LATE WOODLAND CERAMIC VESSELS

by

Jody A. Clauter

The University of Wisconsin-Milwaukee, 2012
Under the Supervision of Professor Robert J. Jeske

This ceramic analysis is focused on a combination of technical and decorative analyses involving energy dispersive X-ray fluorescence (EDXRF) and petrographic data unused by or unavailable to previous researchers. The ceramics used in this study are non-collared forms of Late Woodland (AD 700 - 1200) types found across southern Wisconsin. Ceramic attributes from these data sets are analyzed using multi-variate statistical methods and the resulting clusters are plotted geographically. Results indicate regionalization of particular attributes with a major east-west trend noted in some cases. However, geographical plotting shows broad overlap among river valleys and locales. Importantly, EDXRF data demonstrates that ceramics or clays were transported across the landscape.

The results are used to assess three models commonly used to explain Late Woodland group spatial distribution and interaction: Monolithic, Low-level Territorial, and High-level Territorial. However, while it is argued the Low-level Territorial model best respresents the data, the ceramic attributes indicate that multiple types of social organizations were practiced over space and time during the Late Woodland and that multiple territorial models are necessary to fully understand the social interactions occurring during this period.

Finally, it is hypothesized that these results are best approached from a performance perspective where the social organization provides a contextual basis for investigating the daily performance of pottery making. Pottery manufacture is used to assess the constant making and re-making of social relationships at multiple levels of interaction in an egalitarian setting. It is hypothesized that different suites of attributes reflect different levels of group membership and that potters are consciously selecting attributes to negotiate these nested relationships through the practice of pottery construction.

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Chapter 1: Introduction

The dissertation is focused upon issues of social organization, territoriality, and population movement during the Late Woodland Period (ca. AD 700-1200) of southern Wisconsin. Decorative and compositional data from non-collared Late Woodland ceramics, often referred to as Madison Ware, found at effigy mound and non-effigy mound sites are used to examine and interpret stylistic attribute and compositional variation in pottery. These data are used to assess the relationship between ceramic technology and human social networks with nested levels of affiliations.

The main goals of this research are: 1) examine stylistic attribute and compositional variation to assess the relationship between ceramic production, use, and discard with human social networks and population mobility, and; 2) use the attribute data to assess three different models of Late Woodland social organization and integration of the people who built and used effigy mounds. The three hypothetical models reflect varying levels of social integration, territoriality, population movement, and group interaction. They are based on commonly used explanations of Late Woodland group spatial distribution and interaction offered by other researchers (Goldstein 1995; Hall 1993; Hurley 1975; Kaufmann 2005; Mallam 1976; McKern 1930; McKern and Ritzenthaler 1949; Rowe 1956; Scherz 1991; Storck 1972). These are categorized as Monolithic, Low-level Territorial, or High-level Territorial in this project.

A monolithic system has fully integrated populations with high levels of social cohesion and group interaction resulting in a homogenous material culture of very similar methods of ceramic manufacture with little attribute clustering (c.f.. McKern and Ritzenthaler 1949; Rowe 1956). A Low-level Territorial model illustrates groups moving within a regional territory, but with fluid group membership and high levels of periodic group coalescence and interaction (Kaufmann 2005; Storck 1972). Attributes should be found in clusters representing large geographic areas as contact facilitates the spread of people and ideas (see Braun and Plog 1982). The High-level Territorial model assumes a narrow geographic population range with restricted interaction and little interregional cohesiveness (see Goldstein 1995; Mallam 1976). It produces heterogeneity between many small regions, but homogeneity within those regions due to increased social isolation and pottery production largely for the local community.

A combination of ceramic decorative and compositional analyses, including newly obtained petrographic data and energy dispersive X-ray fluorescence (EDXRF), are used to address the problems of Late Woodland spatial interaction and territoriality tackled in this dissertation. Also, these data are employed to help assess the three models of Late Woodland social organization. Ceramic attribute distribution should display different types of patterning depending on the type of social organization practiced. In a Monolithic model, ceramics should be equally distributed across the study area. In a High-level Territorial situation, attributes will be highly heterogeneous among regions, but more homogeneous within a region. A Low-level social organization will result in some homogeneity, but also some heterogeneity between vessels.

These data were examined using a suite of statistical tests including Fisher tests with Monte Carlo simulated p-values, Cluster analyses, and Mantel tests. Results from all data sets indicate regional variation in Late Woodland ceramics, but also some broad, overarching qualities similar across the sample universe. The EDXRF and decoration zone clusters are statistically significant in Mantel tests, but geographic plotting of the clusters shows overlap. Importantly, the EDXRF results demonstrate that pots or clays were transported across the landscape. The petrographic data show less geographic clustering than the other data sets, but temper choice indicates regional preference.

The Low-level Territorial model fits these results better than the other two, but seems most probable that people in different geographic areas used multiple social organizations at different times through the Late Woodland. The western portion of the study area appears to have a more structured social organization based in a smaller geographic area. The focus in this region may have been geared toward distinction within the effigy mound area and between more southerly neighbors. In contrast, eastern and central Wisconsin ceramic attribute distributions indicate a broader and more open social organization where importance was placed on reifying connections and alliances among multiple groups. For these reasons, it is not tenable to consider the people living during the Late Woodland Period in Wisconsin as undistinguished, static, or isolated. Multiple models of social organization are needed to understand the complex interactions occurring in the Wisconsin Late Woodland.

The Late Woodland ceramic data are interpreted through a performance agency theory (see Beeman 1986; Budden and Soafer 2009; Looper 2009; Parker Pearson 1998; Varela and Harré 1996). As with the social organizational model, these types of affiliations are examined by using the geographical distribution of ceramic attributes as proxy measures for social interaction. The variation and co-variation of attributes can demonstrate how potters were performing to shape and restructure their involvement in a larger system at nested levels. In this manner, pottery manufacture and the distribution of attributes do not just simply signal group membership, but are active ways in which people negotiated their place in a layered social structure.

It is hypothesized that performances aimed at the different levels of affiliation present in egalitarian, hunter-gatherer societies, like family, band, or region, will produce different types of ceramic attribute distributions across the landscape. Performances geared toward expressing commonality will result in many attributes being similar across an area, or in having many attributes shared between areas. In comparison, attributes that are tightly clustered in a small area, or attributes that are not shared outside that region, may demonstrate performances where the focus is on boundary maintenance and delineating one group from another. Importantly, it is argued that potters used the same vessel in a performance that enacted both a shared identity and social distinction.

An application of performance theory and its expectations of ceramic attribute distributions to the decoration, EDXRF, and petrographic data show that potters were acting to strengthen their alliances in the hunter-gatherer social system at multiple levels of family, band, or regional affiliations. Vessel construction was a means to delimit and reinterpret membership within and between groups. Specifically, certain ceramic attributes, like decoration, show much more regional boundedness compared to petrographic ceramic recipe attributes like Body and Paste composition which are similar across the entire study area. Potters used different ceramic attributes to strengthen and/or disassociate themselves within the nested social organizational levels and between the multiple groups present during this time period.

Also, the data indicate different levels of involvement in the Late Woodland social organizational by different groups. Western regions tend to be more focused on distinguishing themselves from other portions of the study area by their limited use of decoration techniques and tightly bound EDXRF clusters. They are linked to the larger study area by their use of similar Body and Paste compositions, but their possible links with more western and southern groups causes the higher degree of segregation as they seek to distinguish themselves from these external groups. In contrast, the eastern groups exhibit a greater degree of attribute sharing and may indicate an emphasis on group participation within a larger whole.

Other researchers studying different types of material culture in later portions of the Late Woodland and the Emergent Oneota have noted the east-west divisions (Egan-Bruhy 2012; Green 1997; Kelly 2002; Richards 1992; Overstreet 1997; Stoltman and Christiansen 2000).   It is possible the roots of these divisions are found during the early portions of the Late Woodland period and are visible through the distribution of ceramic attributes. Therefore, an understanding of this time in the prehistory of Wisconsin can put it into a proper historical context (Pauketat 2001).

Previous Research

Type-Variety Analysis

It is important to discuss why this dissertation focuses on the variation in ceramic attributes and not on type-variety distributions. For this reason, a discussion of the history and critiques of the type-variety method is necessary. Also, the problems of application of this method to ceramics from the Late Woodland Period in Wisconsin, particularly Madison Ware, are evaluated.

Wares, Types, and Varieties

The type-variety system is a taxonomic scheme with ordered and hierarchical stages of inclusivity (Dunnell 1971a). Its nomenclature was developed to facilitate communication and comparison between researchers at different Southwestern United States sites, and therefore carried connotations of chronology building (Phillips 1958; Wheat et al. 1958). Types are a recognizably distinct cluster of attributes with restricted time ranges and geographical boundaries (Rice 1985:276; Wheat et al. 1958:34). As such, they are derived concepts and not actual potsherds (Dunnell 1971b:117). Types are defined by many attributes, including "a specific and cohesive combination of features of paste, temper, texture, hardness, finish, vessel shape, technique and arrangement of decoration, use of appendages, etc." (Krieger 1944:277). However, Sinopoli (1991:53) states, vessel "shape, production technique, and morphology are not considered in type-variety definitions" (Sinopoli 1991:53). Types are presented in binary terms. First, the region of occurrence, then a characteristic attribute of decoration or surface treatment (Sinopoli 1991).

Varieties, the smallest unit, are minor variations within types and usually distinguished by a single item. Types can have an infinite number of varieties, but these have only minor regional, temporal, stylistic or technological departure from types (Sinopoli 1991; Wheat et al. 1958:35). A type and the encompassed varieties form the type-cluster and have the same areal and temporal range as its combined components.

The type-cluster is often thought of as representative of a region with similar ceramics (Sinopoli 1991). Type-clusters are grouped into ceramic systems, or groups related via design style, surface treatment, vessel form or general technology, and were considered characteristic of a culture in a shallow time period in a particular area (Wheat et al. 1958:39-41). A ceramic system expressed little evolution among type-clusters, but the ceramic sequence showed such development of types with similar decorative styles or other attributes (Wheat et al. 1958:42) (Figure 1).

Phillips (1958) disagreed with the ranking or dependence of variety on types, and modified his terminology when he applied the taxonomy to the eastern United States (Figure 2). He also argued that most eastern archaeologists treat types more like clusters whose varieties “are often referred to but seldom defined as such” (Phillips 1958:118).

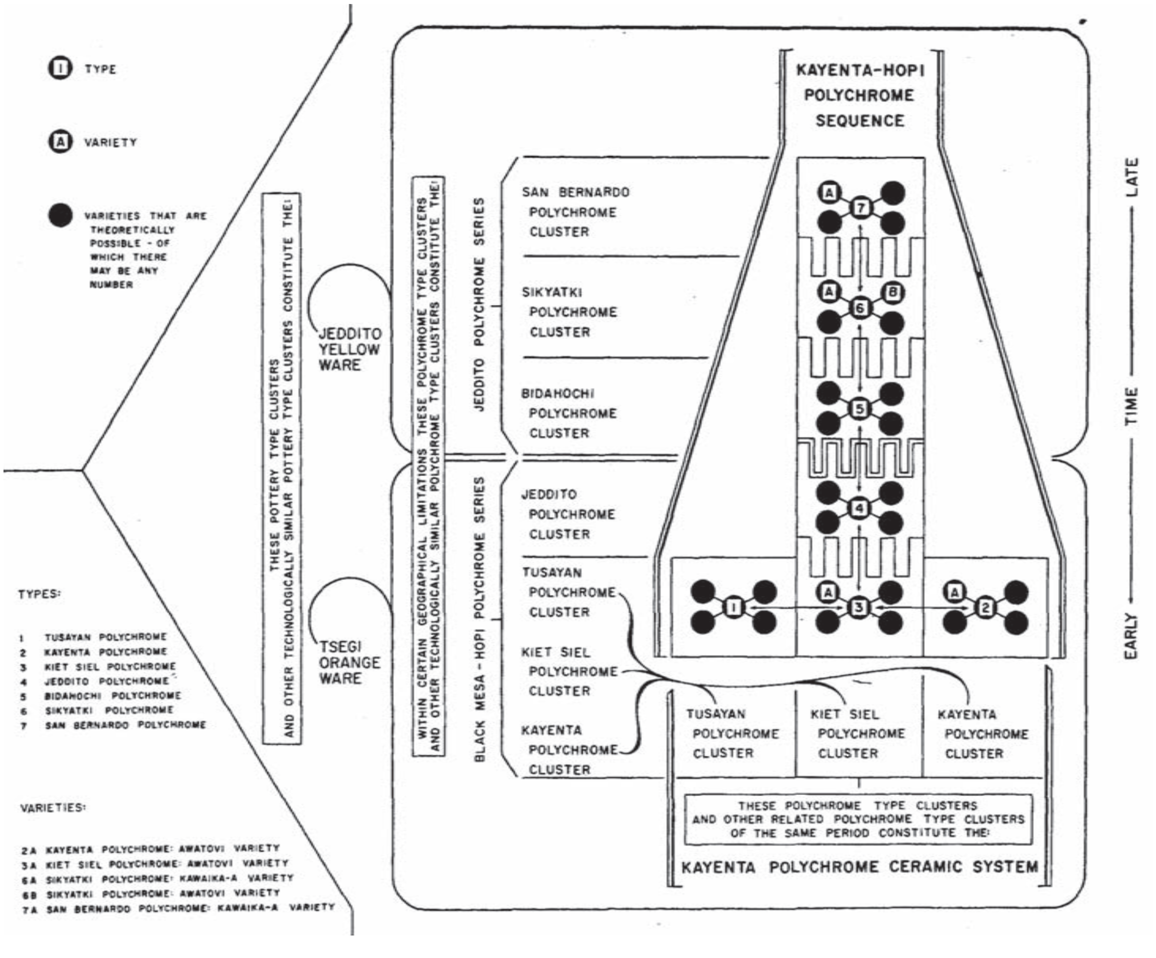

Figure 1: Wheat et al. (1958) ceramic relationship summary.

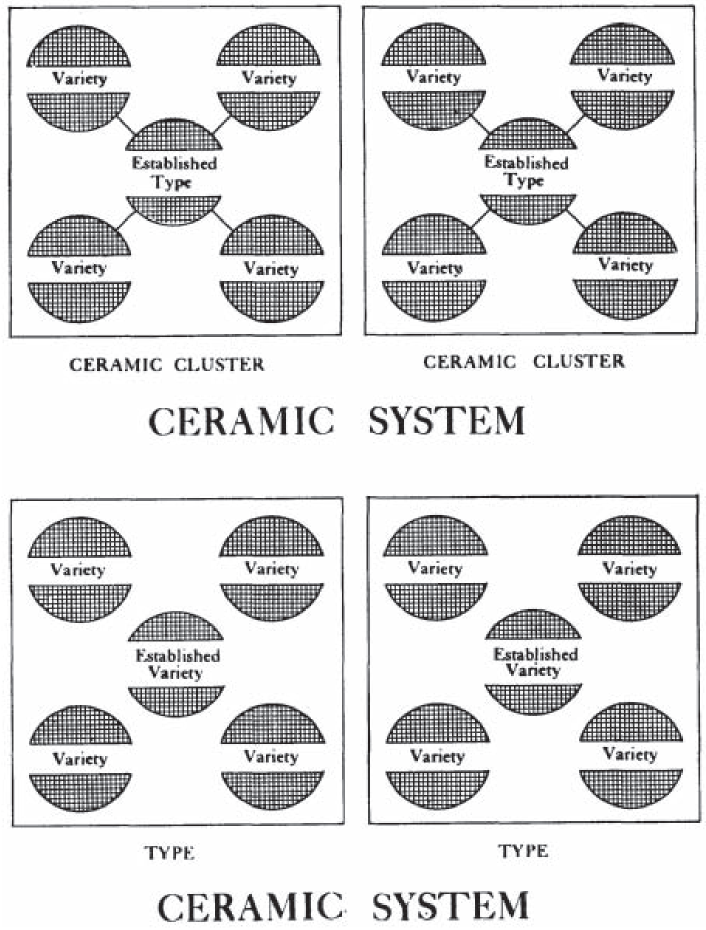

Figure 2: Comparing Wheat et al. (1958) (top) and Phillips (1958) ceramic system (bottom).

His emphasis on types also stemmed from the fragmentary assemblages found in the East, as opposed to whole vessels in the Southwest. Broken sherds can be classed as types, but not varieties due to incomplete information. Eastern archaeologists had to work with types to have enough data for statistical analysis (Phillips 1958:124).

Wares are separate from and cut across type-clusters and ceramic sequences. A ware is a "large group of pottery types which has little temporal or spatial implication but consists of stylistically varied types that are similar technologically and in method of manufacture" (Wheat et al. 1958:34-35). Wares have been identified on many attributes including function, decoration, construction, form, firing technology and geography (Rice 1985:287). However, wares are traditionally grouped by paste composition and surface treatment. The category was developed to incorporate more technological data into the typological scheme, and as a broader definition that exists at a higher order than types (Rice 1976:538; 1985). While not strictly limited in time like types and varieties, most are period sensitive in practice (Rice 1976:541). As their defining criteria relate to aspects of manufacturing technology or composition, wares are the most likely category to reflect materials selection, production organization, construction techniques, intersite comparability or trade (Rice 1987).

Critiques of Ware, Type, and Variety Concepts

As originally conceived, types were a method of mechanical and decorative manufacture that represented a pattern in the prehistoric mind (Krieger 1944:278). The similarities were presumed to represent shared ideas, normative concepts of form, decoration and production technique (Sinopoli 1991). However, the idea of discovering a prehistoric worldview from types is rightfully challenged (see Ford 1954; Spaulding 1953). Types are derived from data and they may or may not represent the manufacturer's thinking or even a cultural relationship. As clusters of attributes, types are amenable to statistical study, but not necessarily clusters of objects in a category recognizable by prehistoric makers (see Rice 1987).

Additionally, Rice (1976) demonstrated two main problems with the ware category application. First, paste is not a singular attribute but is composed of many composite variables including temper type and quantity, texture, hardness, thickness, core color or porosity. Secondly, surface treatment and paste composition are not comparable because they are technologically independent. Paste may be environmentally determined as cultures operate within ecosystem constraints, but surface treatment is less so. Furthermore, paste composition may affect surface treatment. Therefore, they operate within two different spheres and cannot be used together in a level of ceramic organization (Rice 1976:539).

Rice (1976:541) suggests ware definitions be restricted to surface treatment attributes and paste limited to modal analysis. However, paste analysis as its own research tool has vast potential for understanding manufacturing techniques and ceramic production (see Rice 1985; Stoltman 1990) and probably should be treated as a separate means of investigation beyond type-variety classifications.

Types are non-random clusters of equally weighted attributes (Krieger 1944), but researchers often apply attributes hierarchically in type creation though it is not acknowledged (Rice 1985:276; Sinopoli 1991). Also, ceramicists split on minuscule or large differences without clarity (Phillips 1958:124). Secondly, the system depends on an individual's assessment of the definition, description, and number of types and varieties (Phillips 1958:122; Wheat et al. 1958:38). Many types are ill-defined, leading to uncertainties of sorting and deciding when variation is too pervasive. Types are often not secondarily assessed, and therefore not verified through vigorous research after initial publication. The selected attributes must combine consistently at multiple sites to be deemed types, and further tested against the archaeological record and new information (Krieger 1944). It follows that types cannot be defined from one site, but are provisional until explicitly reviewed.

Critiques of the type-variety system are pervasive, but often overly alarmist and important information is gleaned from taxonomies regardless of whether our types or varieties are actually conscious decisions of pot makers. Taxonomic systems create types as an organizational tool for the archaeologist (Dunnell 1971b:118, 1971b). Archaeologists must merely remember that the act of placing sherds into categories does not produce solutions of geographic, temporal, and consistent association, nor will long lists of attributes elicit statistically meaningful results and encompass the total variety observed (Phillips 1958). It is only important that attributes chosen for analysis are relevant to the questions being asked and whether they are appropriate to a specific level of analysis (Rice 1985). Categories help to organize material culture data into a workable system and therefore still useful tools for archaeologists. The type-variety system is a stepping-stone for future processual questions.

Critiques of Madison Ware & Its Type-Varieties

There are problems with previous Late Woodland studies and their use of ceramics given the type-variety critiques. Most research into Late Woodland Wisconsin ceramics are largely based on typological, type-variety, vessel descriptions, or comparisons of the numbers and proportions of Madison Ware types found at a site, with a relatively few recent studies based on specific theoretical or methodological foundations (c.f., Kelly 2002; Keslin 1958; Richards 1992; Rosebrough 2010; Salkin 1989, 1993; Wittry 1959). In addition, some early studies focused solely on using variations in types in order to define new types, without also discussing what the distribution of types means about Late Woodland social structure (Hurley 1975).

There is growing consensus that wares, type varieties, and even phase designations are inappropriate units of analysis due to their tendency to subsume variation and expect homogeneity (Hart and Brumbach 2003; Rice 1987). The type-category approach provides virtually no information on how ceramics were used and what they represented to the people who used them during the Late Woodland, nor does it provide proxy interpretations of group membership, cohesion, or interaction (Brashler 1981; Chilton 1999a, 1999b).

The Madison Ware category is neither a true ware nor type-variety system (Figures 3 and 4). Rather, it has characteristics of both systems and many of the terms associated with either taxonomy are operationalized incorrectly. For instance, wares do not have type, but a type is characterized by a ware. However, most Wisconsin archaeologists treat Madison Ware as if it were made up of the types defined within the state (e.g. Hurley 1975; Keslin 1958; Wittry 1959). Furthermore, the description of what is Madison Ware by researchers has become overly broad and encompassing on both geographic and temporal scales (Benn 1980; Richards 1992). Eastern Wisconsin

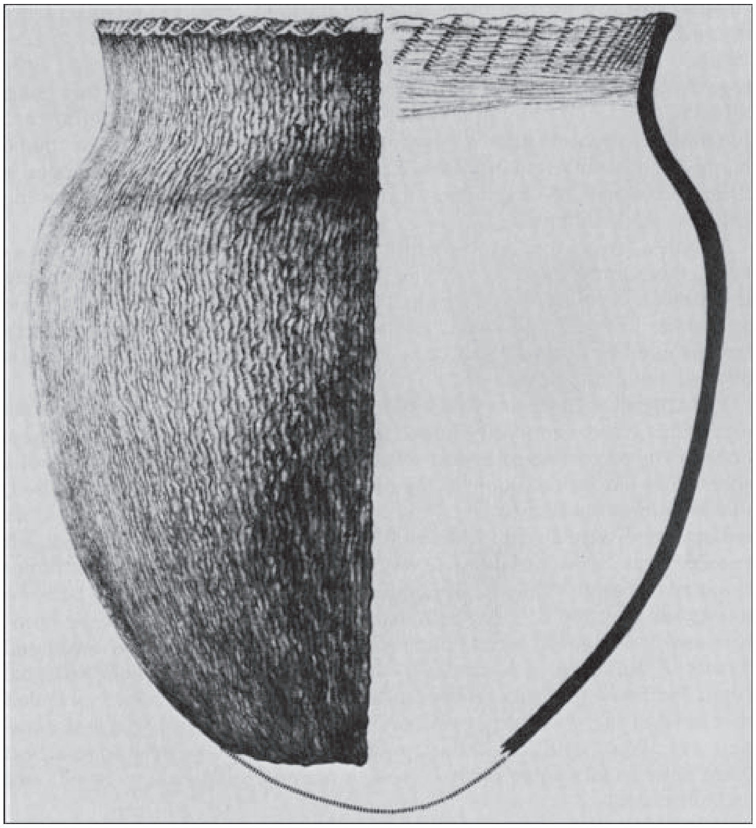

Figure 3: Typical Madison Ware vessel (from Hurley 1975).

Figure 4: Late Woodland vessel from an Unknown Site on the south shore of Fox Lake, Dodge Co., Wisconsin. Vessel SSFL/01 in this study.

Madison Ware vessels are noted to have different paste and temper from western Wisconsin examples, though both can be subsumed under the Madison Ware description (Richards 1992). The limited information from the few surviving complete vessels hinders an assessment of the Madison Ware category.

Likewise, the Madison Ware description makes it possible to classify vessels that may occur seven hundred years apart as the same ware. Possible changes in pottery attributes during the Late Woodland period, like a shift to higher rims, more elaborate cordage, S to Z cordage twists and a greater occurrence of collared varieties, are masked with such wide qualifications (see Benn 2000; Stoltman and Christiansen 2000). The lumping of Late Woodland ceramics into a single category forces Late Woodland sites themselves into inclusive categories as it hides attribute variation that could distinguish sites geographically and temporally.

Types are supposed to have restricted geographic and temporal spread (Wheat et al. 1958), yet most Madison Ware types have neither. The type-varieties are reported across the state and beyond the Mississippi River (Benn 1980; Logan 1959). Baerreis (1953:19) believed “the description of Effigy Mound Ware was too comprehensive to serve as the type description for the local variety,” and developed Madison Cord Impressed as a portion of the ceramic complex with a more restricted type name. It is ironic, then, that use of this Madison Ware type-category has itself become spread over the whole geographic range where effigy mounds are present. The very problem Baerreis sought to alleviate was repeated with his own category by later researchers.

Madison Ware types defy the binary typing rule for type-varieties (Sinopoli 1991). First, a type’s provenience can be geographically disparate. Also, the qualifying second descriptive is never related to surface treatment as all Madison Ware types are supposed to have cord roughening, and also may not be a characteristic decoration. Rather, the Madison Ware type qualifier may relate to morphology, e.g., Madison Folded Lip. However, this would be more apt to use for ware distinctions as wares relate to morphology and production techniques (Rice 1985). Paste characteristics, a ware trait, are generally not integrated into the type-variety system at the lowest levels (Rice 1976:540). However, Madison Ware types are as much defined by their paste as their decoration.

The Madison Ware types have never been fully authenticated as a coherent grouping of attributes. Types are often defined, like Madison Folded Lip (Hurley 1975), but then not subsequently tested by later researchers to see if the attributes used in the type co-vary at multiple sites. Rather, types are often created and a hypothesized integration or genetic relationship is presumed on superficial similarity or simple conjecture (Hall 1962; Hurley 1975; Keslin 1958). Little systematic analytical work has been conducted on the variation in Madison Ware leading it to being inconsistently defined and categorically oversimplified (Mason 1968:61).

Madison Ware and the type-variety system are taxonomically faulty. Their categories are useful for chronology building, but attribute analysis and multivariate statistical research has become the main research tool for those interested in processual analysis and questions of social interaction, information exchange, and settlement patterning (Redman 1978). It is the distribution of elements and their relative frequencies compared between sites that may be more important for sorting geographic, social or temporal variation than comparisons of type-varieties (Storck 1972:144-147).

In contrast to type-variety comparisons, a multi-variate, attribute based analyses is better suited to interpreting results based on questions of cultural affiliation, change, or population movement and distribution (Hurley 1976; Redman 1978; Rosebrough 2010; Storck 1972). By employing this methodology it is possible to look for patterning of individual attributes that may be masked when they are subsumed into general and normative artifact types. Also, artifacts rarely are composed of all the attributes that are expected in a type, nor do they express the total suite of possibilities (Redman 1978). Therefore, an attribute analysis lets archaeologists study sherds that may not fit into common type-variety categories, and does not assume a priori to what categories the artifacts should belong. Studies can then proceed based upon attribute variation and co-variation within particular proveniences, and not type-variety association. Therefore, this study does not seek to generate new typologies for Late Woodland ceramics. Rather, the variation and clustering of decorative and compositional attribute states across a geographic range is used to inform and answer the research problems.

Decoration, Morphologic, and Compositional Analyses

Other Late Woodland studies have approached issues of interaction and territoriality by studying ceramic decorative and morphological attribute distribution (Benn 1980; Hurley 1975, 1979; Keslin 1958; Logan 1976; Mason 1966; C. Mason 2004; Rosebrough 2008, 2010; Storck 1972). The spread of groups or interaction levels was presumed to be demonstrated based on spread of similarities in the ceramic decorative and morphologic attributes. Some researchers have also suggested that some Late Woodland ceramic types and styles are geographically or temporally confined (Kelly 2002; Salkin 2000; Stoltman and Christiansen 2000). Recent research by Rosebrough (2010) documented some geographic clustering of ceramic attributes in southern Wisconsin, but also some overlap. She explains this by postulating short distance territorial bands containing multiple sodalities that cross-cut geographic area and communities. Potters associated with one sodality at a site could move to another site causing the eventual spread of sodality membership and isochrestic style, or the low visibility attributes chosen from a pool of mutually appropriate possibilities. Emblemic style, or highly visible style asserting identity, would stay localized (see Rosebrough 2010:188; Sackett 1982; Wiessner 1983).

However, these prior research studies into Late Woodland social organization have been hampered by the lack of data to differentiate between the physical movements of ceramic vessels versus the idea of ceramic styles. The inability to make this distinction in the three Late Woodland social organization models leaves interpretations of population networking and movement incomplete. Since many analyses focus on decoration alone, they are missing the deeper understanding of vessel or clay sourcing and movement. A statistical comparison of particular decorative elements or motifs across a geographic landscape is ambiguous without the means to tell how frequently or geographically broad the social interaction was to produce those decorative differences or similarities.

To combat this problem, techniques such as EDXRF and petrography can provide the data necessary to make the distinction between the spread of style and the spread of ceramics themselves. In this project, the elemental and technical ceramic data complement a parallel decorative attribute analysis, and help to double-check conclusions between data sets used in this study and against previous researchers. The combined implementation of a decorative analysis with data from independent petrographic and EDXRF compositional analyses is the best way to use the ceramic attributes to verify or refute the claims in the three Late Woodland social organizational models about territoriality, social interaction, and group movement.

The use of independent testing with chemical data resolves issues of circularity when explaining ceramic style variation and spatial group interaction. The combined assessment of decorative and composition style garners an understanding of the social context of production, use and deposition, the significance of material culture as an active mechanism to produce, reproduce and negotiate, and the role of social factors influencing technical choices (Chilton 1999a, 1999b; Lechtman 1977; Skibo 1999; Stark 1999). Ceramic creation from the initial clay selection to final decoration application can be viewed as a style particular to a group and can indicate interactions between the producer and others (Hegmon 1995, 2003). Both decorative and technical style analyses are necessary for a full appreciation of the context of production (Dietler and Herbich 1998; Hegmon 1998). Furthermore, comprehending the production context is essential to interpreting Late Woodland ceramic production as an act of performance.

Study Contributions

The systematic exploration and reassessment of ceramic data relating to attributes, not type-categories, offers a more geographically sensitive account of Late Woodland ceramic variation and helps refine our understanding of pottery from this period. Madison Ware has become a catchall category for virtually all non-collared (and some collared) grit-tempered, cordmarked ceramics in the region. Variation and clustering of the composition and decoration attribute data across the geographic landscape provide insights into degrees of group territoriality and sociality not readily studied using comparison of type-variety frequencies. The geographic spread of variation and co-variation of ceramic attributes can represent social variation, group membership, and group relations (Brashler 1981; Whallon 1969, in Sinopoli 1991).

These attribute data results will be used to assess models of Late Woodland settlement patterning and social cohesion. Variation in material culture informs about group interaction and distribution by using them to test degrees of territoriality and population movement. Researchers generally agree that Wisconsin Late Woodland groups were hunter-gatherers, but have divergent opinions on the degree of social cohesion, interaction, and territoriality (c.f. Birmingham and Eisenberg 2000; Gartner 1999; Goldstein 1980, 1983, 1995; Hall 1993; Hurley 1975; Kaufmann 2005; Mallam 1976; Mason 2002; McKern 1930; McKern and Ritzenthaler 1949; Radin 1911; Rosebrough 2010; Rowe 1956; Salkin 1987, 2000; Stevenson et al. 1997; Stoltman and Christiansen 2000; Storck 1972). Importantly, many of these ideas remain untested, incompletely tested, or need to be independently verified. Evaluating the three generic models used in this study will help to refine our ideas about Wisconsin Late Woodland social organization.

Determining which model, if any, best represents Late Woodland Wisconsin can help future researchers develop processual theories of the transition to later cultures. Late Woodland group interaction and spatial patterning affected the historic trajectories of their neighbors and descendents (Theler and Boszhardt 2000, 2006). The production and organization of material culture impacts and creates new networks of interaction (Hodder and Hutson 2003; Pauketat 2008). Wisconsin effigy mound construction was a unique cultural expression in North America, and the placement and forms of those mounds likely affected use of the landscape by groups that followed. Yet, the structure of antecedent societies, and their impacts on history, must be empirically documented and tested (Sassaman 2004). The variation and co-variation of Late Woodland ceramics attributes across spatial and chronological scales will provide the foundations necessary to decide which model best describes the period and place it in its proper historical context.

The research also has broader impacts for hunter-gatherer inquiries outside of the study's geographic boundaries. Prehistoric material culture data can document cultural variation and social organizations that may not have present day analogies. It also plays a larger role in helping archaeologists define cultural complexity. Archaeological theory is restructured when we can empirically demonstrate complex group interactions in cases lacking many factors we usually associate with complex groups, e.g. market economies with delayed return, high population densities, intensive agriculture or territoriality (see Sassaman 2004). Late Woodland groups may have practiced multiple degrees of territoriality and mobility, and this bends the rules of most current notions of egalitarian social structure (Rosebrough 2010). However, the ceramic attribute, vessel and clay sourcing, and spatial data need to be much better understood before we can demonstrate the form or degree of complexity that existed in this time and place.

This dissertation also explores how we can develop the application of agency-centered concepts like performance in non-hierarchical, egalitarian settings. The work presented investigates a regionally and chronologically defined phenomenon that has the potential to inform general arguments about material culture variation and human sociality in multiple areas of archaeological research. Agency centered approaches like performance theories provide a deeper understanding of hunter-gatherers by studying their material culture production as the daily maintenance and transformation of identity and community. An attempt at data-based theory enrichment has great utility to other archaeologists working with these types of social structures in the Great Lakes region or beyond who want to implement agency-centered interpretations.

These three models of Late Woodland social organization are explored to provide a contextual basis for investigation into how the daily performance of pottery making can be used to assess the constant making and re-making of social relationships at multiple levels of interaction in an egalitarian setting. The results of the attribute analysis and model assessment will be interpreted using theories of agency that focus on performance (Beeman 1986; Budden and Soafer 2009; Looper 2009; Parker Pearson 1998; Shanks 1999; Varela and Harré 1996:323; Voss and Young 1995). The use of ceramics in the three Late Woodland models often view material culture as passive, or merely reflecting social organization or technological constraints. Yet it is prudent to remember ceramics were made within a social context by mobile hunter-gatherers with possibly conflicting levels of cultural interactions from household, to group, to band affiliations. The act of making a pot may be the active material representation of the production of society or group identity on multiple levels of prehistoric interaction. People could position themselves to express how they wanted to be perceived by the production, or performance, of making a vessel (Budden and Soafer 2009; Parker Pearson 1998; Valera and Harré 1996).

An approach that combines both decorative and technical style analyses are necessary to understand agency, performance, and the context of production in prehistoric societies (Dietler and Herbich 1998; Hegmon 1998). The daily production and distribution of material culture during the Late Woodland Period reflects variation due to functional and ideological considerations necessitated by their use in particular social systems, and that variation in ceramic attributes reflects the process of transforming and/

or reiterating social structures relating to identities, group interactions and relationships within those systems. The socially meaningful variation relating to the decisions made during the manufacturing process is contained in both decorative attributes, and the compositional attributes from the EDXRF and petrographic data (see Hegmon 1992; Jeske 1989, 1990, 2003a; Plog 1978; Stark 1999). The theoretical framework provided by the performance theory predicts that Late Woodland ceramic material culture will exhibit differential spatial patterning and variation as a result of these manufacturing concerns, degrees of group interaction, and population movements.

Many scholars have interpreted Wisconsin Late Woodland social organization and have argued for different types and degrees of territoriality and interaction for these groups. In this dissertation, Late Woodland social interaction is viewed through the explicit notion that recognizing intra- and inter-site variation in ceramic technology is the critical element for interpreting boundaries. As importantly, I am approaching the ceramic analysis with a combination of decorative and technical analyses by including petrographic and chemical EDXRF data. These data are important for making the distinction between the spread of ceramic style and population or pottery movements. By using these data sets to evaluate the models of Late Woodland social structure and territoriality, one can interpret the results through an agency perspective that focuses on pottery production as performance at nested levels of social interaction.

Chapter 2: Late Woodland Wisconsin and the Effigy Mounds

The cultural history of the Wisconsin Late Woodland is discussed in relation to how its current interpretation affects the three models used to categorize the time period in this dissertation as Monolithic, Low-level Territorial, and High-level Territorial. Multiple types of evidence from this period are discussed including phases, chronology, ceramics, effigy mound forms and site composition, social organization, settlement, and subsistence data. The three models will be presented in full at the end of the chapter.

Chronology and Phases

The Late Woodland period across the Midwestern United States is a time of social reorganization, population increases, settlement shifts to both lowland and upland locations, introduction of the bow and arrow, decreasing importance in trade compared to earlier periods, increasing use of horticulture, trash deposition in pits rather than middens (Salzer 1969:365), changes in projectile point and ceramic styles, and a shift from S to Z twist cordage (McElrath et al. 2000). Late Woodland dates to between circa AD 400 –1300 in southern Wisconsin. It is often equated with the building of effigy mounds (Benchley et al. 1997; Stevenson et al. 1997:166). Although the chronology of effigy mound construction is still unclear, it appears that they were likely built circa AD 700 –1200 (Stoltman and Christiansen 2000).

Chronology is undoubtedly a significant factor in understanding cultural variation in the Late Woodland period as it has an approximately 900–year span. Stoltman and Christianson (2000), split the period into Initial, Mature, and Final segments based partially on pottery styles in southwestern Wisconsin. A distinctive feature of the Initial Period is Lane Farm Cord-Impressed pottery, a type combining the use of cordmarking and rocker-stamping (Logan 1976; Stoltman and Christiansen 2000). Effigy mound construction and the appearance of Madison Ware ceramics is equated with the Mature Late Woodland (AD 700 – 1000). The Final Late Woodland Period (AD 1000 – 1200) sees a rise in collared ceramics, evidence for Middle Mississippian interaction, shifts in subsistence patterns including a greater use of maize, the presence of stockaded and substantive settlements, reintroduction of exotic materials, and possibly more evidence for violence (Salkin 2000; Salzer 1969; Stoltman and Christiansen 2000).

Salkin (2000) divides the Late Woodland Period into two stages in southeastern Wisconsin. The Early Late Woodland Stage (AD 400 – 700) is exemplified by the presence of Douglass Net-Marked and Baraboo Net-Marked pottery. Douglass Net-marked vessels are found with Late Woodland association in central Wisconsin (Moffat and Boszhardt 2007:69), but may also lie at the transition between the Middle and Late Woodland Periods (Goldstein and Gaff 2002:105; Hall 1962:168).

The following phases related to later Late Woodland effigy mound builders are based on data from material culture, mound form, and landscape divisions: the Horicon and Kekoskee phases in southeastern Wisconsin (Salkin 1987, 2000), the Keyes phase in Iowa (Benn 1980), and the Lewis (Boszhardt and Goetz 2000) and Eastman (Stoltman 1990) phases in southwestern Wisconsin.

Salkin (2000) splits the later Late Woodland (AD 700 – 1300) into the Horicon and Kekoskee phases. The Horicon phase (AD 700 –1200) represents the Effigy Mound manifestation and less permanent occupations from more mobile populations (Salkin 1987, 2000). Pottery traits include non-collared Madison Ware ceramics, especially cord- and fabric-marked, with cord and cord-wrapped stick decorations.

The Kekoskee phase (AD 800 –1300) sites are non-effigy mound, more permanent or fortified settlements where people may have grown maize (Salkin 2000:537). Salkin (2000:529) uses non-effigy mound sites from around eastern Wisconsin as examples including Aztalan, Dietz, Elmwood Island, and Bethesda Lutheran Home. Kekoskee phase sites generally lack fabric-impressed pottery (Salkin 2000:536). The ceramic assemblage usually includes grit-tempered collared Wares including Aztalan Collared, Point Sauble Collared, and Hahn Cord Impressed, with a possible trend towards a larger percentage of collared vessels through time. The incremental shift to collared Wares represents a gradual adoption of the manufacturing technique (Salkin 2000:529). Shell-tempered Middle Mississippian pottery may also be present at these sites. While non-collared Madison Ware ceramics occur, especially Madison Plain or Madison Cord Impressed, they occur in smaller proportion than collared Wares (Salkin 2000:529).

Other research indicates that Late Woodland sites in southeastern Wisconsin do not follow a dichotomous phase pattern between Horicon and Kekoskee. Significant overlap in ceramic assemblages, radiocarbon dates, and settlement locations strongly suggest that these phase distinctions need to be reconsidered or revised (Blaha 2010; Clauter 2003, 2011; Jeske and Richards 2010; Kaufmann 2005; Richards and Jeske 2002; Rosebrough 2008, 2010; Stoltman and Christiansen 2000). Restricting effigy mound building to one phase removes them from the diverse cultural context occurring during this time and forces effigy mound building into isolationist models on both chronological and geographical scales (Kaufmann 2005; Rosebrough 2008, 2010). Furthermore, effigy mound sites contain collared pottery types in the mounds themselves and radiocarbon dates from the Nitschke Mound Group indicate a long period of use of the site (Clauter 2011; Richards 2005).

The phase designation approach to understanding Late Woodland cultural complexity also is empirically flawed (Clauter 2003; Rosebrough 2010; also see Hart and Brumbach 2003). The relative lack of data from effigy mound settlement systems results in researchers filling knowledge gaps by borrowing concepts proposed by others. The proposed settlement system of Late Woodland in southeastern Wisconsin may be similar to the settlement patterning of the Eastman Phase in southwestern Wisconsin with spring and summer habitations above water sources and cold season occupations in uplands, rockshelters and small river valleys (Stoltman 1990:252-255; Stoltman and Christiansen 2000:513; Theler 1987:121) with the lack of cultigen use a difference between the regions (Salkin 2000:536). However, this analogy is questionable given the extremely different topography, environmental zones and access to resources between the glaciated region of southeastern Wisconsin and the Driftless area of southwestern Wisconsin.

Effigy Mounds and Their Interpretation

Effigy mounds are low, earthen mounds in varying animal and anthropomorphic forms built in a geographic range largely isomorphic with modern Wisconsin boundaries, and into immediately adjacent areas of southeastern Minnesota, northeastern Iowa, and northern Illinois (Figure 5). These mounds are generally clustered on bluffs or ridges overlooking waterways including lakeshores, rivers, and streams (Goldstein 1991; Hurley 1986). Effigy mounds are found in groups numbering from single mounds to the several hundred, and as many as 14,000 may have been built during the Late Woodland

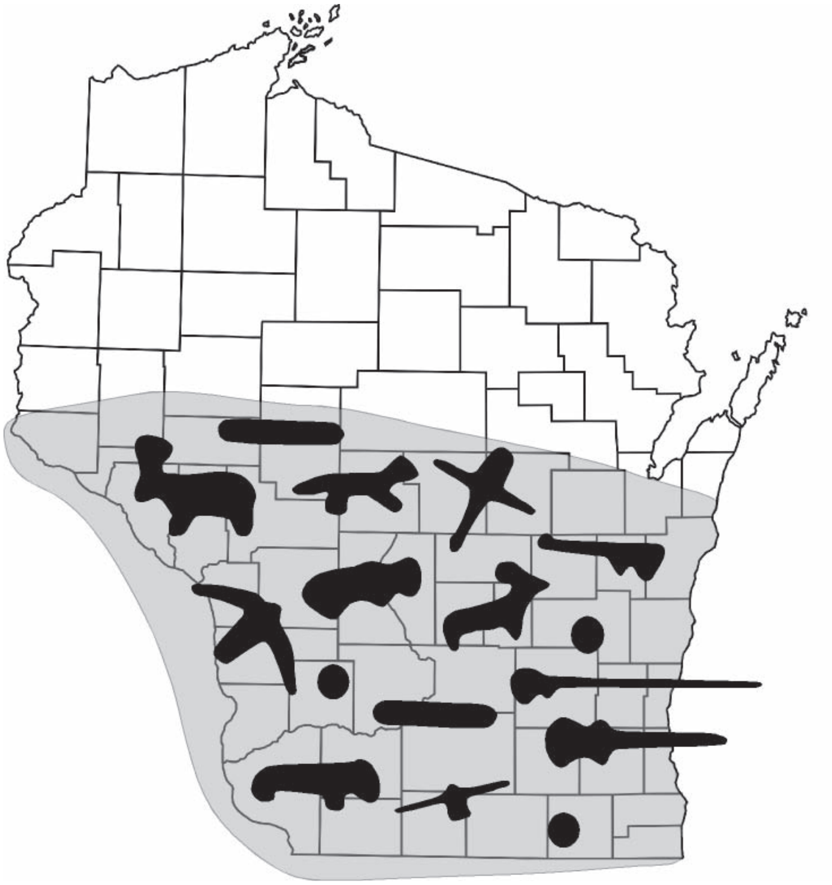

Figure 5: Distribution of effigy mounds and effigy mound forms (modified from Rowe 1956).

Period (Birmingham and Rosebrough 2003:21). While mounds generally were of simple structure, some mounds show complex construction using patterned soil placement (Barrett and Hawkes 1919). Mound groups themselves often appear morphologically similar, but intragroup site structure comparisons exhibit variation in number of mounds, mound forms present, and construction techniques (Kaufmann 2005).

Excavation of effigy mound sites was conducted largely in the early portions of the 1900s (Barrett and Hawkes 1919; McKern 1928, 1930; Rowe 1956), though numerous surveys and mapping programs were conducted in the 1800s (e.g. Lapham 1855; Lewis 1884; Peet 1882, 1884, 1889; Squire and Davis 1840; Taylor 1838). There has been little excavation of effigy mound sites using modern techniques, resulting in few reliable data concerning radiocarbon dates and chronology, lithic and ceramic technology, subsistence or settlement patterning. As a result, effigy mound typology is largely based on geographic locales with little rigorous comparative analysis of material culture or chronology (Benn 1980; Salkin 1987, 2000; Stoltman 1990, but see Boszhardt and Goetz 2000; Rosebrough 2008, 2010). However, several recent osteological analyses have yielded some preliminary insights into patterns among effigy mound burial populations (c.f. Bradley 2005; Handwerk 2007; Smith 2008; Zamecnik 2009).

Interment features, the presence and number of artifacts, and their location in the mounds vary considerably. There is no overarching, regimented burial program for effigy mound sites (Handwerk 2007; Smith 2008; Zamecnik 2009). While many mounds contain burials, the type of burial, sex, age, time of internment, and the type of mound used is inconsistent across multiple mound groups (Bastian 1958; Bradley 2005; Bullock 1942; Handwerk 2007; McKern 1927; Merbs 1966; Neihoff 1956; Smith 2008; Zamecnik 2009). Flexed, bundle, extended, charred, and ossuary type burials are all present in different effigy mound groups. Also, many mounds do not contain burials or other features (Salkin 1976). Burial diversity and a low occurrence of osteological disease signatures are usually interpreted as representing an egalitarian social system within a low-density population (Bradley 2005; Handwerk 2007; Mason 2002; Zamecnik 2009).

Many theories exist concerning the meaning and function of the mounds, and largely rest on the physical placement of mounds on a landscape (e.g., Benn 1979; Birmingham and Eisenberg 2000; Birmingham and Rosebrough 2003; Goldstein 1995; Mallam 1976). Effigy mound groups tend to be clustered near resource rich locations and have been interpreted as resource maps to these diverse areas (Goldstein 1995), gathering points for dispersed hunter-gatherer communities (Mallam 1976), or territorial markers of resource divisions (Boszhardt and Goetz 2000). However, it is more likely that mound location was chosen for cosmological reasons as well as resource procurement (Hall 1993).

The construction of effigy mounds was undoubtedly imbued with multiple levels of meaning. Researchers note the parallel between Ho-Chunk/Winnebago clan totemic structure, mound forms, and upper/lower world animal symbolism of sky, earth, and water (Hall 1993; Rowe 1956). Based on ethnographic analogy, long-tailed effigies may be interpreted as belonging to the lower world, bear forms to the earth, and birds to the upper world. Furthermore, there is some evidence that particular types may cluster both within a certain mound group and across the entire geographic range of effigy mounds (Birmingham and Eisenberg 2000; Goldstein 1991, 1995). Long-tailed forms are commonly found in eastern Wisconsin with its lacustrine, waterway, and marsh environments. Bears are common in the central part of the state, while birds are found in higher numbers in the uplands of western Wisconsin (Birmingham and Rosebrough 2003). However, effigy mound groups dominated by a particular type are commonly balanced by the inclusion of other form categories. Birds are still found in groups with a preponderance of panthers, and vice versa. These particular forms also are sometimes spatially segregated within a group according to their world association or topography. For example, lower world forms are found at lower elevations and tend to be grouped together (Birmingham and Rosebrough 2003:31). Many of these observations, though, have not been tested by spatial analysis, and should be treated as avenues for future research as the early effigy mound data may be limited by the subjective mound identification and mapping of early 19th century surveyors and landowners (Birmingham and Rosebrough 2003:24).

For Late Woodland groups, the creation of a physical landscape by effigy mound builders was wrapped into the cosmological balance at multiple scales through the interplay of symbols and geography. The structure of individual mound forms was as important as partitioning the whole region of southern Wisconsin into cosmological constituents. Hierarchical layers of ideological decisions, starting with mound form, then its location within a group, and finally its placement within a larger landscape, informed effigy mound construction. In doing so, the mounds serve as "metaphorical expressions of social relationships" (Mallam 1980:382) where an ideological framework was fashioned into reality. Their erection probably symbolized the balance between the different parts of the world and may have been part of renewal rituals, reinforced group connections, and perpetuated the worldview of its builders (Kaufmann 2005; Mallam 1980).

Subsistence

The major subsistence strategy pursued during Late Woodland times appears to be one based upon scheduled, seasonal rounds of hunting, gathering, and fishing of diversified, but predictably available, resources. Styles (1981) notes the localized nature of resource collection at Late Woodland sites in the Lower Illinois Valley where resources exploited tended to be dependent on physical geography near a site. Of considerable note is that refuse varied greatly between Late Woodland sites, perhaps given to the localized, adaptive nature of Late Woodland settlements (Braun 1988:27). In Late Woodland Wisconsin, there is considerable need for expanded data sets relating to subsistence, and especially floral remains. The lack of subsistence information at some sites is explained through an inferred mobile hunter-gatherer lifestyle (Stevenson et al. 1997).

At the Pitzner site (47JE199), interpreted as a repeatedly occupied autumn and winter Late Woodland campsite, resource collection appears heavily influenced by immediately available ecological zones near marshland and the Crawfish River (Goldstein 1980; Lax 1982). Pitzner, and the possibly associated Trillium site located 150 m to the northwest, represents short term, multiple reuse of a site through stratified middens, but no radiocarbon dates are available (Goldstein 1983). White-tailed deer are the dominant species, but many varieties of fish, including bass, pike, catfish, and walleye species, are represented. Also turtles, mussels, and a limited number of waterfowl are found. Small mammals are observed, particularly raccoon and muskrat, with river otter, beaver, rabbit, elk, and bison present as well (Lax 1982:235). Floral remains from the site include Chenopodium, hackberry, bedstraw, blackberry, raspberry, hawthorn, sunflower, hickory, and possibly maize (Goldstein 1980:80). Also, at other Late Woodland sites, ceramic pipes point to the use of tobacco (Meinholz and Kolb 1997).

Maize is present in some floral assemblages, but its proportion generally remains low in comparison with other plants and was probably a minor, sporadic dietary component until very late in the period (Hastorf and Johannessen 1994; Munson 1988:7-9; Watson 1988; Wymer 1987). Even at the end of the period, in many locations maize did not supplant other wild resources, and large quantities of collected flora are dominant at most sites (Watson 1988). However, by AD 1000 it does appear that ridged field technology for maize horticulture was increasingly utilized in parts of Wisconsin (Gartner 1999). Also, garden beds are probably associated with the Nitschke Mound Group, and this site has dated to AD 1020–1230 (WIS-182) and AD 1320–1420 (ISGS-A-1095) (Clauter 2011; Kaufmann 2005, 2010; McKern 1930; Richards 2005).

Other research shows wild rice collection was an important dietary strategy through the duration of the period (Moffat and Arzigian 2000). Its collection has been used as a means to explain the percentage of dental caries with low evidence of iron deficiencies in osteological data (Bradley 2005; Sullivan 1990). The number of dental caries at certain mound groups suggests horticulturalists, or mixed agriculturalists, both of which probably still relied heavily on hunter/gathering (Bradley 2005:85, 89; Smith 2008).

A comparison of recent osteological analyses, however, demonstrates some intriguing differences between mound group subsistence signatures despite geographical proximity. Handwerk (2007) concludes that the McClaughry population strictly followed a hunting and gatherer subsistence regime, and did not utilize plants such as maize or wild rice. Smith (2008) posits a model that fits a hunter/gatherer population that relies on supplementary plants, especially maize, at the nearby Kratz Creek site. Kratz Creek is similar to the Nitschke Mound Group in possible reliance on starchy foods, but Bradley (2005) suggests wild rice was the dominant carbohydrate at Nitschke. Zamecnik (2009:75) shows that within the Raisbeck Mound Group dental carries, hypoplasia, and arthritis rates are greatest in the non-ossuary burials. Her results may indicate two different groups with different subsistence strategies utilizing the same site location for mortuary practices (Zamecnik 2009). These osteological differences are explained as the result of temporal differences both within and between mound groups, but testing against chronological data is necessary. Kratz Creek and Nitschke may have been occupied later than McClaughry (Smith 2008:71-72), and the ossuary population older than the non-ossuary individuals at Raisbeck (Zamecnik 2009).

Most recently, Egan-Bruhy (2012) documents differences in subsistence strategies that may be both geographical and temporal, by dividing Late Woodland sites into collared and non-collared types. Additionally, the differences in subsistence patterns appear to represent continuity between groups though time (Egan-Bruhy 2012:5). Differences between sites with non-collared and collared ceramics in southern Wisconsin include an increased proportion of maize and squash, and the addition of maygrass and barnyard grass in the sites where the assemblage contain a majority of collared ceramics (Egan-Bruhy 2012:6). Importantly, she finds the floral remains from collared Ware sites east of the Wisconsin River are more similar to sites found in Michigan or further east, while sites with collared Wares located near the Mississippi River tend to appear more similar to more southerly Middle Mississippian populations (Egan-Bruhy 2012:11-12).

Ceramics

Late Woodland Wisconsin ceramics display a wide degree of stylistic and morphological variety that is commonly overlooked in favor of a view of the pottery as generally similar and subsumed under the label Madison Ware. Madison Ware is most associated with the Late Woodland Wisconsin in both mound and non-mound sites (Richards 2005). These pots are grit-tempered, cord-marked jars with rounded shoulders and straight to slightly everted rims. Vessels are decorated with twisted cord impressions in geometric designs or left plain (Figures 6 and 7).

The category was first distinguished as Lake Michigan Ware (Hall 1950:5; McKern 1930:462-467). Wittry (1959) coined the term Madison Ware when discussing similarities between Madison Cord Impressed and Madison Plain. The Ware category has since been redefined and expanded numerous times with new or existing type varieties

Figure 6: Vessel from Brogley Rockshelter (GT156). Vessel GT156/25 in this study.

Figure 7: Rim from the Kratz Creek Mound Group (MQ039). Vessel MQ039/05 in this study.

and vessel attributes (Baerreis 1953; Baerreis and Freeman 1958; Hall 1950; Hurley 1975; Keslin 1958; Mason 1966; McKern 1931:383-384; Wittry 1959).

The possible genetic relationships of non-collared Madison Ware types are unresolved. Madison Ware has a very long tradition (Hurley 1974) and associated radiocarbon dates are found throughout the Late Woodland period. Jeske and Richards (2010) document the long duration of Madison Ware types, and show that dates associated with vessels typically ascribed to the Horicon or Kekoskee phase do not separate into two divisions temporally. Stoltman and Christiansen (2000:507-511) composed a compendium of radiocarbon dates relating to Madison Ware types, and argue that while there is great temporal range, it is likely they were produced from AD 700-1000.

There are very early dates associated with Late Woodland sherds. Feature 02-13 from the Kelly North Tract produced a calibrated AMS radiocarbon date of 1410 ± 50 BP, or a 1-sigma range of AD 600-680 (Jeske et al. 2002:13; Stuiver and Reimer 1993). However, the associated Late Woodland sherds, probably representing Madison Plain types (R. Jeske, personal communication 2012), were found in the stratum above the level where the feature was discovered (Jeske et al. 2002:18). Salkin (1989:346) dates

Feature 166 from the Elmwood Island site the 1420 ± 70 BP, or cal. 1 sigma AD 565-665 (Stuiver and Reimer 1993).

There are numerous radiocarbon dates from the Sanders site (47WP026) that place Madison Ware types in the middle of the Late Woodland period. A Madison Plain sherd from House 2, Feature 40 at the Sanders site dates to 1020 ± 55 BP, or cal. 1 sigma AD 903-1148 (Hurley 1975:328; Stuiver and Reimer 1993). Dates from other geographic areas also place Madison Ware types near the AD 1000 mark. An assay from Feature 24 at the Weisner III site (47DO339) dates to 1080 ± 80 BP, or cal. 1 sigma AD 832-1030 (Salkin 1993:194; Stuiver and Reimer 1993).

Similarly, very late dates occur. Jeske and Richards (2010), report a very late date of approximately AD 1400 from the Klug Island site (47OZ067) taken from vessel residue from an indeterminate Madison Ware type. Prior and Phelps (1992:148) also found a late date of 770 ± 50 BP, which calibrates to 1 sigma AD 1221-1277 (Stuiver et al. 2009), at the Cabbage Patch site (47OU103). Taken as a whole, these selected Madison Ware radiocarbon dates suggest that Madison Ware types can be found across Wisconsin at many different times during the Late Woodland period.

Current debate focuses on whether all types associated with the Ware should be included under its umbrella-like definition (see Benn 1980; Hurley 1975; Richards 1992; Salkin 1987, 2000; Salzer 1969; Stoltman and Christiansen 2000). One argument of paramount important is the association between non-collared and collared forms given their differences in manufacturing and temporal ranges (Kelly 2002; Richards 1992; Stoltman and Christianson 2000). The relationship between collared types and non-collared forms serves as the basis for many arguments about the local or non-local origin of collared types and population migrations, even though the nature of their relationship, whether genetic or intrusive, is unresolved (Christiansen 2003; Kelly 2002).

It is clear that collared forms occur late in the Late Woodland Period (Kelly 2002). However, the possible genetic relationships to non-collared forms are uncertain.

Mason (1966:15) links collared Wares to non-collared forms based on manufacturing similarities. Numerous authors see collared forms developing from or being derivative of earlier non-collared Madison Ware varieties (Dietz et al. 1956; Freeman 1956; Hall 1962:83; Keslin 1958; Mason 1966; Meinholz and Kolb 1997; Salkin 1987, 1989, 2000). Richards (1992) and Hall (1962) note the similarities between Point Sauble Collared and Madison Cord Impressed types, and believe Hahn Cord Impressed may be the best candidate for a transitional type between collared and non-collared forms. Yet there are no simple successions from non-collared to collared forms (Storck 1972:162). However, ceramics trends between earlier and later portions of the Late Woodland Period visible at other locations should also apply to southwestern Wisconsin. These include a shift to higher rims, more decoration, more elaborate rim forms and eventually collaring (Benn 2000; Kelly 2002; Salkin 2000; Stoltman and Christiansen 2000; papers in McElrath et al. 2000).

Some researchers do not include all collared types in the Madison Ware category (Kelly 2002; Hurley 1975; Mason 1966; Richards 1992, 2005; Salkin 1987, 2000; Salzer 1969). Stoltman and Christiansen (2000:505) exclude Aztalan Collared and Point Sauble Collared based on morphologic differences. Richards (1992) posits Aztalan Collared and Starved Rock Collared are more similar to each other than non-collared Madison Ware types. Hurley (1979:130) suggests that collared and non-collared Wares differ only by location of decorative technique and their frequency of inclusion in different site assemblages.

The meaning of the provenience association of non-collared Madison Ware types with collared varieties at sites also is also unclear. While most Late Woodland sites contain both forms, it is not clear whether this represents interaction, trade, migration, or temporal, and cultural change (see Christiansen 2003; Clauter 2003; Goldstein 1991; Kelly 2002; Richards 1992; Salkin 1987, 2000; Stoltman 1976). Sites with non-collared Madison Ware types are not geographically isomorphic with effigy mound sites, and collared ceramics are represented in some effigy mounds (Clauter 2011; McKern 1928, 1930; Richards et al. 2012). Due to their unexplained cultural associations, and the possible morphologic and temporal differences between collared and non-collared forms of Madison Ware, this study focuses solely on non-collared forms.

The relationships between non-collared form of Madison Ware are overshadowed in the literature by arguments devoted to the collared Ware debates even though many of the same affinity problems exist for the non-collared forms, as well. Some researchers do not believe the non-collared Madison Ware types form a coherent grouping but rather express an ill-defined range in attribute variation of paste, temper and designs (Benn 1980; Richards 1992:264). Superficially similar vessels that may possess distinctive characteristics are often lumped together because of the definition’s lack of rigor (Clauter 2003; Hurley 1975; Richards 1992; Salzer 1969:264). The Ware category suffers from many of the same ailments as the phase concept since it compartmentalizes material culture and makes it difficult to assess variety (Hart and Brumbach 2003).

Wisconsin archaeologists hold different opinions of Madison Ware characteristics because they define it based on a differential preference for the qualities supposedly representative of Wares: surface treatment, manufacturing technique, and paste composition (see Rice 1976, 1987; Wheat et al. 1958). In addition, some archaeologists accept regional morphologic variation or gradation (Hurley 1975; Mason 1966; McKern 1928, 1930; Richards 1992, 2005; Salkin 1987, 2000; Salzer 1969). The attributes that may be included in the acceptable variation in the Ware is thus unclear. For example, it is agreed that Madison Ware has an exterior cordmarked surface treatment (Baerreis 1953), but some researchers include fabric impressed surface treatment (Benn 1980), smoothed-over-cordmarked (Logan 1976; Mason 1968), and cord-rolled or brushed (Hurley 1975). The interior and lip are usually smoothed, but the lip can bear cordmarking or fabric surface treatment (Benn 1980; Salzer 1969). Most authors surmise a paddle-and-anvil hand molding formation (Keslin 1958), others posit coiling (Storck 1972; Wittry and

Bruder 1955) or building the vessel inside a supporting fabric form (Benn 1980).

The same lack of agreement on acceptable variation within the Ware category extends to vessel morphology. Madison Ware types are characterized by globular bodied jars with rounded bases, but shoulder rounding can be gentle to distinct (Benn 1980; Keslin 1958; Wittry 1959). Rims vary from inslanting to outflaring (Hurley 1974), and lips flat to gently round (Baerreis 1953), beveled to the interior or exterior, thickened, folded or rolled (Hurley 1975), extruded (Mason 1966) or pinched (Richards 1992). Orifice diameters range from 9.0 cm (Benn 1980) to 40 cm (Hurley 1975). Vessel heights also vary, but average around 25.0 cm (Keslin 1958; Salzer 1969; Wittry and Bruder 1955). Wall thickness averages 5.0 mm (Baerreis 1953; Hurley 1974; Keslin 1958; Salzer 1970), but some argue for thick and thin varieties, or simply that Madison Ware has thicker walls in different regions (Keslin 1958; Mason 1966; Salzer 1969). Thicknesses are reported as ranging from 2.0 to 14.0 mm (Mason 1968).

Paste characteristics are also broad. Textures vary from medium to fine, friable to compact, contorted to laminated, and silty to sandy (see Baerreis 1953; Benn 1980; Hurley 1975; Logan 1959; Mason 1968; Richards 1992; Salzer 1970; Wittry 1959). Temper inclusion is moderate and most often consists of fine crushed grit, presumably from granitic rock, up to 5.0 mm in size, but averaging below 1 mm (Baerreis 1953; Benn 1980; Keslin 1958; Logan 1959; Witty 1959). However, Storck (1972:130) includes angular chert fragments in his temper categories.

