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Social Agency and Dieffenderfer Ware: A Multiscalar Analysis Investigating Current Archaeological Perspectives Concerning Style, Social Dynamics, Chaine Operatoire and Practice Theory

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SOCIAL AGENCY AND DIEFFENDERFER WARE: A MULTISCALAR ANALYSIS INVESTIGATING CURRENT ARCHAEOLOGICAL PERSPECTIVES CONCERNING STYLE, SOCIAL DYNAMICS, *CHAINE OPERATOIRE* AND PRACTICE THEORY

by

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Dieffenderfer Ware is a recently defined ceramic type found exclusively at the Dieffenderfer site (20SJ179) in southwest Michigan. This Late Woodland (ca. A.D. 1000-1400) pottery exhibits Iroquoian traits which are atypical in this region, but beyond that, very little is known about this ceramic type and the people that produced it. Research assessing the social agency of the producers of Dieffenderfer Ware was carried out by employing the *chaine operatoire* model, which examines the life history of artifacts. Dieffenderfer Ware was compared to the locally produced Allegan Ware. Social groups will procure, construct, use, and discard ceramics differently. Significant differences were observed in most of the stages of the *chaine operatoire* suggesting that Dieffenderfer Ware was produced by a non-local group. Dieffenderfer Ware appears to be have been used more as a food processing and cooking vessel, whereas, Allegan Ware appears to be more of a multi-functional vessel with an emphasis on storage and transportability. Documentation of differences in Iroquoian and Algonquian pottery in the Northeast seem to correlate with Dieffenderfer Ware and Allegan Ware and it is likely that the social and economic structures that existed in these two ethnic groups produced the variation that is evident in this pottery from southwest Michigan.

TABLE OF CONTENTS

CHAPTER

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Social archaeology is a subdivision of the broader discipline of anthropological archaeology that seeks to examine the ways in which the social dimensions of human life structured archaeological remains in the past. Social agency is a recent theoretical development in archaeology that posits artifacts to be the products of active human agents within a simultaneously enabling and constraining socio-economic environment. Social agents produce material culture and use it to create, reinforce, and transform social relations; hence, material culture is actively constituted and not merely a passive reflection of social life (Nassaney 2002). Archaeological interpretations addressing these issues stem from alternative views of technology (in general) and style (in particular), and the incorporation of social theory (e.g., practice theory) into one's research can highlight the activities, experiences, and decision-making processes of past people.

Different types of theoretical orientations and research questions will produce different conclusions. Dobres (1995, 1999b) has emphasized that social agency cannot be addressed as an afterthought if the data is "rich" enough; rather, it must be stated as a research goal from the outset. With this in mind, I intend to assess the social agency of the producers of Dieffenderfer Ware as it influenced their pottery.

Dieffenderfer Ware is a unique pottery type found exclusively at the Dieffenderfer site (20SJ179) on the middle St. Joseph River in St. Joseph County, Michigan. The major component of the site dates to the Late Woodland period (ca. A.D. 1000-1400). Other local pottery types like Allegan Ware, Moccasin Bluff Ware, and Spring Creek Ware were also found there, but 65 percent of the ceramic assemblage consisted of Dieffenderfer Ware (Steeby 1997). Steeby's (1997) research on the Dieffenderfer ceramic assemblage employed a quantitative analysis to type most of the vessels and he assigned a majority of the vessels to a new category, Dieffenderfer Ware. These ceramics may have been produced by a previously unknown cultural tradition with "social ties" to Huron groups from the north and/or east (Steeby 1997: 106). However, these conclusions say little about the actual people that produced these morphologically and stylistically different types of pottery.

Generally, I intend to compare Dieffenderfer Ware to Allegan Ware, a locally produced pottery, in order to determine the physical similarities or differences between these two ceramic wares and their social implications. Numerous methodological techniques will be used to compare attributes ranging from the macroscopic to the microscopic. The main questions this research will answer are: How is social agency identified in material culture, specifically pottery? Is Dieffenderfer Ware a non-local pottery type, as compared to Allegan Ware? What do these differences suggest about differences in lifestyle between these two social groups? Does Dieffenderfer Ware represent an intrusion by Iroquoian neighbors or is it an imitation of non-local pottery by local peoples? Essentially, who were the producers of Dieffenderfer Ware and what can we say about their lives?

Theoretical Orientation

Research addressing social agency requires a theoretical orientation that is different from currently established archaeological paradigms such as Culture History and Processualism. Theory is often metaphorically analogous to a set of "lenses" that archaeologists look through while creating and interpreting archaeological data (Dobres 1999a). This research will be based on three main tenets that include: 1) an alternative conception of the significance of technology and the meaning of style; 2) use of the *chaine operatoire* as a research model; and 3) incorporation of social theories, specifically practice theory.

Technology can be conceived of in many different ways. I suggest that technology can be thought of as the material manifestation of conscious decisions and technical gestures produced within a socio-economic environment. It is not ecologically determined nor is it mindlessly produced in a random or haphazard manner. Even technology that is produced expediently is done so for specific reasons. Variation in technology is the result of different pragmatic circumstances.

Interpretations of style and its relationship to other aspects of ceramics like function, form, ethnicity, social boundaries, technology and meaning have been widely debated (e.g., Chilton 1996, 1998; Conkey 1989; Conkey and Hastorf 1990a; Dietler and Herbich 1989; Dobres 2000; Hegmon 1992; Hodder 1982,1992a; Lechtman 1977; Lemonnier 1986; Pretola 2000; Rice 1987; Sackett 1977, 1982;

Schiffer and Skibo 1997; Stanislawski 1978; Stark 1998b; Tilley 1999; Wobst 1977). Style, as it relates specifically to ceramic technology, is often conceived of as mainly decoration and the primary indicator of group identity. On the contrary, style is much more than that and group identity is better reflected in other ceramic characteristics like vessel morphology. Decoration is added during the final stages of ceramic production and design motifs are easily altered. The latter is true because the technical gestures used to produce different designs are not nearly as difficult to change or imitate as the gestures used to produce pots in different shapes or for different functions. Thus, the social identity of a potter is more likely to correlate with how a pot is made (Dietler and Herbich 1998; Sackett 1977, 1982, 1990; Stark 1999). Any comparison and discussion of various ceramic traditions requires a detailed review of what style is and what it will mean to the researcher during analysis, which will be provided in Chapter III.

Given that a social "signature" is more likely to be found by examining how a pot is constructed rather than how it is decorated, some archaeologists have employed the *chaine operatoire* model to identify other subtle differences between artifact types that may also correlate with social differences. This model suggests that documenting stages in an artifact's life produces a sequence highlighting resource procurement, construction, use, and discard that correlate with social identity. The likelihood of unrelated social groups producing and using artifacts in similar sequences is as remote as the number of options is great (Sackett 1990). The utility of the *chaine operatoire* has been demonstrated in ethnoarchaeology (e.g., Dietler and

Herbich 1998; Gosselain 1998) as well as research programs examining ancient societies (e.g., Dobres 1995, 2000; Sellet 1993; Sillar and Tite 2000).

Social theories, like practice theory and agency, augment archaeologists' conception of the intangible social structures that existed in the past (Dietler and Herbich 1998; Dobres and Hoffman 1994; Dobres and Robb 2000a; Hegmon 1998; Ortner 1984). These structures profoundly influence material culture because the learning mechanisms for producing goods are typically transferred through kin relations and therefore variation, or lack thereof, in the archaeological record can be understood as the product of close social relations. Another reason is that artifacts are produced by agents that are simultaneously enabled and constrained by social and economic systems, whereby "style" is imparted through technical choices and gestures. Different people will produce artifacts in different ways, subtle as they may be, and these differences relate to the social structures that produced them.

Statement of Problem

In Steeby's (1997) quantitative analysis of the Dieffenderfer ceramic assemblage, he found that 65 percent of the vessels did not fit into a preexisting typological category (i.e., Allegan or Mississippian related wares). He subsequently termed these Dieffenderfer Ware. This new ceramic ware is characterized by plain and decorated vessels with abrupt collars, smoothed interiors, and often castellated rims. These attributes are stylistically similar to Iroquoian tradition ceramics found in the east and northeast (Holman and Brashler 1999: 220; Steeby 1997: 106).

However, these observations do not exhaust the potential information that Dieffenderfer Ware evinces.

Typologies have too often become ends in themselves and stylistic types are taken to be a direct reflection of group affiliation (Arnold 1999; Chilton 1998, 1999). Unfortunately, there is not always a direct correlation between artifact styles and the ethnicity of their producers (see Hodder 1982; Stanislawski 1978). Typologies should be treated as hypotheses, which need to be tested if anthropologically interesting questions are to be answered (Chilton 1996, 1999). An emphasis on culture history and typology has ignored questions concerning ceramic production, use, and synchronic variation (Chilton 1996). Typology is a necessary first step during preliminary analyses (e.g., of pottery), but numerous other avenues of research are necessary to test typological conclusions and provide a holistic understanding of a data set.

Steeby (1997) has suggested that Dieffenderfer Ware exhibits Iroquoian influence. Differentiating between Algonquian and Iroquoian pottery types has been the focus of past research in other regions of the Eastern Woodlands (e.g., Chilton 1996; Pretola 2000; Stothers 1978). Ethnohistoric records describe the differences between these distinct social groups and artifacts like pottery have been correlated and explained in conjunction with the written records (see Chilton 1996). For example, Iroquoian people are more sedentary and rely on maize agriculture as a subsistence staple. Thus, their pottery shows clear preferences for particular local raw materials (because they do not travel often) and was constructed to withstand long durations of heating (for boiling maize). In contrast, Algonquian potters were more mobile and therefore constructed their pottery with whatever materials were available to them with an emphasis on durability. Using this past research as a model, I intend to test if Dieffenderfer Ware exhibits the traits normally produced by Iroquoian or Algonquian people.

The middle St. Joseph River is located near the St. Joseph- Kankakee portage and the historic Sauk trail and, therefore, Dieffenderfer may have been a hub for traders and travelers (Steeby 1997). Steeby (1997: 110) also suggested that the Dieffender site locality may be in a “tension zone” or transition zone (see Holman and Kingsley 1996) between cultural traditions. Therefore, research assessing the social agency of the producers of Dieffenderfer Ware which asks the question, is Dieffenderfer a local or non-local type of pottery, seems appropriate. A positive identification of a specific social group is beyond the scope of this research, but identifying local from non-local pottery has been successfully achieved by other archaeologists (e.g., Porter 1984; Pretola 2000; Stoltman 1991).

The Sample

The pottery used in this research comes from three sites in southwest Michigan. All of the ceramics used in this research had been previously separated into vessel lots. Thirty-nine vessels of Dieffenderfer Ware from the Dieffenderfer site were chosen for comparison to thirty-six vessels of Allegan Ware. Five vessels of the latter come from the Dieffenderfer site, eight from the 46th Street site (20AE38), and twenty-three from the Fennville site (20AE54). All of the samples used in this research were exclusively rim sherds. These three sites were chosen because they are the type sites for Dieffenderfer and Allegan Wares (see Rogers 1971; Steeby 1997) (see Figure 1.1).

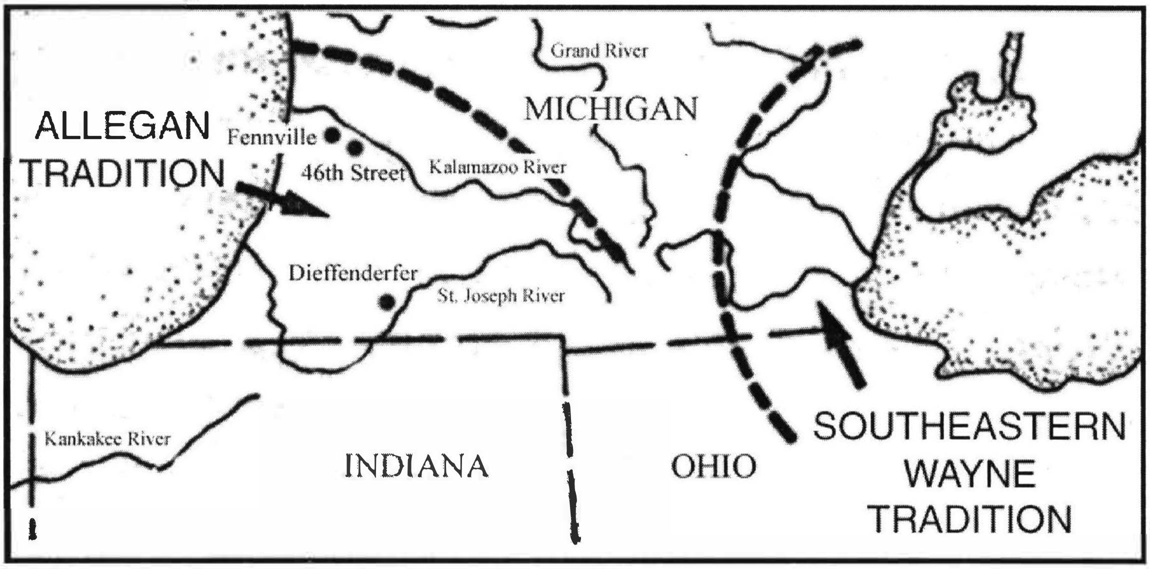


Figure 1.1 The Locations of Sites Used in This Research (after Holman and Kingsley 1996: Figure 2).

The Dieffenderfer site was excavated by the Western Michigan University field schools in 1993, 1995, and 1997 (for site, excavation, and environmental background, see [Steeby 1997: 14-29]). A minimum of 103 vessels were recovered from the site. Other types of pottery found at Dieffenderfer included Middle Woodland Sumnerville and Brangenburg (Hopewell) Wares, Allegan Ware, Moccasin Bluff Ware, Spring Creek Ware and two types of Mississippian pottery including Fisher Ware and Powell Plain (Steeby 1997). The sherds range in size from forty percent complete (in oriface diameter) to thumbnail size. All of the Dieffenderfer Ware vessels are collared, some are decorated with impressions, incisions, push-pull, or punctuations, and a few are castellated (for a complete description of Dieffenderfer types and varieties, see Appendix A). The pottery from the 1997 field school was unfortunately not included in this study for two reasons. The main reason is that neither field notes nor proveniences could be ascertained and these are essential tools for an archaeologist. The other reason is that very few vessels (n=8) were recovered, which represent less than ten percent of the site's ceramic assemblage.

The 46th Street and Fennville sites are both located on the south bank of the lower Kalamazoo River (see Figure 1.1). The former's ceramic assemblage consisted of 24 vessels of Allegan Ware and 17 vessels of Spring Creek Ware (Rogers 1971). Allegan Ware was first defined at this site as coarse grit tempered, cordmarked, and square lipped pottery (Rogers 1971: 18-22). The sample (n=8) used in my research was chosen based on sherd size, which was relatively small and therefore selective (see Appendix A for a complete photo-log of all the vessels used in this study). The Fennville site assemblage contained 170 total vessels of which 116 were Allegan Ware. The sample (n=23) used in this study included one large partially reconstructed vessel, while the rest of the assemblage consisted of sherds that were relatively smaller in size than at the other two sites. Five vessels of Allegan Ware from the Dieffenderfer site were also included in the sample.