Researchers also disagree on characteristic decorative elements. Twisted cord impressions are a standard attribute (Baerreis 1953). Storck (1972) lists six additional decoration techniques: cordage punctates, fingernail incisions, cord-wrapped stick impressions, tool punctates, interior nodes and fabric impressions, but others believe punctates and nodes are not Madison Ware type attributes (e.g., Mason 1966; Wittry 1959). Vessels may also be left plain after surface treatment application.

Including so many decorative elements may conceal culturally meaningful geographical or temporal distribution. Cord-wrapped stick elements are very common in the northern and western regions of Wisconsin during the Late Woodland as Clam River (McKern 1963), Keshena (McKern 1945; Overstreet 2004) and Heins Creek varieties (Mason 1966). Cord-wrapped stick and cord-impressed decorations are found on the same vessels in some locales (C. Mason 2004). Mason (1966:139) suggests that the rise of Madison Ware is associated with the decline of Heins Creek types on the Door Peninsula. Including cord-wrapped stick as a Madison Ware trait may limit our ability to see the linkages and clusters between different portions of the state, or the possible temporal change from one group to another.

Furthermore, it may be impossible to sort Madison Ware types into rigid categories due to the nature of the data set. There is so much overlap in the accepted design attributes that is it just as common for any decorative attribute to be found on its own as it is in combination with others, e.g. twisted cord impressions with tooled punctates (Clauter 2011; Rosebrough 2010; Storck 1972). Also, the great variability in application and designs that archaeologists accept within the definition of Madison Ware provides for an unknown range of variation (Benn 1980; Keslin 1958; Logan 1976:101; Rowe 1956; Salzer 1970).

A further problem is that Madison Ware types are defined based on a cluster of attributes that may be or may not be equally weighted by archaeologists (see Krieger 1944; Rice 1987:276; Sinopoli 1991). For instance, Hurley (1975:244) notes that on Madison Folded Lip, decoration is secondary to the lip deformation for classificatory purposes, but the decoration may become primary when the lip folding is absent. However, even decoration may not be a primary attribute as Madison Plain may be completely undecorated or have interior rim decoration. In this case the primary type characteristic qualifier may be paste even though paste is supposed to be a Ware characteristic (Rice 1976, 1987).

The possible genetic relationships of non-collared forms are also unresolved.

On the whole, Madison Ware has a very long tradition (Hurley 1974). When Mason (1966) subsumed a number of types in his effort to make the Ware a Late Woodland manifestation, he noted that not all the types or forms were fully contemporaneous. Rather, they expressed a “common cultural tradition” (Mason 1966:151). Therefore, the Madison Ware category better represents morphologic similarity, not temporal relationships even though some researchers assume evolutionary relationships among types. Hypothesized integrations or genetic relationships are sometimes presumed based on superficial similarity or conjecture, e.g. that Madison Folded Lip genetically or temporally link non-collared to collared types (Hurley 1975; Keslin 1958).

It is apparent that while non-collared Madison Ware types contain some distinct characteristics, like the use of punctates or cordage decoration or the presence of lip folding, they often are difficult to distinguish from each other given the variation with, and similarities between, form and decoration. To appreciate and understand the range of variation in Late Woodland pottery, or even in Madison Ware itself, it is necessary to utilize attribute analyses instead of those based in the type-variety method. The distribution of elements and their relative frequencies compared between sites may be more important for sorting geographic, social or temporal variation (Storck 1972:144-147). There are relatively few recent studies based on specific theoretical or methodological foundations (but see Kelly 2002; Rosebrough 2010) and little systematic analytical work has been conducted on ceramic attribute variation in Late Woodland Wisconsin (Keslin 1958; Richards 1992).

External Group Relations

Multiple different types of social groups were present in southern Wisconsin circa AD 1100- Late Woodland, Middle Mississippian, and Oneota. Late Woodland groups may be even further divided into those who used collared Wares and those who did not (Salkin 2000). The presence of these different populations, and especially the Middle Mississippians, appear to affect some of the Late Woodland groups beginning in the

Lohmann phase and continuing into the Stirling phase. Importantly, the impact seems to be different in different regions of southern Wisconsin. Middle Mississippian pottery types, like Ramey, Powell or Hyer Plain, are found at across the study area (c.f. Clauter 2003; Finney and Stoltman 1991; Hall 1962; Hendrickson 1996; Richards 1992). Maize occurs more often in subsistence assemblages (Salkin 2000:537). Rock art paintings found at Gottschall Rockshelter appear comparable to Middle Mississippian styles (Salzer and Rajnovich 2000).

Some Wisconsin sites also exhibit more Mississippianized site plans. Platform mounds and rectangular shaped houses are found at Trempealeau (Green and Rodell 1994). Aztalan also possesses these characteristics along with a plaza area (Goldstein and Freeman 1997; Richards 1992). Fred Edwards, Aztalan, and other Late Woodland sites in eastern Wisconsin were also palisaded (Goldstein and Freeman 1997; Green 1997; Salkin 1993).

The reactions to the Middle Mississippian presence appear quite different in different portions of the study area. The Western region near the Mississippi River seems to have been more affected than the eastern portion of the state and there are more sites in this region that display Middle Mississippian characteristics. For instance, ceramics at Trempealeau consist of collared and non-collared grit-tempered pots, but also both local and imported Lohmann phase shell-tempered vessels (Finney and Stoltman 1991). At the Fred Edwards site, both local and imported Ramey and Powell varieties occur alongside Late Woodland types (Stoltman 1991). Furthermore, vessels exhibiting a blending of Middle Mississippian and Late Woodland attributes are present and may indicate a great deal of social interaction between these groups at Fred Edwards (Finney and Stoltman 1991). The Gottschall Rockshelter is also located in the western Wisconsin.

Further north along the Mississippi River, and outside the study area of this research, is the Red Wing locality in Pierce and Goodhue Counties, Wisconsin. The Silvernale phase represents the Middle Mississippian presence in this area, ca. AD 1100-

1300. Characteristics of the Silvernale phase include the Ramey motif on locally made jars and large fortified villages (Gibbon 1991; Rodell 1991). Two possible platform mounds were identified in this area, and other Middle Mississippian items found include a short-nosed god mask and marine shell objects (Green 1997:215). People living in this area also used Hixton extensively (Green 1997:215).

It is possible the western area was more involved in prestige good trade with southerly neighbors. Galena, Hixton silicified sandstone, and hematite are theorized to have been items valued by Cahokians during the Lohmann and Stirling phases and were found at more southerly sites even when suitable materials were available locally (Green 1997:208, 214). Fred Edwards, Trempealeau, and sites associated with the Silvernale phase are all located near a possible major trading route- the Mississippi River. The waterway would have facilitated the movement of Wisconsin raw materials to southern sites. Sites located on or near the trade route could have served as connection nodes in this exchange.

Interaction with Middle Mississippian groups appears very different in eastern Wisconsin. While Aztalan serves as a very imposing reminder of a Stirling phase Middle Mississippian presence, very little else exists outside its boundaries. There seems to be little appreciable contact or acculturation with southern groups (Stevenson et al. 1997). The extensive Crawfish and Rock River survey by UWM did not produce any other major Middle Mississippian sites in the area (Goldstein 1979, 1980, 1981). Rather, Middle Mississippian material culture, and therefore its supposed influence, appears scattered in very small quantities across southeastern Wisconsin, and no other sites can be directly related to Aztalan itself (Clauter and Richards 2009; Hendrickson 1996; Stuebe 1979). Indeed, Aztalan appears isolated from the surrounding countryside and the site is not well situated for trade (Goldstein and Freeman 1997:244; Richards 1992).

Along with a Middle Mississippian presence, Late Woodland groups also shared similar landscapes with more sedentary Upper Mississippian Oneota neighbors

(Richards and Jeske 2002). In southeastern Wisconsin, the Oneota appear to be mainly concentrated around Lake Koshkonong, with little expansion east- or southwards, and extremely little interaction occurred between Middle Mississippian and Oneota groups (Richards and Jeske 2002:43, 46). In western Wisconsin, Oneota horizons are well established, but there is debate on whether many Emergent Oneota radiocarbon assays post-date most the Late Woodland non-collared dates (Boszhardt 1998; Overstreet 1997).

However, given the limited amount of modern excavations conducted of effigy mound sites, it is difficult to determine the amount of possible interaction between Oneota and Late Woodland groups, even though some researchers argue for the development of Oneota groups out of a Late Woodland base (Gibbon 1972). Oneota sherds are found in assemblages dominated by Late Woodland types (Clauter 2003), but Late Woodland groups seem to be allied more with Middle Mississippian people as pottery types typically associated with these groups are both found at Aztalan (Richards 1992). However, the alliance between Middle Mississippians and Late Woodland groups also may have been tenuous in southeastern Wisconsin. Regardless of whether communication can be documented between Oneota and Late Woodland groups, it should still be acknowledged that an Oneota presence may have impacted the Late Woodland subsistence and settlement regime simply by their lack of interaction and possible group avoidance.

Settlement and Social Organization

With no modern excavation of effigy mound sites, and few published excavations of non-mound Late Woodland sites in southeastern Wisconsin, establishing a direct relationship between habitation sites and mound groups is still tenuous, and reconstructing an overarching settlement system is difficult. However, most effigy mound research contains a discussion of social organization and social cohesion (c.f. Goldstein 1995; Hall 1993; Hurley 1975; Kaufmann 2005; Mallam 1976; McKern 1930; Radin 1911; Rosebrough 2010; Rowe 1956; Scherz 1991).

There is general consensus that Late Woodland Wisconsin groups are localized hunter-gatherers with an egalitarian social structure, small band organization, and a semi-sedentary settlement system (Birmingham and Eisenberg 2000; Bradley 2005; Goldstein 1980, 1983; Hastorf and Johannessen 1994; Mason 2002; McElrath et al. 2000; Moffat and Arzigian 2000; Munson 1988:7-9; Stevenson et al. 1997; Watson 1988; Wymer 1987). Significant differences of opinion emerge when authors infer and/or assume the degree of social cohesion within the bands, their regional extent and group interaction based on cooperative behavior and territoriality (c.f. Gartner 1999; Goldstein 1995; Kaufmann 2005; Mallam 1976; McKern and Ritzenthaler 1949; Rowe 1956; Storck 1972). Many of these ideas have remained untested, or incompletely tested, and need to be independently verified.

Early cultural-historical research considered effigy mounds as a monolithic cultural construct. The builders were a wide-ranging, homogenous social group labeled the Effigy Mound Culture or Aspect (McKern and Ritzenthaler 1949). Trait lists incorporated artifacts from across Wisconsin and were considered representative of the whole in order to build cultural chronologies (e.g., Rowe 1956:75). Variation within and among regions was masked by a tendency to seek similarities and connections (Birmingham and Eisenberg 2000; Goldstein 1995). This construct suggested all artifacts and mound shapes to be found in every corner of the culture's geographic extent. Most researchers treat effigy mound ritual as part of an overarching cultural construct shared by related, but locally autonomous bands of foragers (Green 1999; Richards 2005:30).

Cultural-ecology approaches saw groups as small bands that coalesce and disperse around effigy mound sites based on seasonal resource patterns (Goldstein 1995; Mallam 1976; Storck 1972). These approaches allow for variation in material culture and behavior while still finding commonalities pan-regionally. Importantly, these authors offer numerous models of the relationship of mounds to territoriality and social integration. Storck (1972) interprets Mayland Cave within a multi-focus hunter-gatherer subsistence-settlement pattern where winter sites were occupied by small extended families or two or three families. Large aggregations of bands would occur at other sites like mounds or fishing locations during other portions of the year. However, Storck does not discuss territoriality and the relationship of subsistence economy to social organization is “largely unknown” (Storck 1972:412).

Mallam (1976) focuses on variation within the effigy mound research area using an interpretive ecological model. He argues for a flexible and fluid social organization with the family group coalescing to, and dispersing from, larger bands depending on season and resource density. He also postulates that effigy mound complexes signified group territory. Independent, loosely related families constructed separate mound complexes to mark political and economic control over their resources. The small group was the main unit, while multi-family or large band aggregations occurred fairly infrequently. When large-scale aggregations were necessary, mounds served as integrative mechanisms to facilitate interaction. Mallam (1976:57) hypothesizes that there would be a wide distribution of different artifacts and techniques within a region as gift-giving, marriages and alliances served as mitigating mechanisms to alleviate high competition for resources.

Goldstein (1995) argues that mounds map a relation to resources and mark environmentally rich areas controlled by particular groups. She suggests that there are patterned differences in the proportions of upper world (e.g., bird) and under world (e.g., panther) forms across Wisconsin sites. She argues that sky symbols are more prevalent in the dry western region while underworld forms are more common in the wetland-rich eastern region of the state. She proposes that group identity is favored over individuals, and argues that band identity is foremost for social organization (Goldstein 1995:116).

Hurley (1979) describes and analyzes ceramic cordage decoration from Late Woodland sites to suggest temporal and geographic divisions based on the presumed evolution of cord/fabric types. Hurley’s (1979) work approached ceramic variation based on empirical analyses, but his results are not replicable because of the elaborate nature of his cordage categories. In addition, (Benn 1980:54) suggests that some of Hurley's categories may have been incorrectly identified. Hurley also thought that the Late Woodland extended much earlier and later than is now commonly accepted; leading possibly to the inclusion of non-Late Woodland sites in his analysis. Altogether, Hurley's study included many ceramic types not found in southern Wisconsin, types not currently accepted as Late Woodland varieties, or types not considered representative of effigy mound builders (Mason 2002; Stevenson et al. 1997). His results are therefore unsuited to studying effigy mound builder population or pottery movements.

Kaufmann (2005) uses remote sensing technology to demonstrate significant variation in submound construction within sites, as well as between sites, in different regions of southeastern Wisconsin. She suggests that attention to regional integration and overarching cosmology represented by effigy mounds masks significant temporal and regional variation. She also notes that both intersite and intrasite mound group structural patterning means effigy mounds serve multiple functions on both a small band and regional interactive scales (Kaufmann 2005:194). While positing that mounds may represent group territorial markers or aggregation points, Kaufmann also suggests that the mounds and mound ritual reinforce inclusivity and are a mechanism for social control and power relationships within a group.

Recently, Rosebrough (2010) examined variation in both mounds and ceramics across the state. She postulates short distance territorial bands containing multiple sodalities that crosscut geographic area and communities and argues that many sub-populations of effigy mound builders existed contemporaneously. Some subpopulation she interprets as low mobility "semi-territorial" groups who are largely responsible for the variation in mound patterns from east to west (Rosebrough 2010:375), while other subpopulations are interpreted as a set of more mobile groups that are responsible for variation and homogenization in ceramic attributes within and among sites (Rosebrough

2010:543). These types of organizations are achieved through cross-cutting networks in different regions (Rosebrough 2010:547).

As a whole, these studies may be grouped into the three major models presented in Chapter 1: Monolithic, Low-level Territoriality, and High-Level Territoriality. These previous studies provide expectations that can be tested, in part, by new techniques such as EDXRF and petrographic analysis. Moreover, our interpretation of the Late Woodland Period can become much more specific due to these new data sets, which provide answers to questions that previous researchers could not ask. For example, as the models are evaluated in this thesis, the EDXRF data make it possible to determine if ceramic vessels were physically moved around the landscape as opposed to decorative or technical styles alone.

Social Organization Models and Expectations

The three models of territoriality and social organization will also be evaluated through the lens of performance theory. A performance perspective requires knowledge of the context of production at multiple societal levels (Dobres and Hoffman 1994; Dobres and Robb 2000; Sassaman 2001). To discuss agency in Late Woodland Wisconsin, we must first evaluate the social contexts in which persons were acting. This contextual information provides lines of evidence used to generate inferences and illuminate interpretations about how agency could work within that system to both create and restructure it (Dobres and Hoffman 1994). Knowledge of context can bolster predictions of material culture patterning to help guide our interpretation of social process (Dietler and Herbich 1998).

Multiple researchers provide scenarios of Wisconsin Late Woodland hunter-gatherer social organization, and hypothesize different levels of group interaction, social-political cohesion and spatial distribution (Goldstein 1995; Hall 1993; Handwerk 2007; Hurley 1975; Kaufmann 2005; Mallam 1976; McKern 1930; McKern and Ritzenthaler 1949; Rowe 1956; Scherz 1991; Storck 1972).

The focus of the generic models is the spatial distribution and interaction of social groups, and not subsistence or settlement systems. I am not suggesting a correlation between subsistence strategies and ceramic styles. However, I do expect that different types of levels of interaction among populations will produce different material cultural patterns across the landscape. The ceramic assemblage expectations hypothesized for effigy mound builders are summarized in Table 1.

These models do not represent an evolutionary or temporal trajectory, but are simply alternative forms of social organization. Also, by suggesting possible ethnographic examples I do not attempt to connect prehistoric societies to historic groups. Prehistoric hunter-gatherers existed in very different circumstances than modern ethnographic corollaries and parallels may not exist (Sassaman 2004). Indeed, it is possible that different Late Woodland Wisconsin groups used all three social organizations proposed at some point to varying degrees. While there were many flaws in early hunter-gather modeling efforts, including an over-emphasis on causal factors and ethnographic

Table 1: Models of Late Woodland Social Organizaiton

Social Organiza-tion	**Group Movement**	**Multi-family or Band Interaction**	**Ceramic Attribute Correlates**
Monolithic	Groups range freely across entire range of effigy mound culture area.	Frequently and very easily.	All variables equally distributed across all sites in equal proportions. Homogeneity in all attribute states across region. No clustering.
Low-level Territorial	Small groups somewhat contained within an area, but travel between local and regional areas common.	Many opportunities for group interaction and reshuffling causing fluid group membership with weak social boundaries.	Some homogeneity across a region, but also heterogeneity within and between vessels with the localization of attributes.
High-level Territorial	Small groups are tightly contained within a prescribed area.	Occurs irregularly with some degree of stress. Group membership is fairly fixed with rigid social boundaries.	Highly heterogeneous clusters across a region and little regional homogeneity. Each site has a distinct cluster of defining attributes and not all attributes are represented resulting in few broad patterns.

analogies, obtaining and testing empirical data on prehistoric hunter-gatherers is an important step in demonstrating the variation and complexity of groups that do not have high degrees of population density, agriculture or sedentism (Sassaman 2004).

Rather, the models used in this study characterize patterns of hunter-gather organization that can be used for hypothesis building and tested on data recovered from the archaeological record (c.f. Binford 1967; Gremillion 2002; Hill 1991; Wylie 1992). I do not see this work as evolutionary or adaptationist, but as a point of departure for research into social interaction and group distribution. I suggest that within a geographic and chronological framework, the patterns of variation seen in ceramic style attributes combined with spatially specific data on ceramic manufacture and discard can be used to construct and inform models of human social construction and interaction.

Model 1: Monolithic

A monolithic system is defined where households and lineages within the effigy mound geographic range are fully integrated into the same social, political, economic, and ritual activities. High levels of social cohesion and group interaction should result in very similar methods of ceramic manufacture and decoration. I expect a homogeneous material culture as potters and consumers performed production and distribution conforming to rules or scripts within the larger networked region (c.f. McKern and Ritzenthaler 1949; Rowe 1956). Most attributes should be found in equal proportion at every site with little clustering of attributes across sites.

Model 2: Low-level Territorial

This model illustrates a family-band aggregation where most groups move within a relatively wide-ranging regional territory. These groups exhibit little inter-band conflict and high levels of interaction at both the household and larger aggregated group levels (Kaufmann 2005; Storck 1972). Loose, autonomous bands with fluid group membership and high levels of periodic group coalescence and interaction should produce ceramic assemblages similar to Braun and Plog's (1982) hypothesis: a reduced degree of variation between regions as contact facilitates the spread of people and ideas. While there is homogenization across a region, there may be heterogeneity within and between vessels as potters manufactured vessels for different audiences in different contexts from different locally available materials. Attributes should be found in large clusters representing large geographic areas with increased divergences over large regions (Braun and Plog 1982).

Model 3: High-level Territorial

The High-level Territorial model describes a family-band aggregation with high degrees of territoriality and relatively low or restricted multi-band or regional band gatherings and interaction. The model implies a narrowed range of population movement within a relatively limited geographic area. The model assumes resource ownership by specific groups and suggests little interregional cohesiveness (see Goldstein 1995; Mallam 1972). The model should produce a highly heterogeneous ceramic assemblage at the inter-site level as there is less social interaction and sharing among potters at the regional level. However, increased social isolation may result in increased ceramic homogeneity within sites or small areas as pottery is produced and consumed largely within the local community (Braun and Plog 1982). I do not expect formal ethnic boundary formation at this level of integration, but we may expect strong community and kin based self-identification by potters. We expect to find many smaller clusters based on distinctive attributes spread throughout the landscape, possibly associated with specific lineages, households or villages and their associated resources.

Discussion

There are many geographical differences between Late Woodland sites and across southern Wisconsin. Types of mounds present at a site varies (Birmingham and Eisenman 2000; Goldstein 1995), as do inter-mound group construction and intra-site mound group structure (Barrett and Hawkes 1919; McKern 1928, 1930; Nash 1933; Kaufmann 2005; Richards 2005). For example, the Ross Mound Group does not show evidence of prepared surface, while this construction practice is present at the Nitschke Mound Group (Nash 1933; McKern 1930). There are different types of artifacts found in different geographic locations (Boszhardt and Goetz 2000). Also, osteological evidence indicates diverse diets and burial practices at effigy mound sites (Bastian 1958; Bradley 2005; Bullock 1942; Handwerk 2007; Merbs 1966; McKern 1927; Neihoff 1956; Smith 2008; Zamecnik 2009). Rosebrough (2010) has demonstrated geographic patterns in ceramic attributes relating to regional expressions in Late Woodland pottery. Finally, the differences in topography, environmental zones and access to resources between the glaciated region of southeastern Wisconsin and the Driftless area of southwestern Wisconsin would suggest regionally based subsistence adaptations.

Chronological differences may also affect the varying structures of Late Woodland sites and their ceramic assemblages. Many researchers have posited and noted these differences (Gartner 1999; Salkin 2000; Salzer 1970; Stoltman and Christian 2000). However, radiocarbon dates are lacking from many effigy mound sites leading to a glossing over of interpretations based on this scale. In addition, a tendency by researchers to view the effigy mound building phenomenon as an isolated, but static and cohesive whole has led to a reduced ability to explain on chronologic change within the period (Rosebrough 2010).

The Late Woodland period represents a diverse conundrum to archaeologists. Effigy mound builders, non-effigy mound sites, Oneota habitations, and Mississippian related habitation sites are found across the region in similar ecologic zones (Richards and Jeske 2002). The period was also one of change with different geographical locations probably transforming at different rates with the adoption of collared Wares and corn horticulture. However, a plurality of Late Woodland lifestyles may have been possible before and during the co-occurrence of Late Woodland, Oneota, and Mississippian sites. While we attempt to explain the cultural diversity pursued during this time in Wisconsin both spatially and temporally, comparing phase trait lists and producing more categories will not produce insights into questions of cultural variety or cultural process. We must also test the current ideas about the nature of cultural variation including how population movement and pottery transport affected the resulting artifact distributions.

Chapter 3: Theoretical Orientation

The problems addressed in this dissertation involve issues of prehistoric social interaction, population movement, and territoriality. The type-category approach to ceramics provides virtually no information on how ceramics were used and what they represented to people who used them (Brashler 1981; Chilton 1999a, 1999b; Hart and Brumbach 2003; Rice 1987). As such, it is of limited utility for resolving the issues focused on in this analysis. Instead, the question of whether ceramic attribute data vary or co-vary across geographic scales is approached from a theoretical framework that sees material culture variation from both a functional and performative perspective. Theories of ceramic function and style were used to select attributes for study.

It is also important to understand what the patterns of variation and co-variation of ceramic attributes represent within a social context. Variation in ceramic elemental, compositional, and decorative attributes is related to possible differences in social interaction or territoriality and assessed against three models of Late Woodland social organization. The results of these analyses are interpreted using a performance perspective to assess the models of group interaction and distribution. Ceramics are imbued with complex interplay between producer, user, and viewer. Approaching them through a performance perspective also gives a researcher the ability to discuss the active role they play in multiple, nested levels of society and how they are used to structure and negotiate numerous types of social ties.

Agency Theory

Archaeologists increasingly use agency perspectives to incorporate ideas such as habitus, practice, and structure into prehistoric interpretations (Bourdieu 1977; Dobres and Robb 2000; Giddens 1984; Hegmon 2003; Hodder and Huston 2003; Ortner 1984; Pauketat 2001). Such perspectives help envision a past with socially active participants, instead of one determined by antecedent external systems (Hegmon 2003; Hodder and Hutson 2003). It also encourages the study of multi-faceted groups by presuming heterogeneity and differential goals of the constituent actors as sources for change (Brumfiel 2000).

Agency represents any socially significant action where multiple different actions may be chosen (Dobres and Robb 2000:8; Giddens 1984:9). It is the choices made by individuals to realize their goals (Brumfiel 2000). Important to agency concepts is the interplay between agency and structure (Dobres and Robb 2000). Agency is not the strategies of unconstrained individuals. Agency acts within a framework of meaning, or structure. However, while structures constrain actions, individuals can transform the structures they act within according to their own motivations. The dialectic between agency and structure reproduces, enables, and obstructs the making and remaking of the social world. It focuses prehistoric interpretation towards strategies of reworking and renegotiating social relations instead of prescribing static and overarching social structures (Dobres and Robb 2000). This theoretical outlook thereby avoids determinism and allows indeterminacy (Hodder and Hutson 2003).

Since agency is a socially constructed action we can use it to understand a prehistoric world very different from our own. However, this requires knowledge of the prehistoric context as meaning and agency interpretations are dependent on the context of production at multiple levels (Dobres and Hoffman 1994; Knapp and Dommelen 2008; Sassaman 2001). The knowledge of context can bolster predictions of material culture patterning to help guide our interpretation of the social process that could produce that patterning (Dietler and Herbich 1998). Therefore, this type of assessment must be undertaken before interpretations using agency perspectives are assumed.

One method of viewing the intersection of agency and social structure is through the concepts of habitus and practice (Ortner 1984; Pauketat 2001). Habitus is a learned general disposition to practicing a certain way given the perception of limitations, possibilities, and assessment of how others are reacting to one’s practices (Bourdieu

1977; Dietler and Herbich 1998; Pauketat 2000; Hodder and Huston 2003). These are neither monolithically shared, predetermined, nor completely rational, but they produce the regular practices of daily life and link action to structure (Knapp and Dommelen 2008; Pauketat 2000).

Practice is the enactment of a disposition, or habitus, in daily life. Agency is capability, but practice is what people actually do. Through practice agents reproduce and transform structure (Dietler and Herbich 1998; Ortner 1984). One can find the relationship between agency and structure in the routines of daily life. Routines include making material culture. Material culture production is contingent on structure, but it is also a means to express social negotiation, one's dispositions or identities (Pauketat 2001). Focusing on practice gives archaeologists the ability to look at material culture and relate individual agency with structural institutions in a tangible way that are amenable to statistical, empirical study.

Hunter-Gatherers and Performance Perspectives

Agency perspectives are most often used in cases focusing on colonialism, aggrandizing agents, the emergence of complexity and inequality, and domination or resistance where class structure is apparent (c.f. Alt 2001; Nassaney 2001; Pauketat 2001; Silliman 2001; Smith and Choi 2007; Stein 1998; Voss 2005). However, concepts of agency remain relatively undeveloped in non-hierarchical societies (Hegmon 1998, 2003). Agency perspectives have been employed in hunter-gatherer situations, but mostly to discuss group opposition or how groups marked themselves from others (Emerson and McElrath 2001; Sassaman 2001).

As a specific aspect of agency, performance theory can be used in hunter-gatherer societies as an interpretive tool for understanding the relationships among the maker and the object produced, the producer and others in society, and the object and others in society (Budden and Soafer 2009). Performance is an interactive process where people consider how others might act in response to their own act, or their relation to those others, and then perform in a way to produce a desired social outcome while being witnessed by an audience (Looper 2009; Varela and Harré 1996:323). There is a performer and an audience, and the performance, or its outcome, must be watched or witnessed (Budden and Soafer 2009; Parker Pearson 1998). A performance can be a contested social process with a dynamic interplay between participants where people are affected differently and react differently to performances (Beeman 1986; Looper 2009:8; Parker Pearson 1998).

Performance involves the interplay of strategy, tactics, and improvisations to actively negotiate alliances and social construction (Budden and Soafer 2009). Structure guides performance, and performance makes ideas effective by becoming manifest through an appropriate channel of discourse where symbols can be mobilized, manipulated, and perceived (Looper 2009:11). Yet performance can also generate and transform the structure (Looper 2009:8). Therefore performance is continual identity formation, a transformative process of becoming rather than a static end state (Beeman 1986; Looper 2009; Budden and Soafer 2009).

Deploying agency in a performative perspective crosscuts can bridge the gap between processual and postprocessual theory by searching for a synthesis (Hegmon 2003). This approach to agency also is more nuanced than the practice framework (e.g., Dobres 2000:96) that uses concepts such as *chaîne opératoire* to contextualize the meaning of technological behavior as the way technical sequences unfold because it provides a platform to study broader social implications of the deployment of skill to create socially meaningful categories (Budden and Soafer 2009:208; Jeske 2003a; Shott 2003). Performance can express propaganda, shared identity, non-conformity, ideology, power, and the dynamism of interpersonal behavior (see Looper 2009, Beeman 1986). This perspective also takes into account cultural, personal, functional and environmental variables that may constrain a performance and affect its outcome (Looper 2009; Voss and Young 1995).

There are few studies using agency perspectives within hunter-gatherer societies where the focus is the maintenance and reproduction of egalitarianism (Bursey 2006; Sassaman 1995, 2000). Also, applying agency to situations with networks of overlapping identities at multiple scales including individual, family, kinship, and community ties, are not theoretically mature (Lightfoot 2001). Yet agency perspectives are readily applicable to these conditions since egalitarian societies are as actively maintained as other social structures (Sassaman 2000, 2001; Wiessner 2002). However, cases where one group does not control another, or where there is relatively equal power, need different explanatory concepts beyond structures of class, domination, and resistance (Lightfoot 2001; Roe 1995; Sassaman 2000).

Bursey (2006), for instance, uses agency to explain the maintenance of egalitarianism within the Iroquoian social and political system. He argues various leveling mechanisms, like the redistribution of goods, rituals performed outside the village, and an emphasis on women’s role in society, evolved so individuals could partake in self-aggrandizement (Bursey 2006:138). Strongly egalitarian relations are also practiced within Mexican Kickapoo society (Sassaman 2001:225). They maintain this egalitarian structure through codified rules for sharing within communal rituals which focus on group cooperation, social sanctions that discourage group deviations from tradition, and a flexible subsistence strategy that allows for group movement when necessary to preserve their autonomy (Sassaman 2001:225-226).

Agency in a non-hierarchical society may be more a process of identity marking related to alliance, trade, and group membership through the mechanisms of cooperation, reciprocity, and accommodation (Lightfoot 2001). Social inequality and power negotiation are found in the multiple scales of identities of kinship and affinity, e.g. gender, age, household, lineage and band (Sassaman 2000). In these cases, material culture, including ceramic style for example, may be more important as an integrating mechanism than as demarcating group boundaries (Pryor and Carr 1995). One style indicates a boundary at one level, while another relates to a larger social entity through sharing and crosscutting technologies (Hegmon 1998:275).

Material Culture Correlates of Performance

Performance is most apparent in formal or staged special events, but it is not limited to those contexts. Material culture is more than finished objects, and its production in everyday settings is a performative medium that can be researched and interpreted by focusing on the physical remains of what people actively do to show they are community or network members (Hegmon 1995; Looper 2009; Parker Pearson 1998; Sassaman 1995, 2001; Shanks 2004). Technology becomes inseparable from social life as structure and identity are secured and transformed in the practice of production (Dietler and Herbich 1998; Dobres and Robb 2000; Dobres and Hoffman 1994; Pauketat 2001). Agency, and performing, can therefore be seen in daily life (Hegmon 1995; Sassaman 2001).

In an agency perspective, material culture is not passive in that it only reflects social and technological constraints. It is also actively made by someone within a particular social context to uphold or challenge the system (Dietler and Herbich 1998). Material culture production is a powerful facilitator in the production and reassessment of structure and identity when actors position themselves in relation to what they want to express to an intended audience through that production (Budden and Soafer 2009; Parker Pearson 1998; Varela and Harré 1996). Objects become invested with meaning and are actively interpreted by observers negotiating relationships including identity, social structure and alliances (Hodder and Hutson 2003; Parker Pearson 1998). This social transformative effect of a performance by participants or agents is crucial to material culture analyses (Beeman 1986; Looper 2009).

In prehistoric pottery production where ceramics are made locally, the performance may not be witnessed immediately, but it is assumed the spectator will still have the competence to interpret or contest its meaning. The production behavior is still performative, but there is a gap between the performer and audience (Shanks 1999). Therefore, the immediate performance is as important as how the attributes produce an echoing effect that can be interpreted by a future viewer and guides their later actions. Material culture production and exchange is an important intermediary in social relationships and social reproduction even in cases of delayed reciprocity (Sassaman 1995). As created material culture, pottery can exist beyond its original marker and social context, and its meaning can change over space and time (Hegmon 1995:22-23).

There may be a disconnect between the original intended function of a pot and the many different functions that pot actually served during its use life (Skibo and Schiffer 1992:2). Every iteration of function may change the meaning of the pot to the persons who are using it- from signaling mechanism to grog temper. The work presented here proceeds by viewing the pottery as part of the dynamic interplay found in social relations between and within groups. It is likely this causes focus on the beginning, original stages of vessels and their manufacturing process. It is possible the social transformative or integrative mechanisms for which a pot was constructed still transfer to its later uses.

Selecting Attributes for Study

The methodology used to selected attributes for study in this research is based on the above theoretical discussion. The attributes selected are relevant to the questions asked about Late Woodland social organization and interaction because they can act as proxy measures for these occurrences. Pottery production is a good medium to investigate performance in hunter-gatherer societies. It was often produced at household levels for utilitarian use. Pots survive well in the archaeological record, and may have been especially important in non-literate societies without written communications to signal, establish, or challenge structure (Budden and Soafer 2009:205; Pauketat and Emerson 1991). Utilitarian pottery can be mundane objects, but they play a role in encapsulating the formation and changing nature of the social world in their daily production (Hodder and Hutson 2003:94). The daily making of pottery is a process of cultural construction where categories, values, and meaning are reproduced, mediated, transformed, or thwarted because technology is inseparable from social life (Dietler and Herbich 1998:245; Dobres and Hoffman 1994; Dobres and Robb 2000; Pauketat 2001). Ceramic style becomes a strategy within a given social structure, and the pot itself becomes an element of negotiation as meaning is manipulated in its medium (Hegmon 1995; Pauketat 2001:6; Roe 1995).

An attribute is a “property, characteristic, features, or variable of an entity” (Rice 1987:275). It refers to any variable capable of being recorded from a ceramic vessel. Pottery attributes include surface treatment, wall thickness, shoulder angle, neck form, etc. They can also be properties relating to technological variables, like elemental or mineralogical composition. In turn, attributes have at least two or more qualitative or quantitative values. Qualitative attributes are measured in relation or contrast to each other, and quantitative attributes are measured to a specific amount or sum. These specific values or scores are referred to as attribute states (Rice 1987:275).

Attributes selected for this study are those commonly termed technological and stylistic and are presumed to represent, or act as proxies for, group distribution and social interaction. Data sets from which attributes are derived include decoration, energy dispersive X-ray fluorescence (EDXRF), and petrographic thin-sections. They are items that may reflect decisions taken during production that would ultimately affect vessel function, performance and aesthetic appearance (see Chilton 1996). The distribution and co-occurrence of these attribute states across southern Wisconsin are a means of studying the movement of pottery and people during the Late Woodland Period.

Ceramics function within a given cultural system; technical properties of pots are based on cultural context within which the pots are used (Skibo 1999). Functional utility and context are reflected in vessel physical properties and attribute variation (Skibo and Schiffer 1995). Ceramics are designed by their makers to function within a given cultural system and technical properties of pots are planned in accordance (Skibo 1999). This purpose is reflected in the physical properties and attribute variation of the vessels themselves and they are "evidence of the techniques used by potters to achieve particular characteristics of utility" (Braun 1983:107). Varying ceramic attribute states, like wall thickness or temper density, serve as proxy indicators that inform on food preparation, storage, and subsistence behavior by affecting mechanical properties like thermal shock resistance and mechanical strength (Braun 1983; Skibo and Schiffer 1995). Therefore, the settlement and subsistence patterns are in part reflected in the technologies produced by the persons living within that social structure (Chilton 1996).

However, ceramics also reflect social norms, interactive relationships and social boundaries (Budden and Soafer 2009; Hodder and Hutson 2003; Longacre 1991; Rice 1987; Sinopoli 1991; Varela and Harré 1996). Pottery utility is found in mechanical function, and the ability to reflect and manipulate intended social signaling within or between groups (Hodder 1986; Wiessner 1983; Wobst 1977). This information is indicated by decorative attributes, and by construction techniques that produce a desirable pot (Sackett 1977; Sinopoli 1991:119).

The interplay between prescribed aesthetics, information transmission and utility means that technological attribute variables contain as much stylistic information and messaging as decorative ones (Hegmon 1992; Jeske 1989, 1990, 2003a; Stark 1999). The geographic spread of variation and co-variation of ceramic attributes therefore represents social variation, group membership, and group relations (Brashler 1981; Whallon 1969, in Sinopoli 1991). These can be studied though the use of EDXRF and petrographic data.

The daily practice of material culture production produces pattered deposits of prehistoric materials, like ceramics, that are available for study by archaeologists well-equipped and long-versed in this type of analysis (Dietler and Herbich 1998; Hegmon 1995; Lightfoot 2001). Agency and performance perspectives are applicable to research focusing on how items are made, how production space is structured, and how objects are used and disposed (Lightfoot 2001). The results of the performative strategies are seen in the spatial distributions of ceramic attributes, and the variation and co-variation of attributes may represent different levels of meaning or social affinity (Voss and Young 1995). Attribute variations relating to decorative or technical styles can involve agency and identity mediation, and props can be utilitarian objects including clay, temper or the fired vessel (Budden and Soafer 2009). Patterns can either demarcate or deny social groups depending on the social context (Goodby 1998). A performance perspective elevates the interpretation of ceramic attributes beyond using them as a communication mechanism alone and into realms of structure and identity formation, management and re-creation.

It is hypothesized that potters involved in hunter-gatherer societies with multiple levels of group membership will produce their pottery so that it reflects and amends their affiliations with those multiple groups of people at multiple scales. They will manipulate certain attributes to express membership at one group level, and other attributes to express membership in another. This performance should be reflected in the shared and unshared attribute combinations seen on pots found in different locations or among pottery found within particular regions.

Pottery at different sites that have a suite of similar, or co-varying attributes may reflect a performance geared towards expressing the shared identity. In these cases, the performance would be most likely to bolster the argument for Low-level Territoriality or regional band level affiliation as people trade or move pottery clays and ideas across the landscape. However, finding pottery at particular sites that possess attributes that are unique and distinct to that site or a small region may indicate a performance that is focused on reinforcing and negotiating a High-level Territorial structure as the potter signals a membership class that is much more reduced in scale and may even be a family grouping. Additionally, finding attributes that are similar across the whole of southern Wisconsin may show a potter that is working within a Monolithic structure, as everyone is trying to show that they are members of the same, overarching group. The act of pottery making is a daily performance with archaeological correlates that can be studied though the ceramic attributes. Therefore, it is through examining the co-variation of attributes and how they plot on the geographic landscape that helps performance theory translate the ceramic decoration, EDXRF, and petrographic data into a medium that can inform the three models of Late Woodland social organization discussed in this dissertation.

Ethnicity

The delineation of ethnic groups is problematical because clearly defined units are not visible in most cases in the prehistoric record, and ethnic groups are often elusive even in contemporary accounts of social relationships (Lightfoot and Martinez 1995:479; Martin 2005:77). Ethnicity involves self-identification or ascribed affiliation where participants give themselves their title, or where other intangible qualities like group consensus to a particular value system are important (Barth 1969:10; Beres 2001:83). These qualities may exist without reference to material culture correlates, and is thus a great quandary for archaeologists who rely on material remains for interpretation. Also, there may be only limited cultural differences that separate groups (Barth 1969:38). However, many of the concepts used to study ethnicity are pertinent avenues of exploration for explaining prehistoric social groups. It is not necessary to use these methods in an attempt to actually locate prehistoric ethnic groupings. That is, the methodology of ethnicity is more appropriate to archaeological investigation than prehistoric ethnic delineation.

Ethnicity is defined as “ . . .a group identity based on culture, language, religion, or a common attachment to a place of kin ties” (Nanda 1994:467, in Berres 2001:183). Barth (1969:11) adds to this definition a more active role for actors demarcating themselves as an ethnic group: ethnic groups make up a sphere of interaction and communication. It is the active role of actors within a social structure that is applicable to archaeological explanations. Social boundaries define ethnic groups, not just associated material culture (Barth 1969). These boundaries need constant validation and expression in order to be recognized (Barth 1969:15). In this manner, ethnicity is negotiated and managed by active participants, just like actors manage their performance as demonstrated in agency perspectives. Placing importance on how ethnicity and social boundaries are managed and maintained shifts the focus away from a geographic centered concept of ethnicity. People must act to maintain ethnic divisions. Importantly, ethnicity and social boundaries are formed and sustained because of interaction with external groups, not in spite of it. Geographical or social isolation, the absence of mobility or contact, and a lack of information flow are not the cause of ethnicity nor of cultural diversity (Barth 1969:9).

Additionally, the nature of the interaction is just as important as the presence of interaction. Interactions are affected by the relative group sizes of the interacting parties (Barth 1969). Often, ethnic boundaries develop when small groups need to manage their interaction with larger, imposing, and more powerful groups (Sandstrom 1991:323). In effect, ethnicity is a rallying response where people band together in the face of a potentially oppressive power. In doing so, ethnicity becomes a dynamic struggle to assert rights and identities by active participants.

The relative population sizes of interacting groups are also important in prehistory. Jeske (1992) argues that the smaller population sizes of northern Illinois groups had an impact upon their interaction patterns with more southerly and more Mississippianized groups. The preexisting population sizes in the north conditioned their incorporation of dietary maize and affected Mississippian acculturation. Instead, the northern Illinois groups maintained a more Late Woodland-like resource procurement strategy, material culture, and separate identity. Whereas it had previously been theorized that maize incorporation was due to environmental constraint, Jeske (1992) demonstrated that precursor demographic, subsistence, and social patterns were more likely to produce the material culture patterns seen in the archaeological record.

Ethnic groups are not simply victims of larger groups. Actors may also use their identity for social or material gain. For instance, Sandstrom (1991) notes that Mexican Indians will emphasize their Indian identity in order to obtain favorable results when dealing with mestizo landowners and the Mexican government. There is no passivity to ethnicity. Rather, ethnicities are made up of active participants who obtain advantageous results through strategic identity maneuvering (Jeske 1992; Sandstrom 1991:331). Ethnicity is a strategy employed to reduce costs and increase gain in order to produce an output that maximizes the potential economic and social gains (Sandstrom 1991:339).

It should also be noted that ethnicity is not dependent on environmental zone or subsistence regime. Ethnic boundaries may have geographical signatures or even geographical boundaries, but they do not need to do so (Barth 1969:15). There can be the same ethnic group in different resource zones, or different groups within the same zone (Barth 1969:12). As Jeske's (1992) study demonstrates, non-ecological components are perhaps more necessary when seeking to understand identity formation.

Furthermore, social boundaries can persist even with a flow of people across group boundaries or with population movements (Barth 1969:9, 21). People who move may become absorbed in, or at least take part in, their new ethnic environment. Some persons may switch group membership for economical reasons or social gain (Haaland 1969). In non-hierarchical societies, like the Late Woodland Wisconsin, the population movements are often linked to intra-community connections (Berres 2001:168). Creating social links through population movement helps in non-market societies that rely on reciprocity and social connections to facilitate trade and exchange (Berres 2001:43). While Berres (2001:183) eschews the use of ethnicity per se, his description of social movements and meaningful use of material culture to express identity conform to our expectations of ethnic boundary formation (Jeske 2003a:169).

Vital relations can exists across social boundaries based on ethnic divisions even without population flow (Barth 1969:10). Relationships across social boundaries tend to be stable or even symbiotic (Blom 1969; Eidheim 1969). These interethnic relations are structured by ethnicity because there is a predefined way of interacting already established (Sandstrom 1991). As in agency perspectives where actors work within and through a structure in a constant process of negotiation, the social boundaries of ethnicity structure intragroup interaction (Barth 1969:10). By acting in a certain manner, members of that ethnicity are actively maintaining, producing, and reproducing their place within a larger system (Barth 1969:18). More importantly, they are often using material culture to construct these identities and to maintain or construct boundaries. Material culture does not just reflect ethnicity, but also helps to make it or obliterate it.

Material culture correlates of ethnicity

While prehistoric people and ethnic groups can act to suppress of blur group membership by the use of similar material culture (Hodder 1986), social variation will tend to cluster into discernible, if not fluid groupings (Barth 1969:29). Again, it is important to focus on the process that brings about the patterns we see in the archaeological record. Material culture plays an active role is helping people distinguish themselves (Lightfoot and Martinez 1995:485). Archaeologists often use differences in material culture or subsistence pattern as indicators of cultural differences (see Berres 2001; Jeske 1992, 2003a). Prehistoric actors used material culture to show identity as it broadcasts and negotiates that identity in social contact situations. These can include markers such as house plans, point dimension, food consumed, style of dress, or goods exchanged (Barth 1969; Lightfoot and Martinez 1995; Wiessner 1983; Wobst 1977).

Berres (2001:37) reasons that behaviors used the in production of material culture are structured so its materialization in the morphology of artifacts carries socially meaningful information. Importantly, he also views these groups as being agents in their own creation and recreation of an ethnic identity (Berres 2001:12). However, identity distinction may not always be clear-cut. Given the focus on the activities that produce the material culture divisions, blending can signal the active construction of new identities (Lightfoot and Martinez 1995:488). Interestingly, this type of material blending may most often happen at the frontiers of social boundaries where diverse groups meet to trade or exchange (Lightfoot and Martinez 1995:473-474). The crosscutting of social networks will cause a reduction in visibility of sharp divisions in material culture attributes or groups. However, these intersections points are also where the construction and negotiation of ethnicity can become manifest for the archaeologist through the blending or assimilation of material culture attributes (Lightfoot and Martinez 1995:474). As cultural development is dependent on local history, interpretations of social boundary maintenance or blending should occur within the regional sphere of interest (Cobb and Nassaney 1995, in Berres 2001).

A survey of the methodology behind social boundaries and ethnicity brings salient interpretative tools to this study. Social boundaries are continually maintained and negotiated, they manifest because of interaction, they can be sustained in cases of population movement and may even be dependent on that movement. Furthermore, social boundary maintenance produces material culture correlates that can be studied through disposal patterns. All of these can contribute to an understanding of the ceramic data patterns produced in this dissertation. The time period circa AD 1100 in southern Wisconsin was dynamic, with multiple groups occupying similar ecologic zones (Richards and Jeske 2002). If we remember to consider Late Woodland groups as not existing in isolation (Rosebrough 2010), then principles of ethnicity, or at least group identification, may help interpret material culture patterns as representing the interactions and negotiations between Late Woodland, Oneota, and Middle Mississippian populations.

Discussion

Interpreting the past through an agency perspective focused on multiple levels of identity has implications for how archaeologists define and interpret prehistoric entities (Lightfoot 2001). Our social groupings are usually based on normative space-time grids with homogenous data sets (Hart and Brumbach 2003). These traditional culture divisions may not stand up to new research that acknowledges multiple levels of affinities. Performance theory lets us looks at social relations in diverse and dynamic ways by focusing on strategies instead of pigeonholing entire prehistoric groups into static social organizations.

Connecting material culture with performance theory gives a richer interpretation of Late Woodland ceramics and social structure by contextualizing the technological behaviors of pottery production, use, and discard within a broader basis of human interaction. It frees us from the limiting confines of a type-variety approach that usually accompany ceramic studies and uses attributes as more than signaling mechanisms. Late Woodland pottery production can become an example of agency in hunter-gatherer groups where individuals negotiated, mediated, and structured their interaction with different levels of group affinity. The combined use of functional and performance perspectives to ask questions about human interaction and material culture provides a deeper understanding of Late Woodland society. This richer approach is demonstrated using the Late Woodland Effigy Mound phenomenon of Wisconsin.

Chapter 4: Methods

Sample Universe

Ceramic attribute data were compared from 435 Late Woodland ceramic vessels from 59 assemblages (Table 2, Figure 8). These assemblages are housed at the University of Wisconsin-Milwaukee (UWM), the Milwaukee Public Museum (MPM), and the University of Wisconsin-Madison. Sites were selected for analysis based on four criteria: 1) the sites are geographically located within the accepted range of effigy mounds, 2) initial review of the collections indicated the presence of thin-walled, tightly cordmarked, grit-tempered ceramics, 3) the sites are reasonably associated with effigy mounds or are datable to circa AD 700-1200, or 4) sites are not directly associated with effigy mounds but site records indicate the presence of attributes often associated with effigy mound groups. A Wisconsin archaeological site number references most of the sites, ex. OZ067. Some vessels did not have site provenience, and these vessels were designated by a two-letter county code followed by an assigned acronym. For instance, SBTOW refers to the vessel found in Section 23, Town of Wilson, Sheboygan County.

Vessels used in this study are found both in mortuary, burial and mound-fill, and non-mortuary, or non-mound, contexts. It is likely that ceramic assemblages are structurally different among different site types and dependent upon factors like duration of site occupation and reoccupation, functional or technological vessel properties, use-life and replacement rates (Mills 1989; Schiffer 1983; Walker 1995). Obtaining a significant comparative sample sizes is a persistent problem in Late Woodland ceramic research and many sites yield limited numbers of examples (Rosebrough 2010). Sites with low vessel numbers, and ceramics from mortuary and non-mortuary contexts, are included in the study to gain adequate geographic coverage and a large enough sample size. The sites included are not meant to be an exhaustive list of possibilities. Rather, those selected for study reflect assemblages that gave good geographic coverage while also contributing to

Table 2: Sites Included in the Study

Site	Number	County	Institution	Vessels (n)
Mara-Marfilius	CR084	Crawford	UW-Madison	2
Big Lake	CR103	Crawford	UW-Madison	3
Pedretti III	CR127	Crawford	UW-Madison	7
Mill Run	CR185	Crawford	UW-Madison	1
Mill Pond	CR186	Crawford	UW-Madison	6
Fish Lake	CR309	Crawford	UW-Madison	1
Hunter Channel I	CR312	Crawford	UW-Madison	5
Hunter Channel II	CR313	Crawford	UW-Madison	3
Hunter Channel III	CR314	Crawford	UW-Madison	1
Bloyer	CR339	Crawford	UW-Madison	5
Unnamed Site	CR348	Crawford	UW-Madison	2
U.W. Test Pit	CR350	Crawford	UW-Madison	1
Mouth of Gremore Lake Island	CR353	Crawford	UW-Madison	7
Upper Folsom Bay	CR356	Crawford	UW-Madison	7
Middle Folsum Bay	CR357	Crawford	UW-Madison	3
Hunter Channel IV	CR360	Crawford	UW-Madison	9
Indian Isle Travern	CR367	Crawford	UW-Madison	1
Big Lake Shell Midden	CR370	Crawford	UW-Madison	2
Perizzo	CT071	Calumet	UW-Milwaukee	12
Blackhawk Village	DA005	Dane	UW-Madison	5
Monona Grove Campsites	DA011	Dane	UW-Madison	2
Dietz	DA012	Dane	UW-Madison	1
Rosenbaum Rockshelter	DA411	Dane	UW-Madison	9
Canoe	DA457	Dane	UW-Madison	6
Site 5	DA463	Dane	UW-Madison	3
Picnic Point	DAPP	Dane	UW-Madison	1
Nitschke Mound Group	DO027	Dodge	UW-Milwaukee	9
Horicon	DO131	Dodge	UW-Milwaukee	27
Nitschke Garden Beds	DO518	Dodge	UW-Milwaukee	3
South Fox Lake	DOSFL	Dodge	Milwaukee Public Museum	1
Town of Princeton, Sec 1	GLTOP	Green Lake	Milwaukee Public Museum	1
Osceola	GT024	Grant	Milwaukee Public Museum	1
Raisbeck	GT112	Grant	Milwaukee Public Museum	13
Brogley Rockshelter	GT156	Grant	UW-Madison	22
Preston Rockshelter	GT157	Grant	UW-Madison	19
Hog Hollow	GT266	Grant	UW-Madison	3
Gov Dodge Rockshelter	IA001	Iowa	UW-Madison	2

Table 2: Sites Included in the Study, concluded

Site	Number	County	Institution	Vessels (n)
Mayland Cave	IA038	Iowa	UW-Madison	12
Pitzner	JE676	Jefferson	UW-Milwaukee	9
Trillium	JE757	Jefferson	UW-Milwaukee	1
Art Hoard	JE946	Jefferson	UW-Milwaukee	2
Necedah TWP, Sec. 18	JUNT	Juneau	Milwaukee Public Museum	1
Shorewood Mounds	MI083	Milwaukee	Milwaukee Public Museum	1
McClaughry Mound Group	MQ038	Marquette	Milwaukee Public Museum	20
Kratz Creek	MQ039	Marquette	Milwaukee Public Museum	2
S. Buffalo Lake	MQSBL	Marquette	Milwaukee Public Museum	1
Unknown	MQUNK	Marquette	Milwaukee Public Museum	1
Klug	OZ026	Ozaukee	Milwaukee Public Museum	28
Klug Island	OZ067	Ozaukee	UW-Milwaukee	11
Bigelow-Hamilton	PT029	Portage	UW-Madison	28
Sy Hende Mai	RI190	Richland	UW-Madison	2
Jones	RO203	Rock	UW-Madison	4
Black River Collection	SBBR	Sheboygan	Milwaukee Public Museum	49
Town of Wilson, Sec 23	SBTOW	Sheboygan	Milwaukee Public Museum	1
Cooper's Rockshelter	SK001	Sauk	UW-Madison	10
Mile Long	WL110	Walworth	UW-Milwaukee	6
Ross	WO016	Wood	UW-Madison	5
Sanders	WP026	Waupaca	UW-Madison	34
Centra 53/54	WT189	Washington	UW-Milwaukee	1
TOTAL				435

a representative sample size for statistical tests. Other institutions were not contacted for samples once it was determined the ceramics from UWM, UW-Madison and the MPM fulfilled both qualifications for sample size and geographic coverage.

Initial Vessel Sorting

The numbers and sizes of pots are basic to our understanding of the production, use and discard of vessels. Only rimsherds were included in this study. Rims exhibiting significant exfoliation, erosion, or weathering were eliminated from analysis. A minimum number of vessels (MNV) were determined based on the similarity of rimsherd

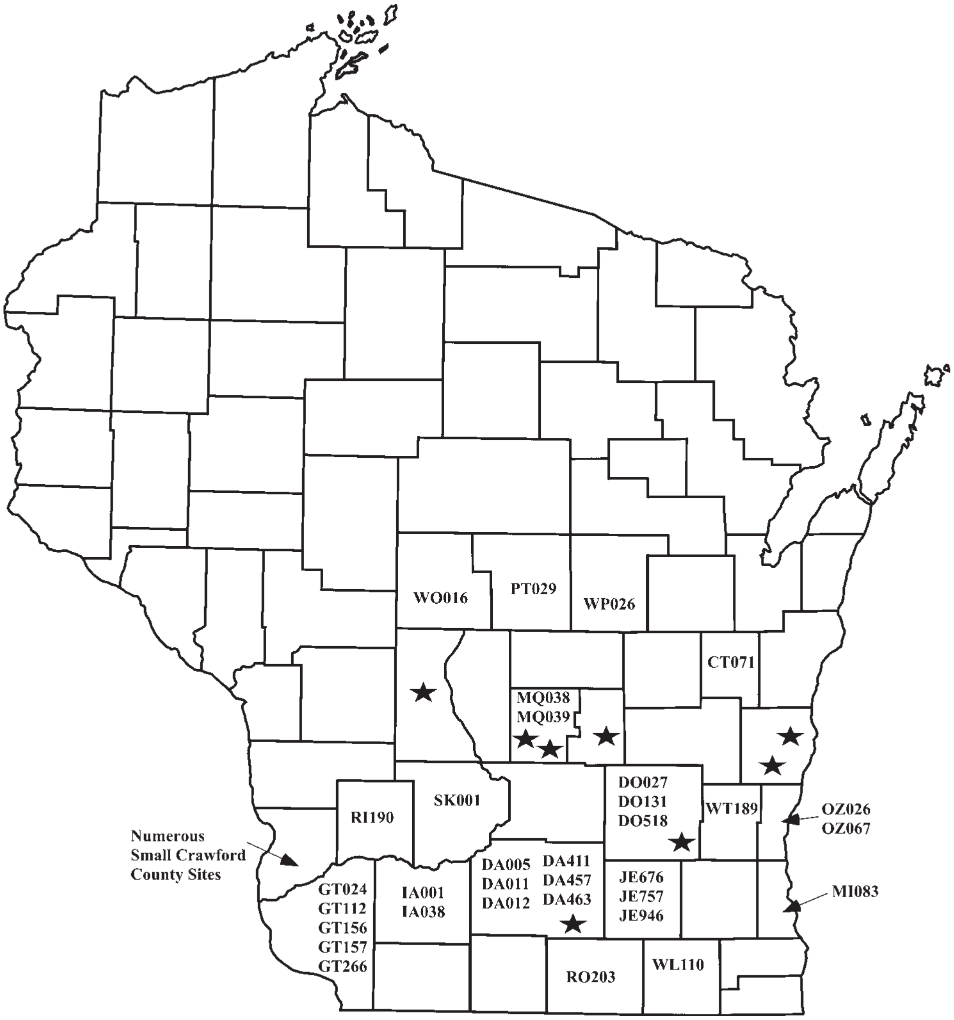

Figure 8: Sample universe sites included in the study. Stars indicate county provenience for assemblages without site provenience.

morphology, provenience, and decoration. The recording of attribute states is based on vessel analysis so as to represent the prehistoric assemblage accurately (Arnold 1985). Statistical tests and descriptive frequencies were also completed using vessel counts.

Decoration Analysis

The artificial separation of style, function and technology limits an understanding of the social context of production, use and deposition, the significance of material culture as an active mechanism used by potters to produce, reproduce and negotiate their world, and the role of social factors influencing technical choices (Chilton 1999; Lechtman 1977; Stark 1999; Skibo 1999). Both decorative and technical style analyses are necessary for a full appreciation of the context of production and should be conducted in tandem (Dietler and Herbich 1998; Hegmon 1998). All characteristics of ceramic vessels, including decoration motifs, paste characteristics, and morphology, can be used to study how people interacted with each other in prehistoric time periods. For this reason, this study includes a combination of technical analyses using EDXRF and petrography alongside a parallel decorative analysis.

Design placement, application, and orientation of decorative elements and motifs are presumed to follow cultural rules or norms (Sinopoli 1991). As such, they act as signaling mechanisms for that society and are often used by archaeologists to ascertain group membership (see Hegmon 1992; Wiessner 1983; Wobst 1977). Also, certain portions of the vessel, perhaps the more visible ones, may be more linked to social signaling than others (Rosebrough 2010). It is important to remember, however, that this does not imply rigidity to group ideals (Rice 1987:245). Rather, decorative expression is an open and flexible system that both receives and transmits information that can be purposefully produced to reflect or manipulate (Hodder 1986; Wobst 1977). However, the point remains strong that the use of certain motifs or decorative elements may be linked with cultural interactions or group and individual identity (Hegmon 1992; Sackett 1977; Wiessner 1983; Wobst 1977).

The original intent was to record decoration by configuration drawn in box squares with symbols indicating decorative element, manner of application, angle, height, and area of placement (see Brashler 1981; Rajnovich 2003; Storck 1972). These configurations are usually transferred into motif modes and categorized using a similarity of attributes and placement areas. Statistical analysis utilizing motifs was found to be impractical for this study as there were very few repeated motifs when considering the vessel as a whole so counts would have been very low.

Rather, it appeared that there were decoration zones that had multiple attribute states that might be chosen. Rosebrough (2010) also encountered this problem, and therefore decoration recording was split into six zones based on vessel segment following her methods, but with different attribute states represented (Figure 9). Splitting decoration into zones also helped determine if certain portions of the vessels were used to denote social organization more than others.

Within these zones, decoration followed horizontal motif rows, for example rows of diagonally oriented twisted cord or rows of vertical columns of circular tool punctates. Logan (1959) notes the occurrence of decorative elements placed in horizontal rows in Late Woodland pottery. Decoration attribute rows therefore reflect 1) Angle, the inclination of the element; 2) Technique, type of element; and 3) Motif, the Angle and Technique attributes combined, ex. horizontal twisted cords. These variable states were subject to their own statistical tests. These attributes are defined by the researcher and probably do not represent prehistoric categories or worldviews (see Dunnell 1971b; Ford 1954; Rice 1987). However, I found them to be the most parsimonious means of describing the myriad of decorative motifs recorded on the Late Woodland vessels subjected to analysis. These attributes should help to encompass the range of variation

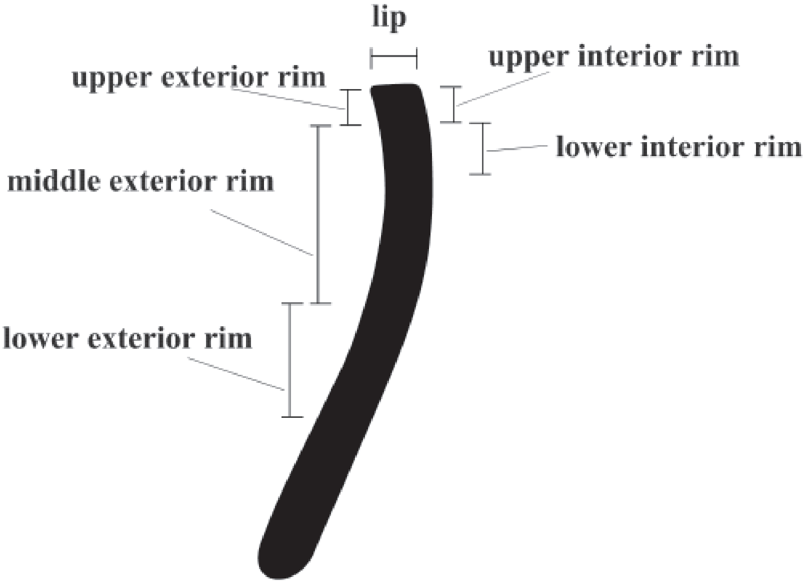

Figure 9: Vessel decoration zones.

possible on Late Woodland non-collared vessels.

Multiple design states were present in each motif category for each decoration zone. For instance, the design states of single, doubled, or tripled horizontal twisted cord are all grouped under the motif of twisted cord horizontal. Attribute categories varied between decoration zones as different zones had different Angles, Techniques, and Motifs present.

Lip decoration was any element found on the lip plane. The Middle exterior decoration zone was often the focus of the major decorative embellishments and may have been the most visible portion of vessel decoration (Rosebrough 2010). It refers to decoration panels found on the rim-neck vessel portion. Lower exterior decoration was classified as decoration occurring below the middle exterior decoration zone, or on the lower neck or vessel shoulder if found alone. Upper interior and exterior rim decoration zones are decoration placed above the middle exterior decoration, or decoration confined to the upper rim margin. Middle exterior rim decoration sometimes extended to the lip juncture and therefore into the upper exterior rim decoration area. This decoration was still classified as Middle exterior decoration because it extended below the upper rim margin and was part of the main panel motif. The upper interior rim decoration represents the primary decoration applied to the vessel interior and may have extended below the upper rim margin. Lower interior decoration was decoration placed below the upper interior decoration, and therefore was always found in combination with a primary design.

This recording scheme represents an attempt to record attributes relating to both decorative element and motif placement organization. However, certain decorative qualities had to be subsumed for statistical purposes. For instance, the final design zone configuration is given prominence causing the distinction between fabric and single cordage to not be considered. Fabric impressions produced the effect of rows of twisted cord impressions and were grouped as such. Also, R- and L- leaning decoration was not considered separately, and both were considered diagonal in coding. Perforations were not included as decoration as it was often unclear whether they were exfoliated bosses. Also, they frequently did not show definable patterning and the possibility exists they are more related to functional vessel use. A complete motif was not always visible due to sherd breakage. However, using decoration zones still makes it possible to discuss the other vessel decoration areas. Broken designs were classified with their best matching motif. The decoration legend and abbreviations used are found in Figure 10.

Decoration Statistical Tests: Fisher's Exact and Haberman Residuals

All statistical tests used in this dissertation were run in the R statistical computing package (R Core Development Team 2009). Fisher tests with Monte Carlo simulated p-values were used to search for relationships between ceramic decoration Angle, Technique, and Motif in four main southern Wisconsin River valleys (Figure 11). River valleys are shown to be a significant type of geographic division in other studies (c.f. Boszhardt and Goetz 2000; Longacre 1991; Stark 1999).

All Fisher tests were run using the fisher.test() call with 10,000 replications in the R Stats package (R Core Development Team 2009). Fisher tests were chosen over Chi-square analyses as small sample sizes often resulted in the expected values of one or more of the contingency table cells to fall below five. Fisher tests are exact tests and therefore are suited for use in contingency tables with small samples sizes because the deviation from the null hypothesis is calculated directly instead of developing an approximation based on a hypothesized larger population, as does the Chi-square (see Agresti 1992:132;

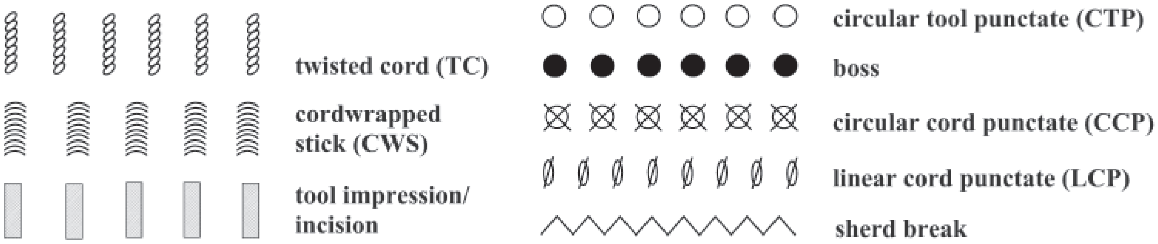

Figure 10: Decoration legend.

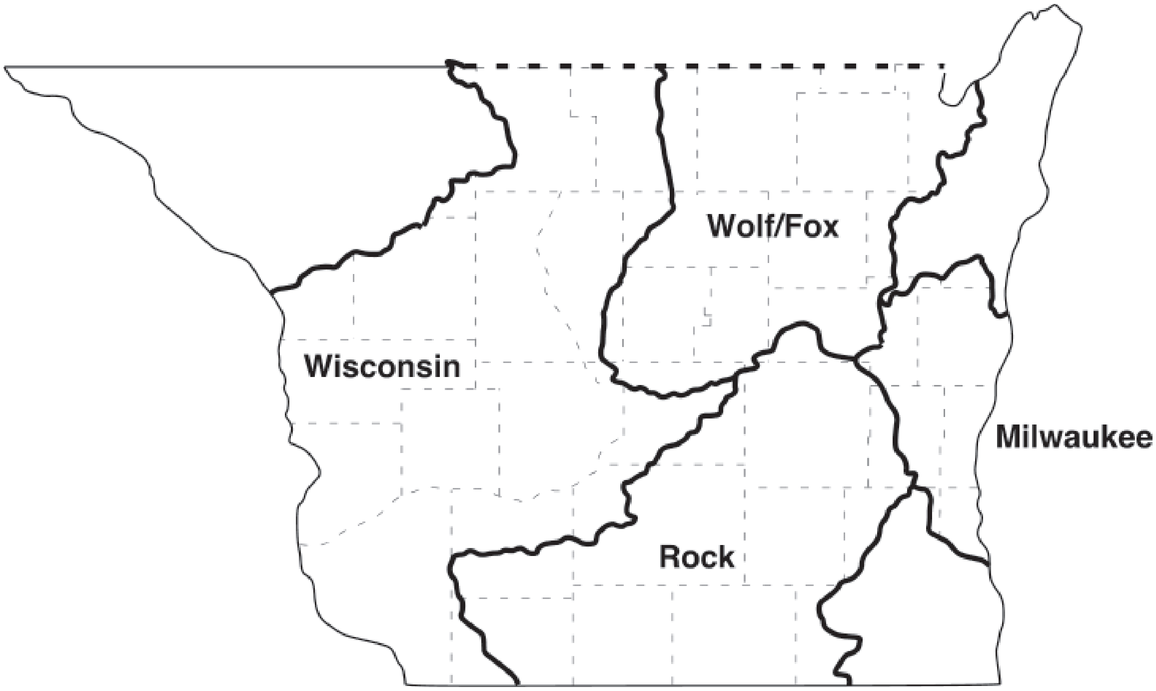

Figure 11: Major southern Wisconsin river valley divisions.

Fisher 1935, in Agresti 1992). Monte Carlo simulations are based on repeated and randomized iterations of substituted numbers that produce a probability distribution of the outcomes (Metropolis and Ulam 1949). The probably distribution can then determine how likely it is that the observed distribution would occur given the approximated expected value (Bauer 1958:438).

Additionally, Haberman adjusted residuals were employed as an exploratory device to see which cells deviated the most from independence if Fisher tests were found to be significant (Haberman 1974, 1988). Residual analysis is a good method to determine if particular cells are more responsible than others for divergence from a hypothesis assuming no correlation. An analysis of raw residuals is not appropriate for contingency tables where the cell counts vary greatly. Rather, residuals are standardized so values are comparable without reference to the actual cell counts (Stevens 2002:584). However, standardized residuals can give conservative estimates for lack of fit. Instead, adjusted residuals, like Haberman values, can provide a more precise estimation of fit because it adjusts for marginal sizes in table so all columns will have the same weight in calculation regardless of the number of cell entries (Everitt 1992; Haberman 1973). Haberman residuals are especially useful in cases of small cell counts where Pearson residuals give poorer approximations for divergence (Haberman 1988).

The Haberman residuals were produced using an R source code designed by Dr. J. Patrick Gray at the University of Wisconsin-Milwaukee (Gray 2010). The Haberman formula is:

$$z_{ij} = \frac{x_{ij} - m_{ij}}{\sqrt{m_{ij}\,(1-p_{i+})\,(1-p_{+j})}}$$

A value of +/- 1.96 was chosen as the limit of meaningful divergence, though this value is not a strict boundary with sparse tables. Positive values indicate overrepresentation, and negative values show underrepresentation. Fisher tests with Monte Carlo simulations and Haberman residual analysis were conducted on all decoration zones as the initial stage of the decoration zone analysis.

Decoration Statistical Tests: Cluster and Mantel

Site similarities for Motifs present on a particular decoration zone were calculated using the principles of the Brainerd-Robinson similarity coefficient (Brainerd 1951; Robinson 1951). The Brainerd-Robinson method is based on measuring how similar or dissimilar the percentage distributions are between cases based on the comparative frequencies of objects in those cases (Brainerd 1951:304; Robinson 1951:294). Cases that are more similar should have similar percentage distributions. This type of computation of similarity is more sensitive to large differences in counts between values measured in each case (Robinson 1951:297).

Converting the decoration zone Motif counts into a matrix measuring the site similarity through the Brainerd-Robinson similarity coefficient was accomplished using the Brerob source code designed by Gray (2011a). This matrix was produced for any site with a total motif count of seven or greater for that particular decoration zone. The code produced a dissimilarity matrix where the dissimilarity was the sum of the absolute differences in the percentages of the rows (Gray 2011a). Low scores in the matrix indicate increased site similarity. The complete set of Motifs present at a site could be analyzed as a whole in this manner regardless of where a particular Motif occurred on a vessel.

The Brainerd-Robinson dissimilarity matrix was converted to a distance matrix also using the Brerob source code (Gray 2011a). The decoration distance matrices for each decoration zone were then submitted to hierarchical cluster analysis using complete linkage by calling the hclust() command in the R Stats Package (R Core Development Team 2009). The Brainerd-Robinson formula is:

$$\boldsymbol{S} = 200 - \sum_{k=1}^{p} \left| \mathrm{P}_{ik} - \mathrm{P}_{jk} \right|$$

All cluster analyses completed in this dissertation used complete linkage (see Lovis et al. 1998). All dendrograms were evaluated for statistical significance using the R sigclust package (Huang et. al 2010) and the call: sigclust(x,nsim=1000,nrep=1,labflag=0,icovest=2). These dendrograms were also produced using hierarchical clustering methods. As will be shown in the results chapters, all of the ceramic data sets have cluster trees with dendrogram branches containing outlier sites that are not geographically close to other sites in the cluster. It is likely the sigclust() R package found these cluster trees statistically insignificant due to presence of outliers. The Mantel tests, however, only ask whether there is a correlation between case composition and geographic distance without a reliance on a hierarchical relationship. For this reason, there may be statistically significant Mantel tests, but statistically insignificant cluster dendrograms. It is possible the ceramic data would have been better explained using a clustering algorithm that is not dependent on a hierarchy, like a k-means clustering.

Cluster trees were cut into different branches using the partitioning cutree() command in R (R Core Development Team 2009). The number of clusters was determined by totaling the number of instances where k ≥ 1.25 when dividing the mean height of the tree branches against the square root of the variances of the branches. After determining the branch compositions and cutting the hierarchical dendrogram into clusters, the branches were mapped on a geographic plot of southern Wisconsin. A label was used to mark every case found in a particular cluster branch, and this label was placed in the appropriate county provenience.

During the individual decoration zone analyses, a second distance matrix was produced from site latitude and longitude coordinates using another R source code also designed Gray (2011b). This distance matrix represents the physical distance between sites. The decoration zone distance matrices were correlated to the latitude/longitude distance matrices through Mantel tests with 999 permutations. Mantel tests correlate between two matrices and help estimate the closeness between the objects (Mantel 1967). The randomizing permutation eliminates concern over placement of variable scores in the matrices since it assumes the mixing of cases will not affect the outcome. The many permutations develop a null Z-score distribution against which an observed value is judged. In this dissertation, Monte Carlo distributions were used (see Mantel 1967:213). Simulated p-values from the Mantel tests were obtained using the mantel.rtest() call in the R ade4 package (Dray and Dufour 2007).

Comparing the decoration distance matrix to the latitude/longitude distance matrix through Mantel tests determines if the two distance matrices were related. A significant simulated p-value indicates that decoration zone motifs are correlated with geographic distance between the sites. It should be noted Fisher and Haberman tests were run using vessels as the unit of analysis, but Mantel and Cluster analysis used sites as the basic unit for decoration analysis.

Technologic Analyses

As with decoration, the use of particular ceramic technological choices can also be linked with identity markers for group membership (Chilton 1999a, 1999b; Hegmon 1992; Stark 1999). Clay acquisition was a primary concern for prehistoric potters. Ethnographic evidence suggest that potters may travel on foot up to 7 km to get clay, but acquisition often happens within societal constraints of when, where, and how often they obtain clays (Arnold 1985; Rice 1987:115-116). Clay and tempering material used by household potting industries are likely to be from local sources (Sinopoli 1991:101). These clays are then cleaned and processed to varying degrees by the potter before vessel construction and tempering (see Rice 1987:120-124). Therefore, ceramic attributes include properties of both temper and matrix that can be considered in tandem or separately (Stoltman 1991).

Temper type and density inclusion impacts a range of vessel behavior including workability, wall thickness, thermal shock via porosity and permeability, thermal expansion, vessel hardness and breakage strength (Sinopoli 1991). Temper choice comes with characteristic benefits and disadvantages, but adding a particular type of temper is not always practical and can be a cultural choice (Rice 1987:230, 407). Temper size, density and type are easily controlled and manipulated during production for both functional and social reasons and are usually considered indicative of time periods or cultures (Rice 1987).

Archaeological approaches to paste and temper can be done through various technological studies including INAA, EDXRF, or petrography. These methods provide a means of characterizing pottery based on precise, objective, and replicable standards (Rice 1984:165). They are readily applicable to archaeological collections because they can be run on even the smallest vessels fragments, and most collections contain more fragments than they do whole vessels. However, the approaches relay different information about the pottery. EDXRF, for instance, records elemental data whereas petrography records mineralogical data. Employing a combination of methods is more fruitful than utilizing a single technique in order to characterize an assemblage (Steinberg and Kamilli 1984; Stoltman 2001). A lack of correspondence between two techniques is an avenue for research into why the differences exist (Ahlrichs and Schneider 2011; Kaplan et al. 1984). The use of the newly available, independent data set from technological studies can also be used to confirm or assess results from previous studies (Steinberg and Kamilli 1984).

Technological analyses can be highly diagnostic and are used to study manufacturing conditions and centers, material control, trade or localized production, temporal change, regional and ecological variation, and correspondence with established typologies (Kaplan et al. 1984; Kolb 1984; Rice 1976, 1984; Steinberg and Kamilli 1984; Stross and Asaro 1984; Stoltman 1986, 2001). These techniques are therefore applicable to the questions of pottery transport and population movement across a prehistoric landscape in this dissertation. Elemental and mineralogical characterizations of the Late Woodland vessels used in this study are approached through two complimentary technologic analyses: EDXRF and petrography.

EDXRF Analysis

EDXRF provides a non-destructive compositional analysis that can be considered another method of describing paste. The fully automated, non-destructive, low-cost procedure identifies elements and their relative intensity in a compound by bombarding a sample with X-rays and recording secondary X-ray wavelength feedback (Rice 1987). While not able to identify specific temper, EDXRF results indicate the bulk elemental compositional data of a vessel.

EDXRF is a significant boost to other attribute analyses, especially in deciding if patterns are resulting from population movement, exchange or continuity (Neff 1993; Rice 1987; Stoltman 1991). Previous researchers suggested that some Late Woodland ceramic types and styles are geographically confined, but their ability to answer questions concerning social interaction and boundaries was constrained due to a lack of ceramic sourcing data (e.g., Rosebrough 2010; Salkin 2000; Stoltman and Christiansen 2000). We can address these questions by treating vessel elemental feedback from EDXRF as signatures for similar material sources and/or social interaction (Fie 2006; Kristmanson 2004; Morgenstein and Redmount 2005).

At least two readings of 120 seconds were taken on a representative rimsherd for each vessel with a portable Thermo Scientific Niton XL3t instrument using University of Wisconsin-Milwaukee Archaeological Research Laboratory (UWM ARL) laboratory standard procedures designed to characterize vessel composition accurately. Reading times were evenly divided into Low, Medium, and High levels. Different levels record a different range of elements. The EDXRF elemental analysis proceeded with 434 vessels because one vessel from the Osceola Site was accidentally skipped during testing.

EDXRF Statistical Tests: Standardization and Principal Components

EDXRF readings were averaged by vessel, then normalized using log10 values to control for differences in elemental magnitude and make sure they had equal weight (Richards and Clauter 2009:170; Richards and Schneider 2008). The averaging and normalization was done before undertaking any EDXRF statistical tests used in this dissertation. After EDXRF readings were averaged and normalized, any elements with missing cases were removed. Therefore, every site had an EDXRF reading for every element on every vessel. This data reduction resulted in eight elements remaining: Zr, Sr, Rb, Fe, Mn, Ti, Ca, and K. The EDXRF data reports in parts per million (ppm) and statistical analysis in this dissertation proceeded using this format. However, future research may seek to use the readings as compositional data, or as percentages of the total in symbolic data analysis (Aitchison 1986, Billard and Diday 2006).

The EDXRF vessel elemental data was first subjected to Principal Components Analysis (PCA). PCA is an exploratory data analysis that transforms multivariate data into a reduced set of variables, or components, in order to more economically explain variance, or the variability in the data (see Harris 1975). The first component will explain the largest amount of variance, and a higher percentage of variance explained on this component means more structure in a data set. Principal Component analysis was conducted through the R Stats package using the princomp() command (R Core Development Team 2009).

EDXRF Statistical Tests: Cluster and Mantel

The averaged and normalized EDXRF vessel elemental values were also subject to Cluster and Mantel tests. The EDXRF vessel values were transformed into a distance matrix using the hclust() call in the R Stats package (R Core Development Team 2009). Again, partitioning was used to assess the number of branches in the hierarchical cluster tree. However, due to the large number of vessels included in the analysis, the EDXRF vessel cluster dendrogram was complicated and difficult to interpret. Also, the EDXRF data had little structure as will be seen in Chapter 6. Therefore, the vessel averaged EDXRF dendrogram was experimentally cut at different partition levels before visually deciding what number of clusters best represented the tree. This was the only time in the analysis that a visual inspection was used to help cut the dendrogram. After the final number of clusters was determined, the clusters were also mapped on a geographic plot of southern Wisconsin. The EDXRF cluster trees were also checked for significant using the R sigclust package (Huang et al. 2010).

As with the decoration analysis, a second distance matrix was produced from site latitude and longitude coordinates for the sites included in the EDXRF data sets (Gray 2011b). The EDXRF vessel distance matrix was correlated to the latitude/longitude distance matrix through Mantel tests with 999 permutations using the R ade4 package call mantel.rtest() (Dray and Dufour 2007). Again, Monte-Carlo distributions were used to simulate the p-value.

EDXRF elemental readings were also averaged and normalized using log10 values by site provenience. Testing by vessel makes the EDXRF vessel readings more comparable to the individual vessel decoration zone analysis. However, averaging EDXRF readings by site made results more comparable to the site-level clustering and Mantel tests run on the decoration Motifs. Averaging EDXRF readings by site also facilitated geographic plotting. PCA, Cluster, and Mantel tests were completed for the EDXRF site averaged data, as well. All statistical methods used for the EDXRF vessel averaged tests were followed exactly in the EDXRF site averaged tests. The exception is that only partitioning was used to determine the number of clusters in the site averaged EDXRF hierarchical cluster tree.

Petrographic Analysis

An alternative method to identifying temper and paste characteristics is petrographic analysis by thin sectioning (Rice 1987; Stoltman 1991). Petrographic thin-section analysis has been used extensively to study archaeological ceramic classification, function, production and exchange (Shepard 1936; Stoltman 1989, 1991, 2001). This technique is destructive and requires a thin slice of ceramic material to be mounted onto a glass microscope slide (Orton et al. 1993). However, the process provides a objective, standardized, and replicable assessment of clay composition that can identify specific minerals present in the paste as well as temper size, shape and inclusion density by point-counting (Stoltman 2001). Petrographic analysis identifies minerals, rather than elements, and so it is a powerful complementary technique to EDXRF (Stoltman 1989). EDXRF and petrography should always be used in tandem and as a means to double-check results (Stoltman 1989, 2001).

An important advantage of petrography is the ability to distinguish between naturally occurring and intentionally added minerals like temper. The distinction between these categories is important for characterizing ceramics for cultural indicators like technology, function, source, production or exchange (Stoltman 1989, 1991). Stoltman (1991) uses body and paste to recognize the independent origins of clays versus temper, and therefore the human agency in making pots. Body refers to the bulk composition including all attributes including temper, but paste refers to the natural materials present before temper was added. Similar body results may be presumed to represent similar manufacturing preferences, or production recipe, by potters. Similar paste composition may represent similar clay sources. However, differences in paste can indicate different clay sources, but it does not ascertain the geographic distance between those sources (Ahlrichs and Schneider 2011).

In this study, petrographic analysis is used to assess results from the EDXRF analysis as well as providing an independent data set on ceramic production and movement. Partitioning the EDXRF vessel cluster tree yielded 30 clusters. Vessels were chosen for petrographic analysis using representative samples of vessels from clusters found during EDXRF analysis. An effort was made to sample at least one vessel per cluster, and more than one vessel per cluster when possible and especially when the EDXRF clusters were larger than three vessels. Some EDXRF clusters are not represented in the petrographic analysis because all rims from that cluster were too small to be cut for thin-sectioning, the only available vessels from a cluster were from sites that had already been sampled numerous times from other clusters, or the sherds were not available from the institution where they were housed. The resulting sample size of 43 petrographic slides still expressed a significant range variation in decoration, morphology and geographic provenience. An attempt was made to select vessels from different counties within the same cluster. This petrographic sample is adequately sized to review and substantiate the EDXRF results.

The petrographic method used in this study largely follows that developed by Stoltman (1989, 1991, 2001). Slides were first subject to qualitative analysis where a listing was made of minerals present within the sample. Secondly, point-count analysis was conducted. Points were counted at a 1 mm interval over the thin-section. A threshold of 100 points was deemed necessary to adequately characterize the slide. If 100 points was not reached after the first count, the thin-section was rotated 180 degree and counted again with the observation counts added to a running tally.

Observations were assigned to the following categories: matrix, silt, natural inclusions (sand), and temper. Natural inclusions and temper were further divided into size classes ranging from fine to gravel. These were fine (0.0625-0.249 mm); medium (0.25-0.499 mm); coarse (0.50-0.99 mm); very coarse (1.0-1.99 mm); and gravel (> 2.0 mm) (Stoltman 1991). A grain size index was also established and represents the average grain size of the natural inclusions and added temper. The resulting size index numbers follow the grain size class categories. These categories are compared using visual inspection of their percentage inclusion in tabular format. Results were also placed in ternary diagrams. These diagrams provide an easily interpreted, visual method of evaluating differences and similarities between body and paste composition (Stoltman 1991).

Petrographic Statistics: ANOVA Tests

Since the petrographic analysis returned different types of data multiple different types of statistical analyses were needed to interpret the results. Temper and Natural inclusion grain size were subject to analysis of variance (ANOVA) by river valley provenience. ANOVA tests compare the variance in means of different groups to ascertain if there are equal, and can be used when there are more than two groups of means for comparison (Welkowitz et al. 2009:317-318). Since there were four river valleys under study, Milwaukee, Rock, Wolf/Fox, and Wisconsin, ANOVA tests were the best method for determining if potters in different river valleys used different grain sizes when constructing vessels. Also, ANOVA was employed because Anderson-Darling tests showed that both the Natural and Temper Inclusion variables were normally distributed. Anderson-Darling tests were completed using the ad.test() command in the R nortest package (Gross n.d.). ANOVA tests were completed using the anova(lm()) call in the R Stats package (R Core Development Team 2009).

Petrographic Statistics: Fisher's tests

Fisher tests with Monte Carlo simulated p-values were used to search for relationships between Temper Type and the four main southern Wisconsin River valleys. All Fisher tests were run using the fisher.test() call with 10,000 replications in the R Stats package (R Core Development Team 2009). Fisher tests were again chosen over Chi-square analyses as small sample sizes caused low cell counts.

Petrographic Statistics: Temper Type Cluster and Mantel Tests

The temper values were transformed into a distance matrix using the hclust() call in the R Stats package (R Core Development Team 2009). Again, partitioning was used to assess the number of branches and their vessel make-up in the hierarchical cluster tree. The petrographic dendrograms were tested for significance using the R sigclust package (Huang et al. 2010). The temper type distance matrix was correlated with a second distance matrix produced from site latitude and longitude coordinates for the sites included (Gray 2011b). This correlation occurred using Mantel tests with 999 permutations with the R ade4 package call mantel.rtest() (Dray and Dufour 2007). Monte-Carlo distributions simulated the p-value.

Petrographic Statistics: Paste and Body Percentage Inclusion Cluster and Mantel Tests

The matrix, silt, naturally occurring, and additive temper counts are studied as percentage compositions of the total vessel make-up (Stoltman 1990). As percentages, they require different statistical methods in multivariate testing through cluster and regression analysis. The Body and Paste petrographic percentage inclusions data set was transformed into distance matrices using principles of Aitchison geometry (Aitchison 1986). Percentage data must be transformed using Aitchison distance because they have a different geometrical structure than other types of data (Hron et al. 2010). Transformations of percentage data using these methods make the compositional data amenable to other, more standard, forms of multivariate analysis relying on Euclidean geometry (Egozcue et al. 2003:299). The petrographic Paste and Body percentage inclusion data sets were transformed into distance matrices using the dist(acomp()) call in the R Compositions package (Boogaart et al. 2008). Then these transformed matrices were then submitted to cluster analysis using the hclust() command in the R Stats Package (R Core Development Team 2009).

As with the decoration and EDXRF statistical analysis, a partitioning was used as an exploratory device to determine the number of branches and their site or vessel compositions in the hierarchical dendrograms. The branches were mapped on a geographic plot of southern Wisconsin after determining the branch composition and cutting the hierarchical dendrogram into the number of clusters suggested by the partitioning.

Like the preceding Mantel analyses in the decoration and EDXRF sections, a distance matrix based on site latitude and longitude coordinates was produced (Gray 2011b). The petrographic percentage distance matrices were correlated to the latitude/longitude distance matrices through Mantel tests with 999 permutations. Monte Carlo distributions were used to simulate the p-value. Simulated p-values from the Mantel tests were obtained using the mantel.rtest() call in the R ade4 package (Dray and Dufour 2007).

Petrographic Statistics: Regression

Instead of ANOVA, a regression analysis was employed to determine if river valley provenience could predict the Paste or Body percentage compositions. A further transformation using isometric log-ratio transformations (ILR) (Boogaart et al. 2008) was necessary to analyze the matrices in regression analysis after their Aitchison compositions were extracted. After undergoing the ILR transformation, the data was subject to regression using the lm() call in the R Stats package (R Core Development Team 2009).

Chapter 5: Decoration Analysis Results

Decoration analysis has been used extensively in Wisconsin Late Woodland pottery studies, particularly in culture-history or chronology building efforts. Decoration, cordage, and fabric studies found regional differences and these were often used to demonstrate regional patterning (Benn 1980; Boszhardt and Goetz 2000; Hurley 1976; Storck 1972). Decoration is also used to distinguish Madison Ware type-varieties from each other (Baerreis 1953; Hurley 1975; Keslin 1958; Logan 1976; C. Mason 2004; Wittry 1959). Early works used cordage analysis to distinguish pottery styles (Hall 1950).

More recent studies have used decoration to test theories of social interaction. Rosebrough (2010) conducted systematic ceramic decoration and morphological analyses to posit that groups of effigy mound builders used pottery style to distinguish themselves from each other while also conforming to larger groups like sodalities. She suggests that Late Woodland ceramic style did not represent homogeneity of ceramic vessel production across social groups, but that the sharing of styles through frequent interaction among discrete groups with high mobility led to ceramic style similarities across the landscape. However, she does not have the data to help discriminate whether it is the ideas of particular styles or the actual movement of ceramic vessels that results in the similarity of ceramic vessel designs across the study area. Additionally, she posits that decorative attributes indicate increased territoriality by the social units through time in the Late Woodland period (Rosebrough 2010). However, Rosebrough (2010:263) acknowledges temporal control in her study is limited, which reduces the testability of this second hypothesis.

In this study, vessel decorative attributes in six decoration zones were compared to a river valley provenience in order to ascertain if differences existed between decoration zone and site location. Attributes tested include: 1) Angle, the inclination of the element; 2) Technique, type of element; and 3) Motif, the Angle and Technique attributes combined. Some variable state categories were collapsed during analysis due to low counts. These are discussed on a case-by-case basis by decoration zone. Only significant results are presented. Decoration zone analysis demonstrates regional grouping of some attributes, but also spread and overlap in cluster geographic plotting.

Lip Decoration Zone

There are 435 vessels with discernible lip area. Of these, 174 are decorated and therefore have Angle and Technique attributes (Tables 3 and 4). Four types of angles were observed: transverse, parallel, diagonal, and multiple. The multiple variable state represents cases where decoration was placed at two separate angles. Angle was significant by river valley (Fisher sim.p=0.002).

Lips exhibiting decoration with multiple angles were overrepresented in the Milwaukee valley (Haberman [hab.]=2.59), transverse impressions were overrepresented in the Wisconsin valley (hab.=2.85) and parallel impressions were overrepresented in the Wolf valley (hab.=3.89). No lip angle variable states were underrepresented by river valley.

Lips exhibited seven techniques: twisted cord (TC), linear cord punctates (LCP),

Table 3: Lip Angle by River Valley

River Valley	Transverse	Parallel	Diagonal	Multiple
Milwaukee	26	2	34	4
Wisconsin	34	1	17	0
Wolf	13	6	9	0
Rock	12	1	15	0

Table 4: Lip Technique by River Valley

River Valley	TC	LCP	CCP	CWS	CTP	Tool	Multiple
Milwaukee	51	3	1	6	0	1	4
Wisconsin	48	2	0	1	0	1	0
Wolf	19	3	0	4	1	1	0
Rock	23	2	1	0	0	2	0

circular cord punctates (CCP), cordwrapped stick (CWS), circular tool punctates (CTP), tool impressions and multiple. The multiple variable state represents lips where two different types of implements were used. Technique, however, was not significant by river valley (Fisher sim.p=0.06).

Twenty-one types of lip decoration were noted, and these were split into ten Motif categories (Table 5, Figure 12). Some of these Motif states represent collapsed attribute categories instead of simple combinations of Angle and Technique states. It should be

Table 5: Lip Motif by River Valley

River Valley	CP	LCP trans	LCP diag	Tool	CWS	TC para	TC diag	TC trans	Combination	Plain
Milwaukee	1	3	0	1	6	1	31	19	4	25
Wisconsin	0	0	2	1	1	1	15	32	0	132
Wolf	1	2	1	1	4	5	7	7	0	43
Rock	1	1	1	2	0	0	13	10	0	61

CP= circular punctate; trans= transverse; diag= diagonal; para=parallel

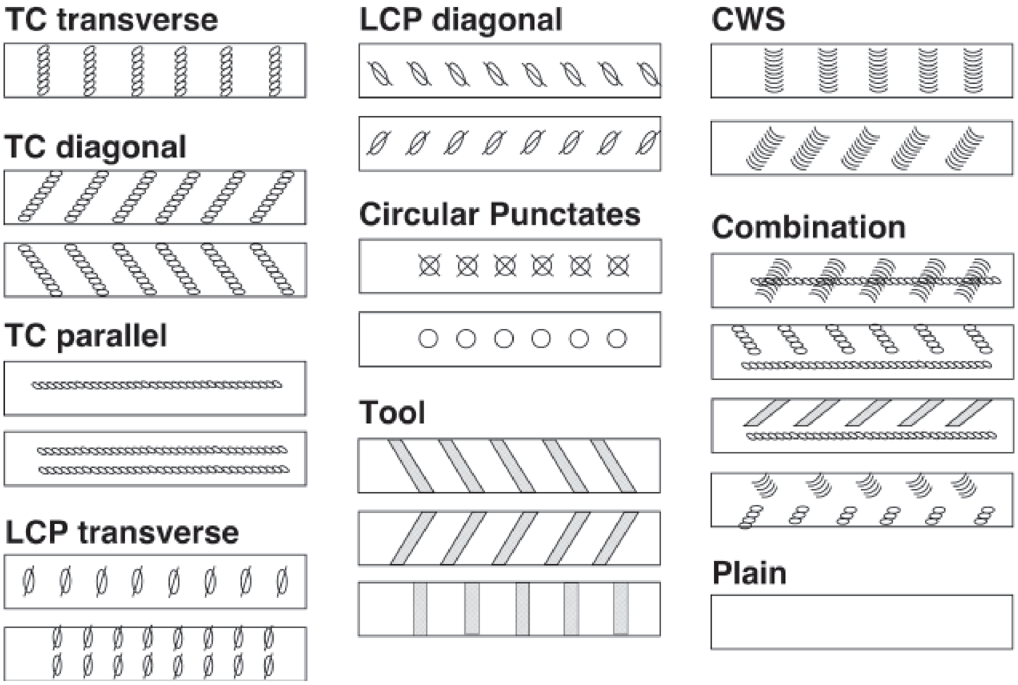

Figure 12: Lip decorations and Motifs.

noted the author subjectively defined and decided when category collapse was necessary for all decoration zones. Category collapse occurred only when cell counts were deemed too low for accurate analysis. CCPs (N=2) were combined with CTPs (N=1) into one Circular Punctate motif. Transverse tool (N=3) and diagonal tool impressions (N=2) were combined into one Tool category. Diagonal CWS (N=3) and transverse CWS (N=8) were also placed together. The Combination motifs represent cases where multiple types of angles and techniques were used on one vessel. Motif was significant by river valley (Fisher sim.p=0.000) (Table 6). The largest difference relates to the presence or absence of lip decoration based on river valley provenience. Vessels found outside the Wisconsin River valley tend to have their lips decorated, while vessels found within the Wisconsin River valley tend to be left plain. Vessels from the Milwaukee River valleys are overrepresented in CWS, TC diagonal, and Combination motifs. Parallel twisted cord impressions are overrepresented in the Wolf River Valley.

Twenty sites have a combined Lip Motif count of N≥7. These sites had their motif counts summed, transformed into a distance matrix, and subject to cluster analysis. Sites in the Lip Motif distance matrix show four major groups in the cluster analysis (Figure 13). The lip dendrogram was not found to be statistically significant (p=0.111). However, Mantel tests indicate Lip Motifs are significantly correlated with geographic distance (Mantel sim.p=0.002). A geographic plot of these Lip motif clusters shows two

Table 6: Significant Lip Motif Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	CWS (2.78)	Plain (-7.12)
	TC diagonal (5.65)	
	Combination (3.91)	
Wisconsin	Plain (4.28)	LCP transverse (-2.11)
		CWS (-2.25)
		TC diagonal (-3.49)
Wolf	TC parallel (3.98)	

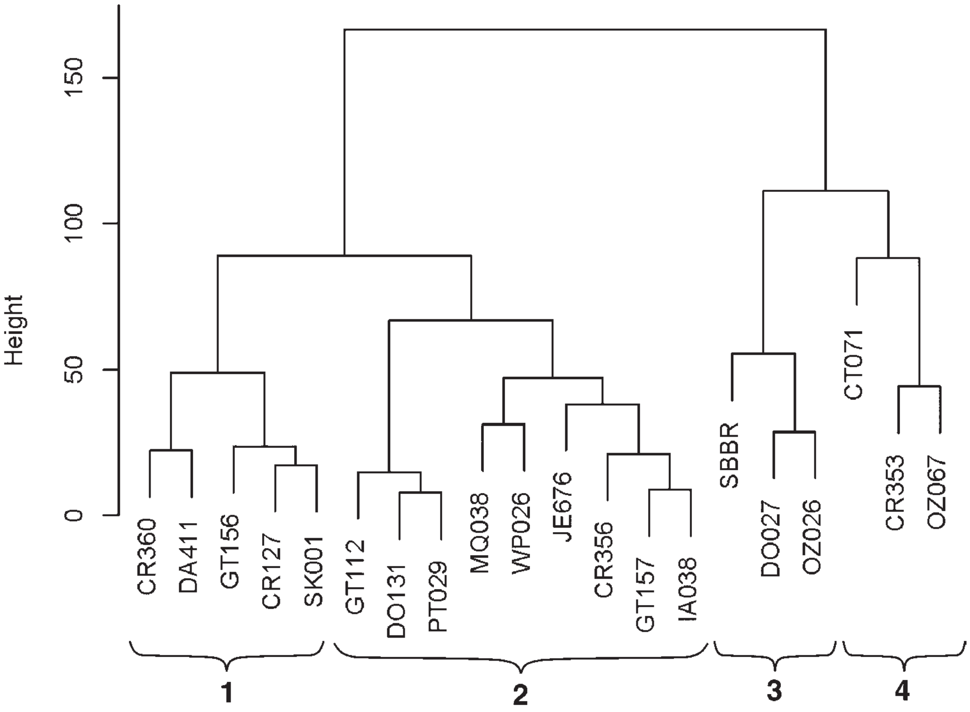

Figure 13: Lip Motif clustering by site.

concentrated clusters on the eastern and western sides of the state (Figure 14). Also, there are another two clusters with wide geographic spread that cover most of the study area. These results indicate that while there may be regionalization of particular lip decoration motifs, there is also sharing of certain aspects of lip decoration.

Upper Interior Decoration Zone

Upper Interior rim decoration was visible on 432 vessels. Of these, 258 are decorated and therefore have Angle and Technique attributes. Four angle types were noted: horizontal, vertical, diagonal and multiple (Table 7). Multiple angles represent banding. A band is defined as a row of decoration where elements comprising the design exhibit multiple, contrasting angle degrees. Angle was not significant by river valley (Fisher sim.p=0.497).

Six techniques were visible: TC, LCP, CCP, CWS, boss, and tool impressions (Table 8). Technique is significant by River valley (Fisher sim.p=0.000). The Wisconsin

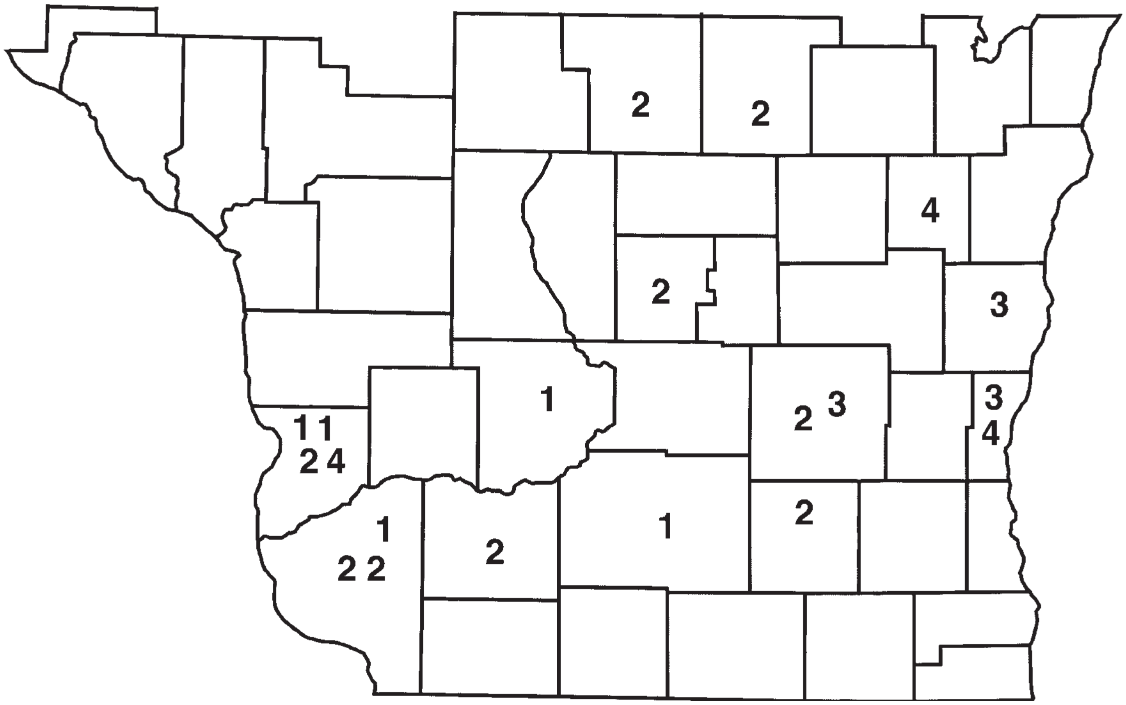

Figure 14: Lip Motif clusters geographic plot. Labels correspond to clusters in Figure 13.

Table 7: Upper Interior Angle by River Valley

River Valley	Horizontal	Vertical	Diagonal	Multiple
Milwaukee	2	20	44	1
Wisconsin	7	32	51	1
Wolf	1	15	32	0
Rock	2	11	39	0

Table 8: Upper Interior Technique by River Valley

River Valley	TC	LCP	CCP	CWS	Boss	Tool
Milwaukee	52	6	0	7	2	0
Wisconsin	88	1	0	1	0	1
Wolf	37	1	2	7	0	1
Rock	34	5	0	7	2	4

River valley is overrepresented in the TC technique, but was underrepresented in LCP and CWS techniques. The Wolf River contained most of the CCP, but the Rock River valley contained most of the tool impressions (Table 9).

Seventeen different decorations were visible on upper interior rims, and these were divided into eleven Motifs (Figure 15, Table 10). Some Upper Interior Motif categories were collapsed in statistical analysis. Diagonal LCP (N=2) was combined with vertical LCP (N=11); horizontal CCP (N=1) was combined with diagonal CCP (N=1); and vertical tool (N=2) was combined with diagonal tool impressions (N=4).

Table 9: Significant Upper Interior Technique Haberman Scores

River Valley	Overrepresented	Underrepresented
Wisconsin	TC (4.58)	LCP (-2.13)
		CWS (-3.15)
Wolf	CCP (2.97)	
Rock	Tool (2.87)	TC (-3.48)

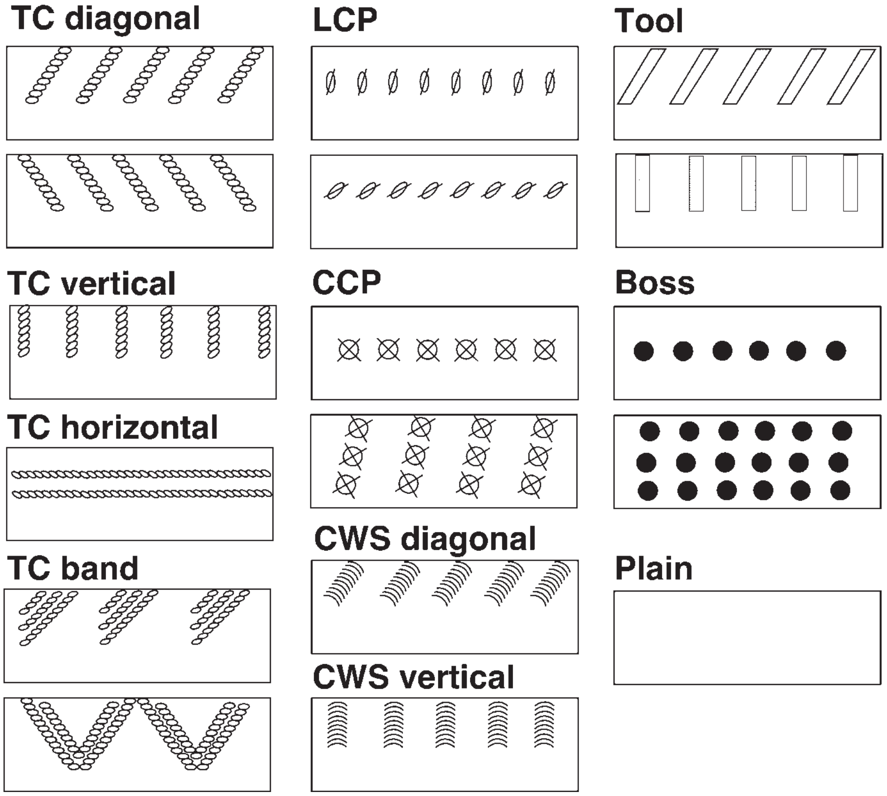

Figure 15: Upper Interior decorations and Motifs.

Table 10: Upper Interior Motif by River Valley

River Valley	TC diag	TC vert	TC horiz	TC band	LCP	CCP	CWS diag	CWS vert	Tool	Boss	Plain
Milwaukee	41	10	0	1	6	0	3	4	0	2	24
Wisconsin	49	31	7	1	1	0	1	0	1	0	91
Wolf	29	8	0	0	1	2	2	5	1	0	22
Rock	29	5	0	0	5	0	5	2	4	2	37
* diag=diagonal, vert=vertical, horiz=horizontal											

Upper Interior decoration Motif was significant by river valley (Fisher sim. p=0.000). Compared to the Lip analysis, where Angle was more important than Technique, the Upper Interior decoration zone is driven by Technique. It is interesting to note the Milwaukee River valley is not significant for either Angle or Technique, but shows significant differences for Motifs. The Milwaukee River valley is underrepresented in Plain motifs, but overrepresented in TC diagonal and LCP (Table 11). The Wisconsin River valley seems fairly narrow in the types of motifs found on the Upper Interior decoration zone: TC (vertical or horizontal) and Plain motifs. In contrast, eastern Wisconsin seems to show many different types of motifs and elements in this zone: TC diagonal, LCP, CCP, CWS and tool impressions. Non-twisted cord motifs, like CWS vertical and tool impressions, are more likely to be found in the Wolf and Rock River valleys.

Table 11: Significant Upper Interior Motif Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	TC diagonal (2.44)	Plain (-3.04)
	LCP (2.25)	
Wisconsin	TC vertical (2.43)	TC diagonal (-2.74)
	TC horizontal (3.12)	LCP (-2.55)
	Plain (3.52)	CWS vertical (-2.87)
		CWS diagonal (-2.25)
Wolf	CCP (3.22)	
	CWS vertical (2.67)	
Rock	CWS diagonal (2.06)	TC vertical (-2.20)
	Tool (2.81)	

There were twenty sites with an Upper Interior Motif total N≥7. Sites in the Upper Interior Motif distance matrix show four major groups in the cluster analysis (Figure 16). The Upper Interior dendrogram was not found to be significant (p=0.733). However, Mantel tests demonstrate that Upper Interior decoration Motif is significantly correlated to geographic distance (Mantel sim.p=0.018). However, when plotted geographically the clusters show wide distribution across the state (Figure 17). Two sites, CT071 and CR356, form separate clusters branches where N=1, and CT071 is especially divergent on the cluster dendrogram. The further cluster partitioning showed only two significant clusters. Cluster 3 seems to be more east-central, while Cluster 4 appears as a more west-central cluster. While the cluster distribution may be geographically large, it is also important to note that the sites included in a cluster may not be evenly distributed.

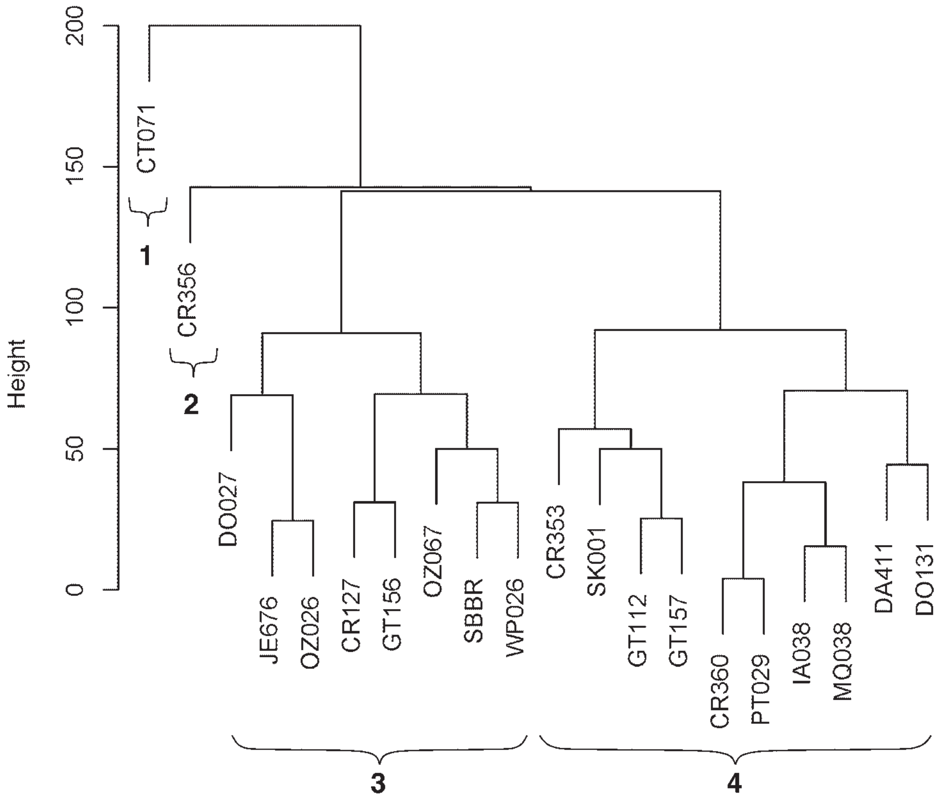

Figure 16: Upper interior Motif clustering by site.

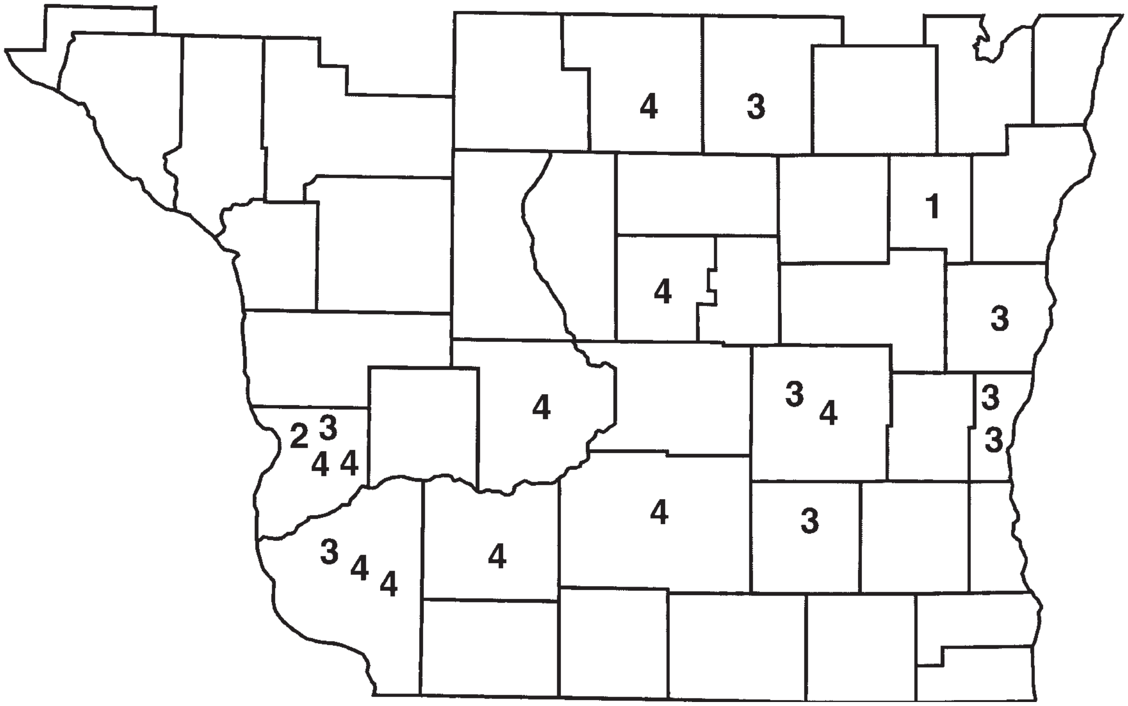

Figure 17: Upper Interior Motif clusters geographic plot. Labels correspond to clusters in Figure 16.

Lower Interior Decoration Zone

There are nineteen vessels that have Lower Interior rim decoration. Cluster trees and Mantel tests were not run on the Lower Interior decoration zone data as no site had a total N≥7 for its Motif counts.

Three types of Angles were noted: horizontal, vertical and diagonal (Table 12). Fisher tests found Angle varied significantly by river valley (Fisher sim.p=0.01), but only for two scores in the Wolf River valley. Horizontal elements were underrepresented (hab.=-3.45) while vertical elements were overrepresented (hab.=4.35) in the Wolf valley. Four techniques were placed on the Lower Interior rim: TC, LCP, boss and tool impressions (Table 13). Fisher tests for Technique were not performed as the Technique data table replicated the exact structure of the Lower Interior Motif table and would therefore also give the same results.

Table 12: Lower Interior Angle by River Valley

River Valley	Horizontal	Vertical	Diagonal
Milwaukee	8	0	1
Wisconsin	6	0	0
Wolf	0	2	0
Rock	2	0	0

Table 13: Lower Interior Technique by River Valley

River Valley	TC	LCP	Boss	Tool
Milwaukee	1	0	7	1
Wisconsin	5	0	1	0
Wolf	0	2	0	0
Rock	0	0	2	0

Six decoration forms were noted and divided into four Motifs (Figure 18, Table 14). Lower Interior Motifs are particular to river valley (Fisher sim.p=0.00). The Milwaukee River valley is overrepresented in the boss motifs, while the Wisconsin River valley is underrepresented in these types of decoration (Table 15). The Wisconsin valley instead is overrepresented in the TC horizontal motif (hab.=3.30). LCP vertical motifs are found in the Wolf River valley (hab.=4.35). Though the sample is small, Lower Interior decoration is perhaps better defined by Technique and Motif attributes than Angle variables.

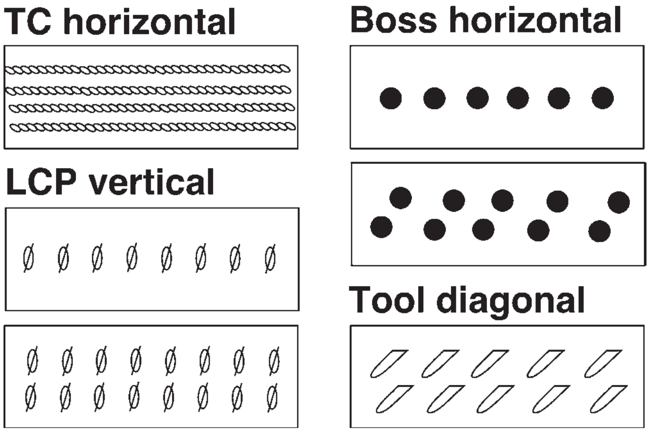

Figure 18: Lower Interior decorations and Motifs.

Table 14: Lower Interior Motif by River Valley

River Valley	TC horizontal	LCP vertical	Boss	Tool diagonal
Milwaukee	1	0	7	1
Wisconsin	5	0	1	0
Wolf	0	2	0	0
Rock	0	0	2	0

Table 15: Significant Lower Interior Motif Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	Boss horizontal (2.08)	
Wisconsin	TC horizontal (3.30)	Boss horizontal (-2.13)
Wolf	LCP vertical (4.35)	

Lower Exterior Decoration Zone

There are 163 vessels with visible lower exterior decoration. Of these, 49 vessels are not plain and have Angle and Technique attributes. Four types of Angles were seen: horizontal, vertical, diagonal, and multiple (Table 16). The multiple variable represents chevrons and filled chevrons, i.e. bands. Angle was significant by river valley (Fisher sim.p=0.04). The Wisconsin River valley was overrepresented in multiple, while the Milwaukee valley was overrepresented in vertical angles. The Wolf River valley was overrepresented in diagonal angles, but underrepresented in vertical angles (Table 17). Five Lower Exterior Techniques were noted: TC, LCP, CCP, CWS, and CTP (Table 18). However, Technique was not significant by river valley (Fisher sim.p=0.26).

There are nineteen different types of decoration visible on Lower Exterior rims (Figure 19). These were divided into nine Motifs after some decoration categories were

Table 16: Lower Exterior Angles by River Valley

River Valley	Horizontal	Vertical	Diagonal	Multiple
Milwaukee	2	9	1	0
Wisconsin	3	12	7	7
Wolf	1	0	3	0
Rock	0	2	2	0

Table 17: Significant Lower Exterior Angle Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	vertical (2.24)	
Wisconsin	multiple (2.37)	
Wolf	diagonal (2.29)	vertical (-1.96)

Table 18: Lower Exterior Techniques by River Valley

River Valley	TC	LCP	CCP	CWS	CTP
Milwaukee	0	8	1	2	1
Wisconsin	11	14	2	1	1
Wolf	1	2	1	0	0
Rock	1	3	0	0	0

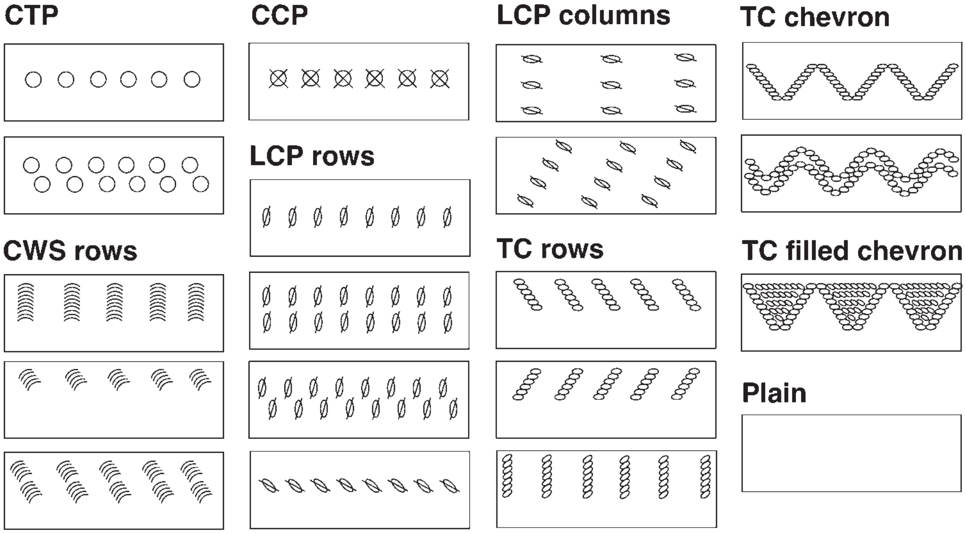

Figure 19: Lower Exterior decorations and Motifs.

collapsed (Table 19). Vertical LCP (N=20) was combined with LCP diagonal (N=5) into a LCP rows category. LCP diagonal column (N=1) was collapsed with LCP vertical columns (N=1) into a single LCP column category. Also, CWS diagonal (N=2) was combined with CWS vertical (N=1) into a general CWS motif variable. Chevrons (N=1) and Waves (N=1) were considered together. Finally, TC vertical (N=1) was added to TC diagonal (N=5) counts and designated TC rows. Motif was not significant by river valley (Fisher sim.p=0.18).

Table 19: Lower Exterior Motifs by River Valley

River Valley	CCP	CTP	CWS rows	LCP rows	LCP columns	TC rows	TC chevron	TC filled chevron	Plain
Milwaukee	1	1	2	7	1	0	0	0	21
Wisconsin	2	1	1	14	0	4	5	2	43
Wolf	1	0	0	1	1	1	0	0	22
Rock	0	0	0	3	0	1	0	0	28

Ten sites had an N≥7 for the summed Lower Exterior Motif types. However, Mantel tests indicate Lower Exterior decoration was not correlated with geographic distance (Mantel sim.p=0.093). The lack of significance may be due to the small counts.

Upper Exterior Decoration Zone

There are 424 rims with a discernible Upper Exterior rim portion. Of these, 158 are not plain and therefore have Angle and Technique measurements. Five Angle categories were recognized: horizontal, vertical, diagonal, alternate diagonal, and multiple (Table 20). Alternate diagonal was divided into its own category because it appeared to represent a recurring theme in exterior decoration zones. Angle is significant by river valley (Fisher sim.p=0.004). The Wisconsin River valley is overrepresented in vertical angles (hab.=3.44) and the Rock River valley in horizontals (hab.=2.34). The Wolf River valley is overrepresented in diagonals (hab.=2.08), but underrepresented in verticals (hab.=-2.55) (Table 21).

Six different techniques were noted in the Upper Exterior decoration zone: TC, LCP, CCP, CWS, CTP, and tool impressions. Technique is significant by river valley (Fisher sim.p=0.01) (Table 22). The Wisconsin valley has the twisted cord techniques,

Table 20: Upper Exterior Angle by River Valley

River Valley	Horizontal	Vertical	Diagonal	Alternate Diagonal	Multiple
Milwaukee	2	16	17	2	1
Wisconsin	2	44	25	0	0
Wolf	3	7	17	1	0
Rock	4	7	9	1	0

Table 21: Signficant Upper Exterior Angle Haberman scores

River Valley	Overrepresented	Underrepresented
Wisconsin	vertical (3.44)	
Wolf	diagonal (2.08)	vertical (-2.55)
Rock	horizontal (2.34)	

Table 22: Upper Exterior Technique by River Valley

River Valley	TC	LCP	CCP	CWS	CTP	Tool
Milwaukee	25	10	1	1	1	0
Wisconsin	58	10	2	0	0	1
Wolf	18	4	2	3	1	0
Rock	11	4	3	0	1	2

while non-twisted cord techniques were found in the Wolf and Rock River valleys (Table 23).

There were sixteen decoration types present in the Upper Exterior decoration zone and these were divided into ten Motif categories (Figure 20, Table 24). Some Motif categories were collapsed for analysis. Vertical CWS (N=3) was combined with CWS diagonal (N=1) into one CWS category. LCP diagonal (N=6) was combined with LCP alternate diagonal (N=1). TC diagonal (N=59) was combined with TC alternate diagonal (N=1) into a single TC diagonal variable. Tool vertical (N=1) was combined with Tool diagonal impressions (N=2) to represent a single Tool category.

Motif was significant by River valley (Fisher sim.p=0.000). The Wisconsin River valley was the only geographic area with an overrepresentation of twisted cord motifs, and this was the only element and motif overrepresented in this area (Table 25). The Milwaukee River valley was not significant for either the Upper Exterior

Table 23: Significant Upper Exterior Technique Haberman Scores

River Valley	Overrepresented	Underrepresented
Wisconsin	TC (2.70)	
Wolf	CWS (3.04)	
Rock	CCP (2.07)	TC (-2.00)
	Tool (2.74)	

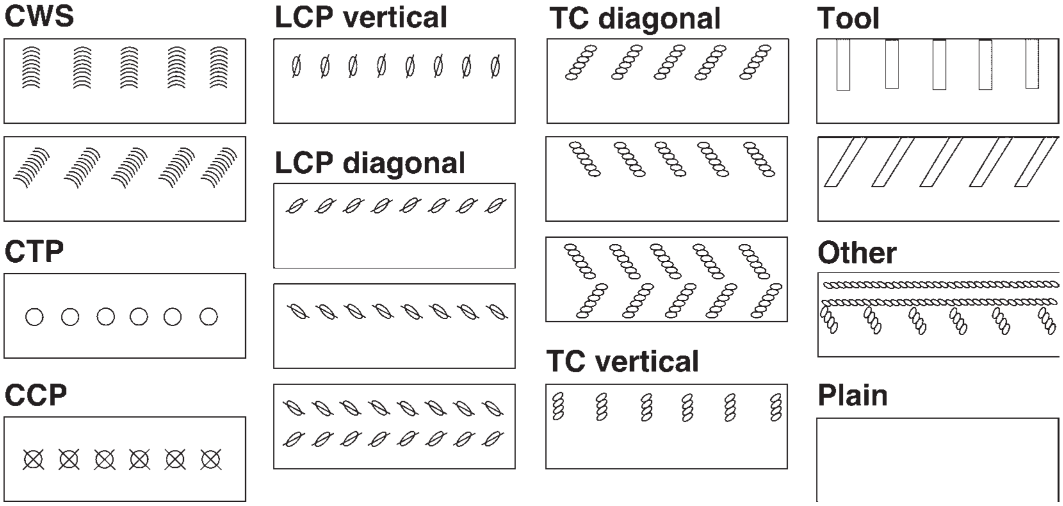

Figure 20: Upper Exterior decorations and Motifs.

Table 24: Upper Exterior Motifs by River Valley

River Valley	CWS	CTP	CCP	Tool	LCP vert	LCP diag	TC vert	TC diag	Combi-nation	Plain
Milwaukee	1	1	1	0	9	1	6	18	1	48
Wisconsin	0	0	2	1	8	2	36	22	0	110
Wolf	3	1	2	0	2	2	3	15	0	43
Rock	0	1	3	2	2	2	4	7	0	65
diag=diagonal; vert=vertical										

Table 25: Significant Upper Exterior Motifs Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	LCP vertical (2.64)	
	Combination (1.98)	
Wisconsin	TC vertical (4.63)	
Wolf	CWS (3.14)	TC vertical (-2.11)
Rock	Tool (2.01)	TC vertical (-2.24)
	Plain (2.76)	

Angle or Technique tests, but was significant in the Motifs test. It was overrepresented in Combination (hab.=1.98) and LCP vertical motifs (hab.=2.64). The Combination motif, though, consisted of an N=1. As with other decoration zones, the motifs based on decoration other than twisted cord, like CWS or tool impressions, were found in the Wolf and Rock River valleys. The Rock River valley also was overrepresented in Plain motifs (hab.=2.76).