Summary of Research

Individuals were not only producing pottery to fulfill functional requirements, but ceramics also express technical decisions that were made within social systems. Therefore, differences in ceramic attributes reflect preferences by different potters. It is important to remember that artifacts are always and everywhere socially embedded (Dobres 2000: 169). The chance of unrelated groups producing and using pottery in exactly the same manner is highly unlikely (Sackett 1990: 33). Therefore, ceramic variations will reflect group identity and lifestyle as well as represent evidence of human agency.

Using this theoretical orientation as a foundation for archaeological research, I intend to examine as many attributes as possible ranging from petrographic analysis to morphological features. The data will be tested statistically to determine if one or two populations are represented. By using the *chaine operatoire* model to aid in conceptualizing the stages of a pot's life, a researcher can identify more potential avenues of variation. It is highly unlikely that different social groups will produce and use pottery in the same ways.

This research will address four issues that are of importance to those interested in Michigan archaeology, particularly during the Late Woodland period. First, it will test the typological value of Dieffenderfer Ware. Because typologies are subjective categories, it is important to test their validity repeatedly and define their utility as a type. Second, this research will further elaborate on the social, functional, and economic aspects apparent in Dieffenderfer Ware and Allegan Ware. Other researchers (e.g., Rogers 1971; Steeby 1997) have commented on these issues, but the data collected in this study will refine and expand our understanding of these aspects. Third, it is possible that the identification of Algonquian or Iroquoian affinities based on ethnohistoric and archaeological correlates may be made. These conclusions would confirm or reject Steeby's (1997) suggestion that Dieffenderfer Ware is the product of Iroquoian influence. Lastly, the technical choices of social agents in southwest Michigan will be identified and explained. These types of interpretations have yet to be put forth by archaeologists doing research in this area and they will also have applications to archaeological studies elsewhere.

Organization of this Study

This research is broken down into six chapters: A brief review of Michigan ceramic (culture) history, a description of the theoretical orientation that informs this study, a description of the methodology, the results of the analysis, the interpretation of those results, and the conclusions. Chapter II provides a general overview of ceramic developments in Michigan beginning about 2000 years ago up to European contact. It is followed with a brief discussion concerning the validity of the concept of Allegan Ware as the product of a local tradition. Chapter III outlines four main theories that assisted with this research. Detailed descriptions concerning the archaeological debate over style, Sackett's (1977, 1982, 1999) concept of isochrestic variation, the *chaine operatoire* model, and the utility of understanding practice theory all help contribute to the archaeological interpretations of this study. Chapter IV describes how the *chaine operatoire* was operationalized and outlines the methods used to collect data from the artifacts. This chapter also explains some of the intricacies that occurred during data collection. Chapter V presents the data, most often in the form of graphs and tables, as well as statistical tests (to identify significant differences or patterns in the data). The "raw" data can be found in Appendix A. Chapter VI is a detailed analysis of the data and the subsequent interpretations concerning the producers of Dieffenderfer Ware and Allegan Ware. The chapter stems from the "interpretive archaeological" framework that was set up in Chapter III. The last chapter summarizes the conclusions of this research and the contributions it makes to our understanding of Michigan archaeology, ceramic analyses, social archaeological and agency.

CHAPTER II

MICHIGAN CERAMICS AND ALLEGAN WARE

Earthenware pottery has been produced in Michigan for about 2,500 years and an understanding of its temporal changes will serve to contextualize this research. First, a general timeline will be constructed describing the origin of ceramics through the development of the Allegan Tradition, concentrating mainly on southwest Michigan. Before one can compare local to non-local pottery, one must first demonstrate the in situ origins of Allegan Ware.

A Brief Examination of Southern Michigan (Ceramic) Culture History

The first ceramic vessels generally coincided with changes in subsistence and settlement patterns and food preparation and marked the beginning of the Early Woodland (ca. 500 B.C.) (Garland and Beld 1999). The style of pottery making was similar to the way it was produced across the Northeast Woodland: large, thick-walled pottery with exterior and interior cordmarking, and lug handles (Fitting 1970; Garland and Beld 1999). However, ceramic technology was not rapidly adopted by everyone and probably did not significantly alter people's lives (Fitting 1970; Garland and Beld 1999). The diverse subsistence base of hunting, gathering, and fishing maintained by mobile groups operating with little concern for geographic boundaries and a greater interest in non-perishable trade characterized the Early Woodland (Fitting 1970).

However, significant changes in pottery occurred during the Middle Woodland. This time period is best known for its affiliation with Hopewell. The incursion of people from Illinois into southwest Michigan is apparent from distinct intrusive pottery forms (i.e., they are not local copies) with incised geometric motifs (see Figure 2.1) as well as from the construction of burial mounds with elaborate mortuary interments (Kingsley 1999). The Saginaw valley exhibits some Hopewellian influence, particularly in ceramics (e.g., Green Point and Tittabawassee Wares), but nevertheless seem to be exaggerated copies reflecting an imitation of Hopewell pottery styles seen in both Illinois and Ohio (Fitting 1970; Kingsley 1999). But subsistence, setttlement and mortuary patterns near Saginaw are unlike the

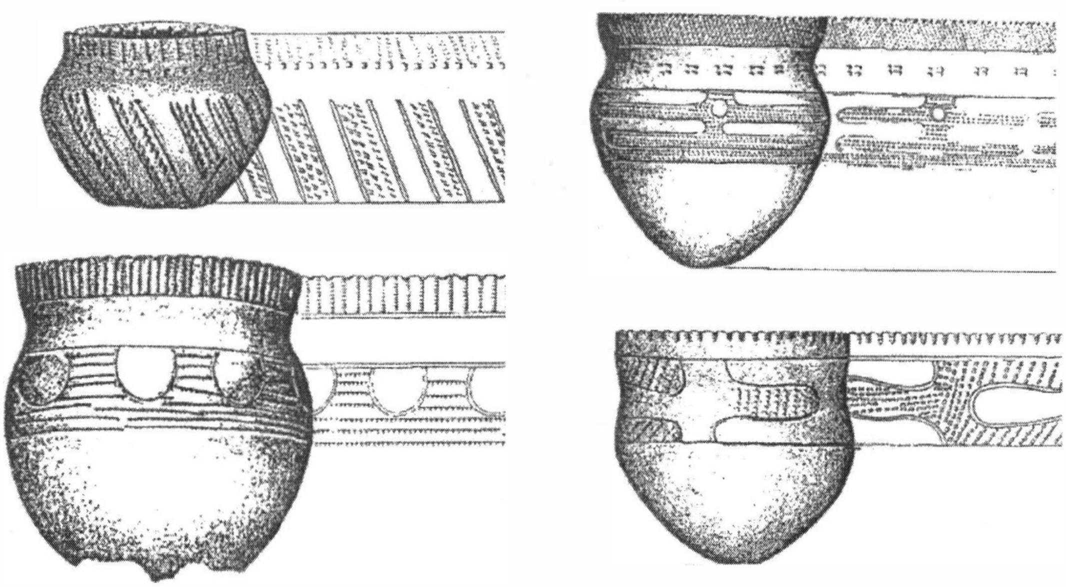


Figure 2.1 Examples of Michigan Hopewell Ceramics (and their diagnostic motifs) From the Norton Mounds (after Kingsley 1999: Figure 8.5).

"authentic" Hopewellian types found in southwest Michigan suggesting that the local population was influenced, rather than replaced or encroached upon by people directly associated with Hopewell (Fitting 1970; Kingsley 1999).

The Hopewell Interaction Sphere only extended into southwest Michigan and the Saginaw valley; however, these people were neighbors to cultural traditions that had existed in Michigan since the Late Archaic and continued into the Late Woodland (Garland et al. 1990; Kingsley 1999). In the southeastern portion of the state, the Western Basin Tradition, a social group related to the Iroquois, first appeared (Fitting 1970; Stothers 1975, 1999). Some have suggested that this tradition is the predecessor of the Late Woodland Younge Tradition (Stothers 1975). It has also been suggested that other Late Woodland ceramic types (e.g., Wayne, Crockery, and Allegan Wares [see Fitting 1970; Garland et al. 1990]) originated in the Middle Woodland, but these continuities have not been demonstrated conclusively (Kingsley 1999). There are conspicuously few Hopewell sites in the Kalamazoo River valley, but the presence of numerous Allegan Tradition sites suggests that resident populations certainly existed independent of and alongside Hopewell (Fitting 1970; Kingsley 1999).

Another Middle Woodland non-Hopewell pottery type found in the Kalamazoo and Grand River valleys was Hacklander Ware. These vessels have distinctive paste, temper, decorations, and rim modes (Brashler et al. 1997; Kinsley 1999). These vessels appear to represent the migration of people or ideas from New York or Ontario (i.e., they do not appear to be trade vessels [Holman and Brashler

1999]) (Brashler et al. 1997; Kingsley 1977, 1999). Hacklander Ware continued to be produced into the early Late Woodland period (Brashler et al. 1997; Kingsley 1999).

The Late Woodland period (ca. A.D. 500-1600) was a socially dynamic era due to the periodic movement of Mississippian and Iroquoian groups into Michigan and interacting with local, indigenous peoples. It also corresponds with the disappearance of Hopewell influence in Michigan as well as throughout the Midwest (Brashler et al. 1997; Fitting 1970). It was during this time that ceramics began to be produced by a majority of people. Variations in social and economic structures significantly affect the form and decoration of ceramics and those differences (or lack thereof) are not only identifiable, they are the basis of archaeological systematics.

During the early Late Woodland period, in situ regional development seems apparent (although as previously stated, not proven) from ceramic continuity in both an etic and emic perspective across most of the southern lower peninsula (Brashler 1978; Brashler et al. 1997; Fitting 1970). However, regional variations (e.g., Wayne, Allegan, and Spring Creek Wares) existed suggesting these spatially separated people were nevertheless closely related, but the boundaries between them were neither fixed nor permanent (Brashler 1978; Holman and Brashler 1999). The Wayne Tradition of the east side of the state, the Allegan Tradition of the Kalamazoo and St. Joseph river valleys, and the Spring Creek Tradition of the Grand and Muskegon river valleys are all similar and exhibit antecedents in the Middle Woodland (Brashler 1978; Holman and Brashler 1999). These antecedents are thick and cordmarked with occasional crosshatched incised lines (Brashler et al. 1997). A significant difference between the pottery produced on the east side of the state (i.e., Wayne Ware) and those produced on the west side of the state (i.e., Spring Creek Ware and Allegan Ware) is that the former exhibits more decoration due to their spatial proximity and interaction with the Younge or Western Basin traditions (i.e., Iroquoian) (Brashler 1978; Holman and Brashler 1999).

During the middle Late Woodland period, different social groups moved into Michigan. Around A.D. 1000, Middle Mississippian ceramics appeared in southwest Michigan (Brashler et al. 1997; McAllister 1999). However, these ceramic assemblages may not represent the actual movement of people (McAllister 1999; cf. Brashler et al. 1997). There appears to be some incorporation of Mississippian traits into local ceramic vessels possibly suggesting a degree of interaction (e.g., trade or cooperative buffering [see Holman and Kingsley 1996]) rather than a migration or displacement (Cremin 1999; McAllister 1999). But between A.D. 1200-1400, significant numbers of Upper Mississippian and Iroquoian people moved into southern lower Michigan and the former also took up residence in the Straits of Mackinac area (Betteral and Smith 1973; Brashler et al. 1997; Holman and Brashler 1999). These two groups brought with them a different means of subsistence: agriculture, particularly corn, beans, and squash (Brashler et al. 1997; Yarnell 1964). Corn was rarely grown by people in the Allegan, Spring Creek, and Wayne traditions (Brashler 1978).

Upper Mississippian pottery (similar to Fisher Ware or Huber Ware) is most easily identified by the inclusion of shell tempering (Brashler et al. 1997; McAllister 1999). This type of temper allows for stronger, thinner walls which are advantageous for cooking as well as being more portable (i.e., it is lighter) (McAllister 1999).

These pots are typically globular, with angular necks and decorations usually on the neck if they are decorated at all (Betteral and Smith 1973; McAllister 1999). However, many pots that look Upper Mississippian also incorporate attributes that are considered local suggesting that other mechanisms of cultural contact like trade or cooperative buffering may have also produced these ceramics rather than simply an influx of people into the southern portions of the state (Holman and Kingsley 1996; McAllister 1999).

In the late Late Woodland and the post-Contact period, cultural movement and disruptions were frequent. Local groups (e.g., Allegan, Spring Creek, and Wayne Traditions) maintained a fairly uninterrupted existence until about A.D. 1200 (Brashler et al. 1997). By A.D. 1400, particularly in southwest Michigan, many groups were displaced north, into the uplands, or were apparently assimilated into Upper Mississippian groups (Brashler et al. 1997). Iroquoian groups were spreading into southeastern Michigan, westward across northern Ohio, Illinois, and Indiana as well as north into the Straits of Mackinac area (Brashler et al. 1997; Cleland 1999; Stothers 1993).

It is clear that different ethnic groups were moving in and out of Michigan during the last 3,000 years. However, some of those people were here longer than others. Michigan was certainly not unoccupied for any extended period of time and people who were here for many hundreds of years can be considered local as opposed to migrating groups like Mississippian cultures or the Iroquois. Allegan Ware appears to be a candidate for a local development in southwest Michigan.

Allegan Ware

Allegan Ware was first proposed as a new type by Rogers (1971) and subsumed what was previously classified as Wayne Ware in southwest Michigan. The transition from the Wayne to the Younge tradition that existed in southeast Michigan did not exist in the southwest part of the state necessitating a typological change (Rogers 1971). Once a typology becomes too big, its function as a descriptive tool declines because the variation that exists (e.g., spatially, temporally, and morphologically) does not properly or usefully characterize all the ceramics under its name. Regardless, there are many similarities between Wayne and Allegan Ware, which suggest significant social ties, but the subtle variations are reflected in their designations as separate ceramic entities (Brashler 1978).

Allegan Ware is predominantly found in the Kalamazoo River valley, which is also where the type sites, 46th Street and Fennville are located (see Figure 1). Rogers (1971) identifies three main differences between Allegan Ware and Wayne Ware besides geography. The first is that temper size is larger in the former. Allegan Ware has more squared lips while Wayne Ware tends to have rounded lips. The last is that decoration is more common in the latter, but when Allegan Ware is decorated, it is usually done so near the rim with a cord-wrapped tool in a row of circular punctuations or cross-hatching (Brashler 1978). Allegan Ware can also be described as being exclusively grit tempered and when they are collared (a phenomena that frequently occurs throughout the Great Lakes region after A.D. 1000 [Brashler et al. 1997; Rogers 1971]) are typically folded over (as opposed to fillet or molded collars) (Pictures of Allegan Ware can be found in Appendix B).