Nineteen sites have a Motif total N≥7 for the Upper Exterior decoration zone. Four major groups were recognized from the cluster dendrogram (Figure 21). The Upper Exterior dendrogram was not found to be significant (p=0.814). Mantel tests confirm Upper Exterior rim motif is correlated with geographic distance (Mantel sim. p=0.018). When plotted on a geographic map, the Crawford County sites show a tight clustering (Figure 22). Also, a small cluster of central/eastern sites including SK001, DO027, OZ067, and OZ026 is apparent. However, two large clusters cover the central portion of the state. Again, some motifs are more regionally located, like those found at site included in the Upper Exterior clusters 1 and 4, while other motifs seem more widespread, like the motifs found at sites included in the Upper Exterior clusters 2 and 3.

Middle Exterior Decoration Zone

The Middle Exterior portion of the vessel may be the most visible and therefore

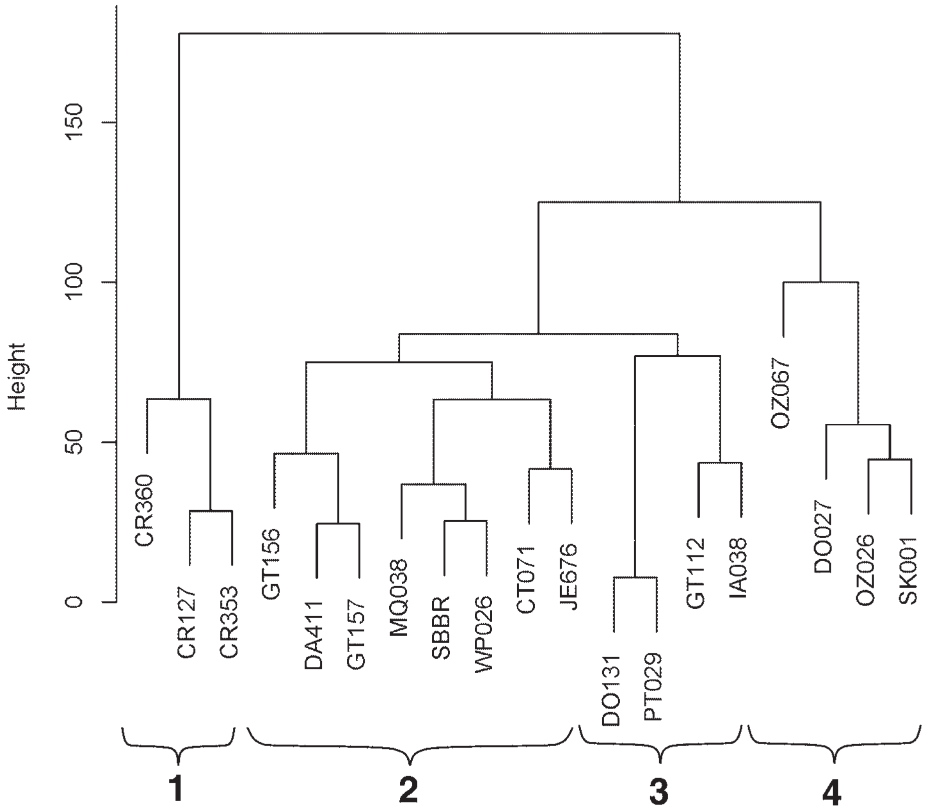

Figure 21: Upper Exterior Motif clusters.

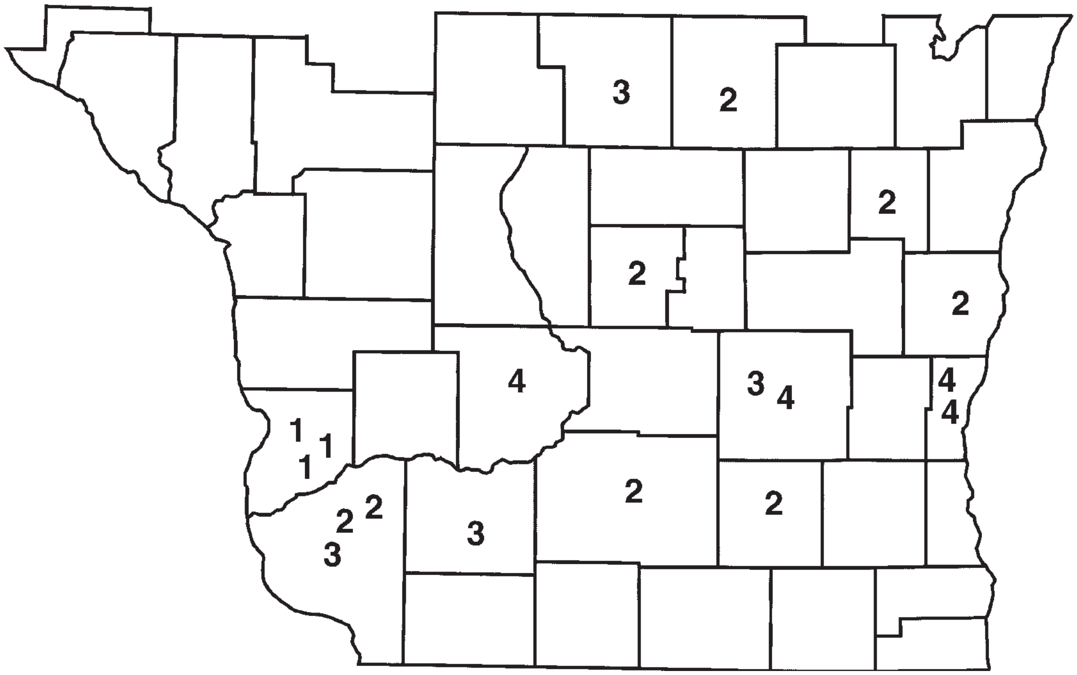

Figure 22: Upper Exterior Motif clusters geographic plot. Labels correspond to clusters in Figure 21.

the most subject to use as identity indicators (Rosebrough 2010). Therefore, any geographic differences found on this vessel portion may be of paramount importance. Decoration on the Middle Exterior rim is discernible in 428 vessels. Of these, 298 are decorated and have Angle and Technique records. There were five types of Angles: horizontal, vertical, diagonal, alternate diagonal, and multiple (Table 26). Angle is significant by river valley (Fisher sim.p=0.000). The difference is a strong east-west division between horizontal and diagonal angles. The Wisconsin valley is overrepresented in horizontals (hab.=4.00) and the Milwaukee River valley is overrepresented in diagonals (hab.=5.26) (Table 27).

Five types of Techniques were noted: TC, LCP, CCP, CTP, and multiple (Table 28). Technique is significant by river valley (Fisher sim.p=0.000). Once again, the Wisconsin River valley is overrepresented in twisted cord techniques, while other types of decoration techniques are overrepresented in other river valleys (Table 29). The Rock River valley is overrepresented in CTP (hab.=2.87), while the Milwaukee valley is

Table 26: Middle Exterior Angle by River Valley

River Valley	Horizontal	Vertical	Diagonal	Alternate Diagonal	Multiple
Milwaukee	22	5	34	1	7
Wisconsin	86	9	14	0	21
Wolf	20	2	13	2	6
Rock	30	5	14	2	5

Table 27: Significant Middle Exterior Angle Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	diagonal (5.26)	horizontal (-4.01)
Wisconsin	horizontal (4.00)	diagonal (-5.04)
		alternate diagonal (-1.98)

Table 28: Middle Exterior Techniques by River Valley

River Valley	TC	LCP	CCP	CTP	Multiple
Milwaukee	54	6	0	1	8
Wisconsin	121	8	0	0	1
Wolf	38	1	1	3	0
Rock	45	4	1	5	1

Table 29: Significant Middle Exterior Techniques Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	Multiple (4.33)	TC (-2.31)
Wisconsin	TC (2.90)	CTP (-2.68)
		Multiple (-2.18)
Rock	CTP (2.87)	

overrepresented in the multiple category (hab.=4.33).

Fifty-eight Middle Exterior decoration designs were sorted into eleven Motifs (Figure 23; Table 30). Some Motifs represent collapsed categories. CTP bands (N=1) were combined with TC bands (N=38) into a single Band category. The LCP rows category represents the combined counts of LCP vertical (N=11) and LCP diagonal (N=1). Also, the LCP column category is combined from LCP vertical columns (N=4) and LCP diagonal columns (N=3). CTP Columns (N=3) and CTP horizontal rows (N=5) were placed into a single CTP category.

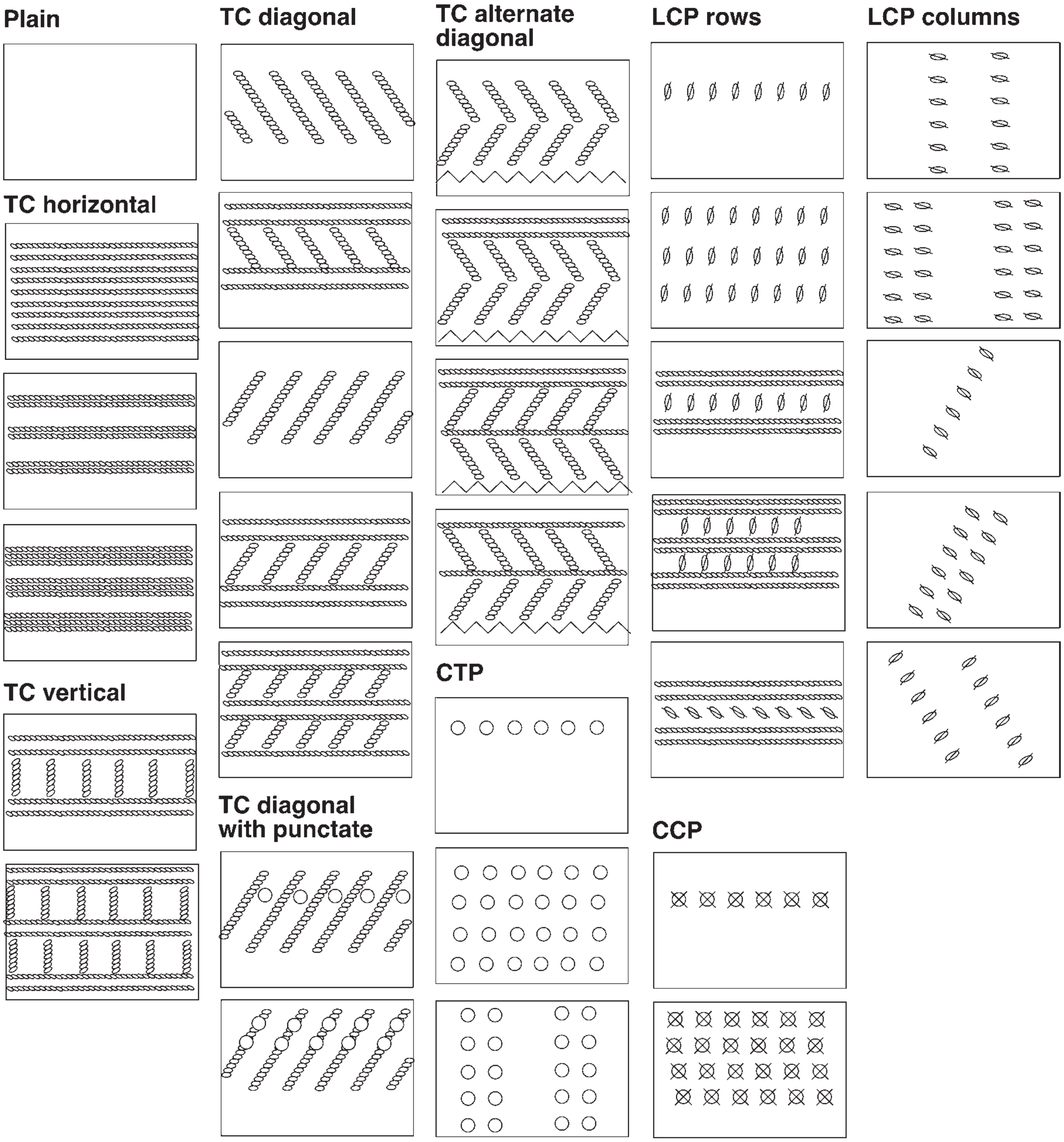

Figure 23: Middle Exterior decorations and Motifs, part 1.

Table 30: Middle Exterior Motifs by River Valley

River Valley	TC horiz	TC vert	TC diag	TC alt diag	TC diag w/ punct	Bands	LCP rows	LCP col	CCP	CTP	Plain
Milwaukee	21	0	25	1	8	7	3	3	0	1	18
Wisconsin	86	3	12	0	0	21	6	2	0	0	53
Wolf	17	0	13	2	0	6	0	1	1	3	27
Rock	27	0	12	2	1	5	3	1	1	4	32
horiz=horizontal; vert=vertical; diag=diag; alt dig=alternate diagonal; col=columns; w/ punct=with puncates											

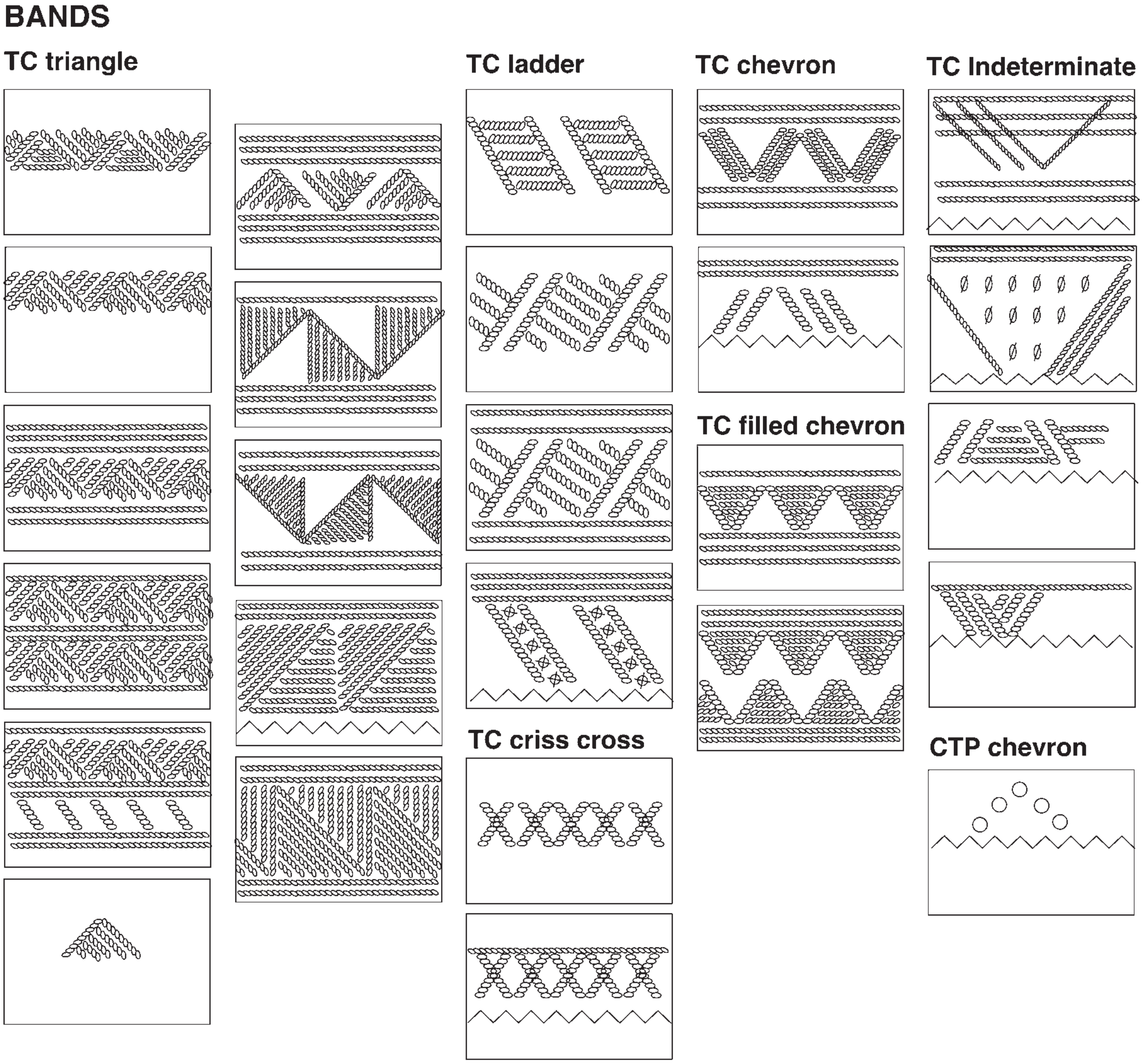

Figure 23: Middle Exterior decorations and Motifs, part 2.

Middle Exterior decoration motifs are significant by river valley (Fisher sim. p=0.000) (Table 31). A main difference is reflected again between the Milwaukee and Wisconsin River valleys. The Milwaukee valley is overrepresented in TC diagonal (hab.=4.23) and TC diagonal with punctate designs (hab.=5.17). However, TC horizontal (hab.=4.38) and TC vertical (hab.=2.01) motifs are overrepresented in the Wisconsin River valley. CTPs are overrepresented in the Rock River valley (hab.=2.08), and this represents another case of non-twisted cord decoration being drawn to this valley.

Nineteen sites have a summed Motif total of N≥7. Four groups were visible

Table 31: Significant Middle Exterior Motif Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	TC diagonal (4.23)	TC horizontal (-2.44)
	TC diagonal w/ punctate (5.17)	Plain (-2.20)
Wisconsin	TC horizontal (4.38)	TC diagonal (4.23)
	TC vertical (2.01)	TC diagonal w/ punctate (-2.62)
		CTP (-2.47)
Wolf		TC horizontal (-2.10)
Rock	CTP (2.08)	

on the cluster dendrogram (Figure 24), but this tree composition is not statistically significant (p=0.705). The cluster map shows that Middle Exterior motifs are found within geographically distinct, but overlapping areas (Figure 25). These are the most distinct geographic clusters of all the decoration zones. Three clusters (1, 2, and 4) are geographically separated, but one cluster (3) is found across the entire state. However, as the cluster dendrogram shows, this group could be further split into two clusters separating the Grant, Iowa and Jefferson County sites from SBBR, WP026, and OZ026 motifs.

The split produces a southwest to northeast division. Mantel tests confirm Middle Exterior rim motif is correlated with geographic distance (sim.p=0.001) and means vessels nearer to each other tend to have similar decoration motifs on the Middle Exterior decoration zone. It is apparent, that the Middle Exterior decoration zone may have been used as method to signal regional group membership and possibly represents the best decoration zone to establish this type of relationship as it produces the most visible geographic partitioning when the clusters on plotted on a map.

Middle Exterior Rim Sub-Tests

Further tests were necessary for Middle Exterior rim portions where it was believed that attributes were too encompassing to elucidate regional variation. These included tests for Bands, TC horizontals, Bordered, and Doubled designs. While Bands

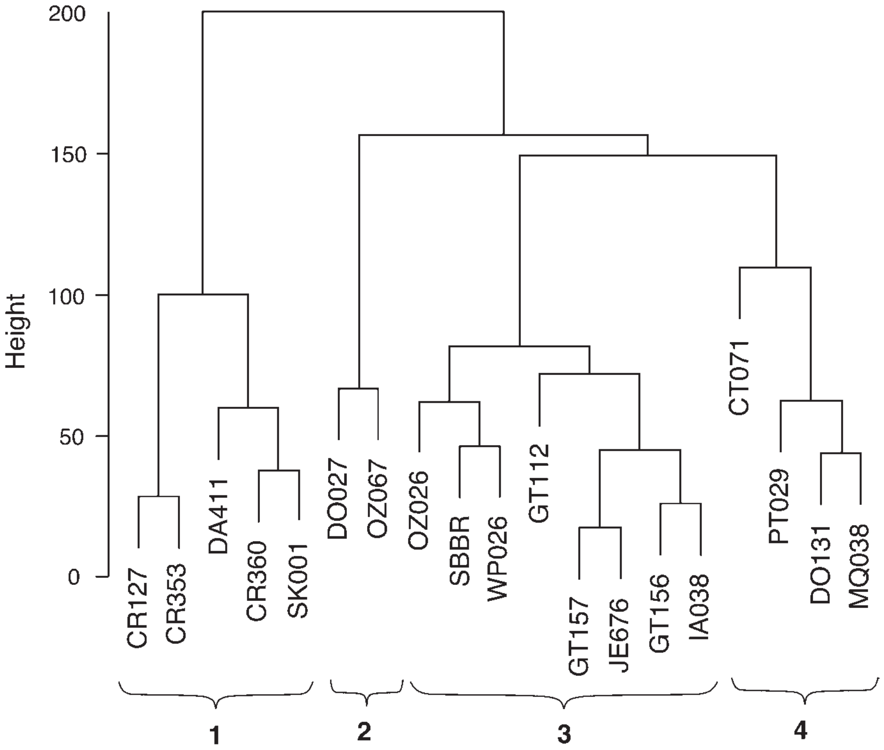

Figure 24: Middle Exterior Motif clusters.

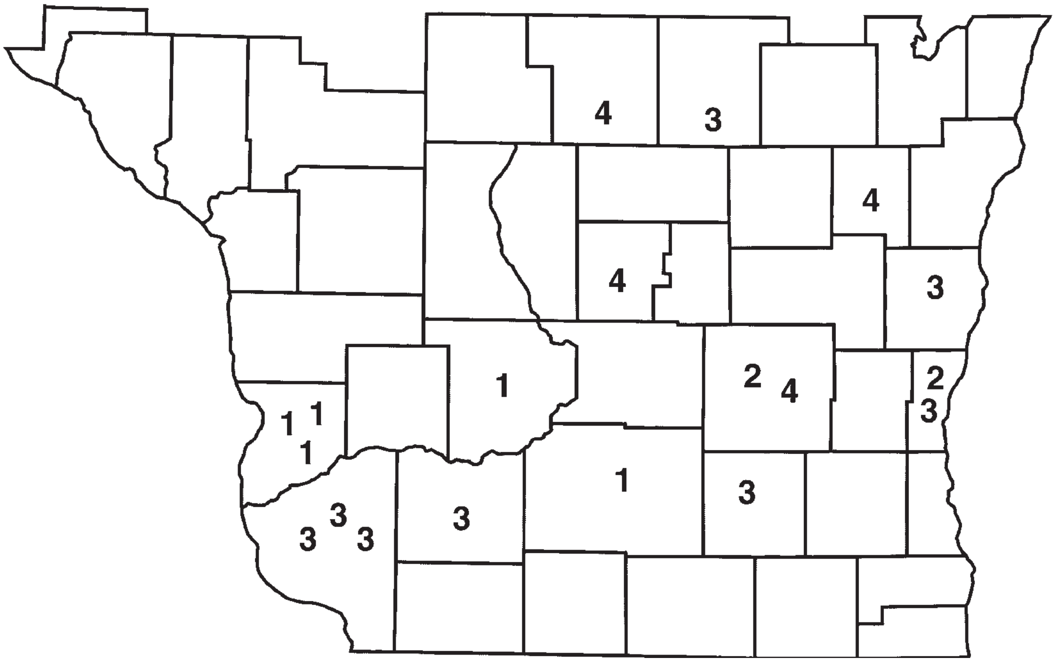

Figure 25: Middle Exterior Motif clusters geographic plot. Labels correspond to clusters in Figure 24.

were considered one category in the general Middle Exterior tests, it was possible to split them into more refined categories and include bands from other decoration zones. It was not possible to conduct Mantel tests on Band motifs as no sites had an N>5.

Similarly, TC horizontal were classed as one category in the general Fisher tests, but could be further analyzed a single, paired, and tripled motifs. Fisher tests were also run on Bordered and Doubled designs. These two categories were considered more structural than decorative components of a design. Therefore, they were not included in the general Fisher tests in the decoration zone analysis. Mantel tests were not conducted on the Bordered and Doubled data because only one site, Black River, had an N≥7 for the number of Bordered or Doubled motifs.

Bands

A band is defined as a row of decoration where design elements exhibit multiple, contrasting angle degrees. Only TC bands were considered in the sub-test as the CTP band was N=1. Banding was present in the Middle Exterior, Lower Exterior, and Upper Interior decoration zones. There are 35 vessels that had a TC band design found at any portion of the vessel. However, three vessels have two different band designs at different locations. These instances were double-counted, bringing the total number of band occurrences to 38. The twenty-one different TC bands designs were grouped into five Motifs: triangles, ladders, chevrons/waves, filled chevrons, and criss-cross (see Figure 23; Table 32). There are an additional eight vessels with bands of TC indeterminate designs, but these are not included in the sub-tests. Future studies may subjugate bands into finer categories as more data become available.

Band type was significant by river valley (Fisher sim.p=0.03) (Table 33). The Wisconsin River valley is overrepresented in chevron/wave motifs (hab.=2.30) but underrepresented in triangle designs (hab.=-2.01). Triangles were more prevalent in the Wolf valley (hab.=1.99), while criss-cross designs are more common in the Milwaukee River valley (hab.=2.52) and ladder bands are found in the Rock valley area (hab.=2.81).

Table 32: Band Type by River Valley

River Valley	Triangle	Ladder	Chevron/Wave	Filled Chevron	Criss-cross
Milwaukee	4	0	0	0	2
Wisconsin	7	5	8	4	1
Wolf	4	1	0	0	0
Rock	0	2	0	0	0

Table 33: Significant Band Haberman Scores

River Valley	Overrepresented	Underrepresented
Milwaukee	criss-cross (2.52)	
Wisconsin	chevron/wave (2.30)	triangle (-2.01)
Wolf	triangle (1.99)	
Rock	ladder (2.81)	

These results show that particular river valleys are associated with particular types of banding, and therefore banding may also be a regional indicator.

Paired Twisted Cords

There are 151 vessels with TC horizontal as the Motif on the Middle Exterior decoration zone (Table 34). The paired twisted cord category was split further into TC single, TC paired, and TC tripled. These TC categories were not significant by river valley (Fisher sim.p=0.41) when the table is taken as a whole. However, Haberman values show significant cell values for the Wisconsin River valley only. Tripled cords were significantly overrepresented there (hab.=2.69) and single cords were underrepresented (hab.=-2.11). The problem is probably one of sample size and the acquisition of additional data would help discover why only a portion of the TC horizontal table was significant. Mantel tests were not conducted on paired twisted cords since the overall Fisher tests were not significant.

Table 34: Paired Twisted Cord Type by River Valley

River Valley	Singled TC	Doubled TC	Tripled TC
Milwaukee	19	2	0
Wisconsin	67	10	9
Wolf	16	1	0
Rock	24	3	0

Bordered and Doubled Motifs

There are fifty-six vessels with Bordered motifs present (Table 35), and eighteen vessels with Doubled motifs (Table 36). Borders are defined as horizontal twisted cords found above and/or below any Middle Exterior Motif. Borders were found in one or multiple rows, but they are always single twisted cords. Doubled motifs are instances where a Motif was repeated below itself.

Borders were significant by river valley (Fisher sim.p=0.04). However, the only contrast is between the Wisconsin and Rock River valleys. Bordering was overrepresented is its presence in the Wisconsin River valley (hab.=2.62) and overrepresented in its absence from the Rock River valley (hab.=1.96). That is, borders are present in the Wisconsin valley, but absent from the Rock River valley.

Doubling was also significant by river valley (Fisher sim.p=0.04). Doubling was generally absent from the Wisconsin River valley (hab.=2.29), and more present in the Wolf River valley (hab.=1.99). The large number of doubled punctate or LCP row designs found in the Wolf valley may be the cause of the overrepresentation in the Wolf River valley.

Table 35: Bordered Decoration by River Valley

	Border	
River Valley	**Absent**	**Present**
Milwaukee	76	11
Wisconsin	150	33
Wolf	64	6
Rock	82	6

Table 36: Bordered Decoration by River Valley

	Doubled	
River Valley	**Absent**	**Present**
Milwaukee	84	3
Wisconsin	180	3
Wolf	64	6
Rock	82	6

Totaled Motifs

In an attempt to look at vessel decoration as a whole, the combined Motif categories from each decoration zone were placed into a data set by vessel. These totaled Motif counts were summed by site and transformed into their own distance matrix. Cluster and Mantel tests proceeded like the individual decoration zone tests. There are 42 sites that have a combined Motif count of N≥7. The Motif dendrogram shows six major groups in the cluster analysis (Figure 26) and the geographic plot seems to indicate a northeast-southwest division (Figure 27). However, the cluster tree is not statistically significant (p=0.628). Four clusters (1, 2, 3, and 4) are strongly clustered around Crawford and Grant counties. The cluster that includes RI190 and JE946 (Cluster 4) stretches further to the east, but these sites are separated early from the western sites on the dendrogram and the low vessel counts by site may contribute to RI190 and JE946 as being anomalous. While Cluster 6, which contains DO027 and WO016, tends to be focused on northeastern Wisconsin, it greatly overlaps with Cluster 5 that spans the entire distance of the state. Cluster 6 is so large and dispersed that it overlaps in geographic spread with three other clusters. It is interesting to note the cluster ranges are somewhat similar to the clusters noted in the Middle Exterior Motif cluster tests. Importantly, the Mantel tests also show that the totaled Motif counts are significantly correlated with geographic distance (Mantel sim.p=0.001). Therefore, while there does appear to be a wide dispersal of traits, vessel decorations are most similar when in geographic proximity.

Discussion

The decoration zone Angle, Technique, and Motif conclusions are discussions of regional variation based on river valley geographic division. Other methods of separation will produce different results and there are multiple factors to consider when assessing Late Woodland population movements and spread within predefined geographic areas. For instance, one could split based on Wisconsin Physiography if one was more interested

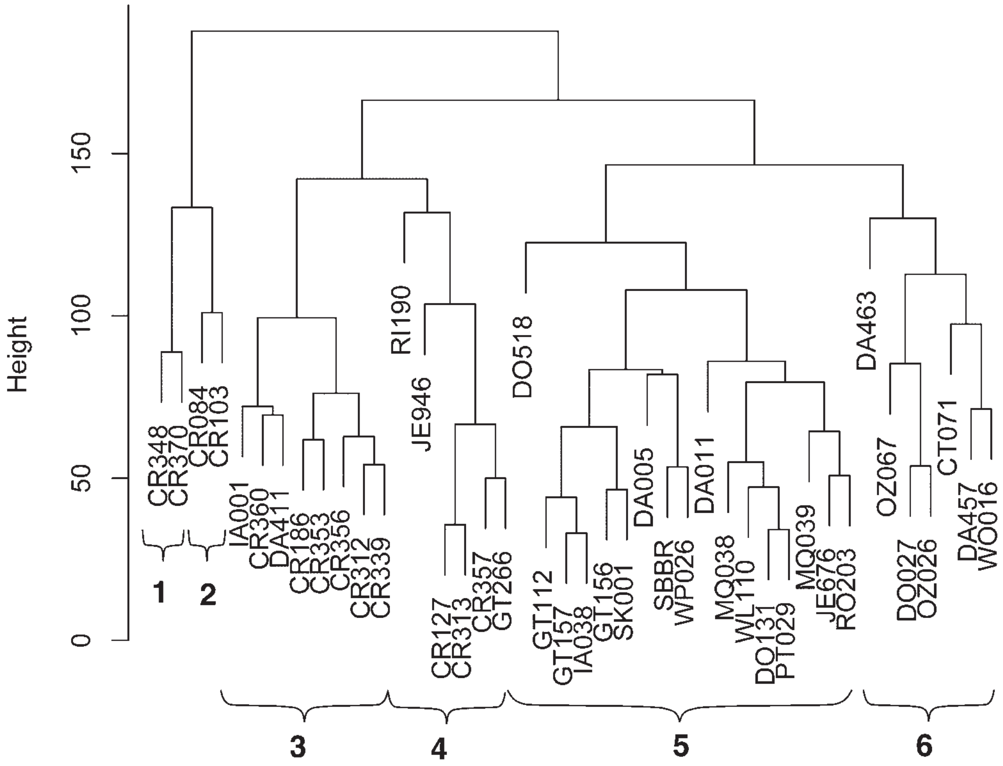

Figure 26: Totaled decoration Motif clusters by site.

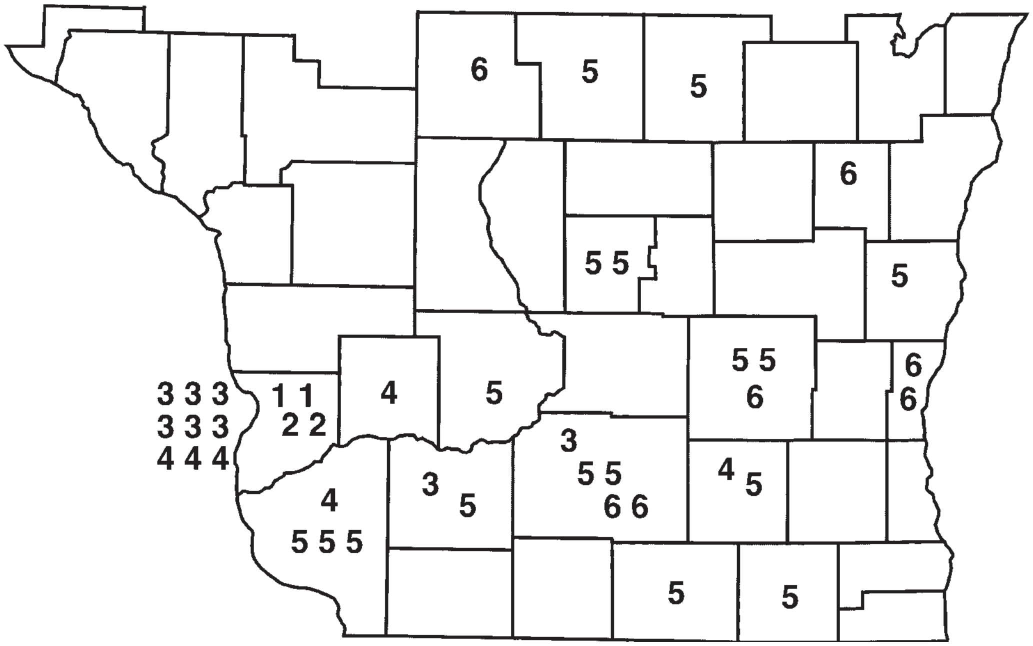

Figure 27: Total decoration Motif by site geographic plot. Labels correspond to clusters in Figure 26.

in the ecologic adaptation of Late Woodland groups (see Martin 1932). Conducting a Middle Exterior decoration zone Motif analysis by Physiography shows that the Central province is significantly associated with the Plain Motif (hab.=5.64). The Western region actually becomes underrepresented in Plain vessels (hab.=-4.81) and overrepresented in Bands (hab.=2.85) in this scenario. However, this study did not focus on subsistence needs, but rather on territoriality, interaction, group movement, and pottery transport. The division by river valleys was chosen for its demonstrated association with group territoriality in both prehistoric and modern ethnographic studies (Boszhardt and Goetz 2000; Longacre 1991; Stark 1999). However, the past may not have modern analogies (Sassaman 2000), and it is likely people moved within ecologic zones as well as river valleys due to subsistence activity needs. Future studies focusing on ecology or Late Woodland subsistence patterns may seek to divide southern Wisconsin into physiographic zones.

It is very important to remember these results are presented with broad and vague chronological control. The ages of the effigy mound sites are based almost entirely by assuming mound sites were built and used in a range of AD 700 to 1200. Researchers have contested both beginning and ending dates (Benchley et al. 2000; Clauter 2011; Hurley 1975; Stevenson et al. 1997; Salkin 2000; Stoltman and Christiansen 2000). Problems with the dates include the fact that most mound sites are dated from wood charcoal from excavations undertaken in the early to mid portions of the 20th century, and often have large standard deviations In addition, many of these dates have little control for the association of a particular vessel with a dated piece of organic material. A long span of probable occupation at a site is therefore problematic. It may be that the clusters seen in the various decoration zone dendrograms are influenced by temporal separation. Comparing geographic to temporal variation will strengthen an understanding of chronologic change and decoration spread. The lack of chronological control probably contributes to views of the Late Woodland period as a static entity. Radiocarbon assays are needed from residue taken from pots themselves to determine which vessels are contemporaneous, rather than relying on dates from general site contexts and/or upon the unreliable process of associating ceramic vessels with radiocarbon dated wood charcoal recovered from a site (Jeske and Richards 2009, 2010; Stoltman and Christensen 2000). One is still left with the problem of associating particular pots with particular mound construction or use episodes. Nonetheless, dating specific vessels is much more likely to produce accurate associations with effigy mound behaviors than the dates from feature or stratigraphically associated material.

Angles, Techniques, and Motifs

While all decoration elements were seen across the study area, certain Angles and Techniques appear to be centered in different geographic regions (Tables 37 and 38). For instance, multiple, transverse and parallel lip decoration angles are associated with

Table 37: Significant Angles by Decoration Zone and River Valley

Decoration Zone	Milwaukee	Wisconsin	Wolf	Rock
Lip				
overrepresented	multiple	transverse	parallel	NS
underrepresented	NS	NS	NS	NS
Upper Interior				
overrepresented	NS	NS	NS	NS
underrepresented	NS	NS	NS	NS
Lower Interior				
overrepresented	NS	NS	vertical	NS
underrepresented	NS	NS	horizontal	NS
Upper Exterior				
overrepresented	NS	vertical	diagonal	horizontal
underrepresented	NS	NS	vertical	NS
Lower Exterior				
overrepresented	vertical	multiple	diagonal	NS
underrepresented	NS	NS	vertical	NS
Middle Exterior				
overrepresented	diagonal	horizontal	NS	NS
	diagonal w/ punctates			
underrepresented	NS	diagonal w/ punctates	NS	NS

NS=nothing significant

Table 38: Significant Techniques by Decoration Zone and River Valley

Decoration Zone	Milwaukee	Wisconsin	Wolf	Rock
Lip				
overrepresented	NS*	NS	NS	NS
underrepresented	NS	NS	NS	NS
Upper Interior				
overrepresented	NS	TC	CCP	Tool
underrepresented	NS	LCP	NS	TC
		CWS		
Lower Interior				
overrepresented	Boss	TC	LCP	NS
underrepresented	NS	Boss	NS	NS
Upper Exterior				
overrepresented	NS	TC	CWS	CCP
				Tool
underrepresented	NS	NS	NS	TC
Lower Exterior				
overrepresented	NS	NS	NS	NS
underrepresented	NS	NS	NS	NS
Middle Exterior				
overrepresented	Multiple	TC	NS	CTP
underrepresented	TC	CTP	NS	NS
		Multiple		

NS=nothing significant

different regions. Also, certain elements may be prescribed to particular vessel portions in different river valleys. The CWS Technique seems most associated with the Upper Exterior zone on vessels from the Wolf River Valley, but is also found on vessel Lips in the Milwaukee River valley. Overall, diagonal Angles are associated with northeastern Wisconsin, and especially the Milwaukee and Wolf River valleys. Conversely, horizontally aligned elements are found the in southwestern regions. By evaluating the types of Angles, Techniques, and Motifs overrepresented in a river valley by decoration zone, one could theoretically devise a template of how a Late Woodland vessel is most likely to be decorated in that location (Tables 37-39). However, decoration motifs are not isomorphic with regional provenience. Regions may possess the entire suite of possible

Table 39: Significant Motifs by Decoration Zone and River Valley

Decoration Zone	**Milwaukee**	**Wisconsin**	**Wolf**	**Rock**
Lip				
overrepresented	CWS	Plain	TC parallel	NS*
	TC diagonal			
	Combination			
underrepresented	Plain	LCP transverse	NS	NS
		CWS		
		TC diagonal		
Upper Interior				
overrepresented	TC diagonal	TC vertical	CCP	CWS diagonal
	LCP	TC horizontal	CWS vertical	Tool
		Plain		
underrepresented	Plain	TC diagonal	NS	TC vertical
		LCP		
		CWS vertical		
		CWS diagonal		
Lower Interior				
overrepresented	Boss horizontal	TC horizontal	LCP vertical	NS
underrepresented	NS	Boss horizontal	NS	NS
Upper Exterior				
overrepresented	LCP vertical	TC vertical	CWS	Tool
	Combination			Plain
underrepresented	NS	NS	TC vertical	TC vertical
Lower Exterior				
overrepresented	NS	NS	NS	NS
underrepresented	NS	NS	NS	NS
Middle Exterior				
overrepresented	TC diagonal	TC horizontal	NS	CTP
	TC diagonal w/ punctate	TC vertical		
underrepresented	TC horizontal	TC diagonal	TC horizontal	NS
	Plain	TC diagonal w/ punctate		
		CTP		
Bands				
overrepresented	criss-cross	chevron/wave	triangle	ladder
underrepresented	NS	triangle	NS	NS
Paired Twisted Cord				
overrepresented	NS	triple†	NS	NS
underrepresented	NS	single†	NS	NS

Table 39: Significant Motifs by Decoration Zone and River Valley, concluded.

Decoration Zone	Milwaukee	Wisconsin	Wolf	Rock
Borders				
overrepresented	NS	presence	NS	absence
underrepresented	NS	NS	NS	NS
Doubled				
overrepresented	NS	absence	presence	NS
underrepresented	NS	NS	NS	NS
* NS=nothing significant				
† only cells significant, not entire table				

ceramic decorative attributes, but the proportional differences in their occurrence causes the statistically significant association of certain attributes with certain regions. The clustered, but permeable, patterns of decoration motif by river valley hints at the open nature of Late Woodland social interaction.

Comparing river valleys by Motif (Table 39) repeats many of the same results from the Angle and Technique Fisher tests. The result is expected since most Motifs are simple combinations of the Angle and Technique attributes. However, it is also interesting to note that sometimes Angles or Techniques may not be significant for a decoration zone in a river valley, but a Motif category is significant for that decoration zone in that same river valley. For instance, the Milwaukee River valley has no significant Angle or Technique Haberman scores for the Upper Exterior decoration zone, but it is overrepresented in LCP vertical and Combination Motifs.

The Wolf and Rock River valley have different types of decoration than what is commonly accepted as effigy mound pottery. These two regions have most of the non-twisted cord decorations. As noted above, the Wolf Valley is overrepresented in CWS Technique on its Upper Exterior. It is possible this overrepresentation may be due to its close proximity to Heins Creek groups, and interactions with people to the north and east (Mason 1966). The Rock Valley also is overrepresented in CTP, CCP, and tool impressions. The heavy use of these types of Techniques may have been a means of differentiating Late Woodland pottery makers from those in other river valleys.

The Wisconsin River valley is very different from the other river valleys because it is overrepresented in the TC Technique in almost every decoration zone. No other river valley is overrepresented in the TC Technique. In fact, almost all other types of decoration are excluded from the Wisconsin Valley. It is underrepresented in LCP, CWS, CTP, and bosses in various decoration zones. The Motifs found in this valley are either TC vertical, TC horizontal, or Plain. The Wisconsin River valley looks limited and standardized in its decoration compared with other valleys. The Milwaukee River Valley, for example, contains many different Techniques and Motifs such as CWS, LCP vertical, Bosses, TC diagonal, TC diagonal with punctates, and Combination Motifs. While the rules for decoration in western Wisconsin sites seem to be fairly restricted, the decoration rules in eastern Wisconsin appear fairly loose. The variation between the valleys is not simply a distinction between diagonal or horizontal twisted cord motifs, but is more complex. There is also a difference between the river valleys with the decoration suite as a whole and includes what types of decoration were considered acceptable in a given area.

Clustering, Mantel Tests, and Geographic Plots

Mantel tests indicated that Motif similarity is correlated with geographic proximity for all decoration zones except the Lower Interior, which could not be tested due to the small sample, and the Lower Exterior, which was not statistically significant. Decoration, then, is regionally determined. Spatial plotting of these decoration clusters, though, shows wide geographic spread in most cases. All decoration zone Motif cluster geographic plots had a branch that spread the entire portion of the state. Also, the clusters often overlapped in their geographic coverage. Interestingly, western Wisconsin displayed the most cases of tight, separate geographic coverage. Clusters covering areas of central and eastern Wisconsin were generally broader in scope. The ability of potters to use multiple types of Technique and Motif combinations in the eastern valleys probably causes this result. However, sometimes this broad spread was caused by the inclusion of one geographically distant site into a cluster that would otherwise be fairly geographically restricted. The totaled vessel decoration Motif cluster tree, as an example, includes JE946 in a cluster mainly composed of sites from western Wisconsin. JE946 has a suite of Motifs that are more similar to the sites in western Wisconsin. However, this occurrence could be culturally meaningful and may indicate interaction among regions.

Also, spatial plotting of the decoration zone clusters indicate that some zones may be more useful than others when searching for regional distinctions. The Upper Interior decoration zone, for instance, had two clusters containing only one site and a further two clusters that covered the entire study range (Figure 17). The Lip and Upper Exterior decoration zones showed slightly better geographic distinction (Figures 14 and 22). These zones demonstrate two distinct eastern and western groups, but then also have two clusters with state-wide spread. The Middle Exterior decoration zone is the best indicator of regionalism (Figure 25). Geographic plotting of the Middle Exterior Motif clustering show three distinct groups in different portions of the state, and then only one cluster that spanned the study area. The Lip, Upper Exterior, and Middle Exterior are some of the most visible portions of ceramic vessels. The results from these cluster analyses supports Rosebrough's (2010) thesis that these vessel portions may be the most likely to be used in social signaling.

Decoration and the Interpretation of Social Organization

Decoration data are viewed in two ways in this discussion: similarities in decoration are examples of cultural interaction or cultural differentiation (e.g., Hegmon 1992; Jeske 1989, 2003a; Richards 1992; Salkin 2000; Stark 1999; Wiessner 1983; Wobst 1977) and that differences may be interpreted as indications of social organization (Baerreis 1953; Boszhardt and Goetz 2000; Brashler 1981; Hurley 1975, 1976; Keslin 1958; Logan 1976; Longacre 1991; C. Mason 2004; Rosebrough 2010; Salkin 2000; Wittry 1959).

The three models presented earlier combine both elements of cultural interaction and social organization. The data from this study suggest that none of the models explains completely Late Woodland social organization or interaction across southern Wisconsin. The decoration data do not produce homogenous groups without any clustering as expected in the Monolithic model. Also, there is little evidence for geographically bound, heterogeneous attribute clusters expected in the High-level Territorial scenarios, with one caveat. The western Wisconsin River valley data do provide some support for this type of social organization. Western Wisconsin most often had tightly bound clusters containing few sites. Also, the Angle, Technique, and Motif data show that ceramics in this region are regulated to a stricter set of prescribed types of elements and motifs than other river valleys. These decoration analyses fit with a High-level Territorial hypothesis of increased ceramic homogeneity within a small area as the local community consumes the majority of the pottery produced for the western Wisconsin region (see Braun and Plog 1982).

However, western Wisconsin clusters can also include sites within central Wisconsin. Therefore, while western Wisconsin shows increased territoriality compared with other river valleys, it is still not completely separated from other sections of the state and interaction did occur. Whether this pattern is the result of different social groups occupying the eastern and western portions of the state, or how much the patterns are the result of chronological differences is impossible to determine at this point. Yet the point remains that different decoration patterns existed among the various portions of the state between their decorative techniques, angles, and motif attributes.

The Low-level Territorial model is supported by the decoration data, particularly in eastern and central portions of the study area, but with some evidence for higher degrees of territoriality, particularly in the western part of the state. Decoration zone attribute data from Angle, Technique, and Motif variables show regional clustering in the Fisher and Haberman tests. Certain attributes are overrepresented in particular river valleys. Furthermore, the Mantel tests indicate that geographic distance is correlated with site Motif composition. Geographically proximal sites tend to have more similarities in decoration zone attributes. However, geographic plotting of the cluster trees from the summed Motif data also reveal geographic spread and cluster overlap in many cases.

Effigy mound building populations appear to have moved freely within relatively broad geographic areas. They likely had flexible or permeable social boundaries with fluid group membership. These decoration zone results bolster previous research that reached similar conclusions (Rosebrough 2010), and are also complimented by other data including human bone isotopic analysis. Isotopic data from the Nitschke Effigy Mound Group near the Horicon Marsh in Dodge County suggest that 9 of 10 individuals tested grew up in southeastern Wisconsin, but that one person probably was raised in northern Wisconsin or the Upper Peninsula of Michigan (Hart et al. 2011).

However, as noted in the cluster geographic plots, the distribution of sites included in any given cluster is uneven. We should expect relatively even distributions of sites in a Low-level territorial model. Since this is not the case, even the Low-level territorial model does not completely explain the decoration results. There appears to be differential degrees of circumscribed movements for different Late Woodland groups. Those living at sites near the Mississippi River valley were more constrained, but they also had some boundary fluidity occurring along the Wisconsin River valley. Most groups were primarily local, but they interacted with, traded with, and possibly participated in marriages with non-locals. The decoration data do not completely support a Low-level territorial model, but the High-level territorial model is also not upheld without caveat.

While decoration studies can demonstrate the distributions of certain ceramic attributes across southern Wisconsin, the characteristics of the clay used to construct the vessels are just as important. Clay, and its distribution across the state, has been a very under-examined source of variation in the distribution of ceramics. Studies that combine compositional techniques with decoration analyses, however, have the explanatory power to demonstrate geographic transfer is not limited to style alone, but can also ascertain whether pots or clays are also being transported. In this manner, decoration analyses support a foundation for further compositional analysis.

Chapter 6: Energy Dispersive X-ray Fluorescence Analysis Results

EDXRF is a non-destructive analysis that provides elemental data on ceramic composition. As a technological analysis, it can be used to study manufacturing conditions and centers, material control, trade or localized production, temporal change, population movements, regional and ecological variation, and correspondence with established typologies (Kaplan et al. 1984; Kolb 1984; Neff 1993; Rice 1976, 1985, 1987; Steinberg and Kamilli 1984; Stross and Asaro 1984; Stoltman 1986, 1991, 2001). It is therefore useful to the questions of pottery transport and population movement across a prehistoric landscape in this study.

Vessel elemental analysis by EDXRF was conducted alongside decorative attribute and petrographic analyses in an effort to garner comparable and mutually supporting results using different types of data. EDXRF analysis was run on two different scales: by vessel and by site. Both levels produced interesting conclusions for intra- and intersite interpretations. The vessel analysis showed the possible transportation of pottery across southern Wisconsin by the co-occurrence of vessels from different sites in the same dendrogram cluster groups. Furthermore, the EDXRF site analysis revealed broad clusters with wide degrees of overlap.

EDXRF Vessel Analysis

The PCA analysis for the EDXRF data shows that the first and second dimensions only explained 43.5% of the variance, which indicates little structure in the data set (Table 40). Fe is the only element that loads negatively on the first dimension (PC1) of the principal components loadings plot (Figure 28; Table 41). The distinction seems to be between Fe and positive inclusions of all other elements, but especially Ca and K. The second dimension (PC2) distinguishes between vessels with a relative lack of Fe and Mn, but a relative abundance of Zr, Sr, and Ca. Taken together, the dimensions sort vessels by those relatively lacking Fe and Mn, but having a relative abundance Ca and Sr.

Table 40: Percentage of variance explained for the EDXRF vessel averaged data principal components

Principal Component	% of Variance Explained
1	24.8
2	18.7
3	15.6
4	13.4
5	9.7
6	7.5

Table 41: Element Loadings for EDXRF vessel averaged PCA analysis

Element	Loading on PC1	Loading on PC2
Zr	0.171	0.255
Sr	0.323	0.283
Rb	0.443	-0.275
Fe	-0.102	-0.683
Mn	0.032	-0.475
Ti	0.310	-0.114
Ca	0.507	0.170
K	0.553	-0.214

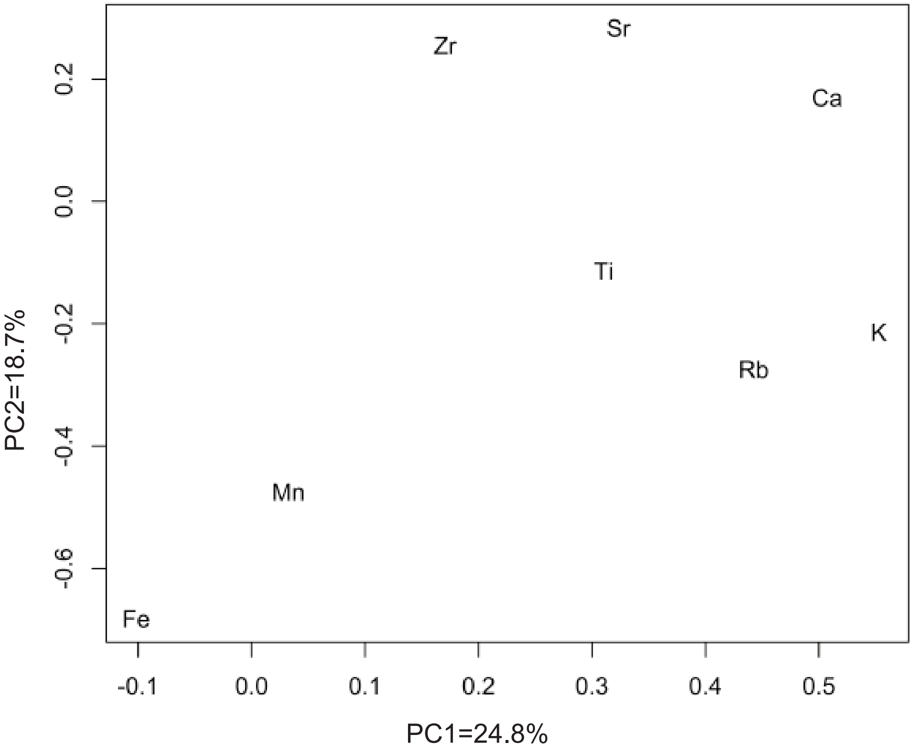

Figure 28: Principal Components loadings for vessel-averaged EDXRF readings.

Cluster analysis usually provides an accessible and easily visible means of ascertaining similarities between objects under study and grouping them into constituents based on those similarities. Cluster analysis by vessel-averaged readings using the methods descried in Chapter 4, however, revealed a complicated and large dendrogram due to the number of vessels included in the study. It was decided that 30 cluster groups best represented the dendrogram (Figure 29, parts 1-4). The large number of clusters is not amenable to geographic plotting as the multiple overlaps quickly make the map uninterpretable. The EDXRF vessel averaged dendrogram is not statistically significant (p=1.00). However, Mantel test correlations confirm vessel elemental composition is related to geographic locale overall (sim.p=0.001). The elemental clusters represent some degree of regional proximity. Pots deposited in the same region tend to have similar vessel elemental compositions.

A closer visual inspection of the 30 cluster groups shows that tree branches are not composed of all the vessels from a particular site. Almost every site had its vessels split between or among multiple clusters, except in cases where a site assemblage was very small or N=1. Most site ceramic assemblages were split among multiple clusters. The vessel clusters can generally be split in four different types. Some clusters were composed of a portion of site assemblage and excluded vessels from other sites (Figure 30a). Other clusters contained vessels from multiple sites that were within close geographic proximity, but the remaining vessels from the site(s) were found on other branches (Figure 30b). In other cases, clusters appeared to be dominated by vessels from a particular location, but were grouped with vessels found at another portion of the state (Figure 30c). Likewise, some clusters were composed of vessels from multiple sites without dominance by a particular assemblage (Figure 30d). In these cases, the sites may be close or distant from each other. It is also noted that Cluster 19 (Figure 29, parts 2-3) is an extremely large cluster composed of 76 vessels that are spread throughout the study area.

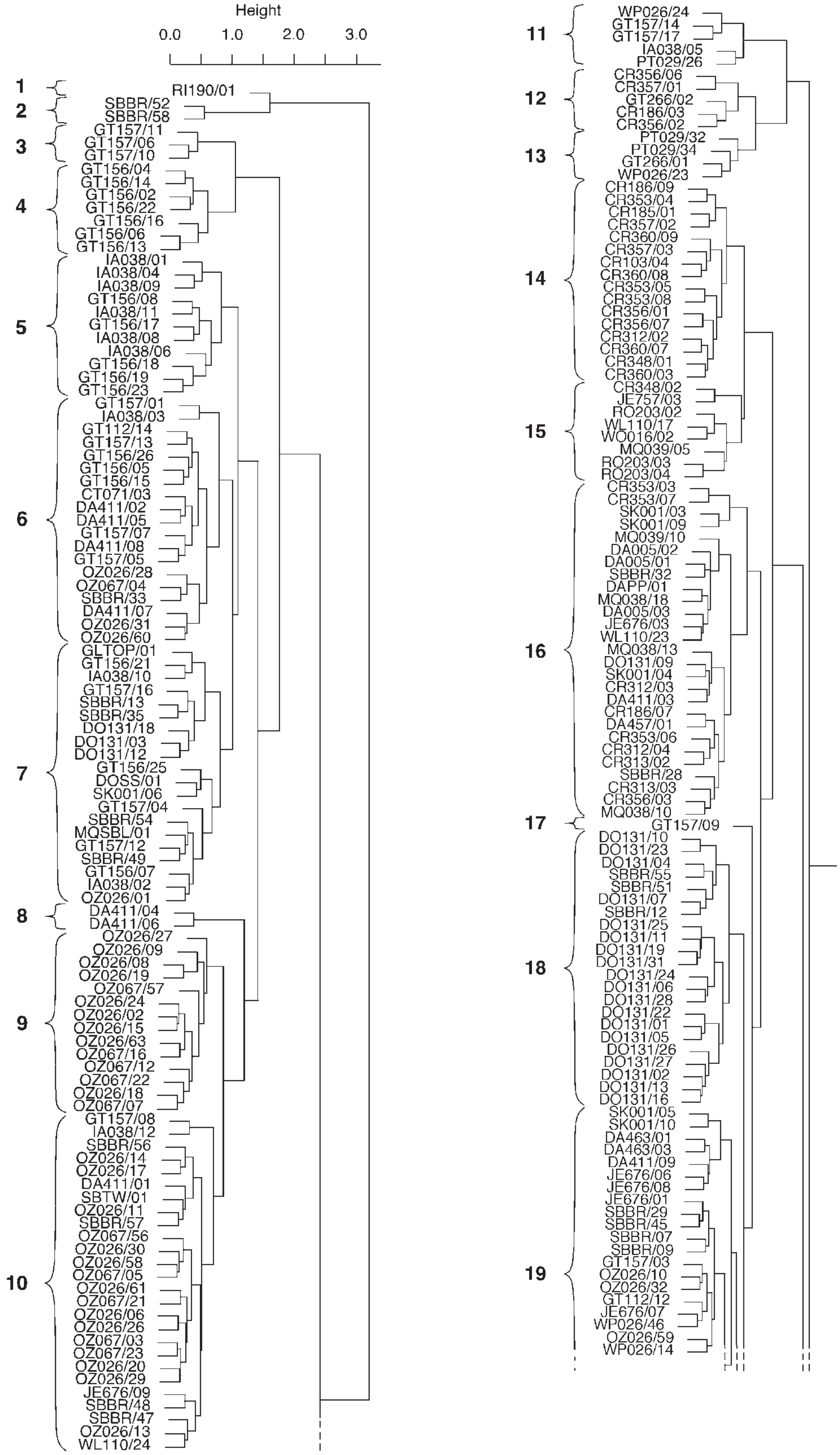

Figure 29: Complete EDXRF vessel cluster dendrogram. Part 1, left; Part 2; right.

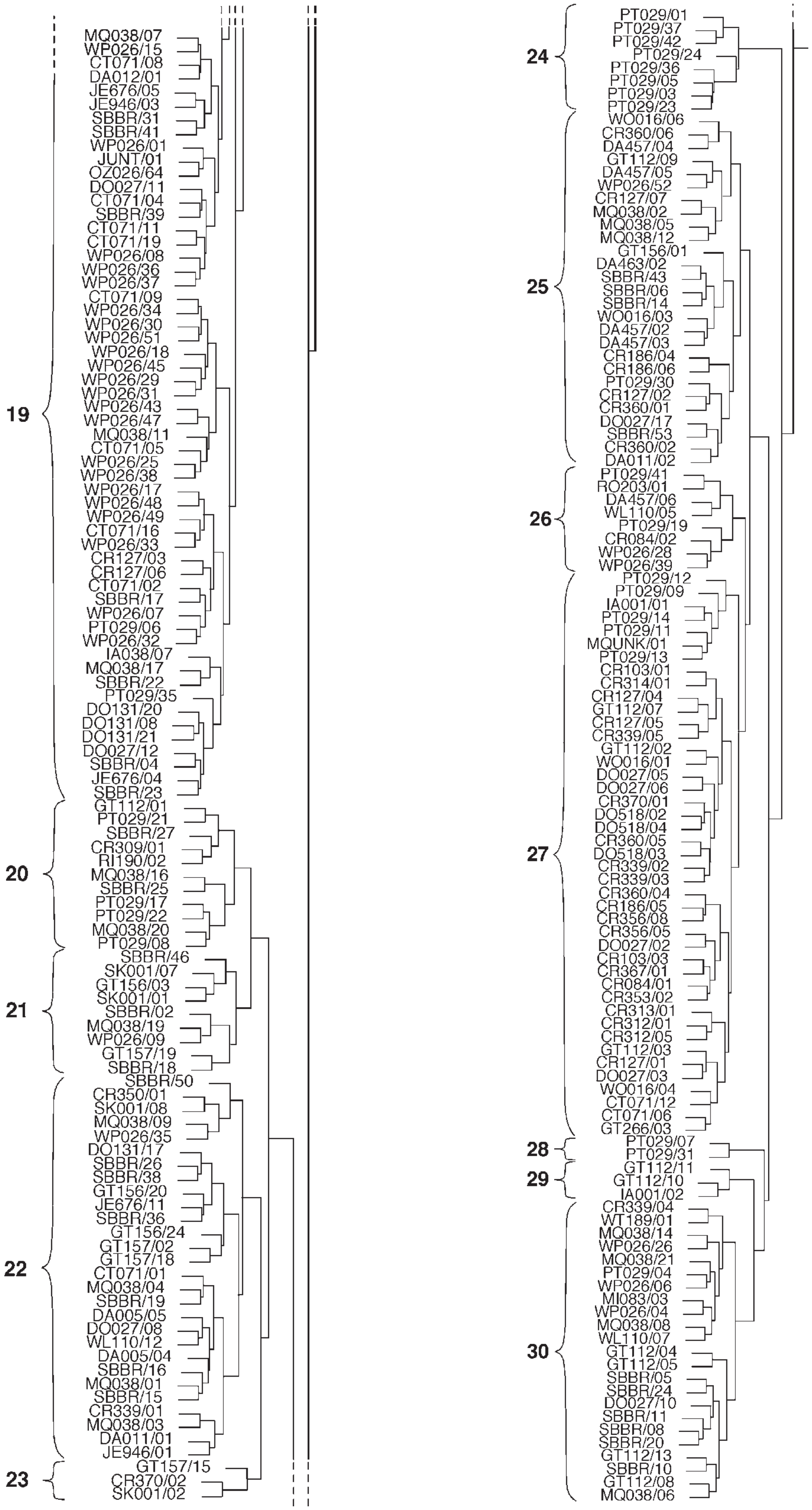

Figure 29: Complete EDXRF vessel cluster dendrogram, continued. Part 3, left; Part 4; right.