The notion that Allegan Ware is a locally produced pottery is not absolutely definitive, but there is evidence suggesting that this is indeed the case. The most convincing evidence is the similarities in ceramic styles, which are shared across a broad area of the southern half of the lower peninsula of Michigan during the early and middle Late Woodland (Brashler 1978; Brashler et al. 1997). Many have suggested that these Late Woodland ceramics have antecedents in the Middle Woodland (e.g., Fitting 1970; see Kingsley 1999: 154), as evidenced by cross-hatched decorations (Rogers 1971), but this assertion is not conclusively supported archaeologically (Kingsley 1999). Regardless, the continuity that exists from ca. A.D. 500-1300 suggests a ceramic (and social) tradition that persisted for hundreds of years and therefore can be considered a local development in southern Michigan.

If one looks at the development of earthenware pottery from the beginning of the Early Woodland through the end of the Late Woodland, it may not be that surprising that ceramic continuity only exists for about 800 years during the early and middle Late Woodland. During the Early Woodland, only a small percentage of people living in Michigan were producing any pottery. In the Middle Woodland, particularly in southwest Michigan, the intrusion of Hopewell people and ideas disrupted and influenced the local people. During the early Late Woodland, the movement of people and trade items declined for hundreds of years and it is not until after A.D. 1300 that these activities significantly pick up again.

Allegan Ware from the Fennville site was radiocarbon dated to the early Late Woodland (ca. A.D. 700) and the same pottery type found at the 46th Street site was dated to the end of the middle Late Woodland (ca. A.D. 1200) (Rogers 1971). This temporal length of continuity in ceramics in southwest Michigan alone would be suggestive of an in situ formation and development of a local social and ceramic tradition, but the ceramic similarities across most of southern lower Michigan (e.g., the relatedness of Allegan, Spring Creek, and Wayne Wares) further support this conclusion. Radiocarbon dates at Dieffenderfer range from A.D. 1000-1400 and therefore correlate with a period of significant change in Michigan. Having demonstrated that Allegan Ware is most likely a locally produced type of pottery, it is prudent to compare Dieffenderfer Ware (which appears to be produced by non-local people) and address the social agency that these two pottery types evince.

But first, one must describe what it means to conduct research that investigates social agency. In this study, I have utilized a concept of social agency borrowed from Dobres (2000). This includes incorporating Sackett's ideas concerning isochrestic variation, the *chaine operatoire* model and practice theory. This paradigm had not been adequately explored during research on archaeological assemblages from Michigan, but holds great potential for elucidating the past.

CHAPTER III

ARCHAEOLOGICAL AND SOCIAL THEORY

Archaeologists use theory to construct statements about fragmented and partial evidence (Hodder 1992b: 5). There are numerous facets of archaeological theory that are currently being employed by contemporary researchers and the type of theory one employs will significantly influence the subsequent research carried out (Cowgill 2000: 59). Theory drives all aspects of archaeological thought, whether one is aware of it or not, as data and even observations are theory-laden (Arnold 1985; Shennan 1989b). Theory is not something a researcher can hide behind (Hodder 1991), but rather it creates a framework for archaeologists to approach their research agenda as well as for interested readers to understand the research goals.

This analysis will employ many different theoretical perspectives, but collectively they may all be called "interpretive" (See Hodder 1991; Shanks and Hodder 1998). Specifically, this research will examine alternative approaches for assessing technology and style, operationalize the *chaine operatoire* model and utilize practice theory and agency. These will be used in conjunction to contextualize the social agency of the producers of Dieffenderfer Ware and Allegan Ware.

The goal of this theoretical perspective is to assess the habitual and mundane actions that correspond with cultural practices. The link between "technologies as acts of material transformation and technologies as acts of social transformations" has yet to be adequately explored (Dobres 1999b: 128). Technical action corresponds with social action and therefore represents social agency (Sinclair 2000). Social agency and the context-specific nature of social relations must be specifically addressed if the anthropological dynamics of technology are to be understood (Dobres and Hoffman 1994). These are the theoretical issues to be addressed in this research.

Technology

Technology has been viewed in many different ways. It is often considered a boundary between people and things; however, this boundary is artificial and has compromised technological studies (Dobres 2000; Ingold 1999). Technology is more than just materials and production processes because people construct more than mere objects through practices that are reflexively constructed and reconstructed (Dobres and Hoffman 1994; Hoffman and Dobres 1999). People simultaneously construct social relations that are made meaningful only through their interaction with others.

An overly materialistic theory of technology has produced numerous problems. For example, adverse effects on research methodologies and an emphasis on practical reason instead of cultural reason, the separation of the physical world from the social world, including past decision-making strategies, "and privileging the tangible aspects of technoeconomic rationality over its supposedly intangible sociosymbolic dimensions for the sake of 'methodological rigor'" have limited archaeological theory and practice to various degrees (Dobres 2000: 38). Views of the world are taken *in* technology through practices; they are not representations *of* it (original emphasis) (Ingold 1999: xi). Conceptualizing technical action as the mechanical implementation of a preconceived design, effectively forces an unnecessary division between knowledge and practice (Ingold 1999). The effects of these methodologies have severely limited the range of factors considered in archaeological explanations (Dobres 2000).

All material culture represents technology, which is composed of learned technical gestures and knowledge that tacitly express identities like ethnicity, gender, age, belief, and class (Sinclair 2000). Technology is also politically and symbolically charged and is central to human existence and the way human beings experience and make sense of their world (Dobres and Hoffman 1999). It needs to be situated in the performative contexts of its use by skilled human agents if its meaning is to be properly understood (i.e., an artifact's morphology or use-wear cannot be examined in isolation from its relationship to social interactions) (Ingold 1999). Technology is materially grounded, but an inherently social phenomenon that extends beyond hardware and represents "social activities made meaningful and enacted through social agency" (Dobres and Hoffman 1994: 247; Hoffman and Dobres 1999). Technology is meaningless without addressing the people that interacted with it. Generally, it also exhibits style (Lechtman 1977), but how that style is interpreted has been the subject of debate.

Style in Archaeology

Style has proven itself difficult to define even though "most archaeologists think they know what they mean by the term" (Hegmon 1998: 265). It has often been referred to as the elusive, controversial, and proverbial "black box" because of its ambiguous meaning (Conkey and Hastorf 1990b: 1; Dobres 2000). However, it is an unavoidable topic because there is nothing to interpret or discuss in archaeology without addressing style (Conkey and Hastorf 1990b). Style, for now, may be considered a means of communication through an individual event in a general "way of doing" (Conkey 1990: 10; Hodder 1990: 45; Wiessner 1990: 106). All human actions are performed with and exhibit style.

There are many different ways to approach stylistic analyses and how they relate to material culture. What does style mean? Where does style reside (Sackett 1982)? Should style be considered as active (see Hodder 1982; Wiessner 1990; Wobst 1977) or passive (see Chilton 1998; Sackett 1982, 1990)? It seems hard to imagine a single, general, comprehensive theory of style (Conkey and Hastorf 1990b; Hegmon 1998). Regardless, "style *does* something" and can be studied at different levels including the individual, group, or society (original emphasis) (Hegmon 1998: 265; see Conkey and Hastorf 1990b). It is clear that style has been thought of in many different ways.

New Archaeologists and Anglophone archaeologists have attempted to deal with the social dimension of material culture by separating variability into three discrete realms: technology, function, and style (Binford 1965; Braun 1983; Dietler and Herbich 1998; Stark 1998b). Technology was defined as raw materials and production steps; function became associated with utilitarian or instrumental purposes; and style was viewed as a kind of residual quality, whose primary function was emblematic, selectively neutral, or even epiphenomenal (Stark 1998b). Analytic priority was often given to the search for attributes of formal variation (e.g., non-functional attributes such as painted designs on ceramics), which became archaeological correlates of past societies or behavior (Conkey 1990). Style was thought of as relating to a cultural subsystem, and methodologies could be derived so that archaeologists "could 'know' prehistoric social life" (Conkey 1990:10). Many researchers have rejected this dichotomy and have emphasized a need to weld technology, function, and style together if artifacts are to be holistically understood (Chilton 1998; Dietler and Herbich 1998; Dobres 2000; Gosselain 1998; Ingold 1999; Sackett 1982, 1990; Stark 1998b).

In order to achieve a social understanding of material culture, an integrated view assessing technical, formal, and decorative aspects should be studied in dynamic juxtaposition to each other (Dietler and Herbich 1998; Sackett 1982). Typology and function have often been the focus of technological studies because they have been considered more accessible, but Gosselain (1998: 81) suggests that since very little is known about stresses (e.g., mechanical or cultural) acting on ceramics in traditional contexts, concepts of "mechanical" or "functional" fitness are perhaps just as tenuous as other interpretative exercises concerning past societies. So, an overemphasis on any of these aspects will hinder a broader understanding of material meanings, particularly those regarding ceramics (Chilton 1998). There is no prescribed avenue of research that can be identified as critical to technological studies, but it is clear that a balance between style and function is necessary.

Ethnoarchaeology has provided numerous insights concerning technology, particularly the interrelationship between style and function in social settings (e.g., Dietler and Herbich 1998; Gosselain 1998; Hodder 1982; Lemmonnier 1986; Sackett 1982; Stanislawski 1978). Research among traditional cultures has demonstrated that style is neither simply decoration, nor are technical choices governed by environmental pressures (Stark 1998b). Decoration is highly variable in relation to other physical attributes (Dietler and Herbich 1998). Ethnoarchaeological analyses have proven that artifacts should not be treated as things in themselves, or as individual works of art; rather, they are intrinsically related to specific social systems and specific types of behavior (Stanislawski 1978). Most importantly, ethnoarchaeology has verified that similar aims can always be reached in different ways, and the choices involved during production and use proceed from the social contexts in which people learn and practice their crafts (Gosselain 1998: 81).

Technology and the operational sequences that produce it are part of a society's structure or *habitus* (Bourdieu 1977; Hegmon 1998), and style is not separate from the social contexts that give cultural materials their social values (Conkey and Hastorf 1990b). As Dobres and Hoffman (1994:2) note:

> ...Technological practice, politics, and world views are inseparable facets of a universal and age-old human activity, one that no longer can be defined on the basis of materiality and functionality, or understood primarily as an economic pragmatic or rational *logos*... technology is a pervasive and powerful complex of mutually reinforcing socio-material practices structured by self- and group-interests, expressions of agency, identity and affiliation, cultural ways of comprehending and acting on the world, practical and esoteric knowledge, symbolic representations, and skill. These dynamics come together to create meaningful arenas in which humans simultaneously engage with each other and with the material world.

Therefore, it follows that concepts of technology, function, and style are intrinsically interrelated and their separation serves to mask the inherent social relations of material culture (Dobres 2000). Assuming that stylistic attributes must be social characteristics simply because they are left over after utilitarian performance, context of use, and technical constraints are considered, provides an unsatisfactorily narrow focus (Dietler and Herbich 1998). Style is not simply added on, to perform either some social function or as a passive residue of social action (Dietler and Herbich 1998). So, how can style and function be integrated into technological research projects? Sackett's (1977, 1982, 1990) "isochrestic" approach is a potential model.

Sackett's research (1977, 1982, 1990) has significantly influenced stylistic studies on material culture. Of course, decoration (i.e., *adjunct* form or variation that is added on [e.g., an incised line on a ceramic vessel]) is a particularly rich source of style, as compared to the utilitarian (i.e., *instrumental* form [e.g., vessel shape]) form, which is influenced by techno-economic constraints (Sackett 1990). "Nonetheless, the instrumental form that is built in, rather than added on, to the pot is also a great reservoir of style" because every stage in the operational chain of production is a locus of stylistic expression (author's emphasis) (Sackett 1990: 33; see Gosselain 1998). In other words, individuals procure, prepare, form, decorate, fire, use, re-use and discard pottery in different ways. Variation in these ways represents style.

Although instrumental forms may be considered less "style-rich" than decoration, variation still exists, but to a narrower degree (Sackett 1990). There is an extremely broad range of options (i.e., a spectrum of equivalent alternatives) to choose from during the various stages of ceramic production, and Sackett (1990) suggests that the likelihood of unrelated groups making similar combinations of choices is as remote as the number of potential options is great (see Dietler and Herbich 1998; Wobst 2000: 45). When stylistic analyses examine numerous characteristics where isochrestic variation exists, often patterns emerge that likely correlate with social groups because the patterns of variation presumably reflect learned behavior (Goodby 1998; Hegmon 1998). Micro-styles exhibit a set of learned dispositions guided by perceptions of an acceptable range of variation in choices during the different stages of an artifact's "life" (Dietler and Herbich 1998; Goodby 1998; Hegmon 1998).

The meaning of the term style is changing from primarily designating decoration to including a broad range of isochrestic variation in instrumental form that may be referred to as technical style. Just as adjunct form is often considered to correlate with social groups, so can instrumental form (perhaps more accurately). Because the physical properties of natural materials are unchanging, variations in the ways practitioners manage these materials reflect cultural choices (Lechtman 1993). Also, decoration like a pattern of incised lines on pottery is relatively easy to alter, but how one *makes* a pot is much more difficult to change. Stylistic variation is the product of numerous technical and cultural choices. Inferring these choices from the archaeological record has been successfully achieved by operationalizing the *chaine operatoire* model.

The *Chaine Operatoire* Model

The *chaine operatoire* model attempts to understand the sequence of events an artifact goes through from resource procurement, through construction, use, re-use, discard as well as the decision-making strategies of raw material transformations (Dietler and Herbich 1998; Dobres 1999a, 1999b, 2000; Dobres and Hoffman 1994;

Edmonds 1990; Sellet 1993; Sillar and Tite 2000; Stark 1998b). During this series of events, numerous technical choices are made concerning not only raw materials and design styles, but conscious and unconscious elements of technological style (see Figure 3.1) (Sillar and Tite 2000; Stark 1998b). This technique allows one to view the production of style as a temporally extended series of interrelated operational choices rather than as an instantaneous act of creation (Dietler and Herbich 1998). The operational sequences of technology are more important than the final product

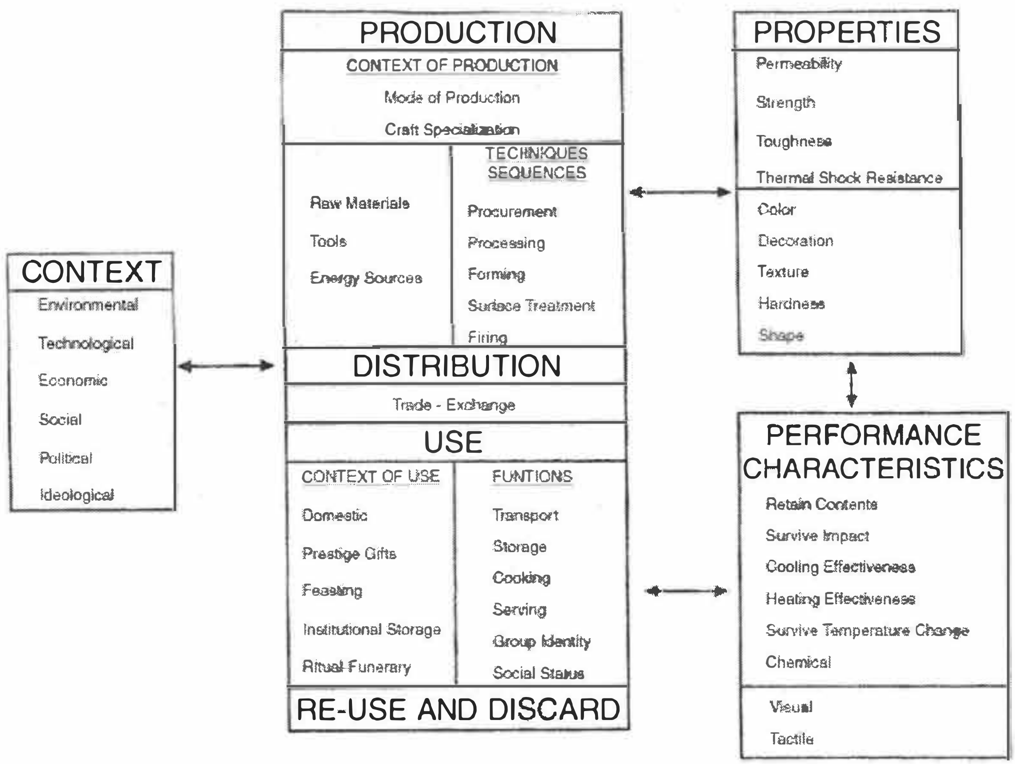


Figure 3.1 Diagram Highlighting Factors Affecting Technological Choices Made in Pottery Production (after Sillar and Kite 2000: Figure 1).

(Lemonnier 1986, 1992). Examining how material acts were differentially pursued by technicians can help archaeologists consider the dynamic social milieus and artifice that produced them (Dobres 1999b).

The concept of technical choices is an essential aspect of *chaine operatoire* research. Lemonnier (1986), in his ethnoarchaeological research among the Anga, found that various solutions to similar problems were developed by neighboring groups who were aware of each other's technological preferences. This emphasizes the importance of choices, intentionality and how those choices are often linked to group identity (Hegmon 1998; Hodder 2000; Lemonnier 1986). Raw materials and design styles are only a few of the technical choices that are critical to the outcome of a product (Stark 1998b). There are numerous other choices concerning a product's construction and use that are identifiable such as function, transportability, and durability.

However, artifacts, agents and their thoughts and actions (e.g., mental templates, technical actions, and technogestures [Dobres 1999b]), and social relations do not occur in isolation from each other. Dobres (2000: 169) emphasizes that physical activities (e.g., artifact production and use) are always and everywhere socially embedded (see also, Dietler and Herbich 1998: 253; Dobres and Hoffman 1994: 213; Dobres and Robb 2000b: 4; Phaffenberger 1999). This concept stems from Ingold's (1993: 342) suggestion that techniques are the "embodied skills of human agents" and they are also the mediating process between material culture and society (Dietler and Herbich 1998). Tangible and intangible dimensions of technological practice can be assessed by regarding techniques as gestures performed in a "public" domain (Dobres 1999b: 129). Artifact production, therefore, takes place in a type of theater, if you will (Pfaffenberger 1999: 160).

> An ethnographer soon learns that seemingly minor gestures, postures, and motor habits are very much the product of socialization within a given ethnic setting, and indeed may be particularly diagnostic of their setting precisely because they are performed in an essentially un-self-conscious manner (Sackett 1982: 106).

Technology is produced by a series of technogestures, which represent a link between artifacts and the social contexts that produced them.

Techniques, including their tangible remains (e.g., artifact variability) and intangible remains (e.g., technogestures), are essential to inferring the social relations of different technicians. The analytical and methodological distinction between things and techniques has often been ignored and hampers an understanding of the significance of material culture (Dietler and Herbich 1998). Techniques are not secondary products of social activity (Dietler and Herbich 1998). Rather, technology exhibits a suite of technical gestures and knowledge that is produced and reproduced by dispositions that generate actions through social practices that often act as a medium for defining, negotiating, and expressing individual and group identity (Dietler and Herbich 1998; Dobres 1999b; Sinclair 2000). Material style can be indicative of social roles and material meanings only if it is seen as the objectified result of techniques (as opposed to straightforward objectified information) that are formed through the *habitus* (i.e., techniques are typically passed down through kin relations and are therefore inherently related to social identity) (Dietler and Herbich 1998). The analytic methods of *chaine operatoire* research link the archaeological record, comprised of static, yet tangible remains of ancient technogestures, to the dynamic social milieus in which they were practiced (Dobres 1999b). Techniques actually form a system because technogestures are the locus of multiple relations of interdependence (Lemonnier 1986). "Artifacts are embedded in and conditioned by social relations and cultural practice" (Dietler and Herbich 1998: 253). Technogestures are an inherently social display exhibiting learned behaviors that are observed best in material culture via *chaine operatoire* analysis.

The *chaine operatoire* model examines stylistic variation in instrumental and adjunct forms in order to assess sequences of technical choices made during an artifact's life cycle (i.e., from procurement to discard). These sequences often correlate with group identities because of the relationship between different techniques (or gestures) used to produce different artifacts and their associations with learned behavior. Material culture should be considered a social phenomenon, produced and used as social activities (Dietler and Herbich 1998). Using the empirically grounded *chaine operatoire* in correspondence with a social agency perspective best creates the possibility of identifying the relationships between "on-the-ground material practices" and the dynamic social processes that created them instead of attributing identities as an afterthought (Dobres 2000: 186). The *chaine operatoire* model examines the practices of individuals occurring within a social context. This avenue of research is inherently related to and greatly augmented by the theoretic advances made in practice theory and agency.

Practice Theory and Agency

The link between complex social theory and the archaeological record is neither obvious nor direct, but neither is the link between social boundaries and material culture (Hegmon 1998). In order to aid a conceptualization of the complexity of social processes and their relationships to material culture, archaeologists would be well served by current social theories including practice theory (Hegmon 1998). Dealing with individual and group interactions and exploring the continuity and change of social structures can benefit from the use of practice theory (Bourdieu 1977, Dobres and Hoffman 1994; Giddens 1984; Ortner 1984).

What is practice theory? Dobres and Hoffman (1994:223) make four primary statements concerning the principles of practice theory: 1) the social collective is comprised of individuals and small-scale groups that interact in different ways at different times that require different solutions; 2) the normative aspects of a cultural "system" are a set of background meaning-structures, or *habitus*, in which social interactions are conducted; 3) "Although both practice theory and optimal foraging theory envision humans as able thinkers and strategizers, the former extends the range of factors that agents confront when making decisions;" and 4) "agents make *culturally reasoned* choices" (see Lemonnier 1986; Wobst 2000: 45). Practice theory is not a call to identify "real" individuals in the past; it is about investigating the mutual transformation of agents and artifacts through meaningful practice (Dobres 2000; Sillar and Tite 2000).

In practice theory, social structures (e.g., cultural traditions and social collectives) are the normative rules as well as the social and material resources available to agents and groups (Dobres and Hoffman 1994). These structures both enable and constrain social possibilities, and this "duality of patterning" relates to social action and "structuration" (i.e., the making and remaking of structures) (Dobres and Hoffman 1994; Giddens 1984). Structuration occurs through agents "insofar as they have the power to recursively create and alter structure or tradition through action" (Sassaman 2000: 149). These social structures, also known as the *habitus*, are not static due to the "generative principle of regulated improvisations" (i.e., people do not always do what they are supposed to), even though the socially constituted structures operate outside the "free will" of individuals (Bourdieu 1977: 78; Dietler and Herbich 1998; Dobres and Hoffman 1994: 222). There is a dialectic relationship between structure and agency, what Giddens (1984:25) terms the "duality of structures," which is a property of all human existence that should not be analytically separated during research concerning agency (Barrett 2000; Dobres and Robb 2000b; Johnson 2000; Joyce 2000; Moore 2000; Sassaman 2000).

Modern views on exactly what agency is, are diverse and apparently sometimes misunderstood. Agency is also not a call to locate and study specific individuals in the archaeological record; rather, it is an emphasis at the theoretical level to move away from behavioral and deterministic perspectives (Barrett 2000; Bell 1992; Hodder 2000; Sassaman 2000; Sillar and Tite 2000). Agency is less a tool than a pradigm; it is more of a worldview or theoretical pair of "glasses" to be used when looking at artifacts (Bell 1992; Cowgill 2000; Dobres 1999a: 20). Agency theory examines the Giddensian concepts of structuration and duality of patterning, and suggests that individual "actions are in relation *to* circumstances (but not mechanically determined by circumstances) which in turn have effects on circumstances (though not usually not large effects)" (original emphasis) (Cowgill

2000: 51). Agency is a socially significant *quality of action* rather than being simply reduced to *action itself* (author's emphasis) (Dobres and Robb 2000b: 8).

Social agents should not be viewed as omniscient, practical, and free-willed economizers, but as socially embedded, imperfect, and sometimes impractical people (Dobres and Robb 2000b). Actions express the capabilities of agents, and the consequences of those actions range from intended to unintended (Barrett 2000; Bell 1992). However, we should be careful not to consider agents to be over-active, over-interventionist and over-creative (Moore 2000). Research examining all the complexities of daily life "render past actors more believable and supply accounts of the past that are more true, relevant, and interesting" (Brumfiel 2000: 255). Social agency is not tacked on to the end if the data is "rich" enough; rather, it should be addressed from the very beginning of a research project and stated as a primary research goal (Dobres 1999a).

So how can an agency perspective be employed during archaeological research? While attempting to understand the meaning of archaeological materials, artifacts should not be considered an authored statement of some past individual, which it is our task to understand (i.e., there were always multiple meanings that were structurally nested within each other [see Lemonnier 1986; Shanks and Hodder 1998]) (Barrett 2000). Agency theorists expect to see microscale variation (i.e., the fine details) between people in different social contexts (Sassaman 2000). Agency (i.e., the actions of agents) is exhibited in material culture variation that is produced by active individuals within non-deterministic (or simultaneously enabling and constraining) social and environmental contexts.

Interpretive archaeology is often accused of ignoring data and expanding the distance between theory and data. However, solid, empirical data are vital to agent-centered prehistory (Sassaman 2000). The concept of agency should not be reified by a definition that creates abstractions; in other words, agency should be thought of as historically situated (Barrett 2000; Hegmon 1998; Johnson 2000). "Agency is not anti-science," but its methodologies cannot be codified and should be context-specific (Johnson 2000; Preucel 1991; Sassaman 2000: 164). Agency is an archaeological concept that has been effectively put to use (see the recent contributions in Dobres and Robb [2000a]). Archaeological interpretation must be based on empirical data, but how that data is collected, analyzed, and interpreted is structured by the theoretical orientation of the researcher.

Social theory is often overlooked during archaeological research. However, it can provide augmentative analytical insights into the relationships between individuals, groups, social rules, ecological adaptations, and technology in a similar way that ethnoarchaeology and experimental archaeology provide practical analogues. Practice theory and agency are often used in correspondence with *chaine operatoire* research because the latter examines technical actions and decision-making processes exhibited in the variation of material culture, which can essentially be thought of as agency. A dialectic relationship links agency to (social) structure(s). Thus, the importance of practice theory becomes apparent when attempting to understand the latter. Social archaeologists are interested in how societies are produced, reproduced, and transformed (Nassaney 2002) and therefore, research utilizing these theoretical and methodological approaches are important.

Why These Theoretical Approaches are Applicable to Michigan Archaeology

Social theories, like practice theory and agency, are generally not directly applicable to material culture; but they provide archaeologists with important insights into the processes of social change Structuration undoubtedly occurred in prehistory, regardless of the degree of social complexity. Hunter-gatherers are not a homogeneous group of people with inevitable, equivalent lifeways and "are not exempt from an existence shaped by agents" (Sassaman 2000: 164). There is an important link between theory and method, and in the case of this research it is the *chaine operatoire*.

The *chaine operatoire* is designed to identify variation, particularly at the microscale, in order to understand agential actions and the social processes of hunter-gatherers. At this scale, fundamental social, material, and antecedent contexts within which technologies are created and used, acquire their social value (Dobres and Hoffman 1999). This perspective highlights the actions of individuals within heterogeneous social communities where "production was a meaningful and socially negotiated set of material-based *practices*" (original emphasis) (Dobres and Hoffman 1994: 213). Microscale analyses are an important *complement* to macroscale perspectives (e.g., regional studies examining ecological conditions and evolutionary processes) because they provides insights into interpersonal arenas (author's emphasis) (Dobres and Hoffman 1999).

Research in Great Lakes archaeology has been dominated by macroscale analyses conducted within Culture History and Processual paradigms (e.g., Brashler

1978; Fitting 1965, 1970; Fitting et al. 1963; Griffin 1961 [ed.]; Griffin et al. 1970; Halsey 1999 [ed.]; Hinsdale 1925; Holman et al. 1996 [ed.]; Krakker 1983; Luedke 1976; White et al. 1963). Multiscalar archaeology (i.e., both microscale and macroscale) is not an emphasis on one more than another, but rather provides a dialectical relationship that creates a hermeneutic circle (or spiral, see Hodder 1986) between part and whole, micro- and macro-, context and content, site and region, and individual and group. Practice theory and agency are appealing theoretical frameworks because they are useful for reexamining old data in a new light (Cowgill 2000; Sassaman 2000). The social implications evident at Dieffenderfer necessitate a theoretical move away from ecological, behavioral, adaptive, descriptive, and culture-history models. The microscalar complement to Great Lakes archaeology is currently absent, but not because it is unfeasible.

The dialectic relationship between agents and groups is an important source of social change in any society, including hunter-gatherers during the Late Woodland in southwest Michigan. Societies with similar social structures generate similar goals, tensions and struggles (Brumfiel 2000). No analysis should exclude these struggles and how they were negotiated by individuals operating in particular social and ecological contexts (Brumfiel 2000). It is not enough that say that all hunter-gatherers dealt with problems in a similar fashion just because they are geographically and temporally similar. "The structures of egalitarianism are asserted, not inevitable" (Sassaman 2000: 164). For example, a potter makes numerous choices and compromises according to various personal, social, and technological criteria (Chilton 1998). Variation in material culture most likely relates to variation in nested structures, which begs to be interpreted. It is our job, as social archaeologists, to identify the structures, choices, and compromises that are exhibited in material culture variation.

Using concepts like isochrestic variation, operationalizing the *chaine operatoire*, and incorporating practice theory allow for research addressing social agency to become viable (even the social agency of hunter-gatherers living in southwest Michigan during the Late Woodland). Research like that just described, has been successfully carried out by archaeologists in other parts of the world (e.g., Chilton 1996, 1998; Dietler and Herbich 1998; Dobres 1999a; 2000). These studies examine similar types of data sets compared to those found in Michigan and suggest that studies of this interpretive nature can be carried out here as well. There are no "ready-made formulae nor methodological short-cuts" for identifying social agency, but the different kinds of formal variation taken into account should be broad (Sackett 1982, 1990: 42). The criteria that identified Dieffenderfer Ware as unique included many characteristics, but also excluded many. Theory-driven methodologies that treat people "as if they matter" is the only way to research social agency because one cannot use methodologies structured to answer other questions and then simply "add people and stir" (Dobres 1999a: 23).