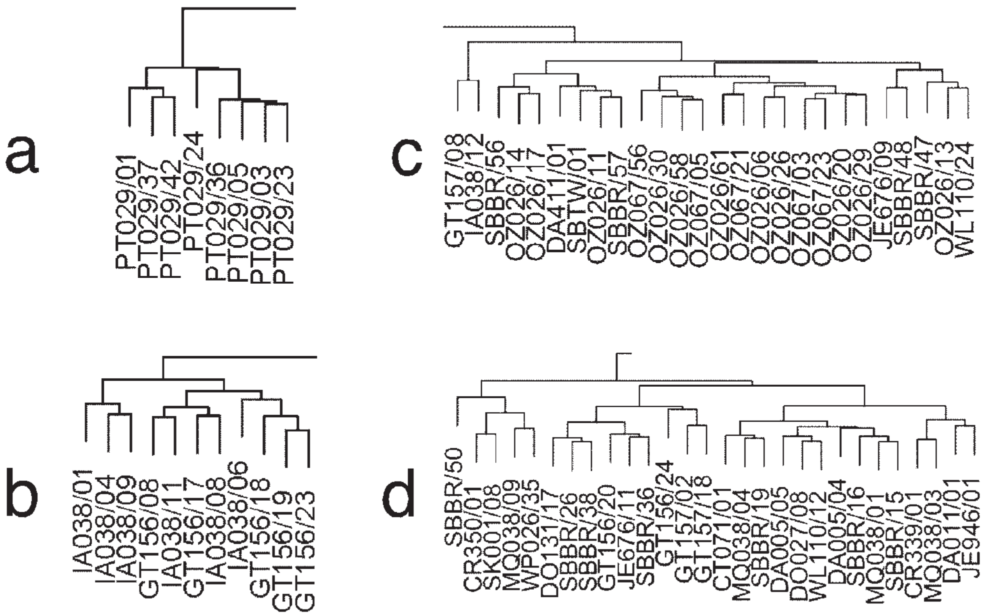

Figure 30: Examples of EDXRF dendrogram branches using vessel-averaged readings: a) clusters made of vessels from one site, b) clusters from sites with close geographic proximity, c) cluster dominated by one locality but also containing vessels from geographically distant localities, and d) cluster with a balanced inclusion of vessels from different localities. (Site number separated by backslash from laboratory assigned vessel number, ex. PT029/01 is vessel 01 from site PT029.)

The cluster pattern shows that while there are some clusters with good differentiation between vessels, there is a large part of the data set that is very similar in elemental composition. These results indicate that while pots with similar elemental composition are generally recovered in the same region, most sites contain vessels made with clays from other portions of the region and/or state.

EDXRF Site Analysis

EDXRF vessel readings were also averaged by site to facilitate geographic plotting and comparison to motif cluster data summed by site. Principal components analysis shows the first two dimensions explain 50.4% of the variance (Table 42). The loadings plot indicates the first dimension is controlled by the relative abundance of Fe and Mn versus the relative lack of Ca and K (Figure 31; Table 43). The results are similar

Table 42: Percentage of variance explained for the EDXRF site averaged data principal components

Principal Component	% of Variance Explained
1	33.6
2	16.8
3	14.4
4	13.2
5	8.2
6	6.1

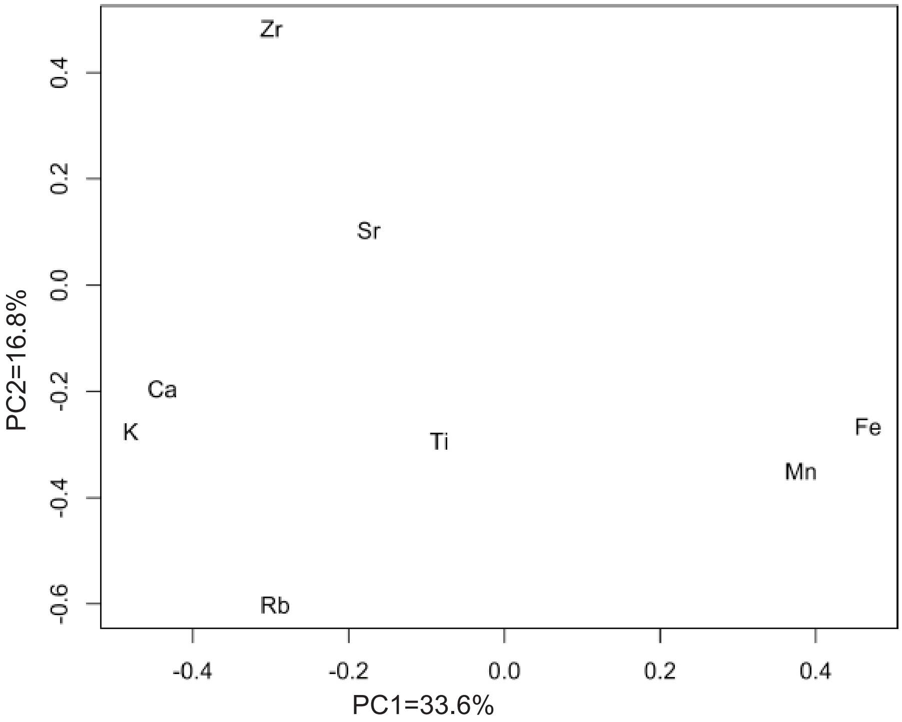

Figure 31: Principal Components loadings for site-averaged EDXRF readings.

to those seen in the vessel-averaged EDXRF analysis (Figure 28). The second dimension indicates a separation between sites that are relatively abundant in Zr, but relatively lack Rb.

The EDXRF site averaged cluster tree yielded seven main groups (Figure 32). Sites with close geographic proximity tend to fall near each other in this dendrogram, but they also cluster with geographically distant groups. It is interesting to note that while some sites with close geographic proximity fall very close to each other on the

Table 43: Element Loadings for EDXRF site averaged PCA analysis

Element	Loading on PC1	Loading on PC2
Zr	-0.299	0.482
Sr	-0.174	0.103
Rb	-0.294	-0.602
Fe	0.467	-0.267
Mn	0.381	-0.350
Ti	-0.084	-0.294
Ca	-0.439	-0.195
K	-0.480	-0.276

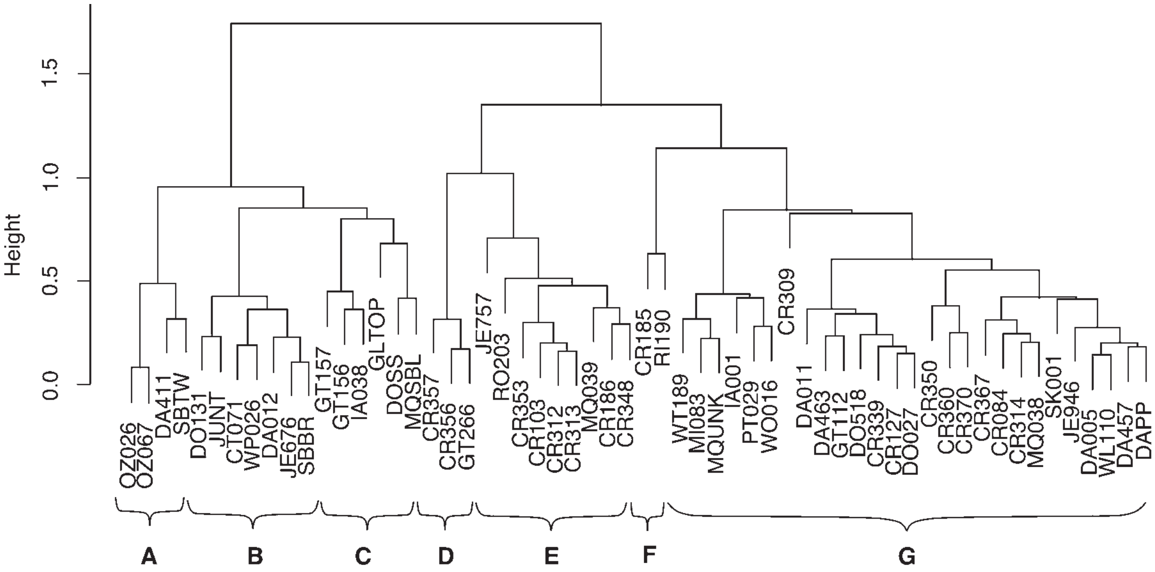

Figure 32: Site-averaged EDXRF cluster dendrogram.

dendrogram, like OZ026 and OZ067, other sites with similar proximity, like the Crawford County assemblages, are separated onto multiple clusters. Also, as with Cluster 19 in the vessel-averaged results, Cluster G contains a large number of geographically disparate sites that have very similar elemental signatures. While the cluster tree is not statistically significant (p=0.920), the Mantel tests indicate geographically proximal sites tend to have similar clay compositions (sim.p=0.008).

When the site clusters are plotted on a map, the resulting distributions show geographically bound groups with large degrees of overlap (Figure 33). The geographic

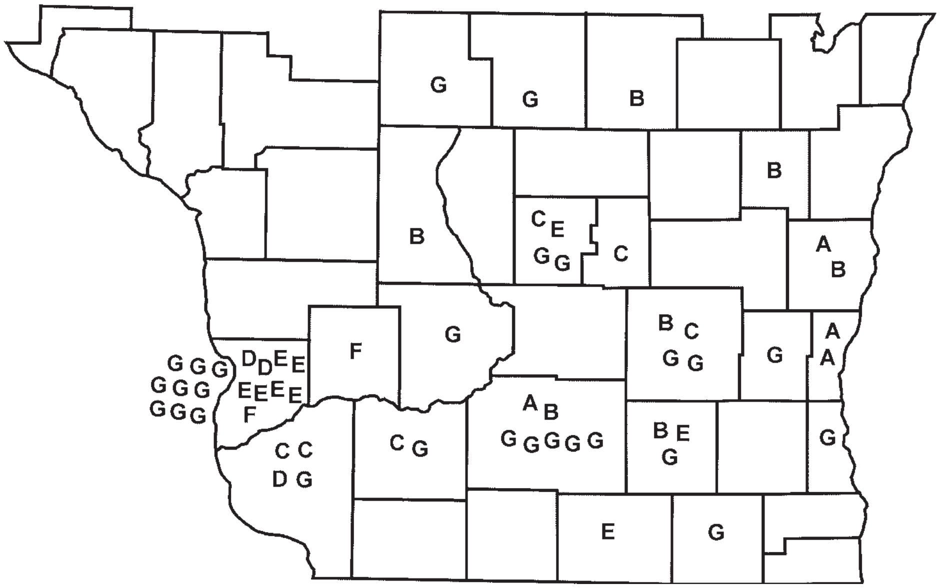

Figure 33: Site-averaged EDXRF clusters geographic plot. Labels correspond to clusters in Figure 32.

cluster plot shows that two small clusters, Groups D and F, are located on the extreme western edge of the study area. These are very tightly bound clusters and contain few sites between them. Cluster E is mostly located in the west with Clusters D and F, and has three outliers in other areas. Clusters A and B seem to be more eastern or northeastern based clusters, with one or two western outliers. Cluster C appears centrally located and overlaps with Clusters B, D, E, and G. Finally, Cluster G covers the entire portion of the study area and overlaps with all other clusters. As with the decoration results, we see geographic discontinuity and unevenness in the sites included in the clusters. Also, there again seems to be more confined western clusters, but wider spread clusters in the east.

Discussion

The EDXRF patterns tend to more dispersed and widespread with fewer indications of tightly bound groups than the decoration results. Clay resources tend to be similar across wider geographic regions. However, the PCA analysis demonstrates that there is little structure in the data set and shows wide similarities in clay composition across the state.

It should be noted that it is possible that clay sources across southern Wisconsin are generally undistinguishable from one another. There has been little research into clay sourcing in southern Wisconsin. However, Schneider and Richards (2011:173) used EDXRF to demonstrate differences in clays from near Lakes Koshkonong and Winnebago. Research in southwestern Ohio has also demonstrated differences in clays sources using EDXRF methods (Schulenberg 2011). Cogswell et al. (1998:2) used neutron activation analysis to find two different clay compositional groups in northeastern Illinois. The results of this analysis were used to demonstrate that pottery or people moved uni-directionally, upstream to downstream, during the Upper Mississippian period in this region (Jeske 2003b:234). Therefore, it is likely clays would also have different signatures in different Wisconsin regions. Unfortunately, I do not have clay samples from the same area as all of the sites in this study. While it is likely that the results presented here are due to the movement of vessels, I cannot rule out entirely that the patterns are due to similar regional clay compositions overall. A study comparing clays from multiple southern Wisconsin sources is necessary.

EDXRF by Vessel Average

The EDXRF vessel results show that clusters are not based on site assemblages. Cluster branches are rarely composed of vessels from one site alone and almost never contain all the vessels from a particular site. Rather, there are different types of clustering patterns ranging from clusters formed of a portion of an assemblage to clusters composed of vessels from widely disparate geographic regions. Most vessel clusters contain a portion of a site assemblage combined with some vessels from another separate site that may not be geographically close. A geographic plot of the clusters instead shows regionally bounded groups that overlap. Also, the Mantel tests indicate that vessel composition is significantly related to geographic proximity with vessels found closer together having more similarities in elemental composition, but these vessels are not necessarily found in the same site assemblage.

A large part of the data set grouped together in one cluster. Also, vessels at the same site have different EDXRF clay signatures and may cluster with vessels that are geographically distant. Furthermore, all of these clusters overlap geographically. As local clay sources are distinguishable in other studies (Schneider and Richards 2011; Schulenberg 2011), it is possible this result is caused by the transport of clay across the study area, population movements, or the exchange of clay resources. Transport of pottery would cause an admixture in the data set where site deposition in not correlated to clay composition.

However, the Mantel tests of distance demonstrate that the majority of vessel or clay transport occurred within moderately broad geographic regions even if vessels at the same site had slightly different clay signature. The data seem to indicate that pots deposited at a site had a tendency to be made from clays within the same region, with an admixture of vessels made from similar clays that extend across a much larger region. It indicates an open system of vessel or clay manufacture and exchange where individuals could have access to clay or resources across the state or traded pottery.

EDXRF By Site Average

Averaging vessel readings by site resulted in the ability to plot similarities in elemental signatures on a geographic map of southern Wisconsin. It also led to the possibility of comparing results with the site-level Motif geographic plot and cluster dendrogram from the decoration analysis. As with the vessel-averaged EDXRF data, sites with close geographic proximity tend to fall near each other in the EDXRF site-averaged dendrogram, but they can also cluster with geographically distant groups. The significant Mantel tests show that the pattern of localization within regionalization also applies to this scale of analysis.

The geographic plot of these clusters, however, shows wide degrees of geographic overlap. Five clusters, Clusters A, B, C, E, and G, have very wide spatial ranges and all meet in central Wisconsin. Cluster G in particular covers the entire study area and all other groups. Furthermore, Clusters C and E have essentially the same geographic coverage in the central-western portion of the state. However, two small clusters, Clusters F and D exist only, and notably, on the extreme Western edge of Wisconsin. These two clusters are distinctive in that they are composed of small site numbers and cover small areas.

The EDXRF site-averaged geographic clusters are considerably wider, broader, and have more overlap than the Middle Exterior or Totaled Motif geographic clusters. The Middle Exterior tests showed three separate clusters with one cluster crossing the entire state. A distinction this clear does not exist for the EDXRF groups. In addition, both the EDXRF and decoration analysis have clusters composed of vessel or sites that are not readily distinguished and which plot geographically across the entire study area.

However, the EDXRF results also indicate a degree of separation of some western Wisconsin sites. Clusters F and D have a very similar distribution with the tightly bound western clusters in the decoration analysis. In sum, sites in western Wisconsin are differentiated from eastern Wisconsin in both the decoration and EDXRF site-averaged analysis.

Social Interaction and Territorial Model Interpretations

The EDXRF distribution is conformable to the decorative distribution pattern. It is possible that potters were able to gather clay or trade vessels from wide areas as the geographic spread of the EDXRF clusters is less restricted and with more overlap than the decoration analysis clusters. Clay composition appear to be less important for indicating regional affiliation than decoration present on the Middle Exterior decoration zone or other portions of the vessel with highly visible decoration zones. Potters were still decorating based on a localized sensibility even while people moved clay or vessels across the landscape. However, this pattern indicates a social organization that allowed for the easy movement of people or open access to trade networks.

For the entire study area, the EDXRF analysis does not produce homogenous groups without any clustering as expected in the Monolithic model. Also, there is little evidence for tightly bound attribute clusters which do not geographically or compositionally overlap, or which contain all the vessels from a particular site, as one would expect in High-level Territorial scenarios.

These EDXRF data show some localized attribute clustering, but also geographically broad patterns that spatially overlap. The data support to some degree the Low-level Territorial model for Late Woodland social structure, territoriality, and group interaction. Groups could have been traveling to get clay, trading for it, exchanging gifts, or making pottery at a localized location before traversing the state with the pots in tow. The large territorial overlaps may be due to the possibility for interaction and territory sharing by prehistoric groups. The low data matrix structure indicated by Principal Components analysis may be because of the large degree of cultural interaction in trading or using clay from different areas before pots were deposited in their final provenience. The significant geographic differences indicated by the Mantel tests would be due to the fact that the majority of pots were from localized sources.

However, western Wisconsin may have a social organization that is more rigidly controlled than the central and eastern portions of the state. There are two EDXRF site-averaged clusters that incorporate a small numbers of sites and found across a limited geographic area. The decoration analysis also produced this pattern in both Haberman and Motif clusters tests. However, many sites from western Wisconsin group with clusters that spread across wider geographic regions. Again, this may indicate some regionalization or involvement in the wider interaction spheres by the western Wisconsin groups even though they may have been more restricted.

In general, the EDXRF data show Late Woodland groups likely had a moderately localized hunter-gatherers settlement system with flexible or permeable social boundaries so they could move somewhat freely across the landscape. However, the EDXRF data also show that as ideas moved across southern Wisconsin, pots or populations were transported as well. People either carried vessels or clay, potters had access to multiple clay sources to produce at their home site, or they had entry into fairly open exchange networks. As clay source material is often obtained locally (Arnold 1985), these scenarios are all plausible in a Low-level Territorial model.

More research is needed into clay sourcing to place vessel clay with its proper geographic origin. While the attempt to link ceramics to known clay sources was not conducted in this dissertation, it has been successfully implemented in a number of other studies to study exchange and social interaction in the prehistoric Midwest (Fie 2000; Lynott et al. 2000; Ahlrichs and Schneider 2011; Schulenberg 2011; Tankersley and Meinhart 1982). We need many more data from geographically specific clay sources for comparison. Sourcing Late Woodland vessels back to clay sources is an avenue for future research. Furthermore, juxtaposing the EDXRF results to petrographic data will help alleviate some problems of pottery sourcing, composition and material differentiation (Stoltman 2001). Petrography gives us a deeper understanding of the mechanisms behind pottery spread and movement than using EDXRF alone. Comparisons with petrography are necessary to support the interpretations gleaned from the EDXRF results.

Chapter 7: Petrographic Thin-section Analysis Results

In order to add another line of evidence for determining the distribution of ceramic vessels across the landscape, petrographic thin-section analysis was undertaken. As noted in Chapter 4: Methods, thin-section analysis can be used to study ceramic production and exchange in prehistoric societies (Shepard 1936; Stoltman 1989, 1991, 2001). Point counting, natural versus included temper differentiation, and mineralogical identification was done by Seth A. Schneider at the Archaeological Research Laboratory at UWM. The petrographic analysis was designed to elucidate vessel temper type, Body, and Paste differences between site and river valley provenience.

A total of 43 petrographic slides were analyzed using the point-counting method (Table 44). Vessels were chosen for petrographic analysis using representative samples of vessels from clusters found during EDXRF analysis. An effort was made to sample at least one vessel per cluster, and more than one vessel per cluster when possible. Some EDXRF clusters are not represented in the petrographic analysis because all rims from that cluster were too small to be cut for thin-sectioning, the only available vessels from a cluster were from sites that had already been sampled numerous times from other clusters, or the sherds were not available from the institution where they were housed. The only clusters that do not have any representative sherds in the petrographic analysis are EDXRF Clusters 1, 2, 18, and 23. EDXRF clusters 1, 2, and 23 were all very small clusters composed of three pots or fewer. The only vessels available for sampling from EDXRF Cluster 23 were from DO131, and vessels from this site were already sampled for other clusters.

Grain Size

The functional aspects of pottery are still subject to individual choices to a certain extent, and these technologic choices can also be considered stylistic (Hegmon 1992; Stark 1999). Often, functional aspects of pottery are related to subsistence

Table 44: Thin-section Sample Information

Vessel ID	EDXRF Cluster	River Valley	Site Name	Institution	Thin-Section ID
CR186/03	12	Wisconsin	Mill Pond	UW-Madison	47-384
CR309/01	20	Wisconsin	Fish Lake	UW-Madison	47-385
CR357/03	14	Wisconsin	Upper Folsom Bay	UW-Madison	47-386
CT071/03	6	Wolf/Fox	Perizzo	UW-Milwaukee	CT071/03
CT071/06	27	Wolf/Fox	Perizzo	UW-Milwaukee	CT071/06
DA411/06	8	Rock	Rosenbaum Rockshelter	UW-Madison	47-388
DAPP/01	16	Rock	Picnic Point	UW-Madison	47-387
DO027/17	25	Rock	Nitschke Mound Group	Milwaukee Public Museum	32648/8970
DO131/12	7	Rock	Horicon	UW-Milwaukee	DO131/12
DO131/17	22	Rock	Horicon	UW-Milwaukee	DO131/17
DO131/18	7	Rock	Horicon	UW-Milwaukee	DO131/18
DO518/03	27	Rock	Nitschke Garden Beds	UW-Milwaukee	DO518/03
GT112/01	20	Wisconsin	Raisbeck Mound Group	Milwaukee Public Museum	38611A/10747
GT112/11	29	Wisconsin	Raisbeck Mound Group	Milwaukee Public Museum	38603/10474
GT156/02	4	Wisconsin	Brogley Rockshelter	UW-Madison	47-389
GT156/03	21	Wisconsin	Brogley Rockshelter	UW-Madison	47-390
GT156/04	4	Wisconsin	Brogley Rockshelter	UW-Madison	47-391
GT156/23	5	Wisconsin	Brogley Rockshelter	UW-Madison	47-392
GT157/06	3	Wisconsin	Preston Rockshelter	UW-Madison	47-393
GT157/09	17	Wisconsin	Preston Rockshelter	UW-Madison	47-394
GT157/17	11	Wisconsin	Preston Rockshelter	UW-Madison	47-395
GT266/01	13	Wisconsin	Hog Hollow	UW-Madison	47-396
IA038/03	6	Wisconsin	Mayland Cave	UW-Madison	47-397
IA038/11	5	Wisconsin	Mayland Cave	UW-Madison	47-398
JE7676/06	19	Rock	Pitzner	UW-Milwaukee	JE7676/06
MQ038/09	22	Wolf/Fox	McClaughry Mound Group	Milwaukee Public Museum	29978/8171
MQ039/05	15	Wolf/Fox	Kratz Creek Mound Group	Milwaukee Public Museum	46951/12747
OZ026/19	9	Milwaukee	Klug	UW-Milwaukee	OZ026/19
OZ067/05	10	Milwaukee	Klug Island	UW-Milwaukee	OZ067/05
PT029/07	28	Wisconsin	Bigelow-Hamilton	UW-Madison	47-399
PT029/23	24	Wisconsin	Bigelow-Hamilton	UW-Madison	47-400
PT029/24	24	Wisconsin	Bigelow-Hamilton	UW-Madison	47-401
RO203/01	26	Rock	Jones	UW-Madison	47-402

Table 44: Thin-section Sample Information, concluded.

Vessel ID	EDXRF Cluster	River Valley	Site Name	Institution	Thin-Section ID
SBBR/18	21	Milwaukee	Thompson Black River Collection	Milwaukee Public Museum	58138/25576
SBBR/32	16	Milwaukee	Thompson Black River Collection	Milwaukee Public Museum	58161/25576
SK001/04	16	Wisconsin	Coopers Rockshelter	UW-Madison	47-403
SK001/05	19	Wisconsin	Coopers Rockshelter	UW-Madison	47-404
WL110/05	26	Rock	Mile Long	UW-Milwaukee	WL110/05
WL110/07	30	Rock	Mile Long	UW-Milwaukee	WL110/07
WO016/01	27	Wisconsin	Ross Mound Group	Milwaukee Public Museum	39218/10582
WP026/04	30	Wolf/Fox	Sanders	UW-Madison	47-405
WP026/23	24	Wolf/Fox	Sanders	UW-Madison	47-406
WP026/24	11	Wolf/Fox	Sanders	UW-Madison	47-407

needs. Braun (1983) related wall thickness, vessel shape, and temper size to changing subsistence trends. The size of inclusions may be culturally determined and specific to time periods or places (Rice 1987). For example, in Wisconsin Middle Woodland North Bay vessels tends to have very large and poorly sorted temper (Mason 1966), while Late Woodland Madison ware types tends to have smaller inclusions (Baerreis 1953; Keslin 1958). Therefore, examining technological choices like grain size inclusion can help to ascertain group membership and group interaction in part because groups may have different subsistence, storage, and other needs for their pottery, but also because they may manipulate the more functional attributes for other social reasons.

A grain size index was employed that characterized inclusions on a scale of 1 to 5, with 1 representing fine sized and 5 representing gravel sized particles. Vessels could contain inclusions of various sizes, but the inclusion index is an average of included grains that gives a general representation of grains size within a vessel. Grains were measured are either naturally occurring, like sand, or as deliberately added temper. Previous studies found that naturally occurring grains are smaller and more rounded (Stoltman 1989). Temper was identified by its larger size and its angular shape.

Only one vessel, GT157/09, did not show any indication of naturally occurring grains. The naturally occurring grain index ranged from 1.00 to 2.83 in the other petrographic samples (Table 45). The temper inclusion index ranged from 2.50 to 4.79 in the vessels. As expected, the results indicate that naturally occurring grains are much smaller than the added temper. Also, the temper index shows that medium to very coarsely sized grains were preferred.

Table 45: Grain Size Indices by River Valley and Vessel

Vessel ID	Natural Inclusion Grain Size Index	Temper Inclusion Grain Size Index
Milwaukee River Valley		
OZ026/19	1.67	4.21
OZ067/05	1.25	4.04
SBBR/18	1.69	3.94
SBBR/32	1.00	4.79
Rock River Valley		
DA411/06	1.94	3.69
DAPP/01	1.53	2.50
DO027/17	1.64	3.38
DO131/12	1.76	4.00
DO131/17	1.24	4.36
DO131/18	1.00	4.17
DO518/03	1.76	3.50
JE7676/06	1.87	3.79
RO203/01	1.55	4.36
WL110/05	2.40	4.73
WL110/07	1.79	4.06
Wisconsin River Valley		
CR186/03	1.31	4.17
CR309/01	1.50	3.50
CR357/03	1.00	3.83
GT112/01	2.83	3.79
GT112/11	2.56	4.20
GT156/02	1.67	3.14
GT156/03	1.13	3.40
GT156/04	2.24	3.78
GT156/23	2.26	3.08
GT157/06	2.31	4.00
GT157/09	0.00	2.80

Table 45: Grain Size Indices by River Valley and Vessel, concluded

Vessel ID	Natural Inclusion Grain Size Index	Temper Inclusion Grain Size Index
GT157/17	2.00	3.56
GT266/01	1.75	3.78
IA038/03	1.15	3.75
IA038/11	1.75	4.00
PT029/07	1.75	3.97
PT029/23	1.00	4.19
PT029/24	1.84	3.97
SK001/04	1.50	4.54
SK001/05	1.43	4.00
WO016/01	1.33	4.57
Wolf/Fox River Valley		
CT071/03	1.46	3.88
CT071/06	1.67	4.39
MQ038/09	1.71	4.00
MQ039/05	1.60	4.24
WP026/04	1.38	3.97
WP026/23	1.93	3.75
WP026/24	2.05	4.37

Anderson-Darling tests for normality found that both the Natural Inclusion (A=0.50, p=0.199) and Temper Inclusion (A=0.66, p=0.080) variables were normally distributed. ANOVA tests found that naturally occurring grain size was not significant by river valley (F=0.30, p=0.58). Additionally, temper inclusion size was also not significantly different by river valley (F=0.14, p=0.71). Potters from all parts of southern Wisconsin were generally choosing the same sized temper during the Late Woodland period.

Temper Choice

It was assumed that almost all the Late Woodland vessels would be tempered with granitic rock because effigy mound ceramics are almost always described as grit-tempered (e.g., Baerreis 1953; Hurley 1975; Keslin 1958; Wittry 1959). However, the petrographic analysis showed that only 79.1% of the total sample (N=34/43) was tempered with this material (Table 46). More than 9.0% (N=4) were tempered with

Table 46: Main Temper Choice by River Valley and Vessel

	Main Tempering Agent				
Vessel ID	**Grit-granitic**	**Grit-opaque mineral**	**Grit-limestone**	**Grit-Ortho-quartzite**	**Grit-granitic/Grog**
Milwaukee River Valley					
OZ026/19	X				
OZ067/05	X				
SBBR/18	X				
SBBR/32	X				
Total	4	0	0	0	0
Frequency (%)	100.0	0.0	0.0	0.0	0.0
Rock River Valley					
DA411/06	X				
DAPP/01	X				
DO027/17	X				
DO131/12	X				
DO131/17	X				
DO131/18	X				
DO518/03	X				
JE7676/06	X				
RO203/01	X				
WL110/05					X
WL110/07	X				
Total	10	0	0	0	1
Frequency (%)	90.9	0.0	0.0	0.0	9.1
Wisconsin River Valley					
CR186/03				X	
CR309/01				X	
CR357/03	X				
GT112/01	X				
GT112/11	X				
GT156/02	X				
GT156/03	X				
GT156/04	X				
GT156/23	X				
GT157/06	X				
GT157/09	X				
GT157/17			X		
GT266/01		X			
IA038/03			X		
IA038/11				X	
PT029/07				X	

Table 46: Main Temper Choice by River Valley and Vessel, concluded

Vessel ID	Grit-granitic	Grit-opaque mineral	Grit-siliceous oolite	Grit-Ortho-quartzite	Grit-granit-ic/Grog
PT029/23	X				
PT029/24	X				
SK001/04	X				
SK001/05	X				
WO016/01	X				
Total	14	1	2	4	0
Frequency (%)	66.7	4.8	9.5	19.0	0.0
Wolf/Fox River Valley					
CT071/03					X
CT071/06	X				
MQ038/09	X				
MQ039/05	X				
WP026/04	X				
WP026/23	X				
WP026/24					X
Total	5	0	0	0	2
Frequency (%)	71.4	0.0	0.0	0.0	28.6
Grand Total	33	1	2	4	3
Grand Frequency	76.7	2.3	4.7	9.3	7.0

orthoquartzite and approximately 7.0% (N=3) with grit-tempered grog. In addition, almost 5.0% (N=2) were tempered with a chert-like siliceous oolite, and 2.0% (N=1) were tempered with an opaque mineral like hematite (Figures 34-38).

There is variation among river valleys in the temper inclusion choices by potters. Vessels from Milwaukee River valley are exclusively tempered with granitic rock. The Rock River and Wolf/Fox River valleys both show a high propensity for granitic rock tempering, but one vessel from each area exhibited grog as its main tempering agent. However, only 66.7% (N=14/20) of the Wisconsin River valley vessels were tempered with granitic rock. This region had vessels with opaque mineral, siliceous oolite, and orthoquartzite temper. None of the other river valleys had vessels with these types of temper. Also, the Wisconsin River valley did not have any examples of grog-tempered

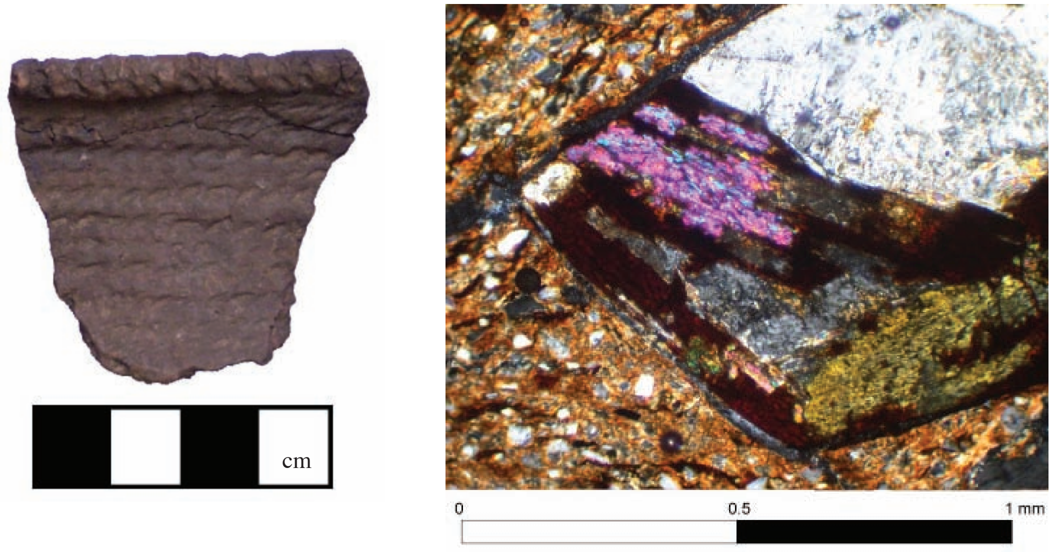

Figure 34: Thin-section of CR186/03 showing grit temper.

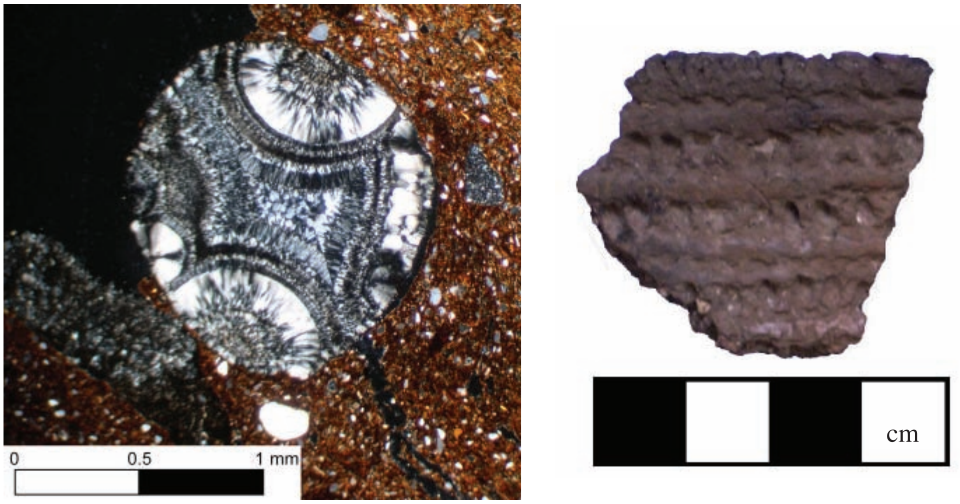

Figure 35: Thin-section of GT157/17 showing siliceous ooilite temper.

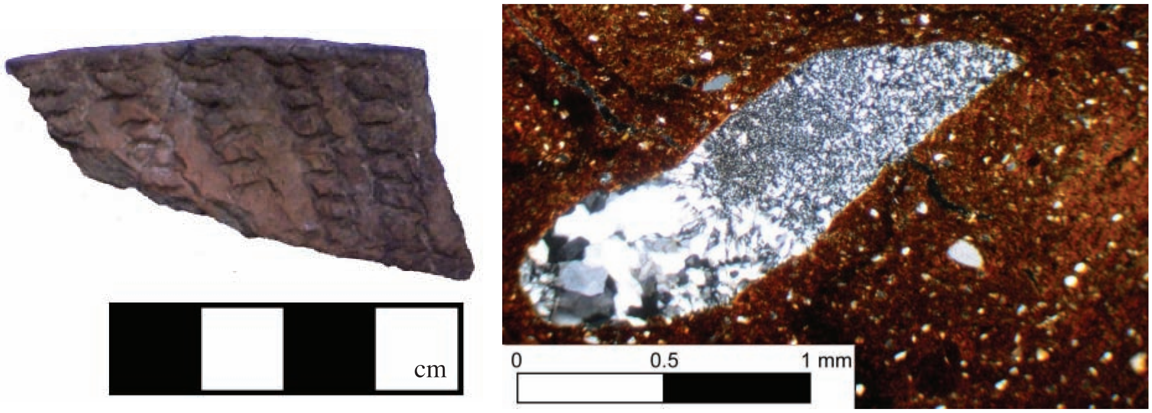

Figure 36: Thin-section of IA038/11 showing orthoquartzite temper.

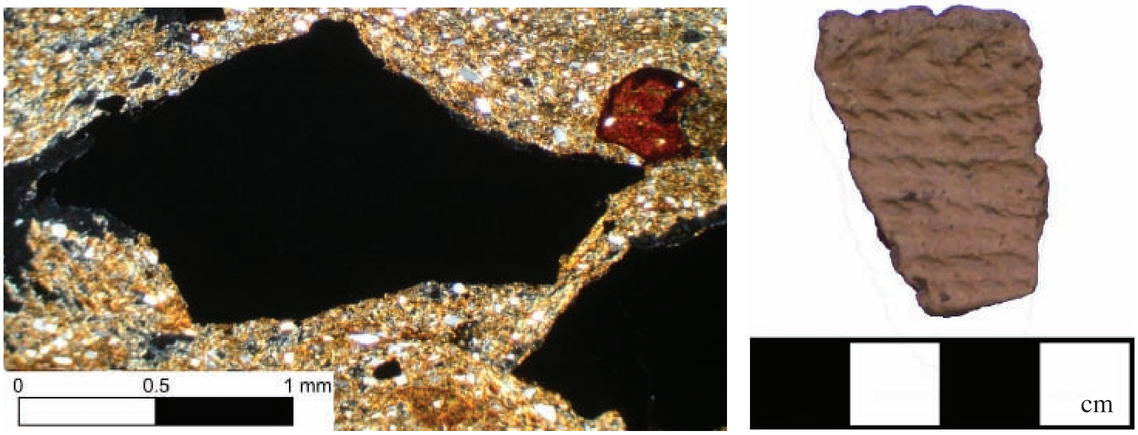

Figure 37: Thin-section of GT266/01 showing opaque temper.

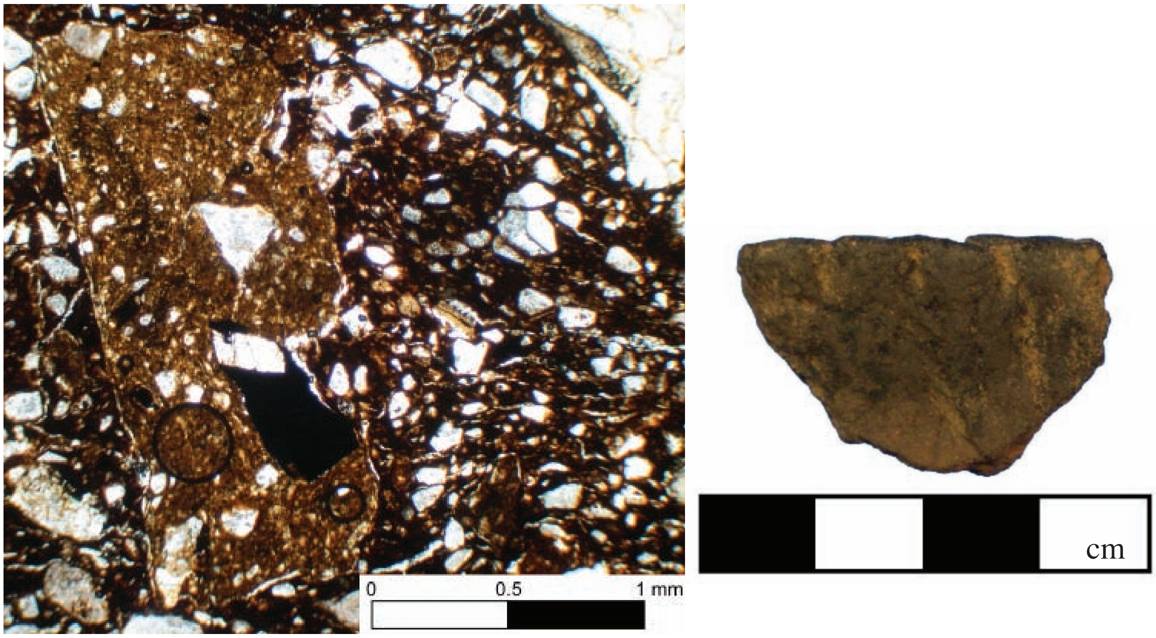

Figure 38: Thin-section of CT071/03 showing grog temper.

vessels. However, the Fisher's test did not show a relationship between temper choice and river valley provenience (Fisher sim.p=0.301). Haberman residuals were not calculated for temper type as the Fisher's test was not significant.

The temper type data were transformed into a distance matrix and subjected to Mantel tests using simulated p-values. Interestingly, Mantel tests showed that vessel temper type was correlated with geographic distance (sim.p = 0.02). It is possible that people were moving within a geographic range that crosscut between river valleys. Temper choice is more related to site distance than with river valley provenience.

The results indicate that there were regional preferences for temper choice. However, temper choice itself does not indicate whether clays or vessels were being transported across the landscape. Rather, it may indicate that if clays were brought in from other locations, the pottery was composed using regional sensibilities. Alternatively, potters may have used different recipes for production depending upon where the potter made the vessel. An understanding of paste characteristics will help determine if clays were transported across southern Wisconsin.

Paste

Paste is the mix of naturally occurring particles found in sediments chosen by potters before they added other tempering inclusions. Paste is studied in petrography through the percentage inclusion of clay (matrix), silt, and sand. The paste composition is most useful for studies attempting to connect ceramics back to clay sources (Stoltman 1991, 2001).

One vessel, GT157/09, did not show any sand in the paste (Table 47). The percentage inclusion of sand in all other sampled vessels ranged from 2.0% to 38.0%. WL100/07 had the highest sand percentage. Sand inclusion percentage averaged 11.7% for all 43 petrographic samples. Silt percentage ranged from 1.0% to 24.0% when excluding a vessel from the Sanders site, WP026/24, which did not have any silt counted on the petrographic slide. Percentage silt inclusion averaged 7.8% across all the petrographic slides. Matrix percentage varied from 54.0% to 97.0%. The average matrix percentage for all 43 vessels is 80.4%.

All the river valleys showed variations in the percentage inclusion of sand, silt, and matrix. However, the regression analysis showed that river valley provenience did not predict the ratio between sand and matrix for the paste data (F=1.314,

Table 47: Paste Percentage Inclusions by River Valley and Vessel

Vessel ID	**Sand %**	**Silt %**	**Matrix %**
Milwaukee River Valley			
OZ26/19	7.0	4.7	88.3
OZ67/05	4.2	1.1	94.7
SBBR/18	16.8	6.3	76.8
SBBR/32	4.0	7.9	88.1
Average	8.0	5.0	87.0
Rock River Valley			
DA411/06	20.7	24.1	55.2
DAPP/01	12.2	12.9	74.8
DO027/17	10.8	6.9	82.4
DO131/12	12.6	11.9	75.6
DO131/17	22.5	11.7	65.8
DO131/18	10.4	13.2	76.4
DO518/03	16.3	9.3	74.4
JE676/06	9.7	17.6	72.7
RO203/01	5.0	7.9	87.1
WL110/05	12.4	14.9	72.6
WL110/07	38.0	8.0	54.0
Average	15.5	12.6	71.9
Wisconsin River Valley			
CR186/03	9.3	11.4	79.3
CR309/01	1.8	16.2	82.0
CR357/03	2.2	2.2	95.7
GT112/01	15.8	7.0	77.2
GT112/11	13.1	12.3	74.6
GT156/02	3.0	5.9	91.1
GT156/03	14.2	7.1	78.8
GT156/04	13.8	11.4	74.8
GT156/23	28.0	3.8	68.3
GT157/09	0.0	3.3	96.7
GT157/17	2.5	20.7	76.9
GT157/6	6.7	7.2	86.2
GT266/01	3.5	15.8	80.7
IA038/03	23.0	2.9	74.1
IA038/11	3.6	6.3	90.1
PT029/07	15.8	2.0	82.2
PT029/23	11.8	6.6	81.6
PT029/24	23.5	4.4	72.1
SK001/04	1.8	5.3	92.9

Table 47: Paste Percentage Inclusions by River Valley and Vessel, concluded

Vessel ID	Sand %	Silt %	Matrix %
SK001/05	7.0	1.0	92.0
WO016/01	2.9	6.7	90.5
Average	9.7	7.6	82.7
Wolf/Fox River Valley			
CT071/03	14.4	2.2	83.3
CT071/06	3.4	3.4	93.2
MQ038/09	28.8	2.3	68.9
MQ039/05	5.3	1.1	93.7
WP026/04	7.1	0.0	92.9
WP026/23	15.6	0.6	83.8
WP026/24	23.6	10.3	66.1
Average	14.0	2.8	83.2
Grand Average	11.7	7.8	80.4

p=0.258). Also, river valley provenience could not predict the ratio between silt and matrix (F=1.844, p=0.182). Therefore, there does not seem to be a regionally defined prescription for a certain type of clay used by Late Woodland potters. Rather, ceramic manufacturers across the study area preferred clays with similar percentages of inclusions.

The paste percentage results were transformed into a distance matrix and subjected to cluster analysis. The resulting tree revealed four main branches (Figure 39). All of these clusters overlap when plotted geographically (Figure 40) and expectedly the dendrogram was not statistically significant (p=0.592). Mantel tests found that geographic distance between sites was not correlated with paste percentage scores overall (sim.p= 0.610). Cluster 1 is largely confined to western Wisconsin in Crawford and Grant Counties. However, all the other clusters are spread across the state in a fairly even distribution. The results is different from the decoration and EDXRF data sets where there were gaps and outliers within the clusters. Furthermore, vessels that are near each other in the paste percentage dendrogram are not near each other on the cluster tree produced using the EDXRF elemental results. The result may be due to the fact that the

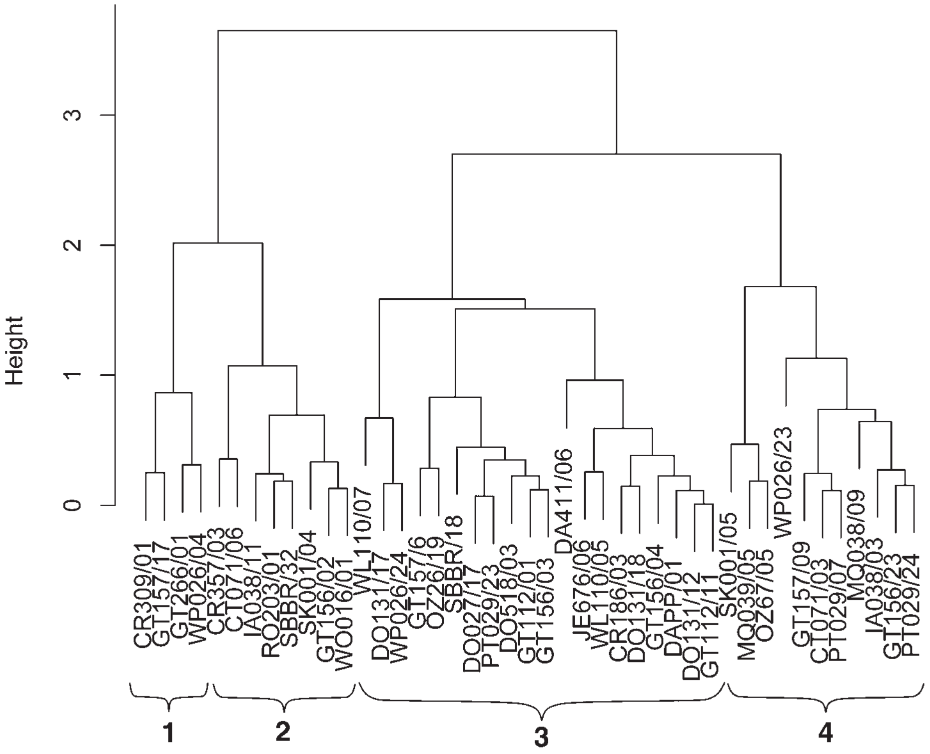

Figure 39: Paste percentage inclusion cluster dendrogram.

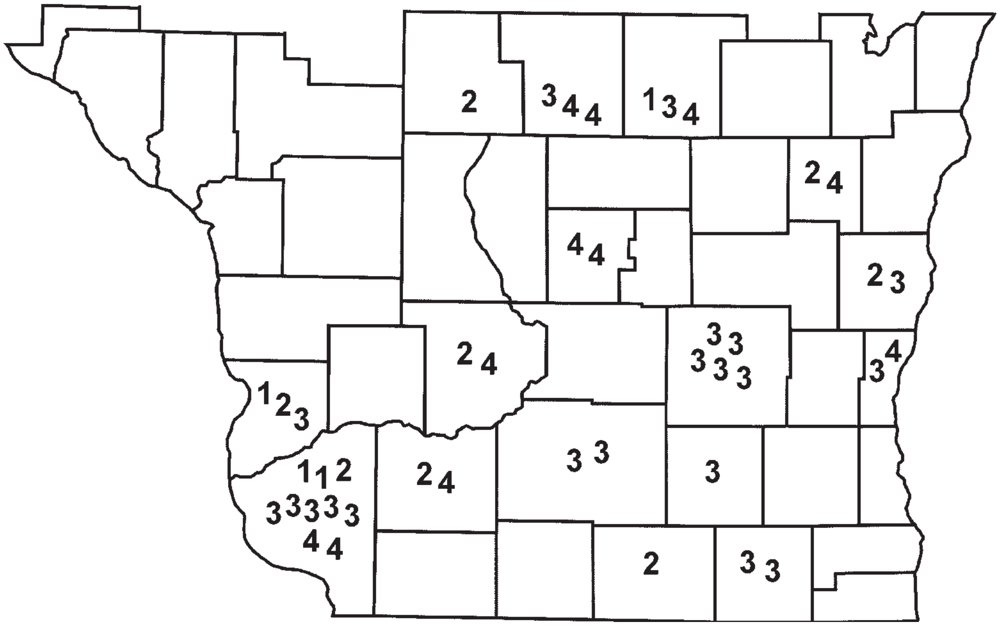

Figure 40: Paste percentage inclusion cluster geographic plot. Labels correspond to clusters in Figure 39.

EDXRF records any elemental signature provided by the added temper, a factor ignored in petrographic Paste analysis.

The paste ternary diagram appears to corroborate the Mantel tests results. Vessels from each river valley do not cluster in any coherent manner on the ternary plot, but rather overlap each other considerably (Figure 41). Encircling the vessels from the same river valley helps demonstrate this overlap (Figure 42). While the Milwaukee River valley vessels show the most concentrated circle, this sample was also only composed of four vessels. The Rock River valley vessels, conversely, show a wide spread but tend towards having less percentage matrix inclusion. The Wolf/Fox vessels tend to be siltier; but this is not substantiated by the regression analysis. The conclusion drawn from

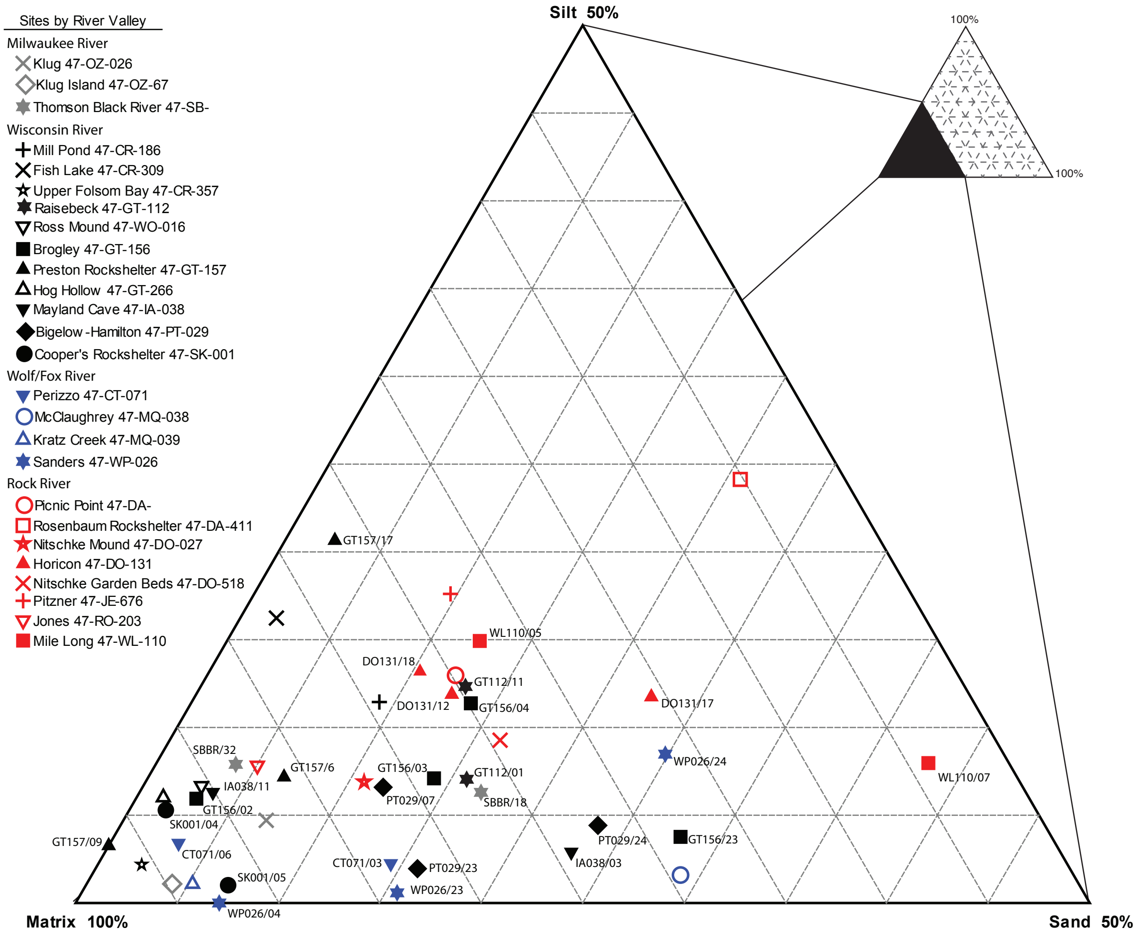

Figure 41: Paste percentage inclusion ternary diagram.

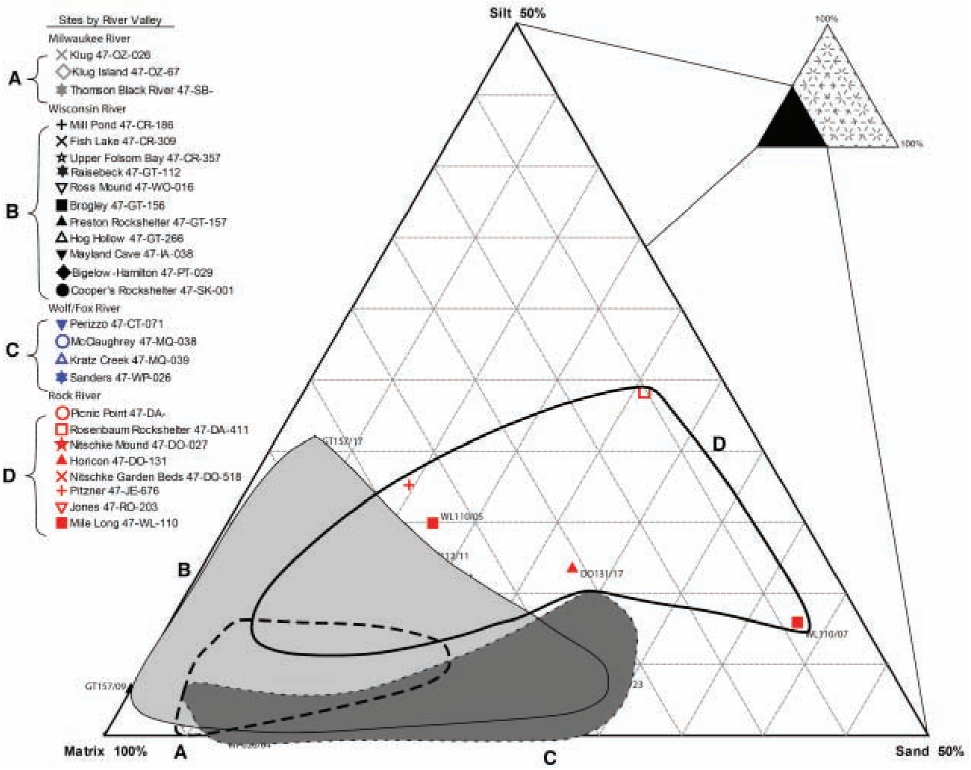

Figure 42: Paste percentage inclusion ternary diagram with river valley provenience plotted.

this figure is that almost all the vessels fall within the same range on the paste ternary diagram.

Data from the EDXRF and paste analyses pattern differently. Vessels in the same EDXRF cluster were expected to be near each other in the petrographic analysis, but this is not always the case. For example, two vessels from EDXRF Cluster 21, GT156/03 and SBBR/18, are very near each other on the paste ternary diagram (Figure 43). Conversely, two vessels from EDXRF Cluster 30, WP026/04 and WL110/07 are very far apart on the paste ternary diagram. This pattern is repeated even when two vessels from the same site represent the same cluster. For instance, DO131/12 and DO131/18, which compose EDXRF Cluster 7, are near each other on the paste ternary diagram, while GT156/02 and GT156/04, composing EDXRF Cluster 4, are very far apart on the paste ternary diagram. These occurrences are the results of the analysis methods: petrographic analysis

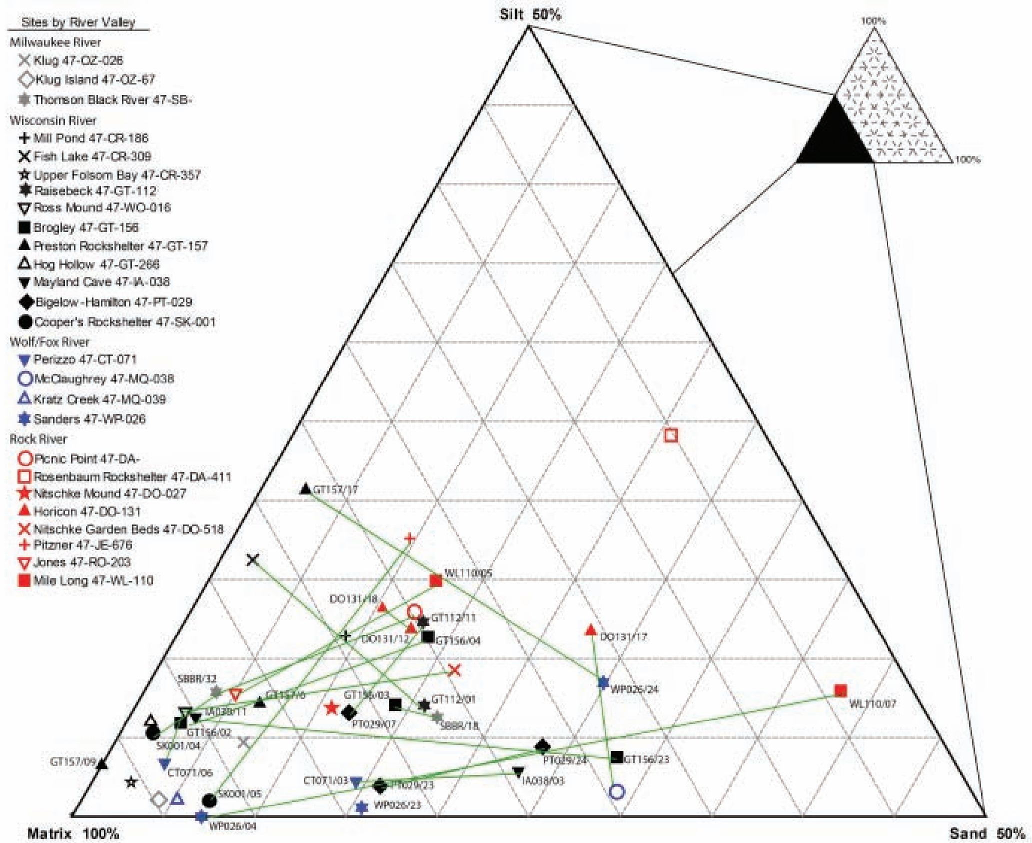

Figure 43: Paste percentage inclusion ternary diagram with vessels from the same EDXRF cluster linked by green lines.

studies vessel particle percentage composition while EDXRF analysis studies elemental composition. The differences between the EDXRF and petrographic analyses are the result of the differences in attributes being measured.

Interestingly, if one ignores EDXRF cluster composition and examines where vessels from the same site fall in the ternary diagram then this also produces conflicting interpretations (Figure 44). For example, SK001/04 and SK001/05 are close to each other in the ternary diagram though they fall in separate EDXRF clusters. However, WL110/05 and WL110/07 are quite far apart. The results indicate that these vessels found at the same site were not made from exactly the same clay source, but with similar clays with somewhat different compositions. Clays from different locations could have been transported to the same site, or the vessels themselves may have been moved across the landscape and deposited at the same location.

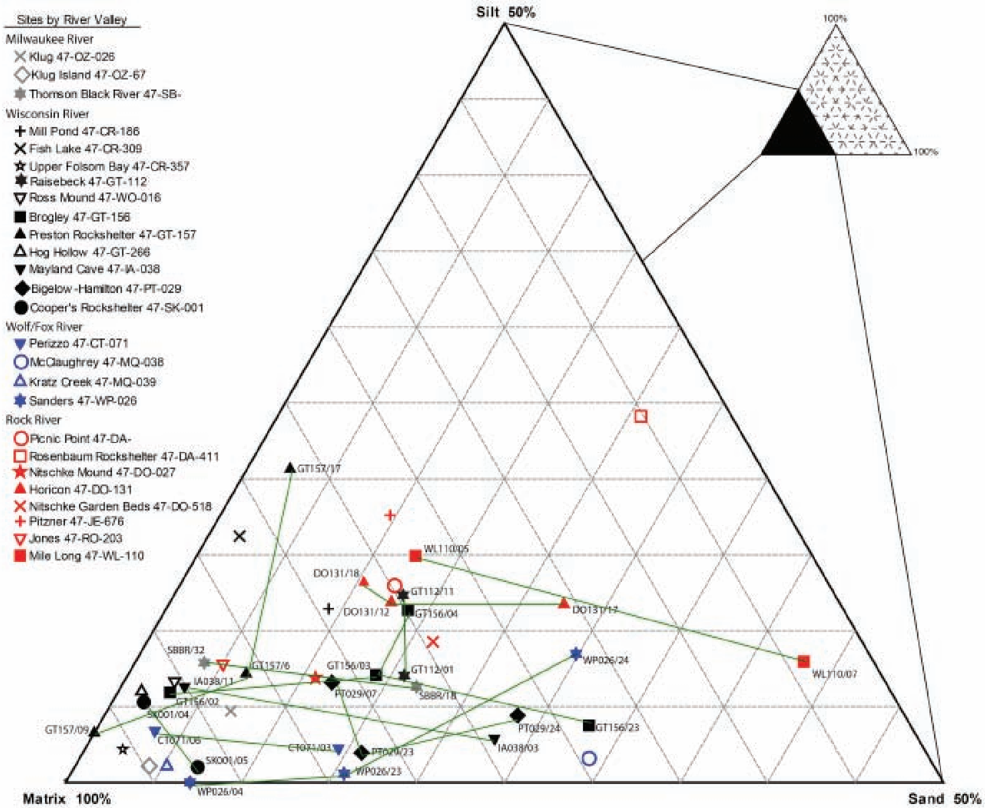

Figure 44: Paste percentage inclusion ternary diagram with vessels from the same site linked by green lines.

Body

In contrast to paste, the petrographic Body considers the composition of the vessel as a whole, including temper and any other added material. For this reason, body results are more directly comparable to EDXRF results because it takes into account the minerals that were deliberately added to the paste. However, EDXRF will not distinguish between body, paste, natural or added ingredients. EDXRF only returns the total elemental signature of a vessel. Body is studied by comparing matrix, sand, and temper percentages. Matrix is a collapsed category combining the clay and silt particles in the Body analysis. As Body takes into account temper, considering it alongside temper type may give an indication of standard ways prehistoric people had of constructing vessels. In this manner Paste indicates clay source choices, but Body indicates choices reflecting human alteration of those clay sources.

Sand percentage inclusion ranged from 1.0% to 32.0% (Table 48). Sand is distinguished from temper based on its smaller size and more rounded appearance (Stoltman 1991). All vessels exhibited temper. The temper inclusion percentage ranged from 2.0% to 40.0%. Interestingly, the vessel with the highest amount of temper, GT157/09, was also the vessel without any sand. This vessel also had significantly more temper than the vessel with the second highest temper percentage inclusion, PT029/07 which had 28.0% temper inclusion. It is possible the increased amount of temper added was a manufacturing means to compensate for the reduced amount of sand in the body. Matrix percentage ran from 52.0% to 92.0%. The vessel with the highest amount of matrix, IA038/11, has very low amounts of both sand and temper.