Summary

Archaeological research is never without theory, and a wide range of theories is currently being used in contemporary archaeology. The type of theory a researcher employs will significantly affect the type of research as well as the conclusions. The theoretical frameworks used in Michigan archaeology have almost exclusively revolved around ecological, adaptive, and typological frameworks. As useful as they have proven to be, I intend to apply a different approach.

It begins with an alternative understanding of the meaning of style (i.e., where does style reside? [Sackett 1982]). Sackett's (1977, 1982, 1990) isochrestic approach suggests that style is more than decoration or something that is simply added on after its functional characteristics have already been formed. Although decoration is a rich source of style (known as adjunct style), the morphological and functional aspects also exhibit a type of style (known as instrumental style). This approach is a departure from traditional ones, which suggested that the social dimensions of technology could best be understood by separating function and style. However, this view has been vigorously opposed. People do not act as symbolists and materialists separately (i.e., an action is the product of both a mental decision as well as physical movement) and the production of meaning inherent in actions *is* practice (original emphasis) (Conkey 1990). Conkey (1990: 22) goes so far as to say that "material culture is not derivative nor merely reflective of ideology, it *is* ideology." Material culture and its production are always and everywhere socially embedded (Dobres 2000). The way an artifact is manufactured, used, and discarded each imparts a style that is identifiable by archaeologists.

An appropriate model for understanding this broad view of style is the *chaine operatoire*. This model examines an artifact's life history by detailing ascertainable information on resource procurement, numerous stages in the manufacturing process, evidence of use and re-use, and discard. It is based on the concept of intentionality (i.e., material culture is produced for specific reasons and patterned variation is not random or accidental). Agents are making conscious decisions and social relationships (similarities or differences) can best be understood with a broad view of style and the *chaine operatoire* model.

The social relations inherent in technology are exhibited in, and the result of, techniques and gestures performed in social settings. Production and reproduction of the skills necessary to carry out technical gestures are typically passed intra-family. Techniques are a mediating action between objects and society, and variation in material culture correlate with various techniques, which can compositely be thought of as practice (Dietler and Herbich 1998). Practices reproduce and transform socio-economic structures as they adjust to demands and therefore social theories like practice theory and agency are incorporated into *chaine operatoire* research (Dietler and Herbich 1998; Dobres and Hoffman 1994).

Practice theory is a framework that suggests individuals (i.e., agents) are enabled and constrained by the socioeconomic structures that are produced, reproduced and transformed by social interactions in a process called structuration. The cultural rules that guide (not determine) an agent's behavior, are called the *habitus* (see Bourdieu 1977). Materials also structure everyday life and are a key aspect of the *habitus* because they play an important role in defining who people are socially (Hegmon 1998). The dialectic relationship between structure and agency is the critical link between theory and practice because the processes of agency are visible in the archaeological record. The types of materials and the techniques used to create a particular tool exhibit a range of factors that expose the decisions of a past technician (Sinclair 2000: 196). Agency is not the identification of specific persons, but rather variations in material culture (e.g., in ceramics) are examples of how different agents pursued different strategies or used different techniques to reach specific ends.

Chaine operatoire research balances theory and practice well. Concerning the latter, if one concentrates too strongly on technology or function, one risks objectifying or reifying practice and turning it into an object separate from human agency (Ingold 1993, as cited in Hegmon 1998). Concerning the former, one should not simply use new and "stylish" words to describe old concepts (e.g., the *habitus* is not the same as culture and agency is not the behavior of an individual in an optimality model) (Hegmon 1998: 269-270). *Chaine operatoire* research incorporates an array of theoretical concepts and provides a practical outline for collecting data from material culture.

In conclusion, utilizing an alternative understanding of style and technology legitimizes *chaine operatoire* research. *Chaine operatoire* research emphasizes the intentionality of agents and their dialectic relationship to structure. Hence, practice theory can be very insightful for archaeologists. However, the simplicity of this description should not mask the complexities inherent in this type of research. Conkey and Hastorf (1990: 3) maintain that stylistic studies must remain flexible *and* problematic and considering that archaeological analyses of style are an interpretive quest at best, "our interpretations should include the recognition that ambiguity and contradictions are central features of both social life and the archaeological record" (Goodby 1998:181). Hodder (1990: 50) suggests that stylistic studies should include a rejection of "objective," quantitative and descriptive approaches and that archaeologists should not assume that "a" style has "a" meaning. Stylistic variation can be found in all stages of artifact production and use and all aspects of that variation are inherently related to the social, economic, and ideological contexts that produced it.

The types of theories one uses significantly affects what one thinks when they look at artifacts, what types of questions will be asked of the archaeological record, what types of data will be collected, and how it will be interpreted. Theory should not be isolated from other dimensions in a research project and it also does not tell a researcher how to collect data. The relationship between theory and method should be a dialectic one which repeatedly inform each other as research advances in a hermeneutic spiral. Theory is an important aspect of archaeological research, but only in relation to practice.

CHAPTER IV

METHODOLOGY

Methods bridge the gap between the theory and the artifact (i.e., methods are how theory is operationalized in practice). They also create data, which is subsequently interpreted. However, there are a limited number of methods that an archaeologist can potentially utilize, thus suggesting that data is interpreted through the theoretical lenses the archaeologist wears (Dobres 1995). The research methods for interpreting the social agency of the producers of Dieffenderfer Ware are derived from the *chaine operatoire* model.

The *chaine operatoire* seeks to understand the life-histories of artifacts (i.e., it seeks to identify as many stages of an artifact's life as possible) by assuming that stylistic similarities or differences represent choices made by agents within enabling and constraining socio-economical environments. Ceramics are an additive technology, which means that numerous events and technogestures were enacted to produce and use them (Chilton 1996). I intend to compare rim sherds from two different pottery types found in southwest Michigan and document four stages of their operational sequences (or chains) via numerous methods. The four stages include resource procurement, vessel construction, use, and discard. The methods will include proton-induced X-ray emission (PIXE), thin-sectioning, petrographic analysis, grain size analysis, measurements and assessments of various physical attributes, and contextual analysis.

Resource Procurement

Two methods were used to relatively assess where the clays were procured from and if preferences for certain types of clays or inclusions exists. Clays, like those found in Michigan, are derived from glacial deposits and are notoriously difficult to source because there is more variation within clay localities than between them (Chilton 1998; Rice 1987: 419). It is also exceedingly difficult to differentiate between temper (material that is added by the potter) and natural inclusions (Arnold 1985; Chilton 1998; Rice 1987; Rye 1981). An examination of inclusions will also be investigated for insights into resource procurement, but this stage of the *chaine operatoire* is mainly an examination of paste. PIXE analysis and petrographic analysis from thin-sections were used to accomplish this.

PIXE analysis was conducted at the van de Graaff accelerator on Western Michigan University's campus. Protons are accelerated and focused into a particle beam aimed at the specimen. When the pottery is bombarded, it emits X-rays, which are detected and deciphered (Pollard and Heron 1996). PIXE has been used to identify major, minor, and trace amounts of elements over the atomic number 13 (Barclay 2001; Pollard and Heron 1996; Rice 1987). The benefits of PIXE analysis included: inexpensive to operate ($80.00); low amounts of time and labor (5 hours to analyze 42 sherds); and nondestructive. The most significant constraints concerned artifact size: sherds larger than 5 cm or ones that are excessively curved could not be used.

Sixteen sherds of Dieffenderfer Ware, sixteen sherds of Allegan Ware (from the Dieffenderfer and Fennville sites), four Mississippian and Hopewellian sherds, and six Plum Bayou sherds from Arkansas were subjected to PIXE analysis. The Mississippian, Hopewellian, and especially the Arkansas pottery, were "run" to determine what non-local pottery looks like and to verify that their PIXE "signatures" were different. The goal of this analysis is not to source the clays to a specific locality, but to determine degrees of similarity or difference through the use of statistics. In other words, were there preferences for particular types of clay? Is there significant intra-type variation?

PIXE and petrographic analyses examine different types of data and are complementary analytic techniques (Riley et al. 1994; Stoltman 1989). The former identifies chemical elements and the latter identifies minerals. Petrographic analysis began with the thin-sectioning of a sample of 17 Dieffenderfer Ware sherds and 16 Allegan Ware sherds. Only larger sherds were chosen due to the destructive nature of the technique. The Geology Department at WMU provided me with access to a rock saw, which I used to slice off a 5 cm x 3 cm x 1 cm chip from each sherd. These chips were each given a unique catalogue number, packaged, and sent to Spectrum Petrographics Inc. (see petrography.com) in Winston, Oregon for processing. There, they were attached to a glass slide, ground down to approximately .035 mm, and given a glass cover.

The type of petrographic analysis performed in this research was point counting (for an explanation of how and why petrographic analysis works, see Drake [2001]; Moorhouse [1959]; and Rice [1987]). It normally consists of systematically identifying minerals (under a polarized microscope) every 1 mm and recording between 100-200 points per thin section (Drake 2001; Stoltman 1989, 1991). Point counting, because it scrutinizes the clay matrix as well as larger inclusions, is an excellent tool for differentiating local and non-local pottery (Garrett 1982; Porter 1984; Pretola 2000; Riley et al. 1994; Stoltman 1991). The benefits of point counting include: a qualitative dimension to research, identification of specific mineral inclusions, and a record of amounts and sizes of inclusions. A drawback is sampling error (i.e., how representative is the thin section of the entire vessel), but Stoltman's (1989) research has suggested that a 95% level of precision is possible if counted properly. Thin sectioning is also a destructive process. Therefore, all of the macroscopic data, as well as a photographic record on 160T slide film, were collected before thin sectioning the specimens.

In practice, I found that counting every 1 mm caused me to "miss" the rocks and minerals I was interested in documenting. By using 100-200 points, according to Van der Plas and Tobi (1965), researchers can only obtain less than a ninety percent confidence level. Therefore, I narrowed the counting interval to 0.5 mm and counted an average of 900 points per sherd. It gave me a ninety-seven percent confidence level and sufficiently recorded the suites of heavy minerals found in the thin-sections. Each point was classified into one of thirteen categories: clay matrix, quartz, feldspars, plagioclase, olivine, hornblende, pyroxene, biotite, muscovite, chert, rock voids, non-rock voids, and unknown inclusions.

Vessel Construction

There are numerous operational stages within the broad category of vessel construction. They begin with the preparation of the clay (e.g., adding temper or sieving clay), how the pot is formed (e.g., coiled or slabbed), how the surface is treated, if and how a collar is added, how large the vessel orifice is, how the lip is formed, if and how the vessel is decorated, and if and how the vessel is fired. These physical attributes were assessed in order to identify as many stages (or techniques) as possible. Attributes included inclusion types, maximum inclusion size, inclusion density, average wall thickness, interior and exterior surface treatment, presence or absence of collars, collar thickness and height, presence or absence of castellations, rim and lip mode, and orifice diameter. Data collected during the point-count analysis will also be informative of vessel construction, particularly clay preparation. For example, average grain size may be indicative of sieving and porosity can be the result of numerous processes including organic content and wedging or kneading. The degree to which organics are present in low-fired, earthenware pottery is exhibited in core color (Rye 1981). Darkened cores are indicative of higher concentrations of organic material.

Grain size analysis and documentation of voids were assessed from the thin sectioned samples. The former was carried out separately from the point counting. Every mineral larger than 0.06 mm was classified into five different fractions: fine sand (0.06-0.24 mm); medium sand (0.25-.0.49 mm); coarse sand (0.5-0.99 mm); very coarse sand (1.0-2.0 mm); and gravel (>2.0 mm). Voids were recorded during the point counting. I was only able to confidently differentiate between rock and non-rock voids. There are numerous types of voids which can be indicative of organic content, firing conditions, and vessel use (see Rice 1987), but I could identify them and the number of counted points per void category would have been too small. Therefore, the percentage of non-rock void counts will be indicative of overall vessel porosity.

Intra-type variation in the petrographic data was also examined. High levels of intra-type variation in paste would suggest that vessels are produced sporadically in small numbers. This may also be the result of numerous potters or production locales, which would mean they had access to a variety of clays. Low levels of intra-type variation would suggest that numerous vessels are produced at one time from the same clay locality. Lower intra-type variation in vessel morphology might also suggest that more experienced potters created similar pots consistently. Therefore, the scale of production may also be inferred from intra-type variation.

Vessel Use

Vessel use can be interpreted directly (e.g., presence of sooting suggests cooking) or indirectly (e.g., thin-walls also suggest cooking) by assessing physical traits exhibited by the pottery (Rice 1987). Much of the data collected for vessel construction can also be used to infer vessel function. However, there are a limited number of usages for pottery. If whole or large portions of pots are available, vessel morphology can be quite suggestive of its intended function (e.g., see Hally 1986). But the artifacts in this study are only about five to fifteen cm^2 (with a few exceptions). Pottery, generally speaking, is meant to hold liquids either for cooking or storage (solid goods are more conveniently stored and transported in baskets [Chilton 1998]) (Arnold 1985; Rice 1987; Rye 1976). There are also choices concerning transportability and durability that may also be evident in ceramic attributes.

The pottery was examined for direct evidence of its use. All sherds were examined for sooting on the exterior of the vessel and food char on the interior. The former would be indicative of cooking over a fire and the latter may be indicative of food processing. The interiors were examined for abrasions that could occur during stirring or serving. However, there are other ways archaeologists can infer vessel use or function.

Potters create vessels to serve certain purposes. Pottery is a material manifestation of technical choices and gestures. Therefore, measurements of vessel morphology and other attributes reflect the socio-economic contexts that produced it. The significant measurements for vessel use will be wall thickness, orifice diameter, interior and exterior surface treatments, interior and exterior colors, and hardness. Thinner walls are more resistant to thermal shock but less durable and thicker walls are less resistant to thermal shock but more durable (Arnold 1985; Chilton 1996, 1998; Rice 1987; Rye 1976). Decorations, like punctations and incised lines, can also serve a functional purpose because they increase thermal conductivity (Arnold 1985; Chilton 1996, 1998; Rice 1987; Rye 1976). Cordmarking makes a vessel easier to hold to or carry; therefore, a lack of corkmarking would suggest a lesser need for vessel (and perhaps group) movement (Chilton 1996, 1998; Rice 1987). Orifice diameter is, under the circumstances, the best indicator of vessel size (Hally 1983a), which may also have implications for mobility. For example, smaller vessels are easier to transport. Vessel color is often the result of firing environment, temperature, and use (Hally 1983b; Mirti 1998; Rice 1987). Vessel hardness correlates with durability, which also relates to mobility (Chilton 1998). There are numerous ways to infer vessel function besides just direct evidence.