Table 48: Body Percentage Inclusions by River Valley and Vessel

Vessel ID	**Sand %**	**Temper %**	**Matrix %**
Milwaukee River Valley			
OZ26/19	6.1	12.9	81.0
OZ67/05	3.4	20.2	76.5
SBBR/18	14.2	15.9	69.9
SBBR/32	3.3	15.8	80.8
Average	6.7	16.2	77.0
Rock River Valley			
DA411/06	17.5	15.5	67.0
DAPP/01	11.9	2.8	85.3
DO027/17	10.0	7.3	82.7
DO131/12	12.1	4.3	83.7
DO131/17	18.8	16.5	64.7
DO131/18	9.8	5.4	84.8
DO518/03	14.9	8.5	76.6
JE676/06	9.2	5.7	85.1
RO203/01	4.5	9.1	86.4
WL110/05	11.8	5.2	83.0
WL110/07	32.0	16.0	52.1
Average	13.8	8.7	77.4
Wisconsin River Valley			
CR186/03	8.6	7.9	83.6
CR309/01	1.5	19.0	79.6
CR357/03	1.8	17.4	80.8

Table 48: Body Percentage Inclusions by River Valley and Vessel, concluded

Vessel ID	Sand %	Temper %	Matrix %
GT112/01	14.1	10.9	75.0
GT112/11	12.6	3.9	83.5
GT156/02	2.6	12.2	85.2
GT156/03	13.0	8.1	78.9
GT156/04	12.1	12.8	75.2
GT156/23	25.8	7.2	67.1
GT157/09	0.0	40.2	59.8
GT157/17	2.1	12.8	85.1
GT157/6	6.2	7.6	86.2
GT266/01	3.2	9.5	87.3
IA038/03	22.5	2.2	75.3
IA038/11	3.4	4.3	92.2
PT029/07	11.4	27.9	60.7
PT029/23	8.7	26.2	65.0
PT029/24	18.5	21.4	60.1
SK001/04	1.3	24.7	74.0
SK001/05	6.4	9.1	84.5
WO016/01	2.5	11.8	85.7
Average	8.5	14.1	77.4
Wolf/Rock River valley			
CT071/03	11.4	21.1	67.5
CT071/06	2.8	18.6	78.7
MQ038/09	26.2	9.0	64.8
MQ039/05	4.3	18.1	77.6
WP026/04	5.3	24.7	70.0
WP026/23	13.4	13.9	72.7
WP026/24	20.0	15.0	65.0
Average	11.9	17.2	70.9
Grand Average	10.2	13.5	76.3

Regression tests to determine if river valley provenience predicted body percentage composition for sand, temper, and matrix showed no significant differences. River valley provenience did not predict the ratio between sand and matrix for the body data (F=0.527, p=0.472). Also, river valley provenience did not predict the ratio between temper and matrix (F=0.493, p=0.487). Therefore, there does not seem to be a regionally defined prescription for the percentage of matrix to sand and temper adhered to by Late

Woodland potters when constructing their pots. Rather, ceramic manufacturers across the study area preferred similar ratios of sand, temper, and matrix.

The Body inclusion percentages were also transformed into a distance matrix and subjected to cluster analysis and Mantel testing. Four main branches were found on the Body cluster tree using k-means exploratory clustering (Figure 45). The Body dendrogram was not statistically significant (p=0.189). When plotted, all the clusters show wide geographic spread and significant overlap (Figure 46). Mantel tests show that Body composition is not significantly related to geographic distance (sim.p=0.620). The result is likely because vessels from the different regions are present in the same cluster tree on the dendrogram.

The Body ternary diagram generally confirms the results of the regression and Mantel tests. The majority of the vessels plot randomly near the center of the diagram and river valley distribution also overlaps significantly (Figure 47, 48). The Body

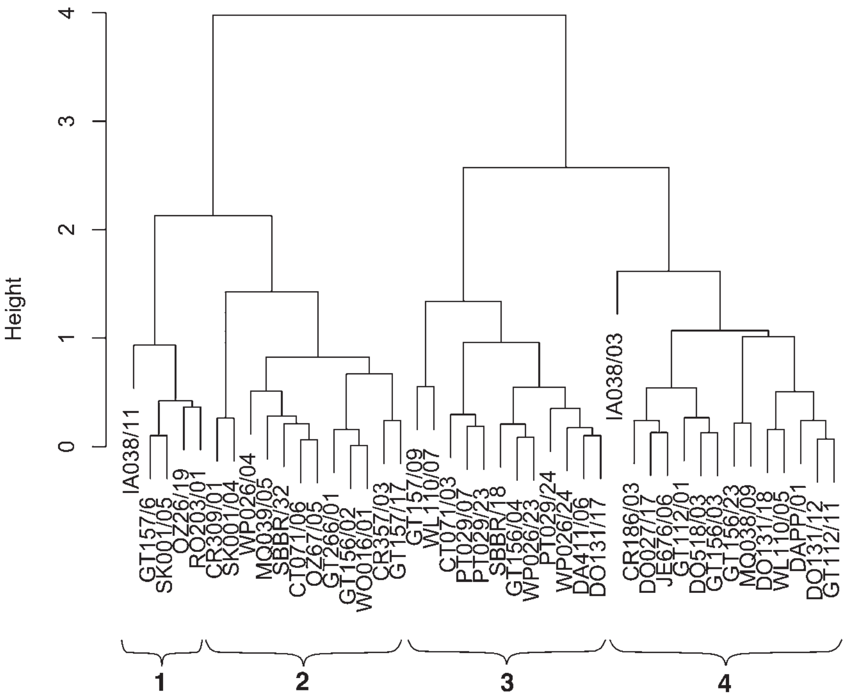

Figure 45: Body percentage inclusion cluster dendrogram.

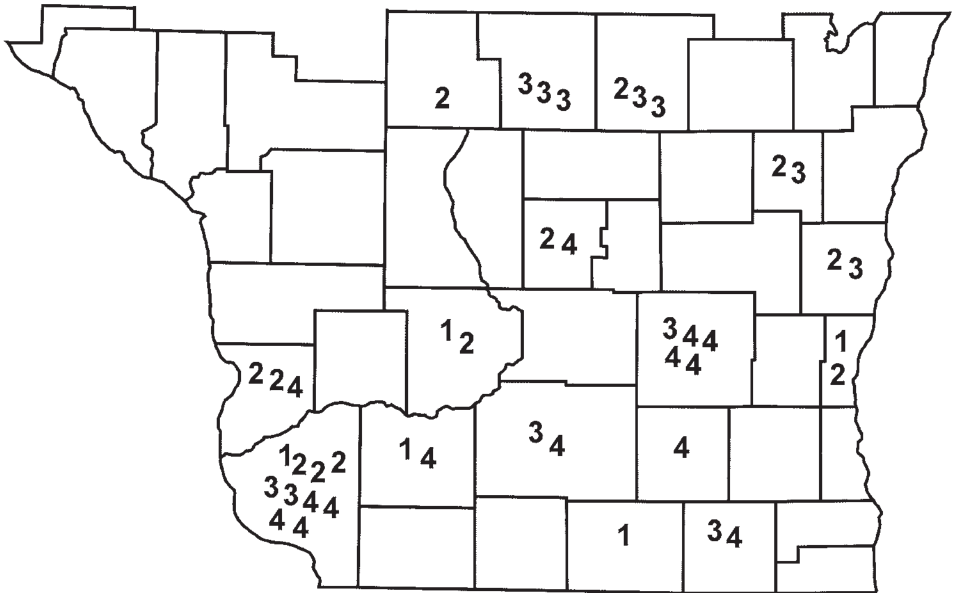

Figure 46: Body percentage inclusion cluster geographic plot. Labels correspond to clusters in Figure 45.

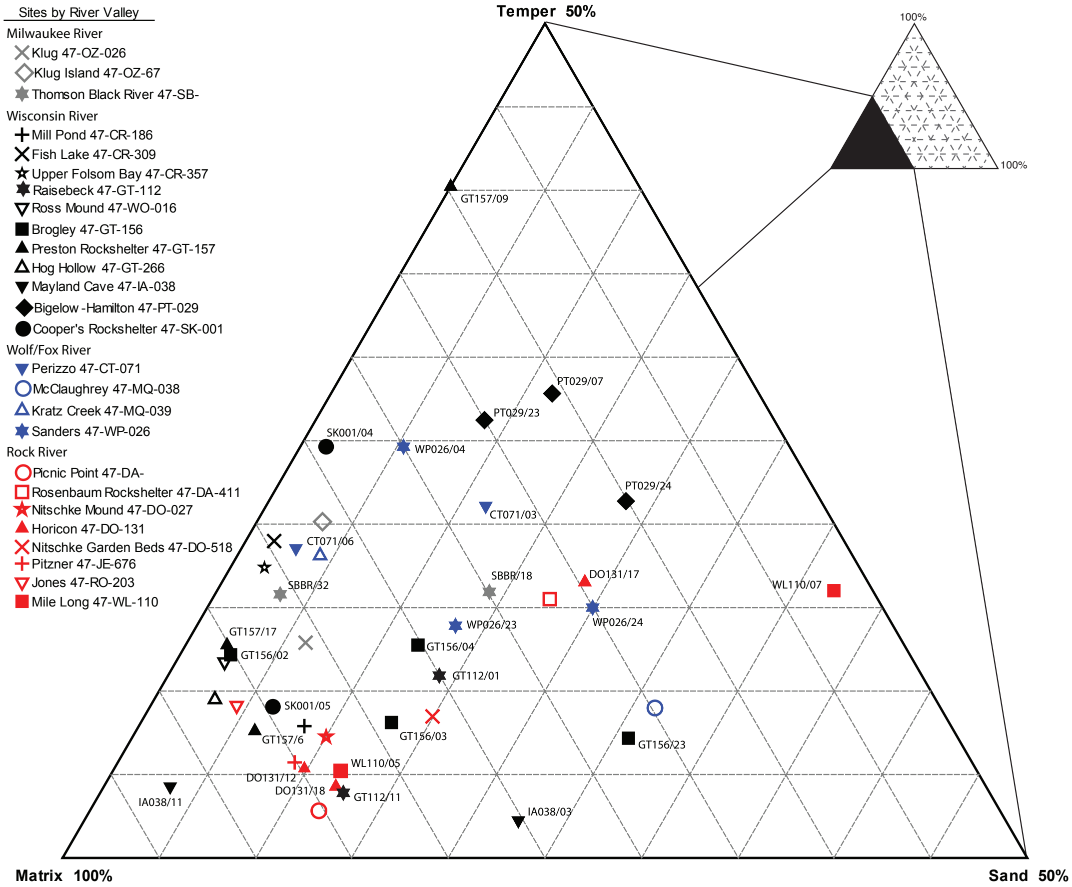

Figure 47: Body percentage inclusion ternary diagram.

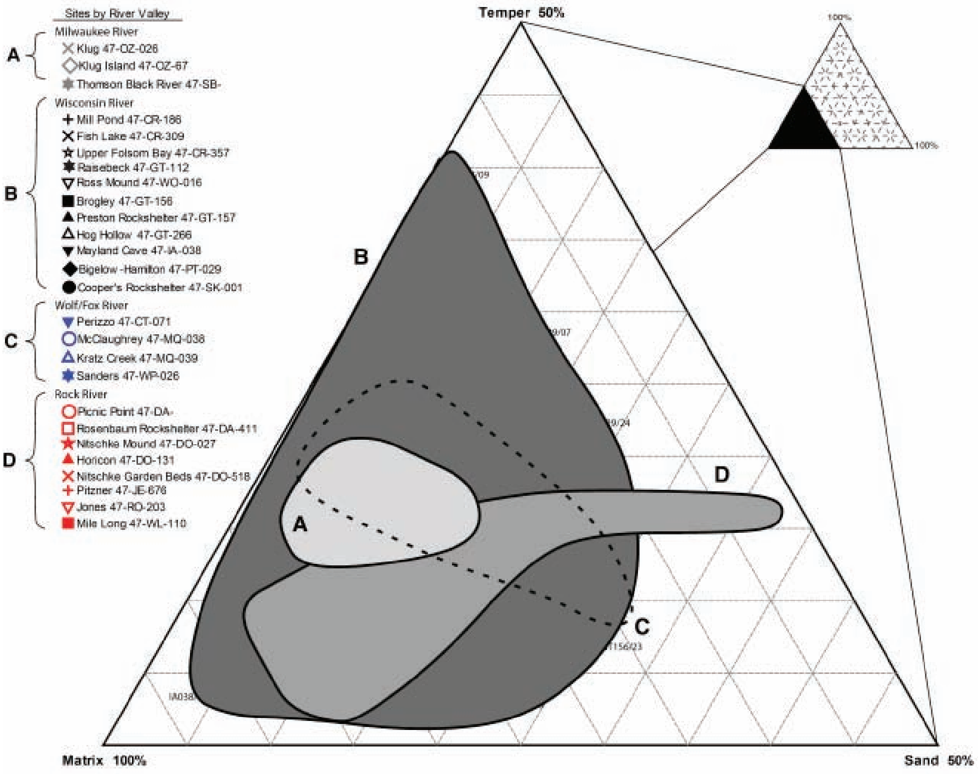

Figure 48: Body percentage inclusion ternary diagram with river valley provenience plotted.

analysis also produces conflicting results when compared to the EDXRF data (Figure 49). Similar to the Paste analysis, vessels from the same cluster or same site do not necessarily plot near each other on the Body ternary diagram (Figure 50). SK001/05 and JE676/06, representing Cluster 19, are near each other. However, WL110/07 and WP026, representing Cluster 30, are again very far apart. In sum, though, it can be said that all Late Woodland vessels are generally made with the same proportion of matrix, sand, and temper.

Discussion

Vessel Petrography by River Valley

In their petrographic analysis, Stoltman and Mainfort (2002) found that the smallest spatial scale at which ceramic products can be recognized is the locality or region. For this reason, the main focus of this dissertation was the comparison of traits

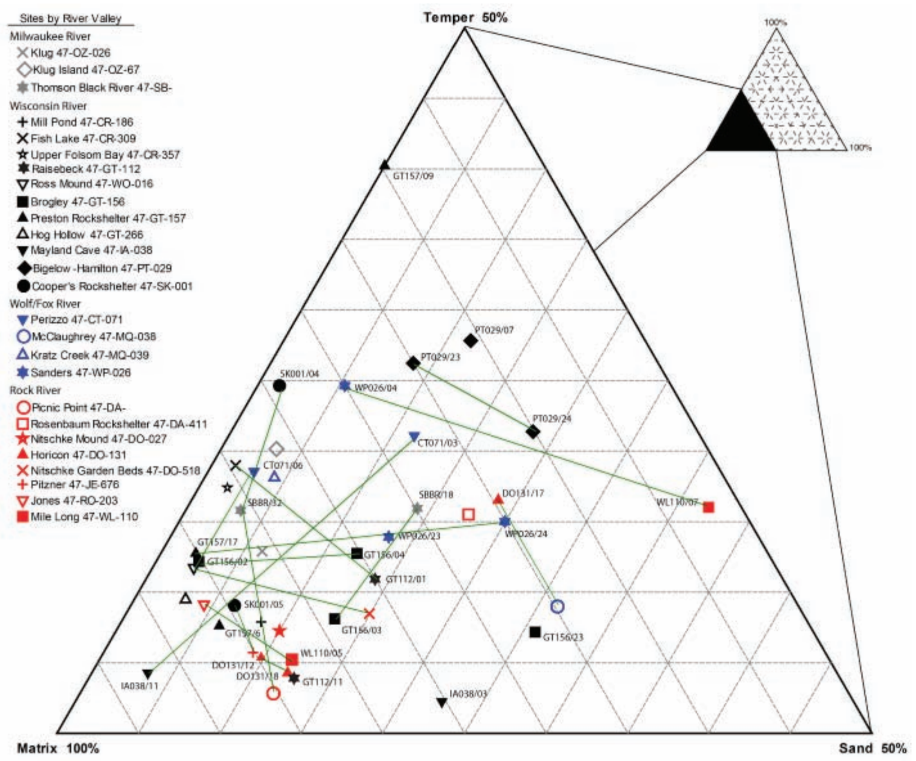

Figure 49: Body percentage inclusion ternary diagram with vessels from the same EDXRF cluster linked by green lines.

between large sections of southern Wisconsin- by river valley provenience and by Mantel tests utilizing a coordination of petrographic data and geographic location distance matrices.

Temper choice was the only attribute significantly different across southern Wisconsin. An interesting result of the petrographic analysis is the demonstrated presence of multiple different types of predominate temper in Late Woodland ceramics. Granitic rock as temper was only predominant in 76.7% of the vessels. The remaining vessels used grog, siliceous oolite, orthoquartzite, or an unidentified opaque mineral. While temper type was not significant in Fisher tests, Mantel tests found it to be significantly different between geographic locations using latitude and longitude coordinates. Vessels in the Milwaukee River valley exclusively used granitic rock for temper, while vessels in the Wisconsin River valley showed a wide range of

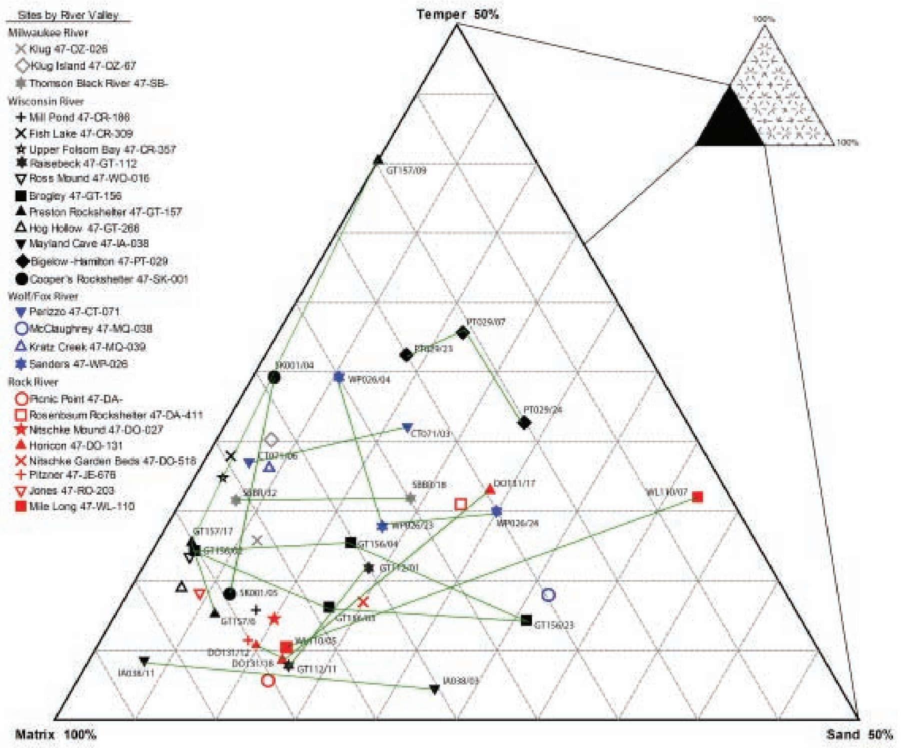

Figure 50: Body percentage inclusion ternary diagram with vessels from the same site linked by green lines.

temper possibilities. Vessels found at the same site also may have had different temper inclusions. For instance, different ceramics found at GT157 used either granitic rock or siliceous oolitic temper.

The implications of the temper differences are threefold. First, it indicates that Late Woodland potters could chose between a variety of appropriate tempers. Also, it shows that temper choice may be regionally defined. Eastern Wisconsin potters preferred granitic rock, while western Wisconsin potters could choose multiple, different types of tempering agents. Also, as paste was found to be generally similar across southern Wisconsin in the multivariate analysis but temper was significantly different, this may indicate that while people went to different clay sources, they constructed ceramics using regional sensibilities at a home location after they got the clays. Also, people could have been using similar clays from different sources as they moved across the landscape as part of their settlement-subsistence round.

While temper choice may vary, all other parts of the Late Woodland pottery recipe were generalized and similar across the study area. Potters used similar natural and cultural inclusion grain sizes, and composed their vessels with the same general inclusion percentages for both Body and Paste. That is, they generally preferred clays with certain characteristics and also tempered these clays with a similar amount of additive material. The main difference in Late Woodland pottery among the different locales of southern Wisconsin is the type of temper chosen for inclusion.

Other researchers have interpreted differences in petrographic composition as indicative of the intermarriage and the movement of women. Hanna (1984:126) found significant differences in the percentage temper used by potters as the Aschkibokahn site in Manitoba, Canada. While the majority of Duck Bay vessels had similar amounts of included temper, a small percentage of the vessels were composed using a different recipe. Hanna (1984:127) posits the results indicate that women were moving between sites as part of exogamous marriage practices geared toward economic and political group welfare. However, her EDXRF research also indicates that vessels were not being transported or traded between sites (Hanna 1984:122). The role of women as pottery manufacturers is critical when assessing prehistoric groups, but this research demonstrates that it may be both pottery and people that are moving across southern Wisconsin.

Site Petrographic Analysis

Detailed site-to-site comparisons are not possible with this study since so few sherds represent so many different sites. It is possible some of the vessels chosen for analysis are themselves non-local to their site location, but without a broad petrographic knowledge of every site in this study is it impossible to know whether the sherds chosen are actually representative of a local vessel. However, the study was not intended to determine local characteristics of each site, and there was no attempt to compare petrographic results to locally known clay sources. Rather, the study determined if vessels found at the same site are more similar to each other than they are to other vessels used in the study. These data are used to discuss whether pots, or potters, moved around the prehistoric landscape.

The ternary diagrams for both Body and Paste percentage inclusions indicate no relationship between vessel composition and site. Some sites have vessels that fall near each other in both the Body and Paste ternary diagrams (Figures 11 and 16). However, other sites, like WL110, show wide differences in composition. Sites with more than two vessels may have two vessels that are close to each other, and a third that is far apart. This is the case with sampled vessels from DO131 and GT157. Also, while vessels from particular sites may be near each other, they are also found close to vessels from sites located in geographically different regions.

The occurrence of vessels from the same site that have different Paste compositions may indicate that those vessels were not made with the same clay source. Clays from different locations could have been transported to the same site, or people could be using similar clays from different locations to make their pottery while they traveled. These finished vessels could have been moved across the landscape and deposited together at the same site. Either possibility requires the movement of people across broad geographic distances.

That multiple vessels at the same site may also have different Body compositions suggests that people had some degree of freedom in the construction of pottery and did not need to follow the exact same recipe. Potters may have chosen slightly different manufacture additions, cleaned their clay to varying degrees, or added different amounts of temper when constructing vessels even though they were in the same locality. These results could also indicate that pots made in different locations, with different clay sources, and made by different potters with different regional potting sensibilities, were being transported to the same area of final use. Trade or population movement between regions could have spread ceramics made in different regions to their final deposition area. In either case, it is clear that the distribution of Late Woodland ceramic decorations are not simply the result of diffusion of style or design concepts, but that people are physically moving pottery vessels across the landscape.

Since the Body percentage Mantel tests were insignificant, the results appear to signify that there was a general, overarching method of manufacturing Late Woodland pottery that was spread across the whole of southern Wisconsin. It shows that there was general consensus in how much clay, sand, and temper should be present in a vessel even if vessels at the same site were not exact replicas. Without local clay sourcing, it will therefore be difficult to ascertain fully if vessels are local or non-local representatives of a site or region.

Petrography compared to EDXRF & Decorative Attribute Analyses

Petrographic analysis did not produce the clusters like those established in both the EDXRF and Decorative attribute analyses. Broad, overlapping geographic clusters were noted in these analyses in river valley comparisons and geographic distance matrices. These groups proved to be statistically significant even with their geographic overlap. It is not wholly unexpected that petrography and decoration do not align completely. There is the possibility that composition and decoration are essentially independent systems, or that decoration is not dependent on the mechanical properties of a pot. Of course, there may also be cases where both decoration and composition are correlated, but this was not seen in the Late Woodland vessels in this study.

The discrepancy between the EDXRF and petrographic results are not unexpected and are likely due to the nature of the techniques. We should not necessarily see a one-to-one correlation in the results of the two different types of analysis. Petrography and EDXRF do not study the exact same compositional characteristics. EDXRF records elements while petrography records minerals and the percentage inclusion of temper and other properties. It is more appropriate to view these techniques as complimentary with any differences offering an avenue for future research (Stoltman 1989). In this case, the complimentary nature of the EDXRF and petrographic evidence suggests that potters across Wisconsin were generally selecting for similar clay characteristics and used similar proportions of temper in their recipes, but used different kinds of temper depending upon where they were on the landscape. Specifically, sites located in western Wisconsin exhibited many different types of temper, but the majority of those vessels from that locality still used granitic rock. Potters, or people transporting finished vessels, were relatively free to move across the landscape, especially in eastern Wisconsin. Western Wisconsin displays a higher degree of spatial boundaries in decoration, elemental composition, and petrographic attributes.

Relations to Territorial Models

There have been many suggestions that eastern and western Wisconsin show differentiation in the Late Woodland through mound construction (Birmingham and Eisenberg 2003; Goldstein 1995), ceramics (Kelly 2002; Rosebrough 2010), and subsistence practices (Egan-Bruhy 2012). The petrographic analysis resulted presented in this chapter can also be used to support this differentiation. Temper inclusion is significantly different between the river valleys. As noted above, the potters in the Milwaukee River valley tempered their vessels exclusively with granitic rock, but potters in western Wisconsin used many different types of temper. Temper choice is geographically indicative.

However, the petrographic analysis also demonstrates statewide commonalities on almost all compositional variables except temper choice. The lack of geographic clusters and significant Mantel tests for the Body and Paste tests may be due to a large degree of cultural interaction, the ability to move between places to obtain clay, or the ease of exchanging finished ceramics. These situations could facilitate the spread of an idea, or the movement of pots themselves, across the landscape. As clay source material is often obtained locally (Arnold 1985), all these scenarios are plausible and would result in pots at the same site having different petrographic signatures.

The petrographic data, therefore, support more than one social organizational model. Regional expression is seen in temper choice and groups may have sought to distinguish themselves by the types of temper used during vessel construction. The statistically different temper choices indicate a Low-level territorial organization. However, the overarching sense of how to construct a vessel, or carry vessels from one region to another without restriction, seen in the similarities in Body and Paste compositions across the study are suggests a Monolithic cultural structure. The generalized nature of the Body and Paste composition indicates a widely shared perception of how a Late Woodland pot should be constructed, even though there was variety allowed within the recipe. The only model not well supported by the petrographic data is the High-level Territory model. Pottery does not cluster by site provenience in the dendrograms or the ternary diagrams as is expected in situations of highly restricted movement of people and ideas.

There is more than one model that fits the petrographic data. The distinctions noted between eastern and western Wisconsin may be due to social signaling denoting differential group membership at a regional level. However, without accompanying radiocarbon information it is possible that the divisions are due to chronology or a combination of geographic and chronologic variation. Yet the geographical separation in temper choice is accompanied by a lack of distinction on all other petrographic attributes. It is therefore important to remember while there are east-west divisions between Late Woodland groups, there must have been some commonalities and connections between these groups that may reinforce group membership to a larger entity beyond regional affiliation. The Late Woodland period social organization and interaction is more complex than a simple east-west geographical division.

Chapter 8: Discussion and Conclusions

The questions asked in this dissertation included ones of social organization, territoriality, and population movements during the Late Woodland Period in Wisconsin. Specifically, I asked if ceramic attribute data could help to demarcate differences in varying social organizations that may have used by these groups, and what was the relationship between ceramic technology and nested levels of human interaction. The answers to these questions are that ceramic attributes can demarcate differences in social organizations and social boundaries. Also, I found that the nested levels of interactions present during the Late Woodland make it impossible to assess the period through only one model of social organization. Ceramics shows us how prehistoric people could use ceramics as a medium to negotiate commonality and distinctiveness.

Importantly, the study demonstrates that vessels were transported across the landscape. In order for this transmission to occur, people were moving and trade was easily facilitated and established. The ceramic attribute distributions indicate that a Low-level territorial model for social organization, interaction, and territoriality do not entirely explain the distribution of ceramic styles or technological design. In fact, it appears that more than one type of model, or a range of similar models to the ones discussed in this dissertation, is necessary to explain what is seen across the area where effigy mounds are found.

These data are best discussed with reference to theories of agency that conceptualize how pottery manufacture was used to negotiate, reintegrate, and distinguish the various Late Woodland performers across different levels of group membership. Combining these theoretical outlooks with data from new techniques, it is possible to draw new conclusions that amplify the work of previous researchers that reached similar conclusions (e.g., Kaufmann 2005; Mallam 1976; Storck 1972; Rosebrough 2010).

Decoration Analysis

The Wisconsin River valley has an almost standardized decoration style compared to other regions. Twisted cords are often overrepresented here, and the geographic area is underrepresented in non-twisted cord decoration in most of its decoration zones. Conversely, eastern Wisconsin areas has almost relaxed rules about what decorative elements are placed on a pot with CWS, bosses, LCP, and Combination motifs all present. Multi-variate tests indicate that Motif similarity is correlated with geographic proximity and the small clusters in the western regions may drive these geographic separations (Figures 22 and 27). Clusters from eastern and northeastern valleys are generally broader, and probably are related to the widespread use of many different technique types.

However, it is not simply an East-West division. There are also southern-northern divisions in the distribution of decorative techniques. The Wolf River area is most associated with CWS techniques, but the Rock is overrepresented in circular punctate and tool decorations. These are not often the most common decoration techniques associated with Late Woodland pottery, but they are found in combination with the twisted cord designs on Late Woodland pottery in these regions.

Certain decoration zones have more defined geographic coverage. The Middle Exterior and Lip decoration zones have the most spatially separate geographic groups. Rosebrough (2010) argues the most visible portions of vessels are the most likely to be use for social signaling. The results from this research appear to corroborate this statement. However, the relationship of vessel decoration zone and regionalism is more intricate than Rosebrough’s (2010) data detected, and the results of this study do not simply reiterate that the Middle Exterior decoration zone is good for social signaling. All the decoration zones with significant Mantel tests had at least one cluster that spanned the entire state. It is possible some decoration zones are not important for regional social signaling, but may show social relationships at a larger, statewide level. They are means of demonstrating commonality through the use of common techniques.

Additionally, decoration is not isomorphic to a geographic area. River valleys do not possess homogenous Angle, Technique, or Motif compositions. The many different types of decorative elements found on Late Woodland vessels are noted across the study area, but they are present in different quantities in particular regions. While potters in different river valleys used different band types, all bands were made using twisted cords because they are a technique associated with the wider culture of the Late Woodland potters. There was some consensus about which elements were appropriate for Late Woodland pottery decoration. However, there does appear to be a more restricted use of motifs for decoration in the western study region. Moreover, the distribution of motifs may be widespread, but not continuous. The result may indicate that not all people or ideas could move in all directions equally. There may be some social purpose to the discontinuity, or the result could be reflecting chronologic changes.

EDXRF Analysis

The EDXRF data also display regional and statewide clustering. Yet the EDXRF data demonstrate fewer tightly bound groups than the decoration data and have more geographic overlap. Averaging EDXRF data by vessels indicates that clusters are not composed of vessels from one site alone. Rather, the cluster patterns demonstrate multiple types of inter-site membership where the constituent vessels may be from geographically distant sites. Averaging EDXRF readings by site also showed that sites with close geographic proximity tend to cluster together, but they can group with distant sites. However, Mantel tests found a significant correlation between cluster composition and geographic distance. It appears that while people were moving particular vessels around the landscape, they were mostly moving within a large regional territory.

When plotted geographically, the site clusters also overlapped considerably. While the clusters could be described as ‘eastern’ or ‘northeastern’, five of these clusters overlap in the central portion of the study area (Figure 33). As with the decoration analysis, there is a large cluster that covers the entire portion of the study area. Interestingly, two western Wisconsin clusters cover small areas near the Mississippi River. Again, there seems to be regionalism, but also some degree of connection across the study area.

Petrographic Analysis

An interesting result from the temper studies was that the pottery from western Wisconsin showed a wide possibility of included temper types (Table 46). Given the overrepresentation of twisted cord types of decoration in this area on almost all ceramic decoration zones, and the small, tightly bound EDXRF clusters from Crawford County, it was unexpected to find this degree of leniency in the western Wisconsin pottery recipes. Rather, it was the Milwaukee River vessels that were exclusively tempered with granitic rock. It seems that for the temper attribute, the eastern Wisconsin potters were very regimented in their manufacturing.

The differences between grain size indices, Paste, and Body percentage inclusions were all insignificant attributes in multi-variate tests. The petrographic data geographic plots show a wider degree of overlap than the decoration or EDXRF analyses. When plotted geographically, the Paste and Body clusters overlap almost completely. The results from the Paste tests may show that people across the study area preferred clays with particular characteristics or cleaned the clays to similar degrees. The Body composition results indicate that there seems to be an overarching prescribed method or recipe for constructing pottery across southern Wisconsin.

A comparison of Body composition of vessels from the same site showed that vessels with the same provenience may not possess the same percentage of inclusions (Figure 50). Also, vessels with the same site provenience may be located near vessels that are geographically distant on the ternary diagram. These results indicate some flexibility in the pottery recipe within a margin of possibilities, or that vessels from different areas were being transported before their final deposition.

Comparisons Among Data Sets

The decoration, EDXRF, and petrographic analysis display different levels of significant attribute clustering. There are small clusters that cover small geographic areas, and also large clusters that cover wide parts of the state. However, the decoration analysis appears to show more geographically, non-overlapping clusters compared to the EDXRF analysis. It is important to note, though, that the clusters in the different data sets do not have the same site compositions, are not geographically isomorphic, and their attribute make-up is not homogeneous. Site associations seem to split or merge depending on what attributes are under review. However, the Mantel tests do affirm that most site associations are based upon geographic proximity.

These data indicate that there is some degree of localization, but this occurs within a wider geographic spread of similarities. Rather, there seems to be varying degrees of interaction between multiple sites, with all sites participating within a larger scheme pan-regionally. Persons living at these sites either had access to external ideas of pottery decoration, composition, and clay sources, or traveled there themselves to trade, live, or for group convergence.

Nested Interactions and the Performance of Pottery Manufacture

Applying agency-centered theories may help to explain the presence of both regionally small and broad clusters found in the same data set whether it is the decoration EDXRF, or petrographic data. Pottery making is essentially a performance that encapsulates the differential goals of the participants and observers even if that vessel is not seen until well after its manufacture is complete (Brumfiel 2000; Shanks 1999). Also, it is possible that material culture production, and especially pottery manufacture, represents a reworking and renegotiation of the social world by using the characteristics of a physical object as a medium for that transaction (Dietler and Herbich 1998; Dobres and Robb 2000). The results of the performative strategies are seen in the spatial distributions of ceramic attributes, in this case the decoration, EDXRF, and petrographic data. The different cluster spatial spreads may represent different levels of meaning or social affinity (see Voss and Young 1995).

It is likely potters in Wisconsin had multiple opportunities for contact with groups from wide-ranging portions of the state on either seasonal or more frequent occasions, or they moved locations for subsistence needs or other social occasions such as marriage or trade. In hunter-gatherer societies, there may have been overlapping networks of social identities and group affiliations in these situations: family, band, or region (Lightfoot 2001). The practice of making pottery and the social signaling imbedded within it may be used as much to maintain alliances and reproduce egalitarianism as it is used to express the multiple social levels to which people and groups belonged (Bursey 2006; Goodby 1998; Hegmon 1998; Sassaman 1995, 2000). Making Late Woodland pottery, therefore, is an attempt by the manufacturer to express the nested levels of commonality present between families, groups, and regions. Importantly, there was continual identity formation and reformation every time a new pot was made (Beeman 1986; Budden and Soafer 2009; Looper 2009).

Late Woodland Wisconsin pottery styles and the performance of decorating a vessel demonstrate the complex role pottery served as being a mechanism for both integration and demarcation. It is even possible different attributes, both decorative and technical/compositional, were serving this differential role on the same vessel. For example, the Paste and Body percentage inclusions are similar across the entire study area. Overall, Late Woodland potters across southern Wisconsin were making pots according to an overarching cultural concept that perhaps encompassed all the river valley regions under its purview. Vessel composition, and especially the idea of what percentage of silt, sand, clay, and temper to include, may have been more pan-regional and important for establishing a group of people as a whole entity within their total geographic range. Therefore, making a pot according to this recipe is a performance that expresses the statewide group affiliation.

Decorative attributes, like certain decoration Angles, Techniques, and Motifs were used to express group membership for smaller, more regional levels like the family or extended family affiliations within that broader order of inclusivity. The use of the diagonal twisted cord with punctates Motif is an outlet for potters to express their eastern Wisconsin relationships within their families of bands, just as the use of tooled punctates may be a way of defining oneself as hailing from the Rock River valley. Yet it is noted that the decoration Motifs data does not produce multiple river valleys with homogenous compositions. Finding tooled punctates in regions beyond the Rock River valley also help to display the ease of movement due to the opportunities for interaction present in a hunter-gatherer society with Low-level territorial interaction.

The EDXRF data straddles a middle ground between the decoration and petrographic data. It displays regionalism through the significant Mantel tests and geographic clusters, but also demonstrates how people could move freely within the system by obtaining, using, or traveling to get clays from different areas. It is possible that the act of being able to obtain those clays also reinforced the notion of an overarching structure because the territory of its geographic origin was available to the entire portion of southern Wisconsin by either trade or travel. Southern Wisconsin during the Late Woodland becomes a shared culture reflected in, or because of, a shared landscape.

It is important that vessel composition seen in the petrographic analysis indicates a wide, pan-regional sense of how to construct pottery and may be related to a degree of functional equivalency. Also, as sites have vessels that do not plot close together on the ternary diagrams, i.e. they are not manufactured in exactly the same manner, this indicates an accepted process of vessel construction that incorporated the possibility for variety within a prescribed range. Where decoration analysis showed regional boundaries, the petrographic analysis displays commonality across southern Wisconsin. Yet as with decoration, it is not enough to say that petrography is not a good regional indicator. Rather, it is possible that vessel construction works on a different social level than decoration. Where decoration best expresses local groups, people may have been using the vessel construction to signal membership in a larger association than was found across the entire study area based on similar functional needs of the pot within the Late Woodland subsistence and settlement regime. Potters were using decoration to express alliances to families or kin groups, but similar vessel construction expressed alliances to larger band, tribe or statewide groupings.

Using performance theory, one can conceive how vessels at the same site are constructed using similar methods of manufacture, but the EDXRF and petrographic data indicates they are made from different clay sources. The pottery is being used to both generate and transform that social structure, even though the producer is performing for an audience that may not see the act of clay acquisition. The act of gathering or obtaining clay is as much a performance as the clay preparation or temper additions. Being able to gather clay via travel to different area, or trading for that clay or finished vessels reinforces commonality by all people being able to use the same portions of the landscape.

Most importantly, it appears that groups in different parts of the state are performing in different manners and expressing different degrees of interaction with the effigy mound builders considered as a whole. While some potters at particular sites seem to be working to distinguish themselves, there also seem to be potters at other sites where the focus was on reinforcing relationships across wide geographic areas through shared commonalties and shared attributes. In the west, potters were expressing a greater level of structural control through their performance of pottery manufacture, potentially as a result of interactions with the larger southern populations in the Mississippi trench (see Egan-Bruhy 2012; Jeske 1992). They were seeking to express more internal solidarity through a restricted set of decorative techniques and regionally small clay trading or choices. In comparison, the eastern and central portions of the state seem to have more permeable and fluid rules that we associate with lower levels of boundary maintenance. Groups living in these areas had potters who sought to show cohesiveness to a larger entity while still demarcating themselves on the regional level. Eastern potters shared many decorative attributes and the EDXRF clusters are very broad in this area.

The presence of multiple types of territoriality and social organization within the same overarching interaction sphere is a more complex understanding of Late Woodland social structure than usually offered. It is possible this type of situation bends the commonly accepted ideas of egalitarian social structure and territoriality (see Rosebrough 2010; Sassaman 2004). Future research on hunter-gatherer societies may seek to develop theories that incorporate multiple types of interaction and territoriality between egalitarian bands that may have considered themselves part of the same broader cultural scheme. There is ample opportunity for agency-centered studies in non-hierarchical societies where the focus is on the maintenance and structure of egalitarianism (Lightfoot 2001).

The data interpretations offered are similar to Kaufmann's (2005) conclusions about effigy mound site structure where mound compositions served to both distinguish and reinforce group membership at multiple levels of social interaction. In this study, the results indicate that there is regionalism, but there also seems to be a good degree of sharing between those regions as evidenced by the large clusters that overlap and spread over vast portion of the study area. Egalitarian societies are as actively maintained as other social structures (Sassaman 2000, 2001; Wiessner 2002), and this is apparent in the ceramic data from the Late Woodland Wisconsin.

The application of a performance based agency interpretation helps to envision a prehistory in the Late Woodland Wisconsin where agency in these hunter-gatherer societies was a continuous process of identity marking related to group memberships at multiple levels of cooperation and reciprocity (see Lightfoot 2001). Instead of agency being used only to set people apart from one another, it was used during this time period as a means to continuously reinterpret and renegotiate a group consensus on many nested scales. Material culture was as much an integrating mechanism as it was used to distinguish boundaries (Hegmon 1998; Pryor and Carr 1995). The performance of pottery production was a transformative process where a group of people sought to continuously reinforce and reintegrate local, regional, and statewide alliances based upon clay acquisition, vessel manufacture, and vessel decoration (see Beeman 1986; Budden and Soafer 2009).

In this sense I differ from Rosebrough (2010:375), who suggests multiple semi-territorial sodalities, perhaps with differing group movement patterns, occupied southern Wisconsin during the Late Woodland time period. I do not find the results presented in this dissertation supportive of evidence for cross-cutting networks of Late Woodland sodalities. Rather, I envision multiple groups of people with nested identities. They share certain pottery making ideas, mortuary and ritual behaviors, but there are clear distinctions on a regional level and they are seeking to manage their various group memberships through pottery manufacture. By making ceramics that displayed the competing local, regional, and statewide affiliations, the potters enacted a performance that intersected between the social structure and their own agency.

I argue the ceramic attribute data show how groups in certain portions of the state moved across the landscape more easily, while for other groups movement was more restricted. This appears to have been the result of both population and vessel movement. The people who are moving could be women participating in exogamous marriage practices (see Hanna 1984) or whole groups moving as part of a seasonal round (see Storck 1972). Regardless, it does not appear as if any groups were completely confined to one locality without contact to Late Woodland groups in other places. It is noted, however, the results presented here are dependent upon data sets not used by previous researchers investigating Late Woodland social interaction, the EDXRF and petrographica data, or data sets used in a different manner. The decoration data analysis proceeded with different motifs categories than those defined by Rosebrough (2010). Likewise, the statistical tests were different between this work and Rosebrough's (2010) study. It is not surprising that the use of different techniques and data sets will cause different, or even new, interpretations of the Wisconsin Late Woodland period.

The western portion of the state kept tighter control of their pottery decoration attributes and performed to solidify their group in contrast to other portions of the state, but the EDXRF vessel-level analysis shows that pots from these areas were traveling just as widely as vessels from other portions of the state. Even though the possibility exists for different degrees of low-level territoriality and multiple types of social interactions, people from within both groups traveled or traded as freely as groups from disparate river valleys. They are envisioned not as two sub-populations with different degrees of movement, but rather regional groups who express different levels of affiliations within a larger cultural area.

Ceramic Attribute Data and the Models of Social Organization

Agency perspectives require an assessment of the context of production (Dobres and Hoffman 1994; Dobres and Robb 2000; Sassaman 2001). For this reason, a return to the discussion of the models of social organization is offered for Late Woodland Wisconsin. The context or structure in which the vessels were produced will greatly affect how potters performed in order to achieve their goals. The multiple lines of evidence gleaned from the decoration, EDXRF, and petrographic analysis help to set the stage actors worked within so their pottery production could both recreate and restructure the social system.

The data presented in this dissertation do not support a Monolithic social organization (Table 1). Ceramic variables are not equally distributed across the state. Rather, certain variables, like Middle and Upper Exterior Motifs, cluster within certain regions. Likewise, the EDXRF data demonstrate vessels with similar elemental compositions are not found in equal proportions across the study area, but seem to have a regional geographic distribution, even if that distribution overlaps with other regionally similar vessels.

The only data set that does not show clustering is the petrographic Body and Paste multi-variate analyses. However, temper choice is found to be regionally variable in the petrographic analysis with the Milwaukee River valley tempered exclusively with granitic rock. These results indicate Late Woodland potters may have used an overarching recipe to construct vessels. Since the final addition of temper depended on regional sensibilities, it also shows that the petrographic analysis cannot be used to support the Monolithic model. However, the petrographic analysis does indicate a very open Low-level territorial system.

The data also cannot be used to support the High-level Territorial model for the entire region. The clusters tend to be heterogeneous, and each site does not have a defining set of attributes. Rather, sites cluster with one group in the decoration analysis, and then with another group in the EDXRF analysis. Furthermore, all decoration attributes are found across the study area. The clusters rather show proportional differences between the river valleys or geographic areas. Almost all of the significant Mantel tests have clusters that overlap geographically. There are large, broad patterns observable in all data sets. The Upper Exterior and Upper Interior decoration zones have two large clusters each that canvas the entire study area (Figures 17 and 22). Also, the petrographic analysis demonstrates wide similarities in methods of vessel construction.

The only part of the region that displays evidence for High-level territoriality is the far western portion of the study area. Sites located in Crawford County tend to separate themselves out from other clusters the most frequently in the different data sets. Also, they appear overrepresented in twisted decoration compared to the other river valleys that seem more varied in their approach to style. However, the vessel-averaged EDXRF results show the Crawford County vessels grouped with vessels from geographically distant portions of the state (Figures 29 and 30d). Therefore, while the western sites at first appear to be a tighter group, they are still participating, trading with, or traveling to different areas. They are not removed from the larger Late Woodland social structure as the High-level territorial model would presume.

The data from the multiple analyses best represent a revised Low-level Territorial model. In some important ways, this study reaches similar conclusions to previous researchers using other material culture attributes (e.g., Kaufmann 2005; Storck 1972; Rosebrough 2010). There are significant regional clusters in all the ceramic data sets. Some forms of decoration cluster in certain portions of the state and the Mantel tests indicate that geographic distance is correlated with Motif choice. Similarly, the EDXRF data also show regional clustering and significant Mantel tests for geographic distance. However, these clusters often overlap and their geographic plots can be very broad. Importantly, the vessel-averaged EDXRF results reveal that either finished pots or clays were moving across the landscape as vessels from disparate sites have similar compositions. While the petrographic data was not statistically significant for the Body and Paste Mantel tests, temper choice shows a degree of localization.

Yet these regional patterns are not continuously distributed across the cluster geographic plots. There are geographical gaps and site outliers in many of the clusters. The patterns could represent some targeted reciprocal exchange of pottery or people. Moreover, the patterns are different in different areas. It appears that there are regional differences with how people interacted with each other, but they act according to social rules that we do not yet fully grasp.

The Low-level model in the Late Woodland Wisconsin area may best be described as distinction within broad geographic patterns. The results are indicative of a society where there was fairly easy transmission of vessel decorative styles, trade in finished pots, or the movement of people from one location to another as a result of hunter-gatherer subsistence patterns, marriages, or other causes of population movements like seasonal group aggregation. A vessel decorated with horizontal twisted cord could be made in western Wisconsin, but then carried or traded to another portion of the state where it was discarded. Conversely, the vessel with the horizontal twisted cords may have been made by potters in eastern Wisconsin emulating the Motif popular in the western study area, or made by a person who originated from western Wisconsin but then lived in the eastern section of the state. In addition, there appears to be a heterogeneity to vessels found at the same site. The petrographic Paste and Body ternary diagrams note that vessels found at the same site do not necessarily have exactly the same constitutional percentages.

Interestingly, the data may even demonstrate multiple tiers of Low-level territoriality operating in the Wisconsin Late Woodland Period. Sassaman (2001, 2004) suggests it is possible that there were multiple types of interactions occurring within and between prehistoric hunter-gatherer communities. The western Wisconsin area seems to be performing a tighter control on decoration styles and vessel sources. The region was the only portion of the study areas that had tightly bound clusters in both the decoration and EDXRF results. Perhaps this portion of the state practiced a type of low-level territoriality that was stricter in nature than the eastern, southern, and central locales.

However, the area should not be classified as High-level Territorial because there is still interaction with other areas as individual vessels from the western sites are found grouping with central and eastern sites in the EDXRF site clusters. Also, petrographic data indicates the western sites composed their vessels in the same manner as other Late Woodland groups, but allowed more different types of temper than other regions. Instead, it is possible people living in sites along the Mississippi River considered themselves part of the larger Late Woodland culture, but were drawn westward and possibly even more southward than the others portions of the state (see Egan-Bruhy 2012). As their focus was different than other portions of the study area, they reacted to this situation by seeking to distinguish themselves in a more structured manner.

While the western Wisconsin region shows the beginnings of a more structured

High-level territorial organization, other portions of the state do not mirror this arrangement. The northeastern ceramics, for example, incorporate many elements of cord-wrapped stick decorations and may indicate some interactions with more northerly Late Woodland groups using Heins Creek ceramics (see Mason 1966). Also, the Rock River valley had vessels with many different types of decorative elements, like tooled punctates, in combination with the twisted cord designs. The more easterly sites are often included in the widespread geographic clusters, and this shows a greater degree of interaction with these groups. Potter's choices in the eastern portion of the study area reflect a performance seeking to uphold very fluid egalitarian relationships between multiple groups.

Therefore, given the differing styles of performance within the study area, the data results indicate that relying on a single model will not explain the multiple types of social interactions implied in the analysis, even though the Low-level Territorial model is the best fit. People living in the western regions of the study area appeared to have a more focused and controlled social organization with more territorial bounding. This may be expected given their proximity to the Mississippi River valley and possible relations to southerly groups. Potters living the eastern portions expressed a greater degree of flexibility in almost all their ceramic attributes and this indicates a more open system based on looser rules of territoriality. What we are likely seeing is differential integration into the larger world resulting in differential patterns of material culture segregation in these different areas. The data indicate different levels of boundary maintenance within the study area and therefore none of the models can completely account for social organizations in the Wisconsin Late Woodland.

That different areas practiced different types of social organization has temporal implications for culture change. Researchers in other areas have found different levels of involvement in larger external systems lead to different levels of change during the Late Woodland period (Jeske 1992). Western Wisconsin regions could be exhibiting nascent ethnic boundary formation, or at least separating themselves from the eastern and central regions.

What we can document in the early Late Woodland may be a harbinger for the later divisions noted across the state. These include the different subsistence practices between collared ware users (Egan-Bruhy 2012), the different types of collared pottery found in different areas (Kelly 2002), the possible dearth of collared wares in the Driftless Area (Stoltman and Christiansen 2000), the different reactions to a Stirling Phase Middle Mississippian presence as experienced at Aztalan and Fred Edwards (Green 1997; Goldstein and Freeman 1997; Richards 1992), and even the east-west divisions between Emergent Oneota groups (Overstreet 1997). An understanding of the differences present in the early Late Woodland informs historic interpretations of descendent populations. Late Woodland groups probably used multiple types of interactions based on geography and chronology that was contingent on their needs at the time. We will miss the important foundational knowledge if we treat the Late Woodland time period as a featureless, static, and unchanging episode.

Conclusions

The ceramic data in this dissertation demonstrate several important aspects of Wisconsin Late Woodland ceramics and social organization. First, there is evidence for a general consensus about some decoration and compositional characteristics between all Late Woodland groups as seen in their ceramic manufacture. However, there is regional variation in all the data sets with certain attributes overrepresented in certain areas and similarities often based on geographic distance. Yet the variation is not isomorphic between sites or data sets. That is, each site or river valley does not differ from others in the same way on all of these attributes. Furthermore, there is physical movement of vessels around the landscape, not just ideas or people. These results suggest regional groups with permeable boundaries, easily accessible trade routes, or subsistence rounds to multiple regions. Taken together, the data seem to support the model for Low-level territorial social interaction.

While other researchers have also noted the geographical divisions between various portions of the state (Birmingham and Eisenberg 2000; Birmingham and Rosebrough 2003; Egan-Bruhy 2012; Goldstein 1995; Rosebrough 2010; Stock 1972), the data in this dissertation also provide more evidence for an east-west Late Woodland split. The regions use different ceramic motifs, different types of temper, and the EDXRF data suggests that clay selection is regionally indicative. There are also more tightly bound and smaller clusters in the western region of the study area even while many of their attributes are similar to the larger groups of Late Woodland people found across the rest of the state. The work here presents evidence that the eastern groups practiced a broader degree of interaction. Therefore, the east-west divisions are not simply related to material culture, but may also be indicative of differing social systems.

It is possible the east-west division can be explained by reference to larger, southern population. Principles of social boundaries in combination with knowledge of the dynamic nature of social interaction in Late Woodland Wisconsin may help us understand the different clustering elucidated from the data sets in this dissertation. The western region of the study area has evidence for more advanced contact with both Middle Mississippian and Oneota groups. Importantly, it is likely the Late Woodland groups were a smaller population in comparison with the larger groups in the Mississippi River valley, particularly the American Bottom region. Late Woodland peoples interacting with Middle Mississippians in the west would probably seek to emphasize their social boundaries in this type situation (see Sandstrom 1991). The occurrence would cause the smaller geographic clusters noted in the EDXRF and decoration data sets as groups along the Mississippi River rallied to preserve their solidarity in the face of a larger and more powerful trading partner.

Conversely, the eastern portion of southern Wisconsin had a more restrained Middle Mississippian presence. The populations living in this portion of the state may not have needed to solidify a group association like people living at sites near the Mississippi River as they had much more irregular contact with the southern groups. Boundaries are maintained because of interaction, not in spite of it (Barth 1969:11). With little external group interaction, Late Woodland groups in eastern Wisconsin did not coalesce to the same degree as their western kin.

The variations in ceramic attributes between eastern and western Late Woodland, and the tightly bound western clusters compared to the broad, eastern patterns, may be caused by the different reactions and interactions Late Woodland populations had with Middle Mississippians. The Late Woodland groups were not isolated, and their interaction with other populations caused profound social change within their mobile, egalitarian social system. These social divisions are seen in the regional ceramic attribute differences. Understanding the social situations responsible for the different eastern and western Wisconsin Late Woodland expressions grants a more complete understanding of why those differences possibly existed or were formed.

The Late Woodland eastern and western group divisions may be an incipient social identity that is tracked through later time periods. The dearth of Late Woodland, and also ceramic vessel, radiocarbon dates is especially needed when discussing the transformative nature of Late Woodland interaction with groups living outside Wisconsin. The east-west division between Late Woodland populations also remains a static concept until we can track how important that social interaction was through time. The results of this dissertation may be obfuscated by the lack of chronologic control. It would be interesting to assess how much the Middle Mississippian interaction impacted the Late Woodland groups at various times by comparing ceramic data from sites with known Middle Mississippian contact to chronologic measures. However, the work remains elusive until more radiocarbon assays are obtained.

Additionally, while an east-west division appears likely in southern Wisconsin during this time, the data results also mean there existed a general sense of what it was to be a member of a Late Woodland group. The actions taken by potters express a shared identity in as many ways as they express regional differences. Pottery recipes are similar across the sites and decoration techniques often overlap among river valleys. Negotiating the pottery production process was a means for potters to materialize their affiliations by not only stating this is “who we are” but also this is “what we do” in order to demonstrate those nested relationships.

It is likely we will fail if we continue to describe the Wisconsin Late Woodland as a whole with reference to only one social organizational model. Rather, multiple models are necessary that are dependent on space and time. There appears to be multiple types of interactions within the same time period and perhaps within the same overarching group of people who built effigy mounds. The results may have broader impacts for hunter-gatherer research outside of the study’s geographic boundaries. Often our theories on hunter-gatherer interaction do not contain discussions of the possibility of multiple levels of interaction by persons living during those prehistoric times (Sassaman 2004). Late Woodland groups may have practiced multiple degrees of territoriality and mobility, and this bends the rules of most current notions of egalitarian social structure by making interactions more complex in nature (see Rosebrough 2010).

Furthermore, boundary maintenance in western Wisconsin may be an early sign of contact with larger groups to the south resulting in formation of an ethnicity distinct from the lower-level territorial social organization practiced in eastern and central Wisconsin. Documenting differing social divisions during the early Late Woodland may help to explain the divisions noted during later times (Egan-Bruhy 2012; Goldstein 1997; Green 1997; Kelly 2002; Overstreet 1997; Richards 1992; Stoltman and Christiansen 2000). Understanding the history of the Late Woodland through the daily maintenance of boundaries and social interactions helps us better understand the time periods that followed (Pauketat 2001).

Also, this dissertation adds further evidence that pottery manufactures reflects and manages social signaling. The performance of pottery making was important for immediate consumers and observers, as well as those who may participate later and/or at a distance. Using performance theory we can envision the tacking back and forth between agency and structure by Late Woodland pottery manufacturers who employed both compositional and decorative attributes in an active and transformative performance to express commonalities and distinguish groups, even if that performance was not immediately witnessed (Dietler and Herbich 1998; Shanks 1999). Interpreting ceramic attributes in this manner elevates these attributes from just being signaling mechanisms. Instead, the performance of vessel making lets a potter manage, reiterate, and reform their relation to the social world.

It is argued that one aspect of Late Woodland Wisconsin pottery production was to express and signal the multiple levels of nested group membership present in these hunter-gatherer societies. The distribution of these ceramic attributes suggests people are integrating within multiple levels of family, band, and region. Importantly, it appears that potters were enacting the nested membership affiliations on the same vessel when they selected different decorative and compositional attributes during construction. Decoration techniques and motif choices were perhaps a means for the potter to express commonality with a band or region. However, the Body composition attributes are very similar over a widespread area. By composing their vessels using a recipe common to the entire study area, potters may have been performing to mark identity and affiliations to an entity larger than the region.

Finally, this performance witnessed through the distribution of ceramic attributes also indicates different groups are involved to differing degrees with the larger, overarching Late Woodland social structure. The performance of pottery manufacture is also managing differences between groups. Eastern Wisconsin potters seem to be producing pottery with an eye toward integration where commonalities were more often reinforced by a sharing of attributes and great degrees of overlap in geographic clusters. In western Wisconsin, though, pottery production seems to have proceeded where manufacturing was directed to reinforcing their status as a Late Woodland social organization, but also distinguish themselves from their eastern, and perhaps southern, trading partners.

The work presented in this dissertation contributes to a broader understanding of Late Woodland studies of social organization, but more research is needed at Late Woodland sites. Archaeologists are currently lacking studies that incorporate radiocarbon data and clay sourcing for this time period. Many of the views of the Late Woodland as isolationist and unchanging are due to a dearth of information relating to chronologic change (Rosebrough 2010). Adding these further dimensions will continue to deepen our perception of Late Woodland groups, their movement, territoriality, and social organizations. Specifically, we need radiocarbon dates taken from ceramic residues on particular vessels from well-defined contexts, not simply dates obtained from "associated" features. Also, we need multiple samples taken from a single site to check for multi-component site reuse like that found at the Nitschke Mound Group (Clauter 2011; Richards 2005). A program of systematic sampling is the best method to control for chronology (see Jeske and Richards 2009, 2010).

Also, work on clay sourcing would tremendously advance studies of Late Woodland ceramic production. It would be helpful to have studies that first ascertain the variety of clay samples available near particular sites and then compare those to samples obtained near other sites. Determining the range of variation in clay sources can be used to link finished ceramics back to known source locations and demonstrate possible variety at one site which results from either trade or manufacturing differences. As with radiocarbon samples, many different clay samples need to be taken in a particular location, not just one sample that represents one location.

The Late Woodland Period has come far beyond the infamous interpretation as "good, gray cultures" doomed to be a time resting between greater eras (Williams

1963, in Braun 1988:18). In Wisconsin, we have a greater understanding of regional variation in material culture and social organization. It cannot be thought of as isolated, homogenous, or undifferentiated any longer. Rather, we see different degrees of interaction by groups through the distribution and clusters of ceramic attributes. We also have a better grasp on how potters constructed, structured, and reiterated different levels of group affiliation through ceramic manufacture in a multifaceted hunter-gatherer society.

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Appendix A:
Decoration, ED XRF, and Petrographic Data

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
CR084/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR084/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR103/01	2	1	1	8	NA	NA	11	NA	NA	NA
CR103/03	2	3	2	3	NA	NA	11	NA	NA	NA
CR103/04	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR127/01	2	NA	NA	10	1	2	2	NA	NA	NA
CR127/02	2	NA	NA	10	1	2	2	NA	NA	NA
CR127/03	2	NA	NA	10	1	2	2	NA	NA	NA
CR127/04	2	1	1	8	NA	NA	11	NA	NA	NA
CR127/05	2	NA	NA	10	1	3	1	1	1	1
CR127/06	2	1	1	8	NA	NA	11	NA	NA	NA
CR127/07	2	NA	NA	10	1	3	1	NA	NA	NA
CR185/01	2	1	1	8	NA	NA	11	NA	NA	NA
CR186/03	2	3	1	7	1	2	2	NA	NA	NA
CR186/04	2	NA	NA	10	1	2	2	NA	NA	NA
CR186/05	2	1	1	8	NA	NA	11	NA	NA	NA
CR186/06	2	3	1	7	1	1	3	NA	NA	NA
CR186/07	2	1	1	8	1	1	3	NA	NA	NA
CR186/09	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR309/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR312/01	2	1	1	8	1	2	2	1	1	1
CR312/02	2	NA	NA	10	1	2	2	NA	NA	NA
CR312/03	2	NA	NA	10	1	3	1	NA	NA	NA
CR312/04	2	NA	NA	10	1	3	1	NA	NA	NA
CR312/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR313/01	2	1	1	8	1	2	2	NA	NA	NA
CR313/02	2	NA	NA	10	1	1	3	NA	NA	NA
CR313/03	2	NA	NA	10	1	3	1	NA	NA	NA
CR314/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR339/01	2	3	1	7	NA	NA	11	NA	NA	NA
CR339/02	2	NA	NA	10	1	2	2	NA	NA	NA
CR339/03	2	1	1	8	1	2	2	1	1	1
CR339/04	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR339/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR348/01	2	1	1	8	NA	NA	11	NA	NA	NA
CR348/02	2	3	1	7	NA	NA	11	NA	NA	NA
CR350/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR353/02	2	1	1	8	1	1	3	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
CR353/03	2	1	1	8	1	3	1	NA	NA	NA
CR353/04	2	3	1	7	6	3	9	NA	NA	NA
CR353/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR353/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR353/07	2	1	1	8	NA	NA	11	NA	NA	NA
CR353/08	2	1	1	8	1	2	2	NA	NA	NA
CR356/01	2	NA	NA	10	1	1	3	NA	NA	NA
CR356/02	2	NA	NA	10	1	2	2	NA	NA	NA
CR356/03	2	NA	NA	10	1	2	2	NA	NA	NA
CR356/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR356/06	2	3	1	7	NA	NA	11	NA	NA	NA
CR356/07	2	NA	NA	10	1	2	2	NA	NA	NA
CR356/08	2	NA	NA	10	1	2	2	NA	NA	NA
CR357/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR357/02	2	NA	NA	10	1	3	1	NA	NA	NA
CR357/03	2	NA	NA	10	1	3	1	NA	NA	NA
CR360/01	2	1	1	8	1	3	1	NA	NA	NA
CR360/02	2	3	1	7	NA	NA	11	NA	NA	NA
CR360/03	2	1	1	8	NA	NA	11	NA	NA	NA
CR360/04	2	NA	NA	10	1	3	1	NA	NA	NA
CR360/05	2	1	1	8	NA	NA	11	NA	NA	NA
CR360/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
CR360/07	2	NA	NA	10	1	3	1	NA	NA	NA
CR360/08	2	NA	NA	10	NA	NA	11	2	2	2
CR360/09	2	NA	NA	10	1	3	1	NA	NA	NA
CR367/01	2	1	1	8	NA	NA	11	NA	NA	NA
CR370/01	2	3	1	7	NA	NA	11	NA	NA	NA
CR370/02	2	3	2	3	NA	NA	11	NA	NA	NA
CT071/01	3	1	4	5	1	3	1	NA	NA	NA
CT071/02	3	1	2	2	2	2	5	NA	NA	NA
CT071/03	3	1	2	2	1	3	1	NA	NA	NA
CT071/04	3	NA	NA	10	NA	NA	NA	NA	NA	NA
CT071/05	3	1	1	8	1	3	1	NA	NA	NA
CT071/06	3	1	1	8	1	3	1	NA	NA	NA
CT071/08	3	3	1	7	1	3	1	NA	NA	NA
CT071/09	3	1	4	5	4	2	8	NA	NA	NA
CT071/11	3	2	1	6	4	2	8	NA	NA	NA
CT071/12	3	1	1	8	1	3	1	NA	NA	NA
CT071/16	3	NA	NA	10	3	1	6	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
CT071/19	3	3	1	7	1	3	1	NA	NA	NA
DA005/01	4	NA	NA	10	NA	NA	11	NA	NA	NA
DA005/02	4	NA	NA	10	1	3	1	NA	NA	NA
DA005/03	4	1	1	8	1	2	2	NA	NA	NA
DA005/04	4	NA	NA	10	5	1	10	NA	NA	NA
DA005/05	4	1	1	8	2	3	5	NA	NA	NA
DA011/01	4	NA	NA	10	1	3	1	NA	NA	NA
DA011/02	4	2	3	1	NA	NA	11	NA	NA	NA
DA012/01	4	1	2	2	2	2	5	NA	NA	NA
DA411/01	4	NA	NA	10	NA	NA	11	NA	NA	NA
DA411/02	4	1	1	8	2	3	5	NA	NA	NA
DA411/03	4	NA	NA	10	NA	NA	11	NA	NA	NA
DA411/04	4	3	2	3	NA	NA	11	NA	NA	NA
DA411/05	4	NA	NA	10	1	3	1	NA	NA	NA
DA411/06	4	1	1	8	NA	NA	11	NA	NA	NA
DA411/07	4	1	1	8	NA	NA	11	NA	NA	NA
DA411/08	4	NA	NA	10	2	2	5	NA	NA	NA
DA411/09	4	NA	NA	10	NA	NA	11	NA	NA	NA
DA457/01	4	3	1	7	1	3	1	NA	NA	NA
DA457/02	4	3	1	7	1	3	1	NA	NA	NA
DA457/03	4	NA	NA	10	1	3	1	NA	NA	NA
DA457/04	4	NA	NA	10	1	2	2	NA	NA	NA
DA457/05	4	1	1	8	1	2	2	NA	NA	NA
DA457/06	4	3	1	7	1	3	1	NA	NA	NA
DA463/01	4	NA	NA	10	2	2	5	NA	NA	NA
DA463/02	4	1	1	8	1	2	2	NA	NA	NA
DA463/03	4	1	1	8	1	3	1	NA	NA	NA
DAPP/01	4	3	6	4	1	3	1	NA	NA	NA
DO027/02	4	3	1	7	1	3	1	NA	NA	NA
DO027/03	4	3	1	7	1	3	1	3	1	3
DO027/05	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO027/06	4	3	1	7	NA	NA	11	NA	NA	NA
DO027/08	4	1	1	8	5	1	10	NA	NA	NA
DO027/10	4	NA	NA	10	4	2	8	NA	NA	NA
DO027/11	4	3	1	7	NA	NA	11	NA	NA	NA
DO027/12	4	3	1	7	1	3	1	NA	NA	NA
DO027/17	4	NA	NA	10	6	2	9	3	1	3
DO131/01	4	NA	NA	10	1	3	1	NA	NA	NA
DO131/02	4	NA	NA	10	NA	NA	11	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
DO131/03	4	NA	NA	10	4	2	8	NA	NA	NA
DO131/04	4	NA	NA	10	4	3	7	NA	NA	NA
DO131/05	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/06	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/07	4	3	1	7	1	3	1	NA	NA	NA
DO131/08	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/09	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/10	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/11	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/12	4	NA	NA	10	4	3	7	NA	NA	NA
DO131/13	4	1	6	4	NA	NA	11	NA	NA	NA
DO131/16	4	NA	NA	10	1	3	1	NA	NA	NA
DO131/17	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/18	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/19	4	NA	NA	10	4	3	7	NA	NA	NA
DO131/20	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/21	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/22	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/23	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/24	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/25	4	NA	NA	10	4	3	7	NA	NA	NA
DO131/26	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/27	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO131/28	4	NA	NA	10	1	3	1	NA	NA	NA
DO131/31	4	NA	NA	10	NA	NA	11	NA	NA	NA
DO518/02	4	NA	NA	10	4	3	7	NA	NA	NA
DO518/03	4	NA	NA	10	1	3	1	NA	NA	NA
DO518/04	4	NA	NA	10	6	3	9	NA	NA	NA
DOSS/01	4	NA	NA	10	NA	NA	11	NA	NA	NA
GLTOP/01	3	NA	NA	10	NA	NA	11	NA	NA	NA
GT024/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/01	2	NA	NA	10	NA	NA	NA	NA	NA	NA
GT112/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/03	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/04	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/05	2	NA	NA	10	1	3	1	NA	NA	NA
GT112/07	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/08	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/09	2	NA	NA	10	1	1	3	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
GT112/10	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/11	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT112/12	2	NA	NA	10	1	2	2	NA	NA	NA
GT112/13	2	NA	NA	10	1	3	1	NA	NA	NA
GT112/14	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/01	2	3	1	7	1	3	1	NA	NA	NA
GT156/02	2	NA	NA	10	1	3	1	NA	NA	NA
GT156/03	2	1	6	4	NA	NA	11	NA	NA	NA
GT156/04	2	NA	NA	10	1	3	1	NA	NA	NA
GT156/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/07	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/08	2	NA	NA	10	1	3	1	NA	NA	NA
GT156/13	2	1	1	8	1	3	1	NA	NA	NA
GT156/14	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/15	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT156/16	2	NA	NA	10	1	2	2	NA	NA	NA
GT156/17	2	NA	NA	10	2	2	5	NA	NA	NA
GT156/18	2	NA	NA	10	1	3	1	NA	NA	NA
GT156/19	2	1	1	8	NA	NA	11	NA	NA	NA
GT156/20	2	NA	NA	10	1	3	1	NA	NA	NA
GT156/21	2	NA	NA	10	1	2	2	NA	NA	NA
GT156/22	2	NA	NA	10	1	2	2	NA	NA	NA
GT156/23	2	NA	NA	10	1	2	2	NA	NA	NA
GT156/24	2	1	1	8	1	2	2	1	1	1
GT156/25	2	1	1	8	1	2	2	1	1	1
GT156/26	2	1	1	8	NA	NA	11	NA	NA	NA
GT157/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/03	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/04	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/07	2	NA	NA	10	1	3	1	NA	NA	NA
GT157/08	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/09	2	3	1	7	1	3	1	NA	NA	NA
GT157/10	2	1	1	8	1	2	2	NA	NA	NA
GT157/11	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/12	2	NA	NA	10	1	2	2	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
GT157/13	2	NA	NA	10	1	1	3	NA	NA	NA
GT157/14	2	NA	NA	10	1	2	2	NA	NA	NA
GT157/15	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/16	2	3	1	7	1	2	2	NA	NA	NA
GT157/17	2	1	1	8	NA	NA	11	NA	NA	NA
GT157/18	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT157/19	2	NA	NA	10	1	3	1	NA	NA	NA
GT266/01	2	NA	NA	10	1	3	1	NA	NA	NA
GT266/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
GT266/03	2	NA	NA	10	1	2	2	NA	NA	NA
IA001/01	2	1	1	8	1	2	2	NA	NA	NA
IA001/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/03	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/04	2	3	1	7	1	3	1	NA	NA	NA
IA038/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/07	2	NA	NA	10	NA	NA	NA	NA	NA	NA
IA038/08	2	NA	NA	10	1	2	2	NA	NA	NA
IA038/09	2	NA	NA	10	NA	NA	11	NA	NA	NA
IA038/10	2	NA	NA	10	1	3	1	NA	NA	NA
IA038/11	2	NA	NA	10	1	3	1	NA	NA	NA
IA038/12	2	1	1	8	NA	NA	11	NA	NA	NA
JE676/01	4	NA	NA	10	1	3	1	NA	NA	NA
JE676/03	4	NA	NA	10	6	3	9	NA	NA	NA
JE676/04	4	NA	NA	10	NA	NA	11	NA	NA	NA
JE676/05	4	3	1	7	1	3	1	NA	NA	NA
JE676/06	4	NA	NA	10	NA	NA	11	NA	NA	NA
JE676/07	4	1	1	8	1	3	1	NA	NA	NA
JE676/08	4	3	1	7	1	3	1	NA	NA	NA
JE676/09	4	NA	NA	10	NA	NA	11	NA	NA	NA
JE676/11	4	NA	NA	10	1	3	1	NA	NA	NA
JE757/03	4	NA	NA	10	NA	NA	11	NA	NA	NA
JE946/01	4	NA	NA	10	1	3	1	NA	NA	NA
JE946/03	4	NA	NA	10	1	3	1	NA	NA	NA
JUNT/01	2	NA	NA	10	1	3	1	NA	NA	NA
MI083/03	1	3	4	5	4	3	7	NA	NA	NA
MQ038/01	3	NA	NA	10	1	3	1	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
MQ038/02	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/03	3	3	6	4	NA	NA	11	NA	NA	NA
MQ038/04	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/05	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/06	3	1	4	5	NA	NA	11	NA	NA	NA
MQ038/07	3	NA	NA	10	1	3	1	NA	NA	NA
MQ038/08	3	NA	NA	10	1	2	2	NA	NA	NA
MQ038/09	3	NA	NA	10	6	2	9	NA	NA	NA
MQ038/10	3	2	5	1	NA	NA	11	NA	NA	NA
MQ038/11	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/12	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/13	3	3	1	7	1	3	1	NA	NA	NA
MQ038/14	3	3	1	7	1	3	1	NA	NA	NA
MQ038/16	3	NA	NA	10	1	3	1	NA	NA	NA
MQ038/17	3	NA	NA	10	1	3	1	NA	NA	NA
MQ038/18	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/19	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ038/20	3	2	1	6	NA	NA	11	NA	NA	NA
MQ038/21	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQ039/05	3	NA	NA	10	1	3	1	NA	NA	NA
MQ039/10	3	NA	NA	10	NA	NA	11	NA	NA	NA
MQSBL/01	3	1	1	8	1	2	2	NA	NA	NA
MQUNK/01	3	NA	NA	10	4	2	8	NA	NA	NA
OZ026/01	1	2	3	1	NA	NA	11	NA	NA	NA
OZ026/02	1	3	1	7	1	3	1	NA	NA	NA
OZ026/06	1	3	1	7	NA	NA	11	NA	NA	NA
OZ026/08	1	3	1	7	1	3	1	NA	NA	NA
OZ026/09	1	1	2	2	2	2	5	NA	NA	NA
OZ026/10	1	1	4	5	1	3	1	NA	NA	NA
OZ026/11	1	3	1	7	1	3	1	NA	NA	NA
OZ026/13	1	NA	NA	10	1	3	1	NA	NA	NA
OZ026/14	1	3	1	7	1	3	1	3	1	3
OZ026/15	1	3	1	7	1	3	1	3	1	3
OZ026/17	1	3	1	7	1	3	1	3	1	3
OZ026/18	1	3	1	7	1	3	1	3	1	3
OZ026/19	1	3	1	7	1	3	1	3	1	3
OZ026/20	1	1	1	8	1	3	1	3	1	3
OZ026/24	1	3	1	7	1	3	1	NA	NA	NA
OZ026/26	1	NA	NA	10	1	3	1	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
OZ026/27	1	3	1	7	1	3	1	NA	NA	NA
OZ026/28	1	2	1	6	1	3	1	NA	NA	NA
OZ026/29	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ026/30	1	1	1	8	NA	NA	11	NA	NA	NA
OZ026/31	1	1	1	8	1	2	2	NA	NA	NA
OZ026/32	1	3	1	7	1	3	1	NA	NA	NA
OZ026/58	1	3	1	7	1	3	1	NA	NA	NA
OZ026/59	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ026/60	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ026/61	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ026/63	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ026/64	1	NA	NA	10	NA	NA	11	NA	NA	NA
OZ067/03	1	1	1	8	NA	NA	11	NA	NA	NA
OZ067/04	1	1	1	8	1	3	1	NA	NA	NA
OZ067/05	1	NA	NA	10	1	3	1	NA	NA	NA
OZ067/07	1	1	1	8	1	3	1	NA	NA	NA
OZ067/12	1	3	4	5	NA	NA	11	NA	NA	NA
OZ067/16	1	3	1	7	1	2	2	NA	NA	NA
OZ067/21	1	1	1	8	1	2	2	NA	NA	NA
OZ067/22	1	NA	NA	10	4	2	8	NA	NA	NA
OZ067/23	1	1	6	4	5	1	10	NA	NA	NA
OZ067/56	1	1	1	8	1	2	2	3	1	3
OZ067/57	1	3	1	7	1	3	1	NA	NA	NA
PT029/01	2	1	4	5	NA	NA	11	NA	NA	NA
PT029/03	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/04	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/05	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/06	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/07	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/08	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/09	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/11	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/12	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/13	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/14	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/17	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/19	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/21	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/22	2	NA	NA	10	1	3	1	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
PT029/23	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/24	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/26	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/30	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/31	2	3	1	7	1	3	1	NA	NA	NA
PT029/32	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/34	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/35	2	NA	NA	10	1	3	1	NA	NA	NA
PT029/36	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/37	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/41	2	NA	NA	10	NA	NA	11	NA	NA	NA
PT029/42	2	NA	NA	10	NA	NA	11	NA	NA	NA
RI190/01	2	1	1	8	NA	NA	11	NA	NA	NA
RI190/02	2	1	1	8	1	3	1	3	1	3
RO203/01	4	NA	NA	10	1	2	2	NA	NA	NA
RO203/02	4	3	1	7	1	3	1	NA	NA	NA
RO203/03	4	NA	NA	10	1	3	1	NA	NA	NA
RO203/04	4	NA	NA	10	1	3	1	NA	NA	NA
SBBR/02	1	1	1	8	1	2	2	NA	NA	NA
SBBR/04	1	3	1	7	1	3	1	NA	NA	NA
SBBR/05	1	NA	NA	10	NA	NA	11	NA	NA	NA
SBBR/06	1	NA	NA	10	NA	NA	11	NA	NA	NA
SBBR/07	1	3	1	7	5	1	10	NA	NA	NA
SBBR/08	1	NA	NA	10	1	2	2	NA	NA	NA
SBBR/09	1	4	7	9	NA	NA	11	NA	NA	NA
SBBR/10	1	1	2	2	1	3	1	NA	NA	NA
SBBR/11	1	4	7	9	2	2	5	NA	NA	NA
SBBR/12	1	4	7	9	1	3	1	NA	NA	NA
SBBR/13	1	1	1	8	2	2	5	NA	NA	NA
SBBR/14	1	1	1	8	1	2	2	NA	NA	NA
SBBR/15	1	3	1	7	1	3	1	NA	NA	NA
SBBR/16	1	NA	NA	10	2	2	5	NA	NA	NA
SBBR/17	1	NA	NA	10	1	2	2	NA	NA	NA
SBBR/18	1	3	1	7	1	3	1	NA	NA	NA
SBBR/19	1	1	1	8	NA	NA	11	NA	NA	NA
SBBR/20	1	1	1	8	NA	NA	11	NA	NA	NA
SBBR/22	1	NA	NA	10	2	2	5	NA	NA	NA
SBBR/23	1	NA	NA	10	4	2	8	NA	NA	NA
SBBR/24	1	3	1	7	1	3	1	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
SBBR/25	1	NA	NA	10	1	3	1	NA	NA	NA
SBBR/26	1	1	4	5	4	2	8	NA	NA	NA
SBBR/27	1	3	4	5	4	3	7	NA	NA	NA
SBBR/28	1	3	1	7	1	2	2	NA	NA	NA
SBBR/29	1	1	2	2	NA	NA	11	NA	NA	NA
SBBR/31	1	3	1	7	1	4	4	NA	NA	NA
SBBR/32	1	3	1	7	1	3	1	NA	NA	NA
SBBR/33	1	1	1	8	1	3	1	NA	NA	NA
SBBR/35	1	NA	NA	10	1	3	1	NA	NA	NA
SBBR/36	1	4	7	9	4	3	7	1	1	1
SBBR/38	1	NA	NA	10	NA	NA	11	NA	NA	NA
SBBR/39	1	NA	NA	10	2	2	5	NA	NA	NA
SBBR/41	1	3	1	7	NA	NA	11	NA	NA	NA
SBBR/43	1	3	1	7	1	3	1	NA	NA	NA
SBBR/45	1	1	1	8	NA	NA	11	NA	NA	NA
SBBR/46	1	NA	NA	10	NA	NA	11	NA	NA	NA
SBBR/47	1	NA	NA	10	1	3	1	NA	NA	NA
SBBR/48	1	1	1	8	NA	NA	11	NA	NA	NA
SBBR/49	1	NA	NA	10	4	2	8	NA	NA	NA
SBBR/50	1	1	1	8	1	3	1	NA	NA	NA
SBBR/51	1	3	1	7	1	3	1	4	3	4
SBBR/52	1	3	1	7	1	3	1	NA	NA	NA
SBBR/53	1	1	1	8	1	3	1	NA	NA	NA
SBBR/54	1	1	1	8	1	2	2	NA	NA	NA
SBBR/55	1	3	1	7	NA	NA	11	NA	NA	NA
SBBR/56	1	NA	NA	10	1	3	1	NA	NA	NA
SBBR/57	1	3	1	7	1	3	1	NA	NA	NA
SBBR/58	1	3	1	7	1	3	1	NA	NA	NA
SBTW/01	1	1	4	5	1	3	1	NA	NA	NA
SK001/01	2	NA	NA	10	NA	NA	11	NA	NA	NA
SK001/02	2	NA	NA	10	NA	NA	11	NA	NA	NA
SK001/03	2	NA	NA	10	1	3	1	NA	NA	NA
SK001/04	2	NA	NA	10	NA	NA	11	NA	NA	NA
SK001/05	2	NA	NA	10	1	4	4	NA	NA	NA
SK001/06	2	NA	NA	10	1	3	1	NA	NA	NA
SK001/07	2	NA	NA	10	NA	NA	11	NA	NA	NA
SK001/08	2	1	1	8	1	2	2	NA	NA	NA
SK001/09	2	NA	NA	10	NA	NA	11	NA	NA	NA
SK001/10	2	1	1	8	1	2	2	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, continued

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
WL110/05	4	3	1	7	1	3	1	NA	NA	NA
WL110/07	4	NA	NA	10	6	3	9	NA	NA	NA
WL110/12	4	NA	NA	10	NA	NA	11	NA	NA	NA
WL110/17	4	NA	NA	10	1	3	1	NA	NA	NA
WL110/23	4	NA	NA	10	NA	NA	11	NA	NA	NA
WL110/24	4	NA	NA	10	NA	NA	11	NA	NA	NA
WO016/01	2	NA	NA	10	4	3	7	NA	NA	NA
WO016/02	2	2	1	6	1	3	1	NA	NA	NA
WO016/03	2	3	1	7	1	3	1	NA	NA	NA
WO016/04	2	3	1	7	1	3	1	NA	NA	NA
WO016/06	2	1	1	8	1	3	1	NA	NA	NA
WP026/01	3	NA	NA	10	4	3	7	NA	NA	NA
WP026/04	3	3	1	7	1	3	1	NA	NA	NA
WP026/06	3	3	1	7	1	3	1	NA	NA	NA
WP026/07	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/08	3	1	1	8	1	2	2	2	2	2
WP026/09	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/14	3	NA	NA	10	NA	NA	11	NA	NA	NA
WP026/15	3	NA	NA	10	NA	NA	11	NA	NA	NA
WP026/17	3	NA	NA	10	NA	NA	11	NA	NA	NA
WP026/18	3	2	1	6	1	3	1	NA	NA	NA
WP026/23	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/24	3	2	1	6	1	3	1	NA	NA	NA
WP026/25	3	3	2	3	1	2	2	NA	NA	NA
WP026/26	3	2	1	6	1	3	1	NA	NA	NA
WP026/28	3	NA	NA	10	4	2	8	NA	NA	NA
WP026/29	3	NA	NA	10	1	2	2	NA	NA	NA
WP026/30	3	NA	NA	10	1	2	2	NA	NA	NA
WP026/31	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/32	3	1	1	8	1	3	1	NA	NA	NA
WP026/33	3	1	1	8	1	3	1	NA	NA	NA
WP026/34	3	3	1	7	NA	NA	11	NA	NA	NA
WP026/35	3	1	4	5	NA	NA	11	NA	NA	NA
WP026/36	3	NA	NA	10	1	2	2	NA	NA	NA
WP026/37	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/38	3	NA	NA	10	1	2	2	NA	NA	NA
WP026/39	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/43	3	NA	NA	10	3	3	6	NA	NA	NA
WP026/45	3	NA	NA	10	NA	NA	11	NA	NA	NA

Table 49: Lip, Lower Interior, and Upper Interior Decoration Data, concluded

Vessel	River Valley	Lip Angle	Lip Tech	Lip Motif	UI Tech	UI Angle	UI Motif	LI Tech	LI Angle	LI Motif
WP026/46	3	NA	NA	10	NA	NA	11	NA	NA	NA
WP026/47	3	NA	NA	10	4	2	8	NA	NA	NA
WP026/48	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/49	3	NA	NA	10	1	3	1	NA	NA	NA
WP026/51	3	NA	NA	10	NA	NA	11	NA	NA	NA
WP026/52	3	NA	NA	10	4	3	7	NA	NA	NA
WT189/01	1	3	1	7	NA	NA	11	NA	NA	NA

River Valley: 1=Milwaukee, 2=Wisconsin, 3=Wolf, 4=Rock
UI= Upper Interior Zone
LI= Lower Interior Zone
Tech= Technique

Lip Angle: 1=transverse, 2=parallel, 3=diagonal, 4=multiple
Lip Technique: 1=TC, 2=LCP, 3=CCP, 4=CWS, 5=CTP, 6=Tool, 7=Multiple
Lip Motif: 1=Circular Punctates, 2=LCP transverse, 3=LCP diagonal, 4=Tool, 5=CWS, 6=TC parallel, 7=TC diagonal, 8= TC transverse, 9=Combination, 10=Plain

Upper Interior Angle: 1=horizontal, 2=vertical, 3=diagonal, 4=multiple
Upper Interior Technique: 1=TC, 2=LCP, 3=CCP, 4=CWS, 5=Boss, 6=Tool
Upper Interior Motif: 1=TC diagonal, 2=TC vertical, 3=TC horizontal, 4=TC band, 5=LCP, 6=CCP, 7=CWS diagonal, 8=CWS vertical, 9=Tool, 10=Boss, 11=Plain

Lower Interior Angle: 1=horizontal, 2=vertical, 3=diagonal
Lower Interior Technique: 1=TC, 2=LCP, 3=Boss, 4=Tool
Lower Interior Motif: 1=TC horizontal, 2=LCP vertical, 3=Boss horizontal, 4=Tool diagonal

Table 50: Middle, Upper, and Lower Exterior Decoration Data

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
CR084/01	2	2	1	2	2	1	7	NA	NA	NA
CR084/02	2	1	1	1	3	1	8	NA	NA	NA
CR103/01	2	3	1	3	NA	NA	NA	NA	NA	NA
CR103/03	2	3	2	7	3	1	8	NA	NA	NA
CR103/04	2	3	1	3	2	1	7	NA	NA	NA
CR127/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR127/02	2	1	1	1	3	1	8	NA	NA	NA
CR127/03	2	1	1	1	NA	NA	9	NA	NA	NA
CR127/04	2	1	1	1	2	1	7	NA	NA	NA
CR127/05	2	1	1	1	2	1	7	NA	NA	NA
CR127/06	2	1	1	1	NA	NA	9	NA	NA	NA
CR127/07	2	1	1	1	3	1	8	NA	NA	NA
CR185/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR186/03	2	1	1	1	2	1	7	4	1	7
CR186/04	2	5	1	6	2	1	7	4	1	7
CR186/05	2	3	1	3	NA	NA	9	NA	NA	NA
CR186/06	2	1	1	1	NA	NA	9	3	2	4
CR186/07	2	3	1	3	NA	NA	9	NA	NA	NA
CR186/09	2	1	1	1	3	1	8	NA	NA	NA
CR309/01	2	NA	NA	11	NA	NA	9	NA	NA	9
CR312/01	2	1	1	1	2	1	7	NA	NA	NA
CR312/02	2	3	1	3	NA	NA	9	NA	NA	NA
CR312/03	2	1	1	1	2	1	7	NA	NA	NA
CR312/04	2	5	1	6	NA	NA	9	NA	NA	NA
CR312/05	2	1	1	1	NA	NA	9	NA	NA	NA
CR313/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR313/02	2	1	1	1	NA	NA	9	NA	NA	NA
CR313/03	2	1	1	1	3	1	8	NA	NA	NA
CR314/01	2	1	1	1	3	1	8	NA	NA	NA
CR339/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR339/02	2	1	1	1	2	1	7	NA	NA	NA
CR339/03	2	3	1	3	NA	NA	NA	NA	NA	NA
CR339/04	2	1	1	1	3	1	8	NA	NA	NA
CR339/05	2	1	1	1	NA	NA	9	NA	NA	NA
CR348/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR348/02	2	5	1	6	NA	NA	9	NA	NA	NA
CR350/01	2	5	1	6	3	1	8	4	1	8
CR353/02	2	5	1	6	NA	NA	9	NA	NA	NA
CR353/03	2	1	1	1	NA	NA	9	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
CR353/04	2	1	1	1	2	1	7	NA	NA	NA
CR353/05	2	1	1	1	3	1	8	NA	NA	NA
CR353/06	2	1	1	1	2	1	7	NA	NA	NA
CR353/07	2	1	1	1	NA	NA	9	NA	NA	NA
CR353/08	2	1	1	1	2	1	7	NA	NA	NA
CR356/01	2	1	1	1	2	2	5	NA	NA	NA
CR356/02	2	1	1	1	NA	NA	9	2	2	4
CR356/03	2	5	1	6	NA	NA	9	NA	NA	NA
CR356/05	2	1	1	1	2	1	7	NA	NA	NA
CR356/06	2	1	1	1	NA	NA	9	1	3	1
CR356/07	2	1	1	1	2	1	7	NA	NA	NA
CR356/08	2	NA	NA	NA	NA	NA	NA	NA	NA	NA
CR357/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR357/02	2	1	1	1	NA	NA	9	NA	NA	NA
CR357/03	2	1	1	1	2	1	7	NA	NA	NA
CR360/01	2	5	1	6	2	1	7	NA	NA	NA
CR360/02	2	1	1	1	3	1	8	NA	NA	NA
CR360/03	2	5	1	6	3	1	8	NA	NA	NA
CR360/04	2	1	1	1	3	1	8	NA	NA	NA
CR360/05	2	1	1	1	2	1	7	NA	NA	NA
CR360/06	2	5	1	6	2	1	7	NA	NA	NA
CR360/07	2	NA	NA	11	2	1	7	NA	NA	9
CR360/08	2	1	1	1	NA	NA	9	NA	NA	NA
CR360/09	2	1	1	1	2	1	7	NA	NA	NA
CR367/01	2	1	1	1	2	1	7	NA	NA	NA
CR370/01	2	1	1	1	NA	NA	9	NA	NA	NA
CR370/02	2	2	2	7	3	1	8	4	1	8
CT071/01	3	2	2	8	NA	NA	9	NA	NA	NA
CT071/02	3	NA	NA	11	NA	NA	9	NA	NA	NA
CT071/03	3	3	1	3	NA	NA	9	NA	NA	NA
CT071/04	3	NA	NA	11	NA	NA	9	NA	NA	NA
CT071/05	3	NA	NA	11	NA	NA	9	NA	NA	9
CT071/06	3	4	1	4	3	1	8	NA	NA	NA
CT071/08	3	3	1	3	2	2	5	NA	NA	NA
CT071/09	3	3	1	3	NA	NA	9	NA	NA	NA
CT071/11	3	3	1	3	2	4	1	NA	NA	NA
CT071/12	3	NA	NA	11	NA	NA	9	NA	NA	NA
CT071/16	3	3	1	3	1	3	3	NA	NA	NA
CT071/19	3	NA	NA	11	NA	NA	9	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
DA005/01	4	NA	NA	11	NA	NA	9	NA	NA	9
DA005/02	4	NA	NA	11	NA	NA	9	NA	NA	NA
DA005/03	4	1	1	1	NA	NA	9	NA	NA	NA
DA005/04	4	1	1	1	NA	NA	9	2	2	4
DA005/05	4	1	1	1	NA	NA	NA	NA	NA	NA
DA011/01	4	NA	NA	11	NA	NA	9	NA	NA	9
DA011/02	4	3	1	3	4	2	6	NA	NA	NA
DA012/01	4	1	1	1	NA	NA	9	NA	NA	NA
DA411/01	4	4	1	4	3	2	6	NA	NA	NA
DA411/02	4	1	1	1	2	1	7	NA	NA	NA
DA411/03	4	1	1	1	NA	NA	9	NA	NA	NA
DA411/04	4	1	1	1	NA	NA	9	NA	NA	NA
DA411/05	4	1	1	1	NA	NA	9	NA	NA	NA
DA411/06	4	1	1	1	2	1	7	NA	NA	NA
DA411/07	4	5	1	6	NA	NA	9	NA	NA	NA
DA411/08	4	2	2	7	NA	NA	9	NA	NA	NA
DA411/09	4	5	4	6	NA	NA	9	NA	NA	NA
DA457/01	4	1	1	1	NA	NA	9	NA	NA	NA
DA457/02	4	3	1	3	NA	NA	NA	NA	NA	NA
DA457/03	4	1	1	1	NA	NA	9	NA	NA	NA
DA457/04	4	1	1	1	NA	NA	9	NA	NA	NA
DA457/05	4	1	1	1	NA	NA	9	NA	NA	NA
DA457/06	4	3	1	3	NA	NA	9	3	2	4
DA463/01	4	NA	NA	11	2	2	5	NA	NA	9
DA463/02	4	1	1	1	2	1	7	NA	NA	NA
DA463/03	4	4	1	4	3	1	8	NA	NA	NA
DAPP/01	4	1	1	1	3	1	8	NA	NA	NA
DO027/02	4	NA	NA	11	NA	NA	9	NA	NA	9
DO027/03	4	3	5	5	NA	NA	9	NA	NA	NA
DO027/05	4	3	1	3	NA	NA	9	NA	NA	9
DO027/06	4	3	1	3	NA	NA	9	NA	NA	9
DO027/08	4	1	3	9	3	6	4	NA	NA	9
DO027/10	4	3	2	8	2	2	5	NA	NA	NA
DO027/11	4	1	1	1	3	1	8	NA	NA	NA
DO027/12	4	1	1	1	3	1	8	3	1	6
DO027/17	4	2	4	10	1	5	2	NA	NA	9
DO131/01	4	3	1	3	NA	NA	9	NA	NA	NA
DO131/02	4	3	1	3	NA	NA	9	NA	NA	NA
DO131/03	4	3	1	3	NA	NA	9	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
DO131/04	4	1	1	1	NA	NA	9	NA	NA	NA
DO131/05	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/06	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO131/07	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO131/08	4	1	1	1	2	1	7	NA	NA	NA
DO131/09	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/10	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/11	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/12	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/13	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO131/16	4	3	1	3	NA	NA	9	NA	NA	NA
DO131/17	4	2	4	10	NA	NA	9	NA	NA	NA
DO131/18	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/19	4	1	1	1	NA	NA	9	NA	NA	NA
DO131/20	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/21	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/22	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/23	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO131/24	4	NA	NA	11	NA	NA	9	NA	NA	9
DO131/25	4	3	1	3	NA	NA	9	NA	NA	NA
DO131/26	4	3	1	3	NA	NA	9	NA	NA	NA
DO131/27	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO131/28	4	NA	NA	NA	3	1	8	NA	NA	NA
DO131/31	4	NA	NA	11	NA	NA	9	NA	NA	NA
DO518/02	4	NA	NA	11	2	6	4	NA	NA	9
DO518/03	4	1	4	10	NA	NA	9	NA	NA	NA
DO518/04	4	1	4	10	NA	NA	9	NA	NA	NA
DOSS/01	4	NA	NA	11	NA	NA	9	NA	NA	9
GLTOP/01	3	NA	NA	11	NA	NA	9	NA	NA	9
GT024/01	2	NA	NA	11	NA	NA	9	NA	NA	NA
GT112/01	2	NA	NA	11	NA	NA	9	NA	NA	9
GT112/02	2	3	2	8	NA	NA	9	NA	NA	9
GT112/03	2	NA	NA	11	NA	NA	9	NA	NA	9
GT112/04	2	NA	NA	11	NA	NA	9	NA	NA	9
GT112/05	2	NA	NA	11	NA	NA	9	NA	NA	9
GT112/07	2	3	1	3	NA	NA	9	NA	NA	NA
GT112/08	2	1	1	1	2	1	7	NA	NA	NA
GT112/09	2	1	1	1	2	2	5	NA	NA	NA
GT112/10	2	5	5	6	2	2	5	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
GT112/11	2	2	1	2	NA	NA	9	NA	NA	NA
GT112/12	2	1	1	1	2	2	5	NA	NA	NA
GT112/13	2	5	1	6	NA	NA	9	2	2	4
GT112/14	2	2	2	7	2	2	5	2	2	4
GT156/01	2	3	1	3	2	1	7	3	4	3
GT156/02	2	1	1	1	NA	NA	9	NA	NA	NA
GT156/03	2	NA	NA	11	NA	NA	9	NA	NA	9
GT156/04	2	NA	NA	11	2	1	7	NA	NA	9
GT156/05	2	NA	NA	11	NA	NA	9	NA	NA	9
GT156/06	2	NA	NA	11	NA	NA	9	NA	NA	NA
GT156/07	2	NA	NA	11	NA	NA	9	NA	NA	9
GT156/08	2	NA	NA	11	2	2	5	NA	NA	9
GT156/13	2	1	1	1	NA	NA	9	NA	NA	NA
GT156/14	2	1	1	1	2	1	7	NA	NA	NA
GT156/15	2	1	1	1	2	1	7	NA	NA	NA
GT156/16	2	1	1	1	2	1	7	NA	NA	NA
GT156/17	2	1	1	1	NA	NA	9	NA	NA	NA
GT156/18	2	1	1	1	NA	NA	9	NA	NA	NA
GT156/19	2	1	1	1	NA	NA	9	NA	NA	NA
GT156/20	2	3	1	3	1	3	3	NA	NA	NA
GT156/21	2	5	1	6	NA	NA	9	NA	NA	NA
GT156/22	2	1	1	1	2	1	7	NA	NA	NA
GT156/23	2	5	1	6	2	1	7	NA	NA	NA
GT156/24	2	5	1	6	3	1	8	4	1	7
GT156/25	2	5	1	6	NA	NA	9	2	2	4
GT156/26	2	1	1	1	NA	NA	9	2	2	4
GT157/01	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/02	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/03	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/04	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/05	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/06	2	NA	NA	11	NA	NA	9	NA	NA	NA
GT157/07	2	1	1	1	NA	NA	9	NA	NA	NA
GT157/08	2	NA	NA	11	NA	NA	9	NA	NA	9
GT157/09	2	1	1	1	NA	NA	9	4	1	7
GT157/10	2	1	1	1	2	1	7	NA	NA	NA
GT157/11	2	5	1	6	NA	NA	9	NA	NA	NA
GT157/12	2	3	1	3	2	1	7	NA	NA	NA
GT157/13	2	1	1	1	NA	NA	9	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
GT157/14	2	1	1	1	2	1	7	NA	NA	NA
GT157/15	2	1	1	1	3	1	8	3	1	6
GT157/16	2	1	1	1	NA	NA	9	2	2	4
GT157/17	2	2	2	7	NA	NA	9	2	2	4
GT157/18	2	1	1	1	2	1	7	NA	NA	9
GT157/19	2	2	2	7	NA	NA	9	2	2	4
GT266/01	2	1	1	1	3	1	8	NA	NA	NA
GT266/02	2	1	1	1	NA	NA	9	NA	NA	NA
GT266/03	2	2	2	7	2	1	7	NA	NA	NA
IA001/01	2	5	1	6	NA	NA	9	NA	NA	NA
IA001/02	2	1	1	1	3	1	8	NA	NA	NA
IA038/01	2	NA	NA	11	3	2	6	NA	NA	9
IA038/02	2	NA	NA	11	NA	NA	9	NA	NA	9
IA038/03	2	1	1	1	NA	NA	9	NA	NA	9
IA038/04	2	1	1	1	NA	NA	9	3	2	4
IA038/05	2	NA	NA	11	2	2	5	NA	NA	9
IA038/06	2	1	1	1	NA	NA	9	NA	NA	NA
IA038/07	2	3	1	3	2	2	5	1	3	1
IA038/08	2	1	1	1	NA	NA	9	2	1	6
IA038/09	2	1	1	1	NA	NA	9	NA	NA	9
IA038/10	2	1	1	1	NA	NA	9	NA	NA	NA
IA038/11	2	5	1	6	NA	NA	9	NA	NA	NA
IA038/12	2	1	1	1	NA	NA	9	2	2	4
JE676/01	4	1	1	1	NA	NA	9	NA	NA	NA
JE676/03	4	5	1	6	NA	NA	9	NA	NA	NA
JE676/04	4	NA	NA	11	NA	NA	9	NA	NA	9
JE676/05	4	1	1	1	1	3	3	NA	NA	NA
JE676/06	4	NA	NA	11	NA	NA	9	NA	NA	9
JE676/07	4	1	1	1	3	1	8	NA	NA	NA
JE676/08	4	1	1	1	1	3	3	NA	NA	NA
JE676/09	4	NA	NA	11	NA	NA	9	NA	NA	9
JE676/11	4	2	2	7	NA	NA	NA	NA	NA	NA
JE757/03	4	NA	NA	11	NA	NA	9	NA	NA	9
JE946/01	4	5	1	6	NA	NA	9	NA	NA	NA
JE946/03	4	1	1	1	NA	NA	9	NA	NA	NA
JUNT/01	2	NA	NA	11	NA	NA	9	NA	NA	9
MI083/03	1	1	1	1	NA	NA	9	NA	NA	NA
MQ038/01	3	NA	NA	11	3	1	8	NA	NA	9
MQ038/02	3	1	1	1	3	1	8	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
MQ038/03	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/04	3	NA	NA	11	1	3	3	NA	NA	9
MQ038/05	3	NA	NA	11	3	1	8	NA	NA	9
MQ038/06	3	5	1	6	3	2	6	3	2	4
MQ038/07	3	NA	NA	11	3	1	8	NA	NA	9
MQ038/08	3	1	1	1	3	2	6	NA	NA	NA
MQ038/09	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/10	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/11	3	NA	NA	11	NA	NA	9	NA	NA	NA
MQ038/12	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/13	3	5	1	6	4	1	8	NA	NA	NA
MQ038/14	3	3	1	3	NA	NA	9	NA	NA	NA
MQ038/16	3	1	1	1	2	1	7	NA	NA	NA
MQ038/17	3	4	1	4	NA	NA	9	NA	NA	NA
MQ038/18	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/19	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/20	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ038/21	3	NA	NA	11	NA	NA	9	NA	NA	9
MQ039/05	3	1	1	1	3	1	8	3	1	6
MQ039/10	3	NA	NA	11	NA	NA	9	NA	NA	9
MQSBL/01	3	NA	NA	11	NA	NA	9	NA	NA	9
MQUNK/01	3	1	1	1	2	2	5	NA	NA	NA
OZ026/01	1	NA	NA	11	NA	NA	9	NA	NA	NA
OZ026/02	1	NA	NA	11	2	2	5	NA	NA	NA
OZ026/06	1	3	1	3	NA	NA	9	NA	NA	NA
OZ026/08	1	3	1	3	NA	NA	9	NA	NA	NA
OZ026/09	1	5	1	6	2	2	5	NA	NA	NA
OZ026/10	1	1	1	1	3	2	6	NA	NA	NA
OZ026/11	1	3	1	3	NA	NA	9	NA	NA	NA
OZ026/13	1	3	1	3	1	3	3	NA	NA	NA
OZ026/14	1	5	1	6	NA	NA	9	NA	NA	NA
OZ026/15	1	3	5	5	NA	NA	NA	NA	NA	NA
OZ026/17	1	3	5	5	2	1	7	NA	NA	NA
OZ026/18	1	3	5	5	3	1	8	NA	NA	NA
OZ026/19	1	3	5	5	NA	NA	9	NA	NA	9
OZ026/20	1	3	5	5	2	1	7	NA	NA	NA
OZ026/24	1	1	4	10	3	1	8	NA	NA	9
OZ026/26	1	NA	NA	11	3	1	8	NA	NA	9
OZ026/27	1	1	1	1	3	1	8	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
OZ026/28	1	1	1	1	3	1	8	NA	NA	NA
OZ026/29	1	3	1	3	3	1	8	NA	NA	NA
OZ026/30	1	1	1	1	5	1	10	NA	NA	NA
OZ026/31	1	1	1	1	2	1	7	NA	NA	NA
OZ026/32	1	1	1	1	2	1	7	NA	NA	NA
OZ026/58	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
OZ026/59	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ026/60	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ026/61	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ026/63	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ026/64	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ067/03	1	NA	NA	11	NA	NA	9	NA	NA	9
OZ067/04	1	3	1	3	NA	NA	9	NA	NA	NA
OZ067/05	1	3	1	3	2	2	5	NA	NA	NA
OZ067/07	1	3	1	3	NA	NA	9	NA	NA	NA
OZ067/12	1	3	1	3	NA	NA	NA	NA	NA	NA
OZ067/16	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
OZ067/21	1	3	5	5	2	1	7	NA	NA	NA
OZ067/22	1	3	1	3	2	4	1	NA	NA	NA
OZ067/23	1	NA	NA	NA	NA	NA	NA	NA	NA	NA
OZ067/56	1	2	2	8	1	5	2	NA	NA	9
OZ067/57	1	1	1	1	2	2	5	NA	NA	NA
PT029/01	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/03	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/04	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/05	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/06	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/07	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/08	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/09	2	1	1	1	NA	NA	9	NA	NA	NA
PT029/11	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/12	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/13	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/14	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/17	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/19	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/21	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/22	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/23	2	NA	NA	11	NA	NA	9	NA	NA	9

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
PT029/24	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/26	2	NA	NA	11	NA	NA	9	NA	NA	9
PT029/30	2	2	2	8	3	2	6	NA	NA	NA
PT029/31	2	1	1	1	3	1	8	NA	NA	NA
PT029/32	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/34	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/35	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/36	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/37	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/41	2	NA	NA	11	NA	NA	9	NA	NA	NA
PT029/42	2	NA	NA	11	NA	NA	9	NA	NA	NA
RI190/01	2	1	1	1	NA	NA	9	4	1	7
RI190/02	2	5	1	6	1	3	3	1	5	2
RO203/01	4	NA	NA	11	NA	NA	9	NA	NA	9
RO203/02	4	NA	NA	11	1	3	3	NA	NA	9
RO203/03	4	1	1	1	3	1	8	NA	NA	NA
RO203/04	4	3	1	3	NA	NA	9	NA	NA	NA
SBBR/02	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/04	1	2	2	7	NA	NA	9	NA	NA	NA
SBBR/05	1	NA	NA	11	NA	NA	9	NA	NA	NA
SBBR/06	1	1	1	1	NA	NA	9	2	2	4
SBBR/07	1	3	5	5	NA	NA	9	NA	NA	NA
SBBR/08	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/09	1	1	1	1	NA	NA	9	1	5	2
SBBR/10	1	1	1	1	2	2	5	NA	NA	NA
SBBR/11	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/12	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/13	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/14	1	1	1	1	3	1	8	NA	NA	NA
SBBR/15	1	3	1	3	NA	NA	9	1	3	1
SBBR/16	1	3	1	3	2	2	5	NA	NA	NA
SBBR/17	1	NA	NA	NA	NA	NA	9	NA	NA	NA
SBBR/18	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/19	1	5	1	6	NA	NA	9	NA	NA	NA
SBBR/20	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/22	1	3	1	3	2	2	5	2	2	4
SBBR/23	1	1	1	1	NA	NA	9	NA	NA	NA
SBBR/24	1	1	1	1	3	1	8	NA	NA	NA
SBBR/25	1	2	2	8	NA	NA	9	NA	NA	9

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
SBBR/26	1	1	1	1	3	1	8	2	2	4
SBBR/27	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/28	1	NA	NA	11	3	1	8	NA	NA	NA
SBBR/29	1	1	1	1	3	1	8	NA	NA	NA
SBBR/31	1	5	1	6	NA	NA	9	NA	NA	NA
SBBR/32	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/33	1	1	1	1	3	1	8	NA	NA	NA
SBBR/35	1	3	1	3	2	2	5	NA	NA	NA
SBBR/36	1	5	1	6	NA	NA	9	NA	NA	NA
SBBR/38	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/39	1	1	1	1	2	2	5	NA	NA	NA
SBBR/41	1	2	2	7	NA	NA	9	NA	NA	NA
SBBR/43	1	1	1	1	3	1	8	NA	NA	NA
SBBR/45	1	NA	NA	11	2	1	7	NA	NA	NA
SBBR/46	1	1	1	1	NA	NA	9	2	2	4
SBBR/47	1	3	1	3	NA	NA	9	NA	NA	NA
SBBR/48	1	3	1	3	NA	NA	9	NA	NA	9
SBBR/49	1	3	2	8	NA	NA	9	NA	NA	9
SBBR/50	1	2	2	7	NA	NA	9	2	2	4
SBBR/51	1	3	1	3	NA	NA	9	2	2	4
SBBR/52	1	3	1	3	3	1	8	2	2	5
SBBR/53	1	4	1	4	4	1	8	NA	NA	NA
SBBR/54	1	5	1	6	NA	NA	9	2	2	4
SBBR/55	1	5	1	6	4	1	8	NA	NA	9
SBBR/56	1	1	1	1	3	1	8	2	4	3
SBBR/57	1	NA	NA	11	NA	NA	9	NA	NA	9
SBBR/58	1	3	1	3	3	1	8	NA	NA	9
SBTW/01	1	3	5	5	NA	NA	9	3	4	3
SK001/01	2	NA	NA	11	NA	NA	9	NA	NA	9
SK001/02	2	NA	NA	11	NA	NA	9	NA	NA	9
SK001/03	2	5	1	6	NA	NA	9	NA	NA	9
SK001/04	2	5	1	6	3	6	4	NA	NA	NA
SK001/05	2	1	1	1	3	1	8	3	1	6
SK001/06	2	1	1	1	NA	NA	9	3	2	4
SK001/07	2	1	1	1	3	1	8	3	1	6
SK001/08	2	1	1	1	2	1	7	2	2	4
SK001/09	2	1	1	1	NA	NA	9	NA	NA	NA
SK001/10	2	2	1	2	2	1	7	2	2	4
WL110/05	4	1	1	1	NA	NA	9	2	2	4

Table 50: Middle, Upper, and Lower Exterior Decoration Data, continued

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
WL110/07	4	NA	NA	11	NA	NA	9	NA	NA	9
WL110/12	4	2	2	7	NA	NA	9	NA	NA	NA
WL110/17	4	5	1	6	NA	NA	9	NA	NA	NA
WL110/23	4	NA	NA	11	NA	NA	9	NA	NA	NA
WL110/24	4	NA	NA	11	NA	NA	9	NA	NA	9
WO016/01	2	NA	NA	11	NA	NA	9	NA	NA	9
WO016/02	2	1	1	1	3	1	8	NA	NA	NA
WO016/03	2	NA	NA	11	NA	NA	9	NA	NA	9
WO016/04	2	1	1	1	NA	NA	9	NA	NA	NA
WO016/06	2	3	1	3	NA	NA	9	NA	NA	9
WP026/01	3	5	1	6	3	4	1	NA	NA	NA
WP026/04	3	1	1	1	3	1	8	NA	NA	NA
WP026/06	3	3	1	3	NA	NA	9	NA	NA	9
WP026/07	3	1	1	1	3	1	8	NA	NA	NA
WP026/08	3	1	1	1	2	1	7	NA	NA	NA
WP026/09	3	3	1	3	3	1	8	3	2	5
WP026/14	3	NA	NA	11	NA	NA	9	NA	NA	9
WP026/15	3	NA	NA	11	NA	NA	9	NA	NA	NA
WP026/17	3	NA	NA	11	NA	NA	9	NA	NA	9
WP026/18	3	5	1	6	3	1	8	NA	NA	NA
WP026/23	3	NA	NA	11	1	5	2	NA	NA	NA
WP026/24	3	NA	NA	11	NA	NA	9	NA	NA	9
WP026/25	3	3	1	3	NA	NA	9	NA	NA	NA
WP026/26	3	3	1	3	NA	NA	9	NA	NA	NA
WP026/28	3	1	1	1	NA	NA	9	NA	NA	NA
WP026/29	3	1	1	1	NA	NA	9	NA	NA	NA
WP026/30	3	1	1	1	NA	NA	9	NA	NA	NA
WP026/31	3	1	1	1	NA	NA	9	NA	NA	NA
WP026/32	3	5	1	6	NA	NA	9	NA	NA	NA
WP026/33	3	3	1	3	3	1	8	NA	NA	NA
WP026/34	3	1	1	1	3	1	8	NA	NA	NA
WP026/35	3	3	1	3	NA	NA	9	NA	NA	9
WP026/36	3	1	1	1	NA	NA	9	NA	NA	NA
WP026/37	3	1	1	1	3	1	8	NA	NA	NA
WP026/38	3	1	1	1	2	1	7	NA	NA	NA
WP026/39	3	1	1	1	3	1	8	NA	NA	NA
WP026/43	3	5	1	6	2	4	1	NA	NA	NA
WP026/45	3	NA	NA	11	NA	NA	9	NA	NA	9
WP026/46	3	2	4	10	NA	NA	9	NA	NA	NA

Table 50: Middle, Upper, and Lower Exterior Decoration Data, concluded

Vessel	River Valley	ME Angle	ME Tech	ME Motif	UE Angle	UE Tech	UE Motif	LE Angle	LE Tech	LE Motif
WP026/47	3	1	3	9	NA	NA	9	NA	NA	NA
WP026/48	3	1	4	10	NA	NA	9	NA	NA	NA
WP026/49	3	3	1	3	NA	NA	9	1	3	1
WP026/51	3	NA	NA	NA	NA	NA	9	NA	NA	NA
WP026/52	3	1	4	10	NA	NA	9	NA	NA	NA
WT189/01	1	3	1	3	NA	NA	9	NA	NA	NA

River Valley: 1=Milwaukee, 2=Wisconsin, 3=Wolf, 4=Rock
ME= Middle Exterior Zone
UE= Upper Exterior Zone
LE= Lower Exterior Zone
Tech= Technique

Middle Exterior Angle: 1=horizontal, 2=vertical, 3=diagonal, 4=alternate diagonal, 5=multiple
Middle Exterior Technique: 1=TC, 2=LCP, 3=CCP, 4=CTP, 5=Multiple
Middle Exterior Motif: 1=TC horizontal, 2=TC vertical, 3=TC diagonal, 4=TC alternate diagonal, 5=TC diagonal with punctates, 6=Bands, 7=LCP rows, 8=LCP columns, 9=CCP, 10=CTP, 11=Plain

Upper Exterior Angle: 1=horizontal, 2=vertical, 3=diagonal, 4=alternate diagonal, 5=multiple
Upper Exterior Technique: 1=TC, 2=LCP, 3=CCP, 4=CWS, 5=CTP, 6=Tool
Upper Exterior Motif: 1=CWS, 2=CTP horizontal, 3=CCP horizontal, 4=Tool, 5=LCP vertical, 6=LCP diagonal, 7=TC vertical, 8=TC diagonal, 9=Plain, 10=Other

Lower Exterior Angle: 1=horizontal, 2=vertical, 3=diagonal, 4=multiple
Lower Exterior Technique: 1=TC, 2=LCP, 3=CCP, 4=CWS, 5=CTP
Lower Exterior Motif: 1=CCP, 2=CTP, 3=CWS, 4=LCP rows, 5=LCP columns, 6=TC rows, 7=TC chevron, 8=TC filled chevron, 9=Plain

Table 51: Band Decoration Data

Vessel	River Valley	Band Type
CR186/03	2	3
CR186/04	2	1
CR186/04_1	2	3
CR312/04	2	6
CR348/02	2	2
CR350/01	2	4
CR353/02	2	5
CR356/03	2	3
CR360/01	2	1
CR360/03	2	2
CR360/06	2	3
CR370/02	2	4
DA411/07	4	2
GT112/10	2	6
GT112/13	2	1
GT156/21	2	1
GT156/23	2	2
GT156/24	2	1
GT156/24_1	2	3
GT156/25	2	4
GT157/09	2	3
GT157/11	2	1
IA001/01	2	2
IA038/11	2	2
JE676/03	4	6
JE946/01	4	2
MQ038/06	3	1
MQ038/13	3	1
OZ026/09	1	1
OZ026/14	1	6
RI190/01	2	3
RI190/02	2	1
SBBR/19	1	6
SBBR/31	1	1
SBBR/31_1	1	1
SBBR/36	1	5
SBBR/54	1	5
SBBR/55	1	1
SK001/03	2	4
SK001/04	2	6
SK001/05	2	3
WL110/17	4	6
WP026/01	3	1
WP026/18	3	2
WP026/32	3	1
WP026/43	3	6

River Valley: 1= Milwaukee, 2=Wisconsin, 3=Wolf, 4=Rock

Band Type: 1= TC triangle, 2=TC ladder, 3=TC chevron/wave, 4=TC filled chevron, 5=TC criss-cross, 6= TC indeterminate

Table 52: Bordered and Doubled Decoration Data

Vessel	River Valley	Border	Double
CR084/01	2	1	0
CR103/01	2	1	0
CR103/03	2	1	0
CR103/04	2	1	0
CR186/04	2	1	0
CR186/05	2	1	0
CR186/07	2	1	0
CR339/03	2	1	0
CR348/02	2	1	0
CR350/01	2	1	0
CR353/02	2	1	0
CR356/03	2	1	0
CR360/01	2	1	0
CR360/03	2	1	0
CR360/06	2	1	0
CR370/02	2	1	0
CT071/06	3	1	1
CT071/08	3	1	0
CT071/11	3	1	0
DA011/02	4	1	0
DA411/01	4	1	1
DA411/07	4	1	0
DA411/08	4	0	1
DA457/02	4	1	0
DA457/06	4	1	0
DA463/03	4	1	1
DO027/08	4	0	1
DO131/17	4	0	1
GT112/10	2	1	0
GT112/11	2	1	0
GT112/13	2	1	0
GT112/14	2	1	0
GT156/01	2	1	0
GT156/23	2	1	0
GT156/24	2	1	0
GT156/25	2	1	0
GT157/11	2	1	0
GT157/12	2	1	0
GT157/17	2	1	1

Table 52: Bordered and Doubled Decoration Data, concluded

Vessel	River Valley	Border	Double
GT157/19	2	1	1
GT266/03	2	1	0
IA001/01	2	1	0
JE676/11	4	0	1
MQ038/06	3	1	0
MQ038/13	3	1	1
MQ038/17	3	0	1
OZ067/04	1	1	0
RI190/02	2	1	0
SBBR/12	1	1	0
SBBR/15	1	1	1
SBBR/18	1	1	0
SBBR/22	1	1	0
SBBR/25	1	0	1
SBBR/31	1	1	0
SBBR/35	1	1	0
SBBR/48	1	1	0
SBBR/50	1	1	0
SBBR/53	1	1	1
SBBR/55	1	1	0
SK001/04	2	1	0
SK001/10	2	1	1
WP026/32	3	1	0
WP026/46	3	0	1
WP026/47	3	0	1
WP026/52	3	0	1

River: 1= Milwaukee, 2=Wisconsin, 3=Wolf, 4=Rock

Border/Double: 1=presence, 0=absence

Table 53: Horizontal Twisted Cord Type Decoration Data

Vessel	River Valley	TC Type
CR084/02	2	3
CR127/01	2	1
CR127/02	2	1
CR127/03	2	1
CR127/04	2	1
CR127/05	2	1
CR127/06	2	1
CR127/07	2	1
CR185/01	2	1
CR186/03	2	3
CR186/06	2	1
CR186/09	2	1
CR312/01	2	1
CR312/03	2	1
CR312/05	2	1
CR313/01	2	1
CR313/02	2	1
CR313/03	2	1
CR314/01	2	3
CR339/01	2	3
CR339/02	2	1
CR339/04	2	1
CR339/05	2	1
CR348/01	2	1
CR353/03	2	1
CR353/04	2	3
CR353/05	2	1
CR353/06	2	1
CR353/07	2	2
CR353/08	2	1
CR356/01	2	1
CR356/02	2	1
CR356/05	2	1
CR356/06	2	1
CR356/07	2	1
CR357/01	2	1
CR357/02	2	1
CR357/03	2	1
CR360/02	2	3
CR360/04	2	1

Table 53: Horizontal Twisted Cord Type Decoration Data, continued

Vessel	River Valley	TC Type
CR360/05	2	3
CR360/08	2	2
CR360/09	2	1
CR367/01	2	3
CR370/01	2	1
DA005/03	4	2
DA005/04	4	1
DA005/05	4	1
DA012/01	4	1
DA411/02	4	1
DA411/03	4	1
DA411/04	4	1
DA411/05	4	1
DA411/06	4	1
DA457/01	4	1
DA457/03	4	1
DA457/04	4	1
DA457/05	4	1
DA463/02	4	1
DAPP/01	4	1
DO027/11	4	2
DO027/12	4	2
DO131/04	4	1
DO131/08	4	1
DO131/19	4	1
GT112/08	2	1
GT112/09	2	1
GT112/12	2	1
GT156/02	2	1
GT156/13	2	1
GT156/14	2	1
GT156/15	2	2
GT156/16	2	1
GT156/17	2	1
GT156/18	2	1
GT156/19	2	2
GT156/22	2	2
GT156/26	2	3
GT157/07	2	1

Table 53: Horizontal Twisted Cord Type Decoration Data, continued

Vessel	River Valley	TC Type
GT157/09	2	1
GT157/10	2	2
GT157/13	2	1
GT157/14	2	2
GT157/15	2	1
GT157/16	2	1
GT157/18	2	1
GT266/01	2	1
GT266/02	2	1
IA001/02	2	1
IA038/03	2	1
IA038/04	2	2
IA038/06	2	1
IA038/08	2	1
IA038/09	2	1
IA038/10	2	1
IA038/12	2	1
JE676/01	4	1
JE676/05	4	1
JE676/07	4	1
JE676/08	4	1
JE946/03	4	1
MI083/03	1	1
MQ038/02	3	1
MQ038/08	3	1
MQ038/16	3	1
MQ039/05	3	1
MQUNK/01	3	1
OZ026/10	1	1
OZ026/27	1	1
OZ026/28	1	2
OZ026/30	1	1
OZ026/31	1	1
OZ026/32	1	1
OZ067/57	1	1
PT029/09	2	1
PT029/31	2	1
RI190/01	2	1
RO203/03	4	1

Table 53: Horizontal Twisted Cord Type Decoration Data, concluded

Vessel	River Valley	TC Type
SBBR/06	1	1
SBBR/09	1	1
SBBR/10	1	1
SBBR/14	1	1
SBBR/23	1	1
SBBR/24	1	1
SBBR/26	1	2
SBBR/29	1	1
SBBR/33	1	1
SBBR/39	1	1
SBBR/43	1	1
SBBR/46	1	1
SBBR/56	1	1
SK001/05	2	1
SK001/06	2	1
SK001/07	2	1
SK001/08	2	1
SK001/09	2	2
WL110/05	4	1
WO016/02	2	2
WO016/04	2	1
WP026/04	3	2
WP026/07	3	1
WP026/08	3	1
WP026/28	3	1
WP026/29	3	1
WP026/30	3	1
WP026/31	3	1
WP026/34	3	1
WP026/36	3	1
WP026/37	3	1
WP026/38	3	1
WP026/39	3	1

River Valley: 1= Milwaukee, 2=Wisconsin, 3=Wolf, 4=Rock

TC Type: 1=single, 2=doubled, 3=tripled

Table 54: Vessel Averaged ED XRF Data

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
CR084/01	234.03	145.72	66.49	35212.39	1115.71	4419.56	3989.11	9575.53
CR084/02	226.68	154.72	68.50	25009.22	978.33	3922.54	5112.92	13044.85
CR103/01	262.72	125.61	56.97	20513.88	888.43	3726.34	3879.44	7486.11
CR103/03	242.40	133.77	71.98	36353.33	1274.09	3034.47	5804.81	9045.92
CR103/04	242.12	90.87	49.33	55191.72	3186.88	2818.89	5340.86	6784.03
CR127/01	294.45	98.76	69.41	59550.05	775.13	3314.82	5862.34	10505.26
CR127/02	260.02	136.56	52.79	25417.59	465.86	3549.42	3985.44	7504.80
CR127/03	191.75	133.89	69.30	28873.34	495.14	4649.24	5970.34	11949.56
CR127/04	383.50	99.30	54.47	27928.70	815.59	3953.21	5674.22	10813.39
CR127/05	275.01	139.06	60.37	29038.83	692.39	4201.05	6108.00	11124.86
CR127/06	229.28	132.67	82.18	39647.99	601.17	4194.36	4901.72	10955.92
CR127/07	199.43	106.25	65.89	31789.50	331.06	3815.63	3537.91	8192.37
CR185/01	180.96	104.32	53.53	110421.65	2894.85	2022.33	4345.01	5163.41
CR186/03	259.83	90.37	50.16	37762.26	2606.47	12103.19	3394.87	3243.70
CR186/04	283.08	67.28	63.03	40793.62	356.56	2599.96	5195.41	4628.48
CR186/05	196.10	97.00	54.12	56644.45	972.49	2593.42	4100.83	5998.68
CR186/06	218.42	69.23	71.60	31602.66	504.68	2402.54	4013.00	3802.00
CR186/07	296.16	101.13	71.29	32265.61	2652.33	2752.20	7341.36	7747.16
CR186/09	217.29	92.47	47.05	68739.75	1716.02	2119.04	6106.17	4736.65
CR309/01	221.69	114.60	45.25	26351.87	414.81	1847.13	3149.25	3784.40
CR312/01	152.79	161.56	52.15	52127.11	564.79	3041.49	5218.05	8706.50
CR312/02	237.42	89.44	52.65	60673.73	1214.07	2546.83	4473.72	6015.14
CR312/03	219.57	131.88	42.71	36669.03	2635.63	3226.42	8773.45	11816.54
CR312/04	282.33	152.16	58.36	43576.10	3100.15	3198.59	6042.12	8389.36
CR312/05	182.30	126.08	59.65	46823.15	776.19	3474.18	5874.29	7800.67
CR313/01	241.76	191.09	54.63	42734.04	829.59	3771.94	5626.99	8766.27
CR313/02	263.57	134.96	51.75	53659.36	3534.79	2814.81	5440.95	7224.89
CR313/03	201.54	154.37	71.68	45391.82	2090.42	3347.88	5611.68	8707.34
CR314/01	247.65	139.65	50.28	31212.06	755.25	3773.36	4141.46	8322.18
CR339/01	179.19	62.36	52.75	28594.06	604.99	2790.11	3955.61	7633.23
CR339/02	318.70	99.60	68.45	26943.82	505.27	3773.72	4209.07	9953.62
CR339/03	314.90	81.39	79.30	34820.39	619.48	3801.55	4434.15	9708.57
CR339/04	168.20	63.68	74.80	30781.36	438.86	3179.59	5876.29	12274.96
CR339/05	291.45	137.71	57.02	28016.51	592.32	3909.83	6403.42	11582.30
CR348/01	245.42	93.57	48.48	51938.16	1902.18	2664.15	4491.51	6026.09
CR348/02	219.31	106.34	67.12	53438.56	6114.23	2273.46	5873.87	6324.73
CR350/01	219.39	104.78	61.08	32117.16	1018.08	2331.80	7952.10	4765.17
CR353/02	274.65	121.27	53.94	35611.03	1478.35	3593.48	4564.14	7400.73
CR353/03	213.33	175.20	59.92	26302.74	1354.99	8051.26	6021.06	8488.92