Data collected during the point-count analysis may also be informative of vessel use. High porosity increases resistance to thermal shock but decreases vessel durability. Low porosity obviously has the opposite effect. Different inclusion types have different thermal expansion rates, which either help or hinder a vessel's ability to withstand thermal shock (Rice 1987; Rye 1976). High inclusion density makes a vessel more durable but more likely to crack during cooking (Rice 1987).

Vessel Discard

The analysis of vessel discard will simply be an examination and comparison of artifact proveniences. Trends regarding inter-type and intra-site spatial relationships were examined for patterning. Inter-site relationships will also be examined. For example, are vessel proveniences at the Fennville and 46th Street sites similar (i.e., are they in close proximity to features? Are they dispersed across the site or are they concentrated together)? How do they compare to vessel proveniences at the Dieffenderfer site? What are the spatial relationships between Dieffenderfer

Ware and Allegan Ware at Dieffenderfer? Are they spatially discrete? Are they concentrated in certain areas of the site? Is Dieffenderfer Ware primarily found inside or outside structures? Do any of the inferences concerning vessel functions correlate with provenience?

Analysis Strategies

The data will be compiled, organized, visually displayed in tables and graphs, statistically analyzed, and subsequently interpreted. Microsoft Excel, SPSS, and Rock Works are the software packages used to quantify and display the data collected in this research. Statistical tests are quantifiable methods for determining the probability that two populations are really different (Madrigal 1998). T-tests are the most common analysis used in this research. When two samples are compared to each other in a t-test, a p-value is produced and p-values less than 0.05 suggest significant differences exist between two samples. Identifying significant statistical differences will be interpreted as the result of different technical, social, and economic choices. Each measurement and trait intrinsically carries functional and symbolic implications, which will provide insights into the lifestyles of the people that produced Dieffenderfer Ware and Allegan Ware.

Once methods, appropriate to the theoretical framework of a research project are determined, they can be employed to collect data to test one's hypothesis. This study utilizes numerous data collection procedures on a limited sample of artifacts. Therefore, it is important to present the data in an organized fashion.

CHAPTER V

RESULTS OF ANALYSIS

Multiple methodologies were used in this study in order to identify numerous stages of the *chaine operatoire*. Therefore, results from PIXE, morphological (or macroscale), and petrographic analyses have been organized in the same fashion as the last chapter (i.e., by stages of the *chaine operatoire*). Some data collected in an analysis often pertains to different stages of the *chaine operatoire*. For example, all the data from petrographic analysis will not be presented at once, but will be separated into its appropriate stage. All of the raw data is presented in Appendix B and all of the statistical and graphical displays are provided in this chapter. It cannot be overemphasized that patterns of similarities in this data reflect technical choices.

Resource Procurement

PIXE and petrographic analysis were used to assess relatively where clays were procured from and if preferences for particular inclusions (either found naturally within clays or intentionally added to them) are identifiable. In other words, are the makers of Dieffenderfer Ware using clays that appear indistinguishable from those used in Allegan Ware? Are there different inclusion types and densities? PIXE and petrographic analysis examine resource procurement from two different scales:

element and mineral constituents. However, the latter was far more successful than the former.

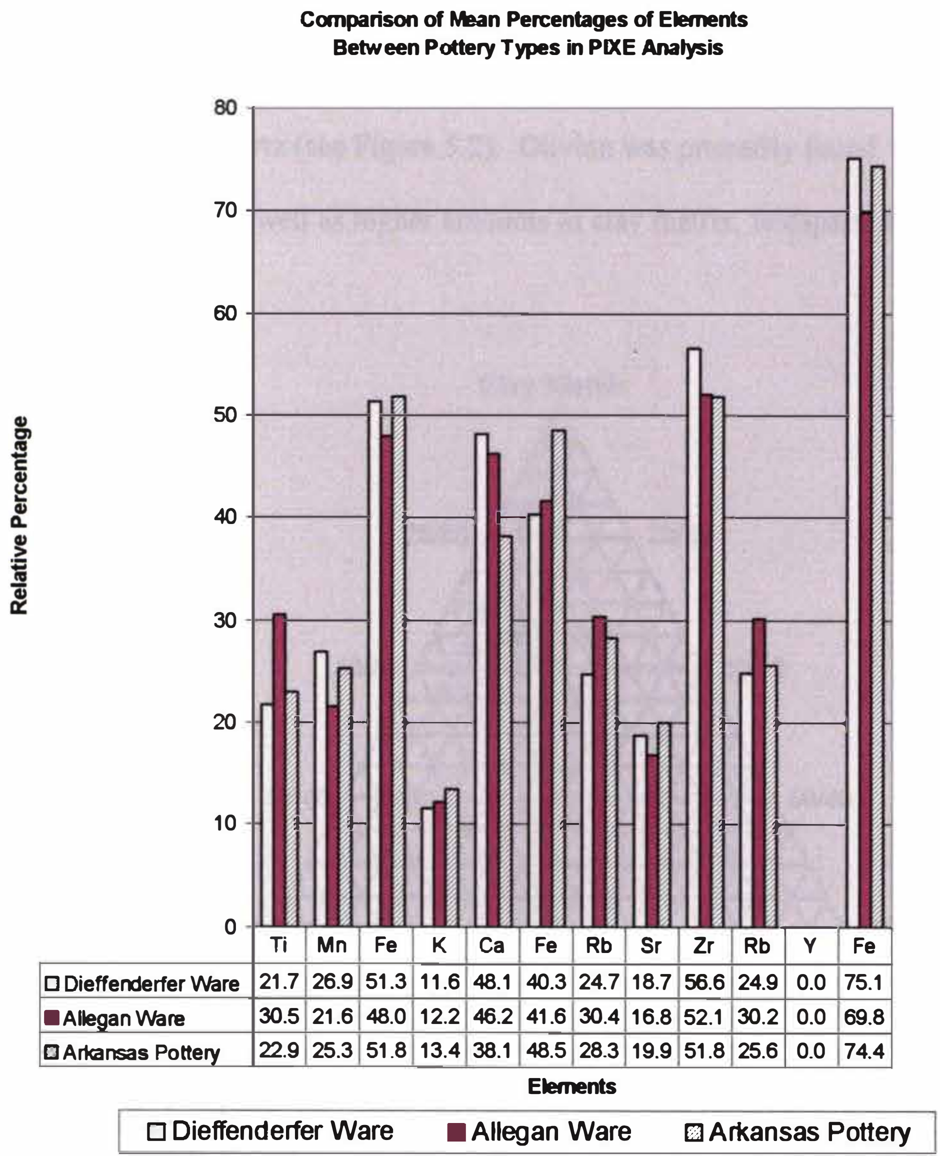
PIXE analysis, in theory, is capable of identifying major, minor, and trace amounts of elements over the atomic number 13 (Barclay 2001; Pollard and Heron 1996; Rice 1987), but at WMU, only four normalized ratios (see Table 5.1) of Titanium (Ti), Manganese (Mn), Iron (Fe), Potassium (K), Calcium (Ca), Rubidium (Rb), Strontium (Sr), Zirconium (Zr), and Yttrium (Y) were identifiable (i.e., only relative amounts of particular elements were identifiable [Ratio 1: Ti, Mn, Fe; Ratio 2: K, Ca, Fe; Ratio 3: Rb, Sr, Zr; Ratio 4: Rb, Y, Fe]). Because of the limitations in the types of data collected from WMU's van de Graaf accelerator, results obtained in the PIXE analysis proved to be insignificant. T-tests on three elements in Dieffenderfer Ware and Allegan Ware suggest some significant differences (e.g., Rb levels in Ratios 3 and 4 and Fe levels in Ratio 4) (see Table 5.1). But the pottery from Arkansas exhibited no significant differences from Michigan pottery, thus suggesting that this PIXE analysis is unable to accurately differentiate clays that come from vastly different locales (see Figure 5.1). PIXE, specifically at WMU, has been successfully used to identify variations in slip composition (e.g., Garrett 1980). The Arkansas pottery analyzed in this research exhibited significant differences between slipped and unslipped vessels. In theory, PIXE is an excellent complement to petrographic analysis and is capable of identifying trace elements which can differentiate local from non-local clays; but for this research, it did not provide any insightful information.

t-tests	TI	RATIO 1 MN	FE	K	RATIO 2 CA	FE
Dieffenderfer/Allegan	0.051	0.259	0.369	0.729	0.671	0.762
Dieffenderfer/Arkansas	0.483	0.999	0.643	0.205	0.072	0.197
Allegan/Arkansas	0.225	0.361	0.799	0.420	0.228	0.362
Dief-Allegan/Arkansas	0.598	0.602	0.934	0.277	0.105	0.219

t-tests	RB	RATIO 3 SR	ZR	RB	RATIO 4 Y	FE
Dieffenderfer/Allegan	0.006*	0.113	0.071	0.001*	NA	0.001*
Dieffenderfer/Arkansas	0.242	0.459	0.171	0.444	NA	0.444
Allegan/Arkansas	0.497	0.045*	0.932	0.013*	NA	0.013*
Dief-Allgan/Arkansas	0.779	0.120	0.401	0.238	NA	0.238

* t-tests <0.05 are significant.

Table 5.1 Statistical Tests of PIXE Analysis



	Ti	Mn	Fe	K	Ca	Fe	Rb	Sr	Zr	Rb	Y	Fe
Dieffenderfer Ware	21.7	26.9	51.3	11.6	48.1	40.3	24.7	18.7	56.6	24.9	0.0	75.1
Allegan Ware	30.5	21.6	48.0	12.2	46.2	41.6	30.4	16.8	52.1	30.2	0.0	69.8
Arkansas Pottery	22.9	25.3	51.8	13.4	38.1	48.5	28.3	19.9	51.8	25.6	0.0	74.4

Figure 5.1. Histogram of Inter-Type Comparison of PIXE data.

The petrographic analysis yielded interesting results concerning resource procurement. Generally, Allegan Ware contained more inclusions with particularly higher densities of quartz (see Figure 5.2). Olivine was primarily found in Dieffenderfer Ware as well as higher amounts of clay matrix, feldspars, and chert (see

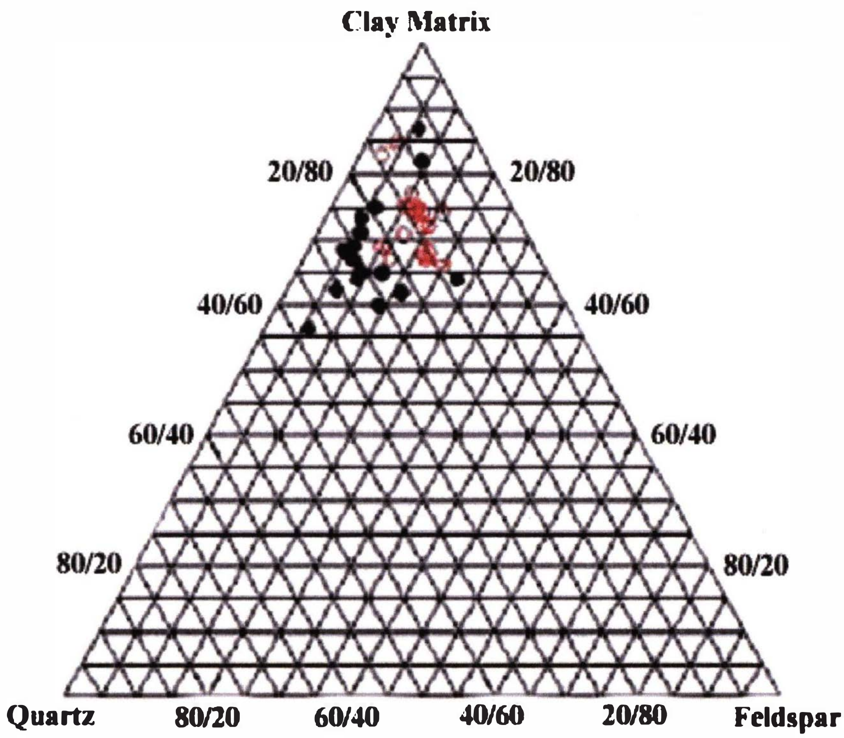


Figure 5.2 Ternary Diagram of Inter-Type Comparison of Main Paste Constituents.
Key: Red Open Circle = Dieffenderfer Ware, Black Filled-In Circle = Allegan Ware.

Figure 5.3). The data collected on the heavy minerals do not exhibit significant differences between Dieffenderfer Ware and Allegan Ware (see Figure 5.3). However, there are significantly fewer heavy minerals in the Allegan Ware from 46th

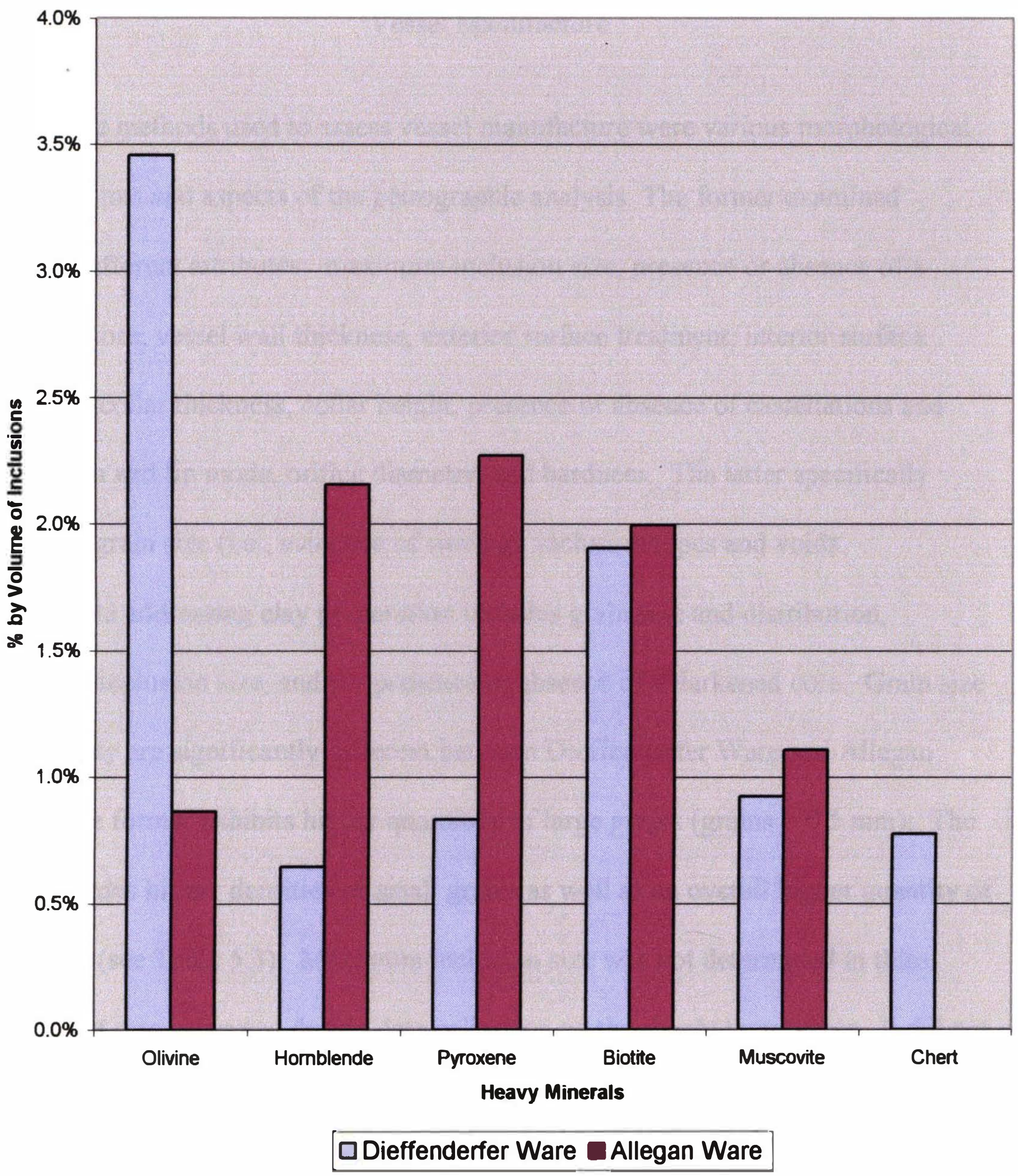


Figure 5.3 Histogram of Inter-Type Comparison of Heavy Minerals.