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
CR353/04	182.67	92.86	39.67	71758.43	1995.53	2013.31	4034.57	4579.56
CR353/05	266.43	98.06	41.45	76309.94	2390.77	3692.03	3685.26	5785.15
CR353/06	304.43	97.75	56.07	41936.38	2953.83	4255.05	5183.50	7535.03
CR353/07	235.29	134.82	63.38	28275.96	1672.73	12235.52	6060.98	10378.85
CR353/08	254.75	97.10	46.47	60465.91	1934.98	4177.69	4450.73	6558.28
CR356/01	244.03	62.33	36.80	62096.53	1835.91	2743.85	3248.48	5095.97
CR356/02	255.65	116.99	46.16	36054.03	1655.63	12655.96	4029.72	6587.32
CR356/03	265.22	135.45	46.94	37523.49	2078.74	3445.03	6313.34	6573.90
CR356/05	329.50	113.41	54.74	60433.47	1439.30	3476.63	3817.18	8310.24
CR356/06	212.63	86.94	52.75	85005.09	1883.46	29020.88	3174.99	4302.91
CR356/07	227.11	79.85	43.56	70550.31	1750.48	2882.33	3497.50	5405.07
CR356/08	253.40	95.27	54.87	57242.71	993.56	2959.86	5068.33	6523.79
CR357/01	183.04	87.96	80.46	61730.41	1979.13	46853.78	3803.31	6246.64
CR357/02	178.00	60.93	48.45	98515.04	2517.86	1954.49	4210.11	4172.86
CR357/03	198.22	123.65	47.87	52919.40	2691.87	2756.65	5824.85	6178.58
CR360/01	194.66	150.34	47.30	22920.22	558.71	3108.97	4897.51	8387.52
CR360/02	275.60	143.30	58.76	37970.61	329.21	2926.52	4423.33	6034.28
CR360/03	247.91	70.84	42.40	49705.62	1457.57	2697.48	5510.01	5385.06
CR360/04	207.75	127.72	53.06	48619.39	1061.89	3369.25	4373.11	6612.49
CR360/05	249.62	109.59	58.64	34683.92	473.67	3382.63	4471.16	9422.43
CR360/06	245.85	61.39	49.34	44996.66	575.17	3175.69	5126.19	5635.67
CR360/07	215.45	84.63	55.47	64191.34	1576.23	2344.03	4466.42	6227.72
CR360/08	261.50	86.22	54.92	54378.79	2613.54	2634.22	5270.86	5962.38
CR360/09	204.31	77.46	41.15	48895.62	2125.09	2322.12	7561.84	7214.20
CR367/01	264.48	148.54	67.04	46450.27	1040.39	3523.69	6113.55	8140.93
CR370/01	317.36	111.43	54.24	34086.55	657.94	2774.32	4633.21	7324.80
CR370/02	204.99	116.06	60.45	38920.27	1862.54	1537.83	2553.58	3832.30
CT071/01	221.00	96.45	52.19	33923.64	1213.58	2231.44	4503.73	10287.31
CT071/02	252.79	115.35	63.69	55608.08	550.04	4244.79	5905.23	15061.19
CT071/03	211.35	108.42	54.44	33944.99	807.21	2856.87	18689.88	11816.78
CT071/04	277.99	106.36	63.55	39109.50	1230.22	3764.52	8484.23	16089.31
CT071/05	242.11	83.74	70.38	39691.85	1375.40	3758.17	5073.72	14099.54
CT071/06	248.21	86.48	58.08	49750.30	1012.97	3716.53	4954.38	9570.52
CT071/08	237.97	113.82	59.00	26292.10	868.74	3245.53	6692.64	12624.42
CT071/09	278.42	89.15	73.68	34921.77	776.08	4488.34	5758.51	16537.51
CT071/11	238.38	116.12	67.32	39251.47	925.26	4082.20	8810.51	16437.62
CT071/12	284.51	91.55	59.95	60131.66	797.91	5183.41	5550.73	13859.19
CT071/16	246.48	106.12	80.49	36968.76	639.00	4053.84	7824.95	19378.89
CT071/19	225.19	113.96	61.42	38513.96	725.83	4172.26	7618.34	16591.44
DA005/01	266.93	91.90	50.60	28031.66	1474.02	3254.37	7276.19	15610.45

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
DA005/02	293.75	107.04	43.53	28211.95	1754.08	3078.88	7064.00	8614.73
DA005/03	249.86	99.95	43.77	39778.23	1387.03	3392.91	7145.72	10451.96
DA005/04	177.80	109.41	41.90	38256.24	793.82	2786.54	6247.33	9778.74
DA005/05	295.97	79.09	38.19	31142.60	788.36	3474.31	5806.64	9765.57
DA011/01	138.85	46.39	34.55	25151.10	999.87	2278.38	4871.93	11339.94
DA011/02	323.09	124.03	40.62	27917.61	266.43	2987.18	6184.67	6413.71
DA012/01	263.85	137.48	54.92	32792.66	934.86	3044.64	8226.30	14138.59
DA411/01	228.97	169.42	68.46	34379.52	901.52	2775.56	23879.69	16666.60
DA411/02	288.80	132.10	55.07	28467.39	738.39	2620.93	25856.13	13185.75
DA411/03	280.50	177.61	53.05	40579.68	2160.51	3270.06	9320.24	13184.51
DA411/04	259.56	165.42	77.98	17424.03	796.33	1480.71	95427.84	19066.86
DA411/05	266.47	124.79	58.05	26607.84	665.18	2652.69	20029.28	10791.15
DA411/06	315.24	196.39	62.23	20489.01	832.98	2130.68	70002.63	10496.70
DA411/07	230.53	149.21	55.99	26408.39	1103.91	2774.56	27208.61	10623.37
DA411/08	253.14	119.48	66.93	25891.39	559.08	2347.96	14439.64	10067.36
DA411/09	298.02	135.07	53.81	28713.48	751.45	2412.12	7735.69	8215.16
DA457/01	318.36	112.62	66.07	35762.89	3874.62	2813.20	7783.79	9512.68
DA457/02	349.68	119.02	42.87	27649.03	348.05	3638.60	6140.53	9064.38
DA457/03	322.87	93.35	52.77	24760.19	412.07	3096.11	5746.71	8643.99
DA457/04	312.53	72.71	54.58	45811.73	395.67	3596.82	4624.91	7218.65
DA457/05	269.57	68.60	41.62	30463.80	298.37	3145.65	5706.76	7789.68
DA457/06	395.30	103.40	56.02	22875.84	1105.99	2926.99	4949.63	7108.18
DA463/01	371.26	166.00	47.90	31200.85	727.90	3732.35	8634.06	11028.34
DA463/02	267.53	83.80	41.29	33599.03	579.72	3398.45	8635.53	9424.14
DA463/03	339.57	138.48	48.67	30776.46	723.28	3799.93	6780.22	8397.84
DAPP/01	267.05	112.04	53.06	31066.84	1062.51	2840.09	7648.55	9369.62
DO027/02	253.03	125.84	61.06	49906.35	1499.46	3876.73	3777.16	10840.32
DO027/03	322.40	110.39	58.33	57988.50	640.74	3458.72	5393.60	8894.94
DO027/05	303.95	96.96	57.55	45954.99	687.23	3430.66	3959.73	9094.81
DO027/06	386.34	108.51	53.13	48059.35	666.82	3662.23	3414.25	7784.06
DO027/08	261.44	97.02	53.65	32610.40	903.97	3444.60	5403.55	9058.62
DO027/10	238.12	123.51	83.51	32063.40	253.90	3635.28	7509.23	15913.41
DO027/11	273.22	143.78	78.92	37715.80	996.09	3984.41	7321.61	14922.88
DO027/12	248.75	102.11	67.61	46214.63	928.36	4174.56	10837.34	16040.36
DO027/17	211.06	94.23	41.99	28205.44	327.64	1780.87	5837.79	5483.13
DO131/01	376.84	116.74	53.31	42776.76	1098.32	4680.53	9520.73	24105.78
DO131/02	344.34	138.92	54.96	47117.91	1024.96	4342.58	12130.08	16989.94
DO131/03	317.74	119.44	48.72	45059.69	586.98	4584.51	13083.39	17934.47
DO131/04	305.70	132.02	53.18	45914.37	823.99	4769.45	17363.29	19673.28
DO131/05	395.21	137.27	56.09	40178.30	851.06	5117.47	9674.27	24220.69

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
DO131/06	283.75	136.31	65.85	42364.26	2208.73	4533.77	14029.85	19812.68
DO131/07	223.46	98.31	68.72	43095.27	677.34	4608.93	17057.65	19812.71
DO131/08	321.00	111.62	57.65	41830.08	878.42	4541.97	10802.32	19933.56
DO131/09	265.22	126.46	50.87	41737.17	2947.73	4039.23	8256.99	15968.64
DO131/10	223.46	111.41	63.58	47864.14	849.36	5348.02	10305.55	27491.20
DO131/11	439.65	119.64	65.96	43169.30	1604.84	4132.27	9769.76	20765.29
DO131/12	332.49	114.43	62.11	42132.50	507.05	4463.82	10471.44	16839.83
DO131/13	274.11	120.54	54.97	47262.56	1226.25	4374.12	11757.04	16916.80
DO131/16	294.33	123.90	51.06	42779.12	1166.75	4605.41	12932.72	21008.25
DO131/17	228.51	120.08	46.87	36595.80	598.45	2772.62	10897.15	12976.48
DO131/18	385.49	120.29	53.51	35188.92	434.75	4940.28	8038.26	20265.67
DO131/19	358.18	118.90	65.72	43590.25	1358.23	4391.60	10340.52	19995.80
DO131/20	264.07	120.42	60.07	44376.48	699.06	4742.80	12932.77	21630.84
DO131/21	322.87	111.64	58.85	40698.49	752.31	4971.81	11527.01	20333.48
DO131/22	478.51	122.74	53.30	34266.29	1048.37	4956.80	9888.08	19770.21
DO131/23	221.30	111.71	70.38	52068.92	817.13	4869.26	11641.20	32979.04
DO131/24	237.14	127.77	69.77	52532.83	1632.88	5062.66	12681.94	27241.73
DO131/25	363.11	103.72	57.80	48042.03	1643.24	4121.81	9790.14	21015.18
DO131/26	281.30	129.23	52.90	59701.77	1627.57	4243.32	13763.24	17459.29
DO131/27	271.32	130.36	50.61	55452.60	1005.20	3978.08	14622.85	16296.07
DO131/28	329.93	117.36	57.24	42857.00	2142.43	5612.61	11882.81	26095.71
DO131/31	372.47	120.29	65.80	46081.98	1414.21	4107.94	11228.17	19193.38
DO518/02	341.29	97.02	46.20	33237.13	529.96	3126.09	4070.74	9352.90
DO518/03	276.09	91.41	50.93	37375.67	424.82	3535.10	4835.15	10143.91
DO518/04	263.23	87.03	48.80	34087.43	526.29	2844.82	4302.24	8602.03
DOSS/01	391.48	186.51	50.45	26757.55	334.57	3277.78	20374.06	11127.27
GLTOP/01	276.98	48.62	52.70	25067.53	310.73	4179.73	11280.89	15697.08
GT112/01	349.22	112.92	53.44	19175.54	693.52	2424.00	2228.39	5883.21
GT112/02	388.00	87.79	46.43	37949.86	810.51	4451.04	3523.85	6671.37
GT112/03	293.12	84.64	76.73	52205.62	666.29	3799.71	7140.65	9566.14
GT112/04	211.74	155.78	57.31	21502.87	205.92	3645.45	5753.43	10485.15
GT112/05	269.35	226.18	77.21	30875.15	228.06	3506.70	4517.24	11824.11
GT112/07	411.06	106.34	61.17	29139.25	749.86	4028.40	5613.11	11255.23
GT112/08	282.39	190.00	73.27	27108.97	357.93	3664.57	8481.45	10476.10
GT112/09	221.32	66.01	42.25	28372.25	269.68	4624.68	4106.68	9940.27
GT112/10	295.89	92.37	55.02	30013.44	142.11	3355.71	3437.79	9460.63
GT112/11	366.67	47.50	34.25	34051.12	161.37	4166.82	2734.86	5877.37
GT112/12	226.52	144.11	83.49	31448.82	728.99	3510.84	10729.00	11789.82
GT112/13	202.47	125.06	85.80	26478.17	295.59	3215.01	5725.80	8897.86
GT112/14	208.46	150.84	55.16	20785.33	508.75	2691.21	22914.47	11274.79

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
GT156/01	371.44	46.87	40.70	26050.68	556.89	3339.29	7677.35	6400.83
GT156/02	193.01	86.89	87.30	20702.71	264.04	13308.03	42383.15	6253.91
GT156/03	272.34	106.29	61.58	21612.88	399.62	1587.27	10670.22	6890.71
GT156/04	217.97	160.55	84.30	18183.07	329.25	11082.20	54733.80	8112.34
GT156/05	341.79	107.82	73.93	18762.78	603.18	2930.14	23627.13	8696.49
GT156/06	249.86	83.79	43.30	17761.78	739.52	21343.49	52632.12	7260.31
GT156/07	355.12	125.33	67.46	21981.47	515.14	4282.07	24514.38	14128.82
GT156/08	218.28	138.12	98.26	35325.66	441.34	7827.16	26165.16	16491.80
GT156/13	266.67	81.30	42.99	20380.29	628.59	20584.27	54492.76	9573.17
GT156/14	253.99	138.76	72.66	22540.44	289.20	12508.57	36340.51	8141.76
GT156/15	248.07	104.59	68.81	20157.82	444.73	2385.88	24133.71	8722.93
GT156/16	285.07	137.32	64.69	20575.55	390.07	23455.65	78960.20	8373.60
GT156/17	253.01	96.72	68.93	38038.92	719.86	5404.75	19241.18	8577.93
GT156/18	196.12	95.05	56.32	20761.86	1139.35	13778.30	35252.79	9544.65
GT156/19	329.06	115.58	68.92	24534.07	841.34	9168.22	31013.11	11928.82
GT156/20	175.36	81.91	68.89	34166.23	378.11	2681.95	12524.44	9242.78
GT156/21	223.96	86.62	60.07	23364.21	301.50	2951.16	10761.68	11276.42
GT156/22	219.94	80.11	78.71	27409.76	375.89	9863.49	53107.30	9462.18
GT156/23	259.52	136.86	76.33	22712.34	973.62	9276.76	24588.53	10113.56
GT156/24	210.96	76.11	71.74	58234.52	567.98	1669.72	11222.35	6298.33
GT156/25	246.94	101.53	69.61	22096.92	273.98	4309.75	18216.44	6870.77
GT156/26	277.73	115.89	76.53	20419.08	717.76	2522.18	35691.26	8915.70
GT157/01	173.59	46.50	51.75	21761.28	848.35	1941.92	10956.88	16600.78
GT157/02	167.99	61.76	60.10	34392.24	877.52	1512.05	12422.71	10052.49
GT157/03	250.96	134.74	75.83	28997.40	622.48	3355.52	13847.03	16443.82
GT157/04	171.22	144.00	79.11	20235.80	413.00	2640.95	12559.07	19170.65
GT157/05	258.57	108.97	70.84	22761.10	520.39	2063.12	17225.38	9180.21
GT157/06	273.01	107.62	84.16	28750.25	1014.42	53175.53	19986.88	15172.62
GT157/07	376.92	109.06	64.89	23812.24	670.00	2489.23	14029.52	10374.84
GT157/08	290.67	107.81	47.28	31406.52	1580.06	2006.01	35439.66	6991.05
GT157/09	171.84	77.85	71.70	154943.71	834.83	3665.62	13613.99	11231.80
GT157/10	236.70	89.71	88.92	29616.31	542.71	50756.74	23593.08	14920.84
GT157/11	357.11	84.61	78.96	22178.43	991.75	70840.82	40279.01	14444.28
GT157/12	287.24	95.74	57.61	23677.41	611.99	3269.37	25606.07	16489.15
GT157/13	256.90	135.16	62.58	23154.68	518.62	1681.06	28095.20	10282.52
GT157/14	245.85	86.09	61.59	23667.11	379.79	31068.64	11478.62	9984.54
GT157/15	162.19	32.79	61.01	16018.96	864.40	836.40	4801.31	7689.39
GT157/16	346.70	97.19	71.50	28348.84	501.19	2799.29	10802.93	13949.85
GT157/17	246.07	79.80	58.87	21730.02	470.37	16185.92	13070.50	8461.94
GT157/18	241.00	76.44	55.31	20665.06	902.80	1581.54	10932.46	6899.63

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
GT157/19	235.15	75.51	55.10	28996.11	277.48	1023.72	7089.97	3496.33
GT266/01	359.93	89.21	47.41	66504.81	754.16	30912.28	3882.25	6242.55
GT266/02	216.02	67.30	56.48	74023.25	3467.17	10533.37	4841.64	7714.01
GT266/03	314.44	86.54	45.96	42368.14	802.30	4405.60	5025.95	9069.26
IA001/01	258.48	94.18	62.81	34010.30	629.57	3554.31	2985.41	11207.00
IA001/02	313.02	66.75	64.60	42356.24	135.95	3302.24	1944.84	16499.27
IA038/01	221.30	82.51	63.61	15408.57	538.28	4956.12	53650.37	14746.51
IA038/02	251.71	160.99	62.42	25826.58	572.82	3470.08	31334.39	20559.10
IA038/03	194.58	55.21	59.25	22789.32	920.73	1972.94	29906.46	21252.98
IA038/04	248.00	42.10	62.81	17845.82	1204.53	4661.73	34614.52	19234.01
IA038/05	253.55	87.00	67.57	19569.39	191.64	11370.28	6406.30	30929.93
IA038/06	243.78	88.88	52.62	25975.89	889.59	10887.35	20429.82	27994.23
IA038/07	257.44	131.53	69.39	27607.92	826.49	6383.10	7217.24	11157.80
IA038/08	206.65	104.00	55.63	21797.04	469.62	7034.20	19538.74	11100.02
IA038/09	241.73	34.49	62.47	27376.49	671.48	6379.91	40435.63	13870.85
IA038/10	228.18	93.86	59.34	24285.02	240.42	3660.63	9902.73	17402.46
IA038/11	256.37	71.94	88.93	27330.44	582.94	9488.72	28849.87	14971.34
IA038/12	392.34	84.20	64.42	29417.03	1610.24	3192.46	40386.15	7264.34
JE676/01	257.20	102.76	68.99	34396.19	882.84	3638.80	11850.65	12875.82
JE676/03	223.88	123.75	56.37	39114.80	1395.29	3294.12	8085.08	11456.53
JE676/04	223.35	108.01	54.60	38259.00	745.33	4177.40	10227.22	14944.70
JE676/05	228.20	82.24	86.70	32994.96	997.65	3466.86	7368.50	14413.26
JE676/06	326.10	111.99	56.85	35674.85	618.94	3377.16	8993.10	10305.79
JE676/07	204.85	144.87	79.25	31162.11	727.80	3248.55	11178.12	16075.52
JE676/08	336.22	122.27	56.98	29103.42	568.14	3109.06	10907.39	8126.88
JE676/09	220.84	90.15	89.87	36155.99	1106.19	3139.53	22540.66	16421.41
JE676/11	205.47	96.12	54.96	25510.03	529.10	2781.32	12864.61	10153.30
JE757/03	196.43	74.84	41.56	35936.82	7165.92	2853.39	6094.90	8314.39
JE946/01	207.19	72.85	40.29	19222.25	1009.96	2335.49	5617.56	8212.45
JE946/03	226.87	77.27	84.04	36791.79	817.92	3708.60	6556.28	14566.74
JUNT/01	268.74	83.86	76.25	38161.57	1222.82	4028.48	10676.23	18451.85
MI083/03	215.98	81.39	78.97	30052.02	649.35	2762.84	3548.19	13649.63
MQ038/01	238.00	98.69	61.73	29934.65	861.81	2716.10	8210.19	9295.07
MQ038/02	249.01	116.78	70.97	33149.62	310.21	3769.04	3126.19	9256.67
MQ038/03	224.20	68.79	52.89	25841.41	716.24	2162.82	4127.95	8484.45
MQ038/04	246.12	101.08	43.85	35735.20	1132.93	2442.33	6048.94	7262.93
MQ038/05	215.37	68.60	60.92	20953.52	283.69	2783.36	3585.09	10973.39
MQ038/06	250.23	139.20	51.95	18970.22	410.58	3880.18	8540.30	10841.21
MQ038/07	255.70	134.71	64.41	36084.22	733.87	3569.52	6669.33	12753.86
MQ038/08	250.44	83.43	58.14	22917.95	557.50	2804.20	3455.29	9640.96

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
MQ038/09	218.37	144.59	40.48	25238.37	827.08	1662.05	3505.36	5725.74
MQ038/10	291.63	158.88	60.69	41077.41	2045.80	3271.57	7026.81	8483.68
MQ038/11	239.07	91.25	92.08	24302.97	1226.97	4308.40	5013.33	19211.18
MQ038/12	247.70	75.95	56.09	25206.95	289.87	2760.52	2135.82	10408.91
MQ038/13	325.61	119.27	54.03	49712.45	3146.70	3250.97	9232.90	9756.55
MQ038/14	253.08	107.49	56.26	20619.29	649.81	4870.35	5434.01	16648.07
MQ038/16	188.39	219.94	88.05	26668.51	430.97	2539.15	2525.98	9180.44
MQ038/17	272.63	122.97	60.47	51660.56	887.93	7493.23	9726.77	12985.29
MQ038/18	242.86	100.21	55.76	36965.20	1137.17	2533.20	7419.57	10504.69
MQ038/19	221.19	95.57	54.19	24946.68	358.46	1991.10	2687.96	7838.93
MQ038/20	295.14	121.14	64.82	20177.32	317.73	3237.08	3475.44	6339.25
MQ038/21	271.34	120.19	59.70	26705.21	422.06	4102.89	3988.18	14752.32
MQ039/05	260.17	123.10	84.68	64167.01	3430.43	2811.70	3001.22	7806.50
MQ039/10	211.36	77.27	73.03	24068.30	2121.60	2651.64	7021.67	12068.16
MQSBL/01	233.35	100.29	52.91	31702.95	473.78	3536.89	21013.33	14770.34
MQUNK/01	242.59	86.53	60.90	40117.67	767.46	3547.82	3449.00	14753.22
OZ026/01	232.38	192.27	77.74	25224.21	616.19	3506.03	21509.23	15506.00
OZ026/02	208.19	114.15	80.48	32031.24	2644.68	3534.91	15670.20	22609.94
OZ026/06	203.47	112.61	77.05	31308.84	1285.82	2936.67	14952.10	13531.62
OZ026/08	265.24	115.58	87.15	42468.75	3805.13	3479.84	25512.32	17881.48
OZ026/09	211.22	123.15	72.16	30804.29	4703.52	2487.80	16433.50	9356.20
OZ026/10	236.05	124.91	80.70	31532.46	856.60	3541.54	13961.60	16499.04
OZ026/11	238.40	130.03	81.81	27735.16	969.71	3321.16	24522.56	18565.24
OZ026/13	222.28	83.72	80.70	25011.35	1851.69	2416.12	17619.57	12341.83
OZ026/14	235.14	113.42	80.10	35286.64	1452.00	3881.49	28084.51	16797.43
OZ026/15	206.71	134.16	86.47	35100.47	2327.06	3445.91	18030.50	21985.96
OZ026/17	229.30	124.93	72.17	33795.63	1772.18	3129.91	34027.59	17590.85
OZ026/18	217.46	121.11	80.11	40722.29	1786.29	3697.71	19266.85	13834.83
OZ026/19	238.32	98.46	85.60	37544.32	5208.34	2957.42	21645.81	15163.75
OZ026/20	238.47	117.39	80.53	32106.64	1127.95	2804.81	24711.17	15220.46
OZ026/24	214.72	105.85	86.88	30994.01	2162.50	3108.61	17319.69	19654.36
OZ026/26	200.51	117.96	74.41	28529.10	1470.78	2971.49	17198.89	16499.12
OZ026/27	224.96	267.30	71.06	26313.42	2681.58	2573.56	25979.94	12271.03
OZ026/28	180.70	120.53	75.41	34275.39	519.68	2574.60	38914.48	11348.33
OZ026/29	209.99	111.31	71.85	29606.83	1242.18	2530.37	24288.45	11773.55
OZ026/30	219.92	115.92	84.23	35170.72	937.34	3282.38	21366.29	13259.58
OZ026/31	205.94	110.46	71.55	23497.18	1215.66	2401.95	36694.47	14216.98
OZ026/32	220.03	134.02	84.65	34624.42	714.37	3634.41	13634.32	17980.54
OZ026/58	204.06	129.52	83.83	37068.11	803.75	3390.91	19062.02	14493.22
OZ026/59	282.31	139.96	79.33	25351.12	908.25	3464.61	13364.39	14457.12

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
OZ026/60	267.02	123.04	76.10	33465.80	1124.61	3128.54	35907.58	12471.18
OZ026/61	231.45	147.15	63.39	38439.87	1292.76	3381.88	22650.53	11708.49
OZ026/63	214.26	101.24	77.46	30241.32	2614.94	3889.69	12995.84	18699.81
OZ026/64	230.19	98.62	102.81	38792.14	1102.95	3654.56	10753.54	17717.36
OZ067/03	222.00	111.59	76.80	31263.22	1487.90	3082.26	21577.87	12605.69
OZ067/04	204.16	100.71	76.22	30546.08	682.28	2783.51	24083.56	12029.34
OZ067/05	228.74	108.10	80.14	37207.24	739.79	3452.46	19094.05	15240.28
OZ067/07	239.33	119.12	74.09	40992.02	1588.59	3218.74	16875.64	14033.31
OZ067/12	238.12	111.88	73.25	29334.68	2371.30	2885.51	26047.04	14976.66
OZ067/16	271.35	111.46	82.71	31972.57	2169.85	3680.19	14954.34	17827.90
OZ067/21	253.52	135.70	72.07	36038.73	1198.47	3548.39	18567.90	14767.72
OZ067/22	214.20	141.81	72.92	40402.38	2372.69	3831.12	19002.42	15779.09
OZ067/23	234.04	108.42	79.00	33475.34	1462.77	2700.90	22018.53	15387.06
OZ067/56	215.79	102.74	86.23	33724.57	940.01	3046.34	13896.91	13997.14
OZ067/57	202.70	101.65	82.93	36488.27	2323.64	1595.11	21597.81	18207.51
PT029/01	253.56	53.50	80.66	114937.71	960.50	8451.18	2206.18	14357.31
PT029/03	160.99	31.67	111.40	71904.64	1032.80	3845.17	1530.10	15264.41
PT029/04	256.46	95.88	75.24	36111.68	536.81	3959.08	3853.02	15981.13
PT029/05	133.64	52.46	99.33	85288.35	676.51	3940.50	1321.66	12923.35
PT029/06	218.96	135.79	63.23	37006.02	650.19	3863.18	5091.25	13438.01
PT029/07	164.98	48.87	89.00	35436.70	398.59	3188.93	1140.52	23544.42
PT029/08	277.53	112.60	52.16	15437.69	310.35	2767.21	2113.33	6460.33
PT029/09	315.62	169.27	73.25	44681.33	568.29	4296.61	3273.24	18115.09
PT029/11	269.48	101.98	70.47	53298.84	959.76	3860.93	3383.21	14151.71
PT029/12	265.65	115.12	67.19	64908.24	359.64	3336.72	2568.20	9744.61
PT029/13	259.36	98.50	56.56	35946.38	912.77	3517.84	3823.08	12104.79
PT029/14	232.57	78.69	73.54	45441.90	644.05	4110.74	3223.24	12314.47
PT029/17	279.14	121.31	48.25	19884.62	451.12	4304.62	2153.05	8171.86
PT029/19	258.87	189.67	81.73	34799.13	945.51	4559.86	2593.71	7762.49
PT029/21	254.16	97.39	38.58	20464.83	699.61	3508.74	2376.61	6057.14
PT029/22	304.93	139.23	41.99	16267.89	347.83	4651.29	3060.21	7938.38
PT029/23	153.72	46.42	92.51	99095.76	958.51	5293.31	1994.77	15834.11
PT029/24	299.52	52.39	59.76	67470.88	1285.55	3329.86	673.68	15718.94
PT029/26	240.07	86.27	47.47	18021.62	185.77	11726.56	2775.71	8118.88
PT029/30	228.00	145.25	44.39	21631.39	379.20	2314.33	5078.75	7848.82
PT029/31	106.78	40.81	73.02	32522.80	231.65	3093.58	3515.79	21270.94
PT029/32	365.37	47.51	104.41	50021.57	705.86	19543.33	1970.14	14922.28
PT029/34	267.67	74.21	41.16	20986.36	624.91	20439.73	2337.91	5443.38
PT029/35	195.35	91.06	66.65	66564.08	627.48	4564.49	8369.64	16250.14
PT029/36	154.69	58.83	146.86	81998.26	906.12	3494.10	1967.40	19189.43

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
PT029/37	175.22	45.95	85.33	149128.75	1017.69	5198.87	1467.35	10330.33
PT029/41	304.80	108.44	39.97	23485.81	1605.39	4373.18	2391.24	6824.75
PT029/42	198.43	89.33	60.14	165151.30	864.10	6384.06	1164.72	9133.33
RI190/01	137.41	34.88	37.97	144384.94	2691.10	505.28	1239.07	3822.84
RI190/02	229.82	96.52	30.82	21277.22	420.78	1777.40	2641.56	3961.74
RO203/01	356.41	108.71	45.78	29320.60	1654.55	3783.53	2380.18	8295.14
RO203/02	196.14	53.12	62.95	32817.24	2322.60	3440.32	2299.60	9930.10
RO203/03	306.20	100.22	43.08	27360.04	4015.75	3459.16	3173.93	8557.00
RO203/04	305.51	83.02	45.69	29698.22	2975.28	3642.63	3377.13	8483.79
SBBR/02	170.15	126.34	52.88	20731.65	248.77	1345.26	2387.01	5693.64
SBBR/04	251.97	91.18	68.07	43020.42	796.89	4195.02	11581.22	14465.07
SBBR/05	279.18	120.33	61.78	32315.60	455.05	4351.10	8830.71	13168.82
SBBR/06	278.37	86.67	45.83	26190.16	505.87	2904.58	8390.75	7186.51
SBBR/07	202.45	121.04	59.50	34686.08	1042.66	2611.87	11829.78	11518.03
SBBR/08	231.81	100.42	69.42	32234.05	389.29	3243.90	8025.37	13447.61
SBBR/09	214.42	149.64	58.89	30111.60	1127.55	3309.72	15168.81	13424.42
SBBR/10	234.74	116.65	83.29	24910.85	352.00	2223.78	6244.03	11106.95
SBBR/11	230.30	93.45	65.07	26850.57	340.69	2768.08	7838.62	10964.52
SBBR/12	232.18	108.64	80.46	43588.17	697.76	4299.52	15517.96	17857.64
SBBR/13	212.83	113.58	57.91	33016.09	463.92	3564.99	10050.93	13486.41
SBBR/14	245.36	75.19	53.79	28034.82	512.25	2831.30	6698.69	8028.79
SBBR/15	220.12	91.33	58.27	31565.94	744.29	2758.65	6272.54	10810.20
SBBR/16	216.87	88.76	50.82	22037.15	696.85	2296.48	7184.95	9743.59
SBBR/17	227.01	97.83	69.26	43385.57	432.85	4390.29	5476.03	15378.10
SBBR/18	172.00	67.58	47.91	17252.33	300.90	1080.69	4058.90	3625.80
SBBR/19	218.29	91.53	52.77	25895.67	1175.07	2021.34	5901.08	7485.21
SBBR/20	217.29	98.66	69.34	29383.56	357.57	3484.91	7745.34	11541.17
SBBR/22	224.16	94.98	64.38	45240.84	761.07	7596.60	10383.48	10917.54
SBBR/23	235.61	119.67	61.56	34256.45	799.67	5043.19	12529.15	16466.79
SBBR/24	263.69	94.69	59.45	37400.11	315.34	4046.57	9764.07	11470.73
SBBR/25	229.13	181.81	71.16	33645.01	423.39	2577.25	3688.89	10759.37
SBBR/26	189.81	112.31	49.54	35502.19	768.08	2781.07	12001.24	9507.57
SBBR/27	198.44	87.22	45.73	27987.47	753.34	1731.89	2271.77	4769.77
SBBR/28	282.53	156.31	79.18	56296.12	2425.35	2416.19	7402.06	6654.59
SBBR/29	261.76	114.38	57.30	32823.68	951.37	2934.32	10478.44	11748.74
SBBR/31	211.93	88.03	66.75	36643.43	739.49	3722.86	6684.00	13143.45
SBBR/32	211.69	88.39	62.04	28764.19	1423.46	3047.09	7348.19	11714.90
SBBR/33	204.48	103.11	68.42	36176.14	534.00	3307.42	24475.46	13672.10
SBBR/35	225.78	110.23	69.27	31372.15	463.07	3262.97	11917.49	15244.72
SBBR/36	197.43	112.57	51.72	36300.11	446.66	2963.21	10666.89	9560.80

Table 54: Vessel Averaged ED XRF Data, continued

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
SBBR/38	198.70	98.32	55.78	35961.59	635.21	2907.01	9916.28	10900.62
SBBR/39	225.74	118.77	71.14	29665.58	1215.68	3528.95	7303.86	14782.47
SBBR/41	189.80	88.51	60.34	39315.04	763.57	3268.91	8001.59	11731.16
SBBR/43	250.12	85.95	47.58	33055.65	451.97	3407.39	8961.91	10257.70
SBBR/45	243.20	99.26	62.23	31439.63	905.12	3028.08	11305.58	13012.26
SBBR/46	239.69	90.14	66.29	29069.86	168.50	1690.16	8293.82	8303.03
SBBR/47	214.53	105.97	57.49	34122.39	1702.78	2291.59	12371.61	14643.55
SBBR/48	229.75	81.57	89.11	38228.11	1519.58	2116.44	21292.62	16616.55
SBBR/49	223.54	101.25	61.79	26743.62	675.59	2907.46	25771.81	18543.34
SBBR/50	164.71	157.72	39.92	28118.46	1110.95	1358.56	14256.28	5626.68
SBBR/51	233.12	103.55	83.20	34578.86	695.76	3882.76	17358.55	26203.73
SBBR/52	190.91	90.06	52.86	17499.79	390.99	431.86	1479.84	2339.60
SBBR/53	188.28	103.25	63.28	27501.56	322.35	1862.27	4679.02	6662.09
SBBR/54	284.33	118.92	62.09	25213.85	419.20	2347.12	22528.98	15626.83
SBBR/55	274.53	103.51	62.70	44914.11	842.03	4186.67	21689.16	20446.54
SBBR/56	227.67	114.53	62.84	39935.83	1516.18	3860.33	26699.89	24809.19
SBBR/57	233.60	111.04	67.70	29450.29	899.10	2982.93	25733.42	20278.67
SBBR/58	164.89	70.30	60.80	12887.32	273.85	358.35	551.15	1425.71
SBTW/01	209.92	131.39	66.35	25978.20	1020.87	2551.61	23548.94	24173.03
SK001/01	254.32	170.17	74.69	23204.78	476.75	1202.64	9293.39	6350.09
SK001/02	149.71	127.30	43.58	14826.67	1352.81	1038.06	3109.21	3394.98
SK001/03	229.15	98.99	32.08	27721.58	3032.04	11019.45	11791.52	8945.45
SK001/04	293.66	143.54	54.19	47260.84	2220.78	4268.62	7119.54	12345.43
SK001/05	192.98	153.62	48.77	31885.98	836.42	2075.06	10925.96	10222.95
SK001/06	248.68	246.26	72.65	29929.71	440.00	5848.85	16547.04	9463.56
SK001/07	270.18	142.48	83.50	16097.48	321.46	1659.35	5391.10	8355.78
SK001/08	244.56	108.15	48.18	21366.04	870.26	2119.99	6461.24	4700.18
SK001/09	211.59	68.54	56.36	26628.95	1805.68	9529.09	10752.52	5621.60
SK001/10	246.26	177.50	72.72	23854.92	801.63	1968.56	10692.31	10853.52
WL110/05	315.34	77.51	59.24	26817.52	1264.79	3217.02	3597.69	10961.55
WL110/07	236.45	97.86	60.56	23548.73	721.15	3042.34	2846.44	12428.71
WL110/12	279.25	77.91	56.62	30792.55	793.86	2882.03	4594.08	9869.99
WL110/17	242.31	96.70	52.25	30883.38	1839.99	3843.47	3214.24	11864.27
WL110/23	215.78	121.89	48.31	33282.25	1406.32	3505.86	6483.07	12470.31
WL110/24	226.64	80.19	60.01	28043.73	1436.66	3182.74	15804.98	10925.61
WO016/01	312.00	82.75	44.46	28268.51	623.99	5239.01	3174.44	7062.88
WO016/02	253.42	88.68	73.12	41342.99	1725.13	3753.20	2882.83	14105.40
WO016/03	322.97	110.16	37.69	29183.18	522.94	4026.09	5896.56	9138.75
WO016/04	256.17	85.95	44.26	68521.56	717.74	4941.98	4018.71	8889.62
WO016/06	171.46	45.48	52.25	62176.34	477.91	3795.09	3433.70	10110.54

Table 54: Vessel Averaged ED XRF Data, concluded

Vessel	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
WP026/01	251.96	112.95	81.03	31687.59	1616.81	3530.85	9550.36	19324.75
WP026/04	225.63	109.41	72.68	32171.47	772.85	2663.75	3891.94	13967.72
WP026/06	209.47	87.48	65.82	33608.20	435.14	2754.79	4142.08	14744.78
WP026/07	214.67	125.79	62.23	34711.56	528.10	3146.39	5651.92	13640.83
WP026/08	194.41	99.67	73.35	36596.25	977.03	4008.56	7303.50	21483.65
WP026/09	213.71	117.52	59.19	26144.70	257.79	1754.27	3170.36	7550.11
WP026/14	248.22	139.33	90.03	32612.65	1097.78	3427.70	11967.09	20258.76
WP026/15	212.76	113.91	67.04	35246.32	790.53	3054.30	7205.69	15086.09
WP026/17	209.25	150.30	75.29	33282.56	569.20	3618.19	8921.15	19376.55
WP026/18	216.46	88.38	78.53	40329.16	637.01	5067.50	5333.85	23249.91
WP026/23	206.93	103.38	59.62	36523.24	618.06	24142.43	3950.23	11321.51
WP026/24	241.02	105.05	48.59	24937.54	566.55	13276.58	8598.75	13030.84
WP026/25	223.96	107.26	75.21	35495.50	1268.67	3492.22	5272.04	17713.13
WP026/26	218.32	94.66	53.33	28114.18	481.01	4080.90	5256.46	19593.18
WP026/28	207.69	152.87	65.36	33763.95	789.52	3054.48	3972.26	14871.39
WP026/29	272.61	100.40	81.78	33374.14	667.73	3875.53	4064.64	23488.11
WP026/30	249.01	105.19	99.02	39220.30	881.66	3807.19	6555.16	18920.69
WP026/31	256.18	111.48	71.86	36604.19	617.41	4331.43	4164.05	21783.87
WP026/32	235.21	129.48	69.92	41431.90	655.76	3660.50	5356.87	17102.98
WP026/33	211.89	103.43	80.63	44165.38	693.61	3972.89	7350.98	18729.33
WP026/34	245.14	95.70	72.67	33717.87	901.13	3450.25	5760.42	17990.16
WP026/35	173.02	106.67	57.69	23814.54	795.48	1206.81	4498.73	4755.22
WP026/36	218.56	147.88	71.65	37677.29	968.53	4174.55	7280.13	22472.72
WP026/37	245.05	134.60	70.95	40710.92	1103.91	3872.55	6366.55	22336.82
WP026/38	249.28	111.65	79.64	38304.45	1106.34	3838.72	5028.90	17645.46
WP026/39	222.76	170.03	73.97	30174.93	982.78	2133.05	4490.09	11960.95
WP026/43	258.42	127.70	76.58	36035.87	1414.12	3980.26	5259.44	22543.29
WP026/45	259.62	141.54	80.79	33306.14	703.25	4143.59	5269.63	20403.89
WP026/46	202.31	155.79	84.21	29577.07	676.18	3215.19	10535.54	15966.05
WP026/47	282.11	146.30	73.22	37973.55	1136.92	4209.21	4609.91	19592.10
WP026/48	260.01	130.05	77.94	32114.41	693.74	3441.85	7874.37	18011.65
WP026/49	208.56	114.21	92.46	34845.90	513.38	3648.41	7170.39	20249.86
WP026/51	249.68	106.46	88.51	35335.59	917.59	4136.21	4802.21	21715.19
WP026/52	204.08	95.20	47.84	30681.05	331.88	2840.39	5353.26	9474.22
WT189/01	206.52	73.42	93.78	38955.45	571.56	3580.79	5378.60	15708.24

Table 55: Site Averaged ED XRF Data

Site	Zr	Sr	Rb	Fe	Mn	Ti	Ca	K
CR084	230.353	150.215	67.495	30110.804	1047.019	4171.048	4551.010	11310.191
CR103	249.078	116.750	59.425	37352.978	1783.135	3193.234	5008.368	7772.018
CR127	261.917	120.925	64.915	34606.571	596.619	3953.960	5148.565	10149.452
CR185	180.960	104.315	53.525	110421.650	2894.853	2022.330	4345.008	5163.413
CR186	245.148	86.247	59.540	44634.723	3021.813	4095.057	5025.271	5026.113
CR309	221.685	114.600	45.250	26351.870	414.805	1847.130	3149.248	3784.395
CR312	214.880	132.222	53.103	47973.821	1658.166	3097.500	6076.324	8545.639
CR313	235.621	160.141	59.349	47261.736	2151.598	3311.542	5559.871	8232.831
CR314	247.648	139.648	50.280	31212.063	755.248	3773.355	4141.463	8322.180
CR339	254.488	88.948	66.461	29831.230	552.183	3490.959	4975.707	10230.535
CR348	232.363	99.954	57.798	52688.356	4008.200	2468.804	5182.685	6175.410
CR350	219.390	104.780	61.075	32117.155	1018.075	2331.795	7952.100	4765.170
CR353	247.363	116.720	51.555	48665.769	1968.739	5431.191	4857.178	7246.644
CR356	255.362	98.605	47.972	58415.087	1662.440	12743.619	4164.218	6114.173
CR357	186.421	90.845	58.928	71054.948	2396.284	17188.307	4612.755	5532.692
CR360	233.625	101.277	51.225	45151.351	1221.574	2884.544	5122.269	6764.639
CR367	264.478	148.540	67.038	46450.268	1040.393	3523.685	6113.545	8140.928
CR370	261.174	113.743	57.341	36503.413	1260.243	2156.071	3593.393	5578.553
CT071	247.030	102.290	63.681	40675.671	910.185	3816.489	7488.902	14362.808
DA005	256.860	97.476	43.599	33084.135	1239.459	3197.401	6707.974	10844.288
DA011	230.965	85.209	37.584	26534.353	633.150	2632.779	5528.299	8876.826
DA012	263.850	137.480	54.915	32792.655	934.855	3044.635	8226.298	14138.585
DA411	266.389	153.719	61.963	27566.742	963.121	2503.778	34920.967	12864.978
DA457	328.053	94.949	52.321	31220.580	1072.460	3202.895	5825.386	8222.926
DA463	326.120	129.424	45.952	31858.778	676.965	3643.577	8016.603	9616.774
DAPP	267.045	112.040	53.060	31066.838	1062.510	2840.093	7648.553	9369.620
DO027	273.035	101.144	60.726	37979.863	711.241	3427.685	5826.172	10619.424
DO131	315.238	118.602	58.140	44619.805	1171.318	4552.356	11718.117	20619.479
DO518	293.532	91.818	48.640	34900.072	493.688	3168.668	4402.708	9366.277
DOSS	391.475	186.505	50.450	26757.550	334.565	3277.780	20374.060	11127.270
GLTOP	276.975	48.620	52.695	25067.525	310.730	4179.725	11280.885	15697.080
GT112	288.441	119.446	60.425	29812.492	468.778	3737.365	6434.367	9318.921
GT156	257.553	104.726	68.272	25262.409	540.497	8466.376	31270.433	9148.991
GT157	249.982	92.175	66.163	31848.075	713.214	13310.181	17148.960	11675.616
GT266	296.798	81.015	49.950	60965.400	1674.543	15283.748	4583.277	7675.268
IA001	285.750	80.460	63.706	38183.268	418.021	3428.274	2465.124	13853.134
IA038	249.634	86.391	64.038	23769.124	726.564	6121.458	26889.351	17540.296
JE676	247.343	109.126	67.173	33596.813	841.252	3359.197	11557.257	12752.575

Table 55: Site Averaged ED XRF Data, concluded

Site	**Zr**	**Sr**	**Rb**	**Fe**	**Mn**	**Ti**	**Ca**	**K**
JE757	196.425	74.835	41.555	35936.815	7165.915	2853.390	6094.900	8314.385
JE946	217.028	75.058	62.165	28007.018	913.940	3022.040	6086.918	11389.593
JUNT	268.735	83.855	76.250	38161.570	1222.815	4028.475	10676.225	18451.850
MI083	215.980	81.385	78.970	30052.015	649.350	2762.835	3548.190	13649.630
MQ038	249.802	114.434	60.372	29843.383	837.367	3307.400	5296.768	10517.177
MQ039	235.763	100.185	78.855	44117.653	2776.010	2731.665	5011.443	9937.328
MQSBL	233.350	100.290	52.905	31702.945	473.775	3536.890	21013.330	14770.335
MQUNK	242.585	86.530	60.895	40117.665	767.460	3547.815	3448.995	14753.215
OZ026	224.781	126.475	79.524	32433.490	1706.412	3151.944	21723.211	15406.309
OZ067	229.448	113.924	77.847	34676.824	1576.116	3074.955	19706.393	14986.515
PT029	235.554	90.300	70.866	54567.662	708.806	5568.500	2764.918	12471.958
RI190	183.616	65.701	34.394	82831.079	1393.773	1141.341	1940.315	3902.211
RO203	291.066	86.268	49.373	29799.023	2742.041	3581.411	2807.710	8816.506
SBBR	223.819	105.001	62.016	32175.577	733.730	2969.976	10755.288	11974.962
SBTW	209.920	131.385	66.350	25978.195	1020.870	2551.610	44095.785	24173.030
SK001	234.108	143.654	58.670	26277.693	1215.782	4072.966	9208.384	8025.352
WL110	257.451	90.892	56.399	28734.909	1245.408	3274.148	5898.358	11384.802
WO016	263.202	82.600	50.353	45898.515	813.539	4351.069	3881.245	9861.436
WP026	229.352	118.874	72.901	34243.834	799.043	4382.691	6058.204	17363.405
WT189	206.515	73.420	93.780	38955.445	571.555	3580.785	5378.600	15708.235

Table 56: Petrographic Slide Counts

		Natural Inclusions						Temper						
Thin Section Number	**Matrix**	**Silt**	**NI- Fine**	**NI- Medium**	**NI- Coarse**	**NI-Very Coarse**	**NI- Gravel**	**T-Silt**	**T- Fine**	**T-Medium**	**T- Coarse**	**T-Very Coarse**	**T- Gravel**	**Total**
CR186/03	111	16	10	2	1	0	0	0	0	0	3	4	5	152
CR309/01	91	18	1	1	0	0	0	0	0	7	5	8	6	137
CR357/03	132	3	3	0	0	0	0	0	0	4	6	10	9	167
CT071/03	75	2	10	1	1	1	0	0	0	1	8	8	7	114
CT071/06	70	3	2	0	0	0	0	0	0	1	1	5	13	95
CT071/06	68	2	1	0	2	0	0	0	0	1	2	3	8	87
DA411/06	48	21	8	3	7	0	0	0	0	0	5	11	0	103
DAPP/01	104	18	9	7	1	0	0	0	2	0	0	2	0	143
DO027/17	84	7	4	7	0	0	0	0	0	1	3	4	0	110
DO131/12	102	16	9	3	5	0	0	0	0	1	1	1	3	141
DO131/17	73	13	19	6	0	0	0	0	0	0	2	10	10	133
DO131/18	81	14	11	0	0	0	0	0	0	0	1	3	2	112
DO518/03	96	12	9	9	2	1	0	0	1	2	2	4	3	141
GT112/01	88	8	6	2	3	3	4	0	0	2	3	5	4	128
GT112/11	91	15	5	3	2	6	0	0	0	0	1	2	2	127
GT156/02	92	6	2	0	1	0	0	0	1	3	3	7	0	115
GT156/03	89	8	14	2	0	0	0	0	0	3	0	7	0	123
GT156/04	92	14	7	2	5	3	0	0	0	0	7	8	3	141
GT156/23	62	4	6	5	7	1	0	0	0	4	5	2	0	96
GT156/23	65	3	4	16	10	3	0	0	0	1	0	2	0	104
GT157/09	59	2	0	0	0	0	0	1	3	7	23	7	0	102
GT157/17	49	16	0	2	0	0	0	0	1	1	5	2	2	78
GT157/17	44	9	0	1	0	0	0	0	0	0	2	4	1	61
GT157/06	80	5	1	2	3	0	0	0	0	0	4	4	0	99

Table 56: Petrographic Slide Counts, continued

		Natural Inclusions						Temper						
Thin Section Number	Matrix	Silt	NI- Fine	NI- Medium	NI- Coarse	NI-Very Coarse	NI- Gravel	T-Silt	T- Fine	T-Medium	T- Coarse	T-Very Coarse	T- Gravel	Total
GT157/06	88	9	1	3	3	0	0	0	0	0	0	4	4	112
GT266/01	67	15	1	1	0	0	0	0	0	1	2	4	2	93
GT266/01	71	12	1	2	1	0	0	0	1	0	2	3	3	96
IA038/03	129	5	35	4	1	0	0	0	0	0	1	3	0	178
IA038/11	100	7	2	1	1	0	0	0	0	0	0	5	0	116
JE676/06	63	9	4	3	3	0	0	0	0	0	0	3	1	86
JE676/06	57	20	3	1	2	0	0	0	0	0	4	2	0	89
MQ038/09	91	3	17	15	6	0	0	0	0	0	3	7	3	145
MQ039/05	89	1	3	1	1	0	0	0	0	0	3	10	8	116
OZ26/19	113	6	4	4	1	0	0	0	0	0	4	7	8	147
OZ67/05	90	1	3	1	0	0	0	0	1	2	1	11	9	119
PT029/07	83	2	8	4	4	0	0	0	1	4	6	12	16	140
PT029/23	62	5	9	0	0	0	0	0	0	0	6	10	11	103
PT029/24	98	6	17	7	5	2	1	0	0	0	7	24	6	173
RO203/01	63	6	2	3	0	0	0	0	0	0	1	2	4	81
RO203/01	59	5	1	1	0	0	0	0	0	0	1	3	3	73
SBBR/18	73	6	7	7	2	0	0	0	0	1	4	8	5	113
SBBR/32	89	8	4	0	0	0	0	0	0	0	1	2	16	120
SK001/04	105	6	1	1	0	0	0	0	0	1	1	12	23	150
SK001/05	92	1	5	1	1	0	0	0	1	1	1	1	6	110
WL110/05	146	30	6	9	6	2	2	0	0	0	0	3	8	212
WL110/07	88	13	32	15	11	4	0	0	1	1	4	14	11	194
WP016/01	95	7	2	1	0	0	0	0	0	0	0	6	8	119

Table 56: Petrographic Slide Counts, concluded

		Natural Inclusions						Temper						
Thin Section Number	**Matrix**	**Silt**	**NI-Fine**	**NI- Medium**	**NI-Coarse**	**NI-Very Coarse**	**NI-Gravel**	**T-Silt**	**T-Fine**	**T-Medium**	**T-Coarse**	**T-Very Coarse**	**T-Gravel**	**Total**
WP026/04	105	0	5	3	0	0	0	0	0	7	3	11	16	150
WP026/23	69	0	5	8	0	1	0	0	0	3	3	5	4	98
WP026/23	71	1	4	5	1	2	0	0	0	2	3	2	5	96
WP026/24	115	18	10	22	6	3	0	0	0	1	2	12	15	204

CURRICULUM VITAE

JODY A. CLAUTER

Education

2006-present Dissertator, ABD, University of Wisconsin-Milwaukee (UW-M)
  Dissertation Title: Effigy Mounds, Social Identity, and Ceramic Technology: Decorative Style, Petrography, and Clay Composition of Wisconsin Late Woodland Ceramic Vessels.
2003 M.S. in Anthropology, UW-M
  Master's Thesis: "Late Woodland Cultural Complexity: A Ceramic Analysis from the Klug (47OZ26) and Klug Island (47OZ67) Sites"
1999 B.A. in Archaeology, Geology Minor, College of Wooster (COW)

Research Interests

Eastern North America, Great Lakes Prehistory, Woodland Society, North American Taxonomy, Experimental Archaeology, Prehistoric Ceramics, Anthropological Statistics

Fellowship & Awards

2012 Midwest Archaeological Conference, Student Paper Competition, 1st Place.
2011 Midwest Archaeological Conference, Student Paper Competition, 2nd Place.
2010-11 Dissertation Fellowship. Awarded by the University of Wisconsin-Milwaukee Graduate School.

Laboratory and Curation Experience

2012-present Collections Manager, University of Wyoming Archaeological Repository, Wyoming Office of the State Archaeologist, Laramie, WY.

2006-09 Collections Manager, UW-M Archaeological Research Laboratory. Responsible for collection processing, accession, and loans, laboratory maintenance and organization, and supervising students conducting artifact analysis through the Work Study and Undergraduate Research Programs.

2006 Schmeling Site (47JE833) ceramic analysis. Upper Mississippian pottery from Southeastern Wisconsin. Robert J. Jeske, director.

2004 Crescent Bay Hunt Club Site (47JE904) ceramic analysis. Oneota ceramics recovered during 1998 and 2000 UW-M excavations in Jefferson Co, Wisconsin, Robert J. Jeske, director.

2004 Eisenman Site (47DR452) ceramic analysis. Middle and Late Woodland pottery recovered by HRMS from Door Co., Wisconsin, John D. Richards, director.

2003 Beaudhuin Village Site (47DR432) ceramic analysis. Middle and Late Woodland ceramics from Door Co., Wisconsin, John D. Richards, director.

2002 Klug (47OZ26) and Klug Island (47OZ67) ceramic analysis. Early Woodland, Late Woodland and Upper Mississippian pottery completed as Master's research, Robert J. Jeske, major advisor.

Publications

2011 Ceramic Analyses from the Nitschke Mound Group (47DO27) and Nitschke Garden Beds (47DO518). *The Wisconsin Archeologist* 92(2).

2009 (Richards, John D and Jody A. Clauter) The "Midden Years:" Morphological and Compositional Variation in Ceramics from the Riverside II Site, Menominee County, Michigan. *The Wisconsin Archeologist* 90(1/2).

2009 (Clauter, Jody A., and John D. Richards) *Archaeological Investigations at Aztalan State Park, Jefferson County, Wisconsin*. Historic Research Management Services, Archaeological Research Laboratory, Report of Investigations No. 168. University of Wisconsin-Milwaukee, Milwaukee, WI.

2007 (Richards, John D., Brian D. Nicholls, Jody A. Clauter and Ralph Koziarski) *Archaeological Investigations at the Eisenman Site (47DR452), STH 57 Project in Brown, Kewaunee, and Door Counties, Wisconsin*. Historic Research Management Services, Archaeological Research Laboratory, Report of Investigations No. 159. University of Wisconsin-Milwaukee, Milwaukee, WI.

2005 (Clauter, Jody A., and John D. Richards) Out of Time and Out of Place: The North Bay Component at the Beaudhuin Village Site (47DR432), Door County, Wisconsin. In *Transportation Archaeology on the Door Peninsula: Progress and Prospect 1992-2004*, edited by Patricia B. Richards and John D. Richards, pp. 29-41. Historic Research Management Services, Archaeological Research Laboratory, Report of Investigations No. 157. University of Wisconsin-Milwaukee, Milwaukee, WI.

Papers delivered at Professional Meetings

2011 *Spatial Differences Between Decorative and Technical Attribute Clusters in Wisconsin Late Woodland Ceramics.* Paper presented at the 57th Annual Meeting of the Midwest Archaeological Conference, La Crosse, Wisconsin.

2010 *Discussing a Late Radiocarbon Date from the Nitschke Mound Group (47DO27), Dodge County, Wisconsin.* Paper presented at the 56th Annual Meeting of the Midwest Archaeological Conference, Bloomington, Indiana.

2010 *Same Vessel, Different Mound: Ceramic Analysis from the Nitschke Mound Group (47DO27) and Nitschke Garden Beds (47DO518)*. Paper presented at the Annual Meeting of the Society of American Archaeology, St. Louis, Missouri.

2008 *Surveying Aztalan: Fifty Years of Pedestrian Reconnaissance.* Paper presented in the Symposium "Since 'Aztalan Revisited': Recent Advances in the Archaeology of the Aztalan Site and Cahokia's Northern Hinterland" at the 54th Annual Meeting of the Midwest Archaeological Conference, Milwaukee, Wisconsin.

2007 (Richards, John D., and Jody A. Clauter) *The "Midden Years": Morphological and Compositional Variation in Ceramics from the Riverside II Site, Menominee County, Michigan.* Paper presented in the Symposium "A Superior Kind of Archaeology: Marla Buckmaster and the Archaeology of Michigan's Upper Peninsula" at the 53rd Annual Meeting of the Midwest Archaeological Conference, South Bend, Indiana.

2007 (Schneider, Seth A., and Jody A. Clauter) *Preliminary Analysis of Upper Mississippian Ceramics from the Crescent Bay Hunt Club and Schmeling Sites*.

Paper presented at the 84th Annual Central States Archaeological Society Annual Meeting, Minneapolis, MN.

2006 *The Ceramic Assemblage from the Schmeling Site (47JE833)*. Paper presented in the Symposium "New Perspectives on Oneota Archaeology at Lake Koshkonong, Southeastern Wisconsin" at the 52nd Annual Meeting of the Midwest Archaeological Conference, Urbana, IL.

2006 (Schneider, Seth A., Jody A. Clauter, and Melissa Brown) *The Ceramic Assemblage from the Crescent Bay Hunt Club (47JE904) and Its Significance to the Late Prehistory of Southeastern Wisconsin*. Paper presented in the Symposium "New Perspectives on Oneota Archaeology at Lake Koshkonong, Southeastern Wisconsin" at the 52nd Annual Meeting of the Midwest Archaeological Conference, Urbana, IL.

2003 (Clauter, Jody A., and John D. Richards) *Out of Time and Out of Place: The North Bay Component at the Beaudhuin Village Site (47DR432), Door County, Wisconsin*. Paper presented in the Symposium "Transportation Archaeology on the Door Peninsula: Progress and Prospect 1992-2004*"* at the 49th Annual Meeting of the Midwest Archaeological Conference, Milwaukee, WI.

2002 *Ceramics and Cultural Complexity at the Klug Island Site (47OZ67), a Late Woodland site in Southeastern Wisconsin*. Paper presented at the 48th Annual Meeting of the Midwest Archaeological Conference, Columbus, OH.

1999 *World-Systems Interaction Between the Southeastern United States and Mesoamerica?* Paper presented at the Central States Archaeological Society Annual Meeting, Chicago, IL.

Supervisory Field Experience

2008 Field Director, Historic Research Management Services (HRMS), UW-M Department of Anthropology. Phase I survey of Aztalan State Park, Jefferson County, Wisconsin.

2007 Crew Chief/Field Director, Commonwealth Cultural Resources Group, Inc. Phase I survey and Phase II excavations in West Central Illinois and Northwestern Wisconsin.

2006 Crew Chief, 22nd Street Cemetery Project, HRMS, UW-M Department of Anthropology. Excavation of human remains from a Historic cemetery on Milwaukee's near-east side.

2003-09 Crew Chief, HRMS, UW-M Department of Anthropology. Phase I survey and Phase II and III excavation of sites in Wisconsin.

2002 Teaching Assistant, Crescent Bay Hunt Club (47JE904), UW-M Field School. Instructing in survey and excavation techniques, group excavation leader.

Other Archaeological Experience

2001-03 Field Technician, HRMS, UW-M Department of Anthropology. Phase I, II, and III survey and excavation of various Wisconsin sites.

2003 Field Technician, UW-M Program in Midwestern Archaeology. Late Woodland Blue Heron Site (47JE1001) excavations.

2001 Field Technician, UW-M Program in Midwestern Archaeology. Theel Site

(47SB374) excavation of human remains from Late Archaic/Early Woodland burials in Sheboygan County, Wisconsin.

2000 Student, UW-M Field School. Survey and excavation of Crescent Bay Hunt Club (47JE904), a Developmental Horizon Oneota site, Robert J. Jeske, director.

1999 Student, Eastern Korinthia Archaeological Survey in Greece. Timothy Gregory, Ohio State University, director.

1997 Intern, SunWatch Archaeological Park. Experimental archaeology focusing on architecture reconstruction methods, outreach programs such as site tours and community activity days, Robert Cook, director.

Classroom Teaching Assistant Experience

2001 & 2002 Introduction to Anthropological Statistics, UW-M, J. Patrick Gray, Instructor.

2002 Criminalistics, UW-M, Michael Camp, Instructor.

1999 Introduction to Archaeology, COW, P. Nick Kardulias, Instructor.

Editorial Experience

2003-09 Assistant Editor, *The Wisconsin Archeologist*, John D. Richards, editor. Text formatting, figure and table processing, and volume compilation using the InDesign, Photoshop, Canvas, Excel, and Word computer programs.

2003-06 HRMS, UW-M Department of Anthropology. Compilation and formatting of multiple ROI documents.

Other Presentations

2007 (Seth A. Schneider and Jody A. Clauter) *Preliminary Analysis of Upper Mississippian Ceramics from the Crescent Bay Hunt Club and Schmeling Sites*. Paper presented at the 1st Annual University of Wisconsin-Milwaukee Department of Anthropology Mini-Conference, Milwaukee, WI.

2002 *Ceramics and Cultural Complexity in Late Woodland Wisconsin*. Invited paper at the University of Wisconsin-Milwaukee Department of Anthropology *Buzzwords* series Bi-annual presentation session, Milwaukee, WI.

1997 *Thatching and Daubing: A Summer of Research and Reconstruction at SunWatch Archaeological Park*. Paper presented at the College of Wooster Annual Archaeology Student Seminar, Wooster, OH.

Public Outreach

2004 *Late Woodland Ceramics from the Klug and Klug Island Sites*. Invited paper presented for the Kenosha Archaeological Society, Kenosha, WI.

2001 College for Kids Outreach Program. Discussing an archaeological profession and constructing activity programs for Lake Bluff Elementary School students in Shorewood, WI.

1999 Bexley High School. Invited presentation to high school students on fieldwork opportunities, college programs, or pursuing archaeological careers in Bexley, OH.

Honors & Society Memberships

2008-present Wisconsin Archaeological Survey
2008-present Society for American Archaeology
2003-present Wisconsin Archeological Society
1999 Magna Cum Laude (3.8/4.0) & Archaeology Department Honors, COW
1999 Phi Beta Kappa, COW
1999 Lambda Alpha Society, COW
1995-1999 Dean's List, All Semesters, COW
1995 College Scholar & Arthur H. Compton Scholar, COW

Professional Leadership Positions

2002 Student/Faculty Liaison, Anthropology Student Union, UW-M Department of Anthropology
2001-02 Union Steward, Milwaukee Graduate Assistants Association, UW-M