Street and Dieffenderfer sites. The Fennville ceramics, with the exception of one sample, contain rock inclusions of hornblende, pyroxene, and plagioclase (see Figure 5.4). T-tests show that almost all of the heavy mineral categories, with the exception of micas, are significantly different (see Table 5.2).

Vessel Manufacture

The methods used to assess vessel manufacture were various morphological measurements and aspects of the petrographic analysis. The former examined fourteen different attributes: maximum inclusion size, presence or absence of a darkened core, vessel wall thickness, exterior surface treatment, interior surface treatment, collar thickness, collar height, presence or absence of castellations and collars, rim and lip mode, orifice diameter, and hardness. The latter specifically examined grain size (i.e., evidence of sieving), inclusion types and voids.

Data addressing clay preparation includes grain size and distribution, maximum inclusion size, and the presence or absence of a darkened core. Grain size and quantity are significantly different between Dieffenderfer Ware and Allegan Ware. The former exhibits higher quantities of large grains (grains > 0.5 mm). The latter includes higher densities of small grains as well as an overall higher quantity of inclusions (see Table 5.3). Maximum inclusion size was not determined in thin-section, but was measured during data collection on the sherds themselves. It did not prove to be significantly different.

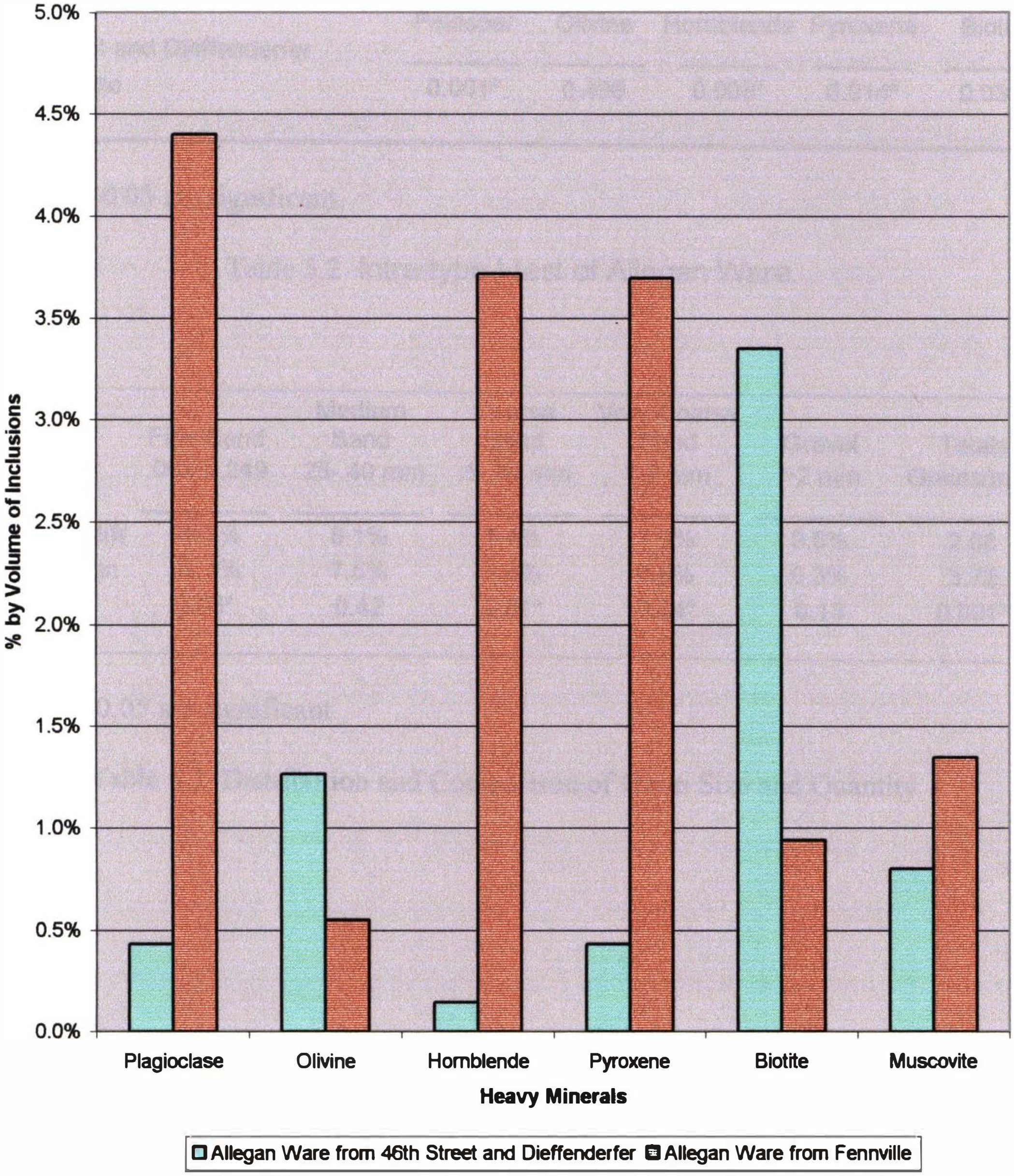


Figure 5.4 Histogram of Intra-Type Comparison of Heavy Minerals in Allegan Ware.

46th Street and Dieffenderfer vs. Fennville	Feldspar	Olivine	Hornblende	Pyroxene	Biotite
	0.001*	0.496	0.008*	0.014*	0.033*

* t-tests <0.05 are significant.

Table 5.2 Intra-type t-test of Allegan Ware

	Fine Sand .0625-.249	Medium Sand .25-.49 mm	Coarse Sand .5-.99 mm	Very Coarse Sand 1-2 mm	Gravel >2 mm	Totals Grains/mm²
Mean-Dfndrfr	86.2%	8.1%	3.4%	1.7%	0.6%	2.08
Mean-Allegn	89.5%	7.5%	1.8%	0.9%	0.3%	3.72
t-test	0.03*	0.42	0.01*	0.04*	0.13	0.001*

* t-tests <0.05 are significant.

Table 5.3 Distribution and Comparison of Grain Size and Quantity

However, a slight trend towards larger inclusions for Dieffenderfer Ware and smaller inclusions for Allegan Ware exists (see Figure 5.5) and this observation is supported by the grain size analysis. But statistical analysis confirms that maximum inclusion size is not significantly different (see Table 5.4). Large differences in organic content are also apparent from the data on the presence or absence of darkened cores (see Figure 5.6). Allegan Ware exhibits darkened cores four times as often as Dieffenderfer Ware.

The data concerning vessel wall thickness in this research suggested that there is a trend towards thinner walls for Dieffenderfer Ware and thicker walls for Allegan Ware (see Figure 5.7), but statistically they were not different (see Table 5.4). However, it was observed during data collection that vessels from the Dieffenderfer site (including the five vessels of Allegan Ware from that site) were relatively larger than those from the Fennville or 46th Street sites. It is my opinion that if vessel lots from the latter two sites included more than just a few centimeters of "body" below the lip, statistically significant differences would be found (i.e., a future examination of body sherds would likely confirm this). This argument is supported by previous research that compared all of the local pottery from the Dieffenderfer site (i.e., Allegan Ware, Spring Creek Ware, and Moccasin Bluff Ware) to Dieffenderfer Ware (see Figure 5.8). T-tests confirmed that these two classes of data were significantly different (see Table 5.5).

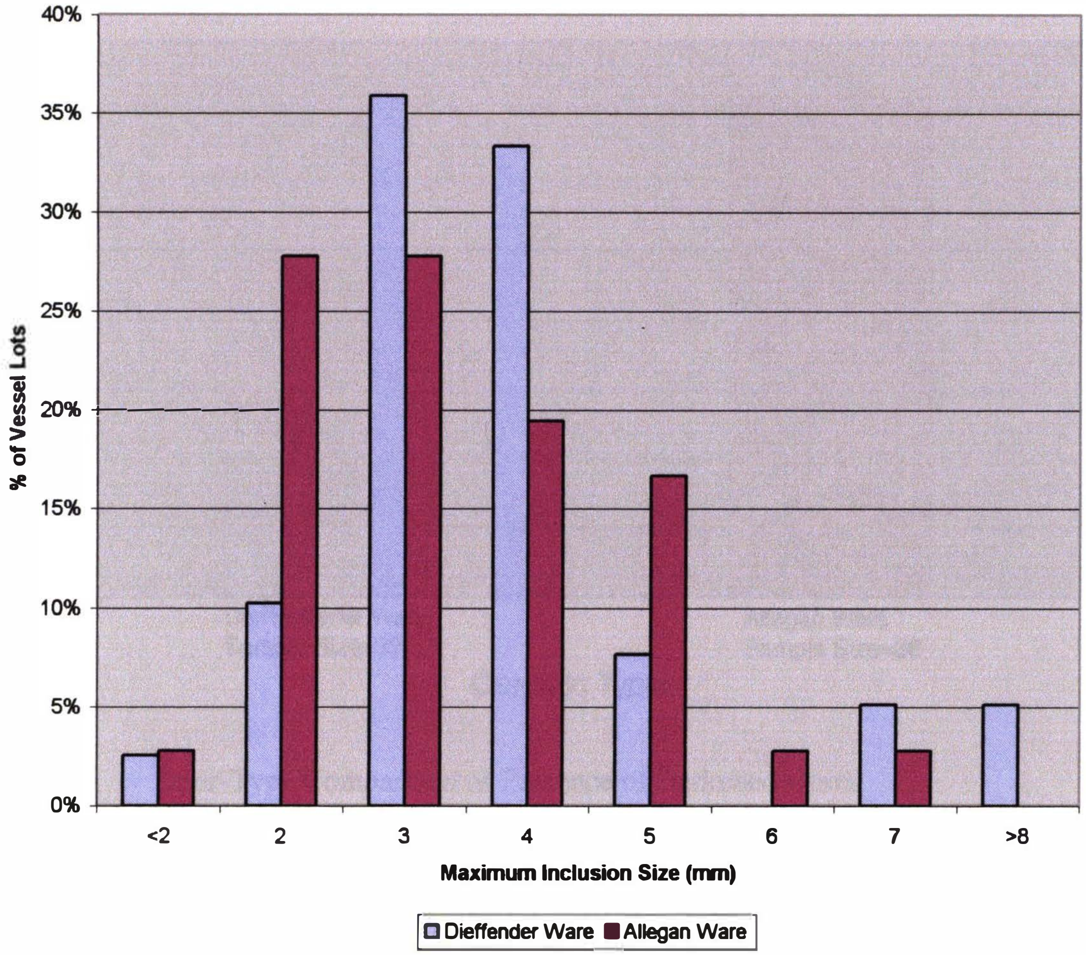


Figure 5.5 Histogram of Inter-Type Comparison of Maximum Inclusion Size.

t –tests

Maximum Inclusion Size	Maximum Wall Thickness	Oriface Diameter	Hardness
0.382	0.160	0.006*	0.311

* t-tests <0.05 are significant.

Table 5.4 T-Tests of Various Attributes Comparing Dieffenderfer Ware to Allegan Ware

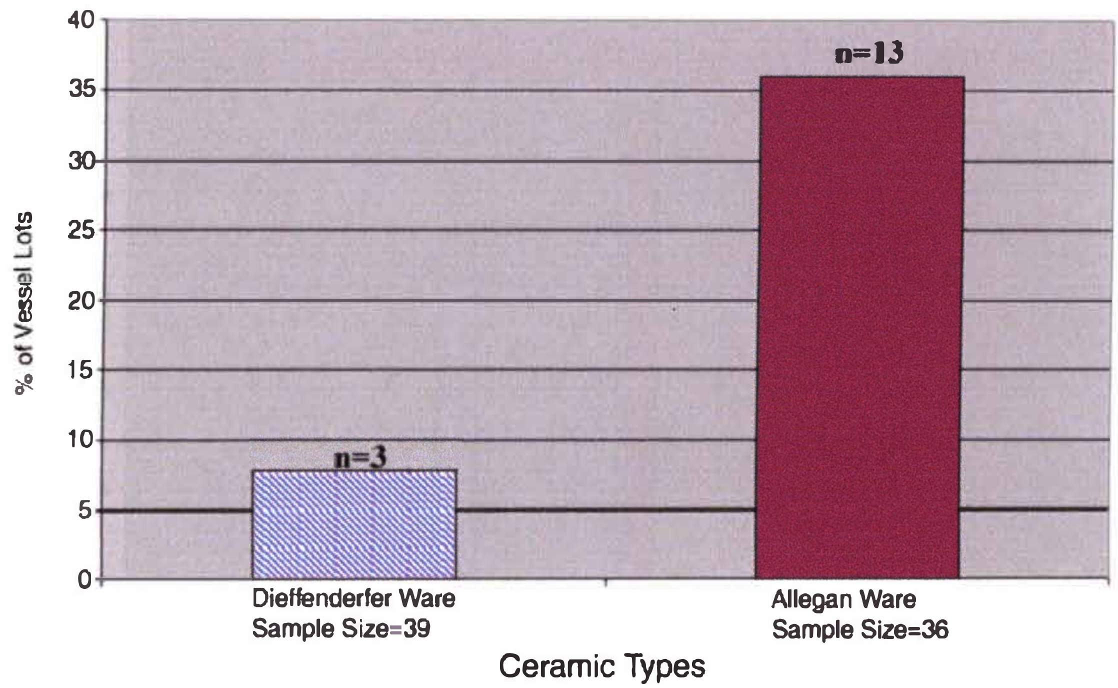


Figure 5.6 Inter-Type Comparison of Presence of Darkened Cores.

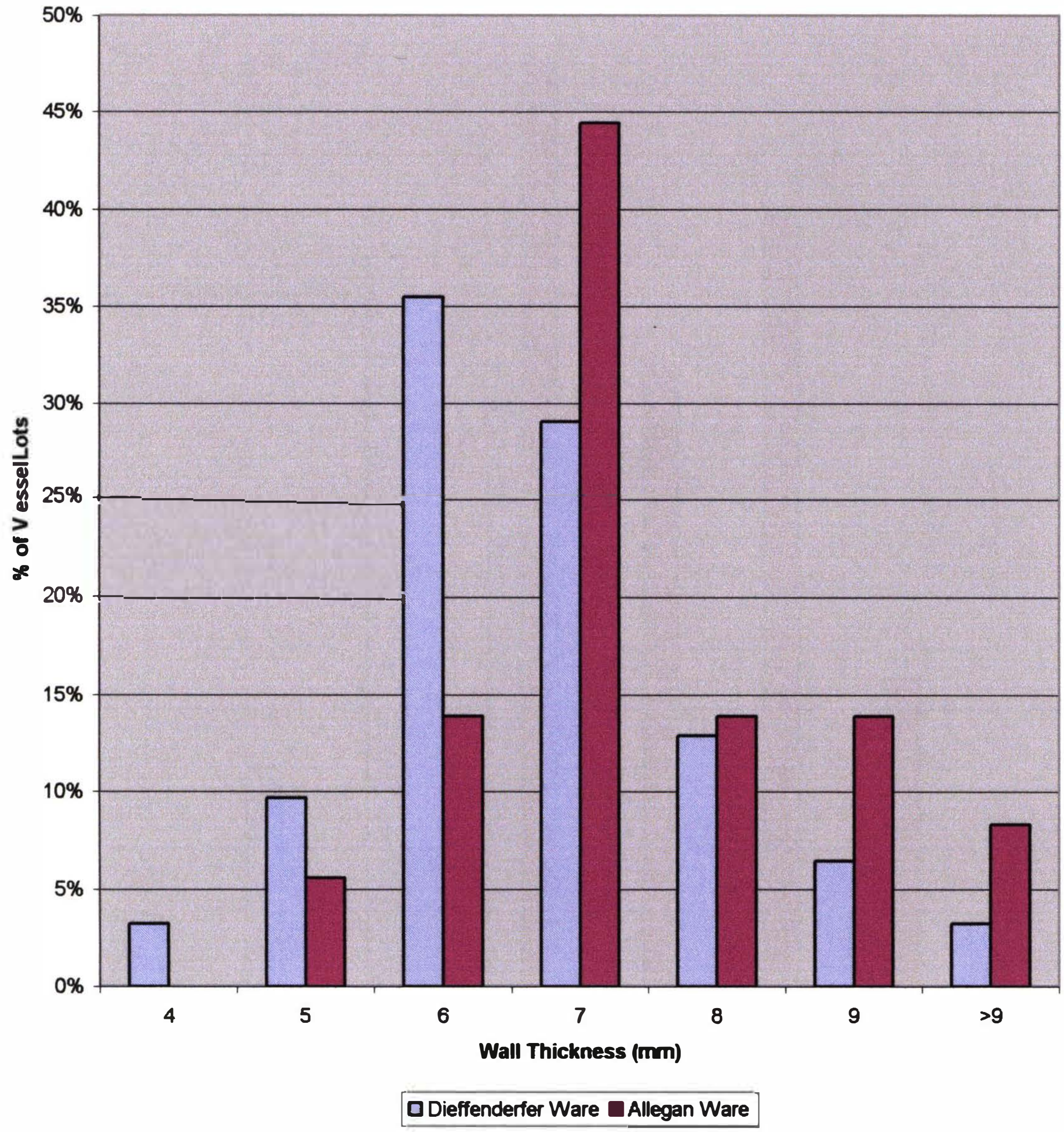


Figure 5.7 Histogram of Inter-Type Comparison of Vessel Wall Thickness.

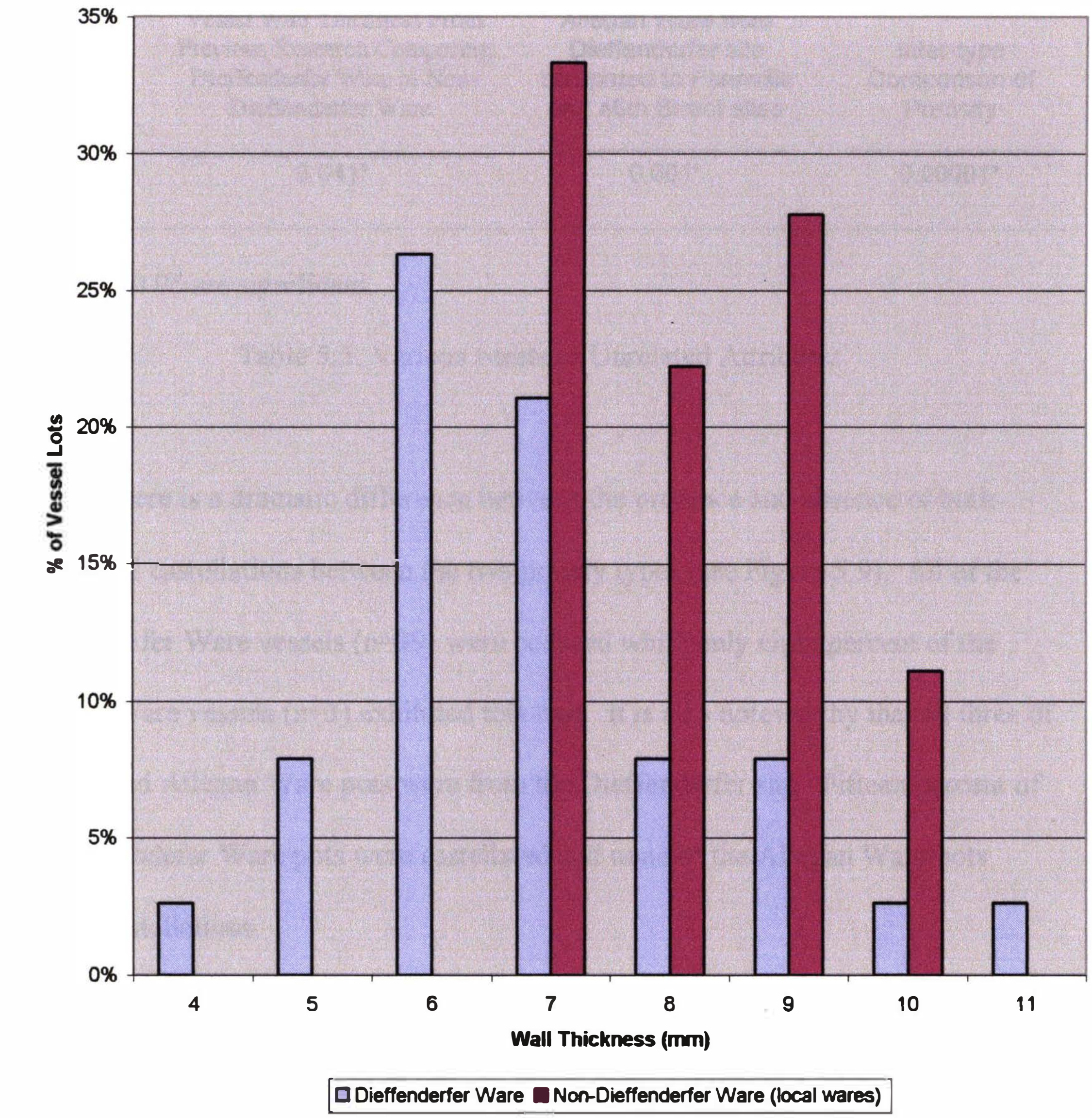


Figure 5.8 Histogram of Inter-Type Comparison of Wall Thickness From Previously Unpublished Research.

	Vessel Wall Thickness From Previous Research Comparing Dieffenderfer Ware to Non-Dieffenderfer Ware.	Allegan Ware from Dieffenderfer site compared to Fennville and 46th Street sites	Inter-type Comparison of Porosity
t-tests	0.041*	0.001*	0.00001*

* t-tests <0.05 are significant.

Table 5.5 Various t-tests of Unrelated Attributes

There is a dramatic difference between the presence and absence of both collars and castellations between the two pottery types (see Figure 5.9). All of the Dieffenderfer Ware vessels (n=39) were collared while only eight percent of the Allegan Ware vessels (n=3) exhibited this trait. It is also noteworthy that all three of the collared Allegan Ware pots were from the Dieffenderfer site. Fifteen percent of the Dieffendefer Ware pots were castellated and none of the Allegan Ware pots exhibit castellations.

Orifice diameter exhibited significant differences between Dieffenderfer Ware and Allegan Ware (see Figure 5.10). The former had statistically larger orifices than the latter (see Table 5.4). The sample size was relatively small (i.e., Dieffenderfer Ware [n=17] and Allegan Ware [n=18]); only half of the vessels were large enough to estimate orifice diameter, but the results show significant differences.

Rim modes (see Figure 5.11), as well as lip modes, do not exhibit any significant differences between vessel types. Vessels from both types were predominantly everted or slightly everted; some were straight; and a few were

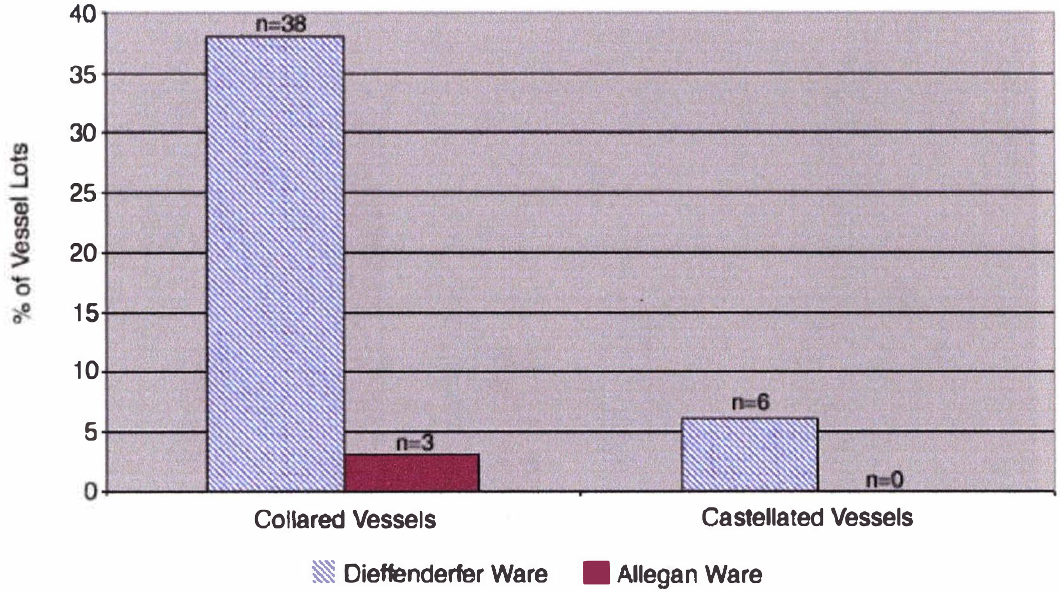


Figure 5.9 Histogram of Inter-Type Comparison of Collars and Castellations.

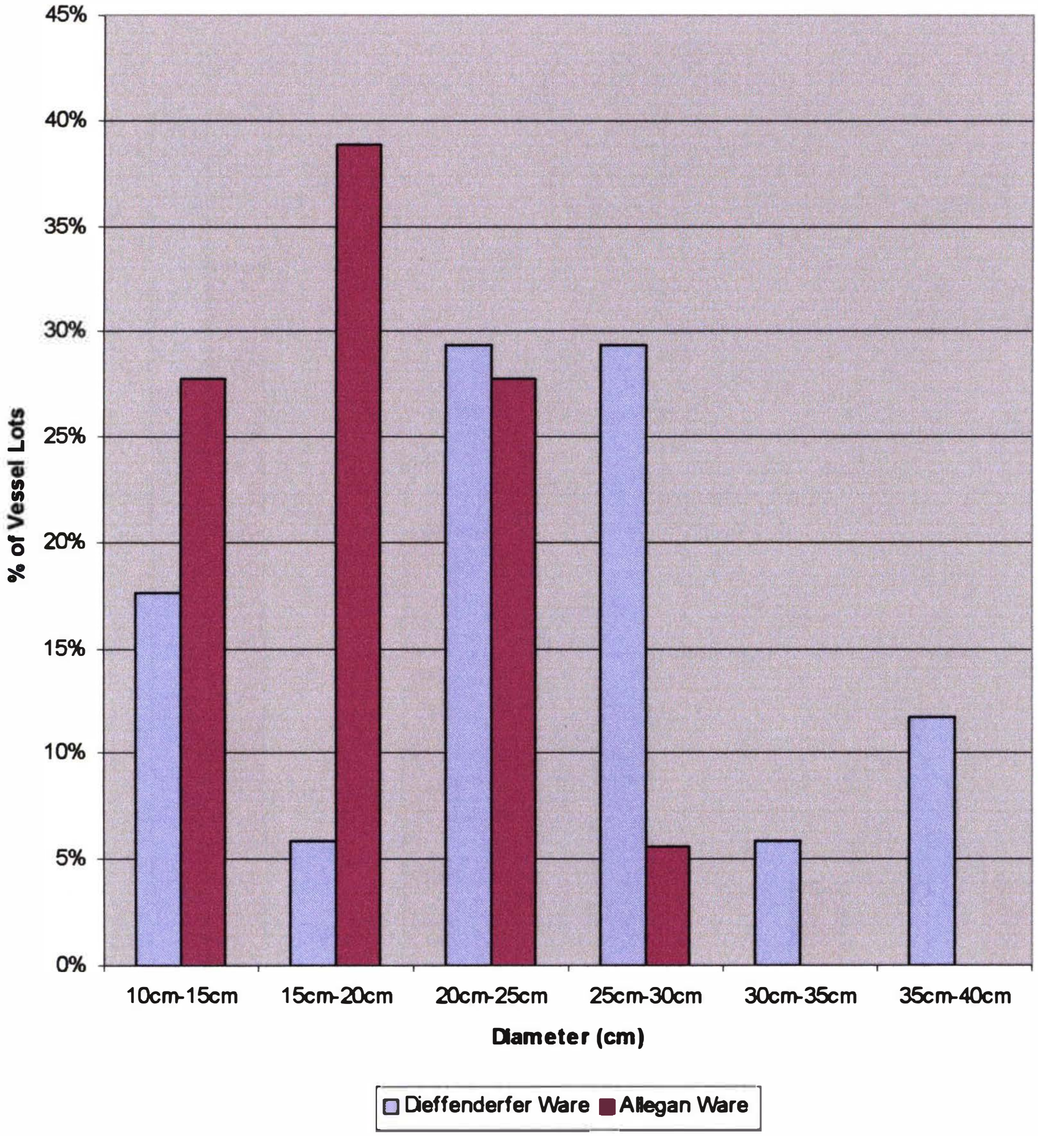


Figure 5.10 Histogram of Inter-Type Comparison of Orifice Diameter.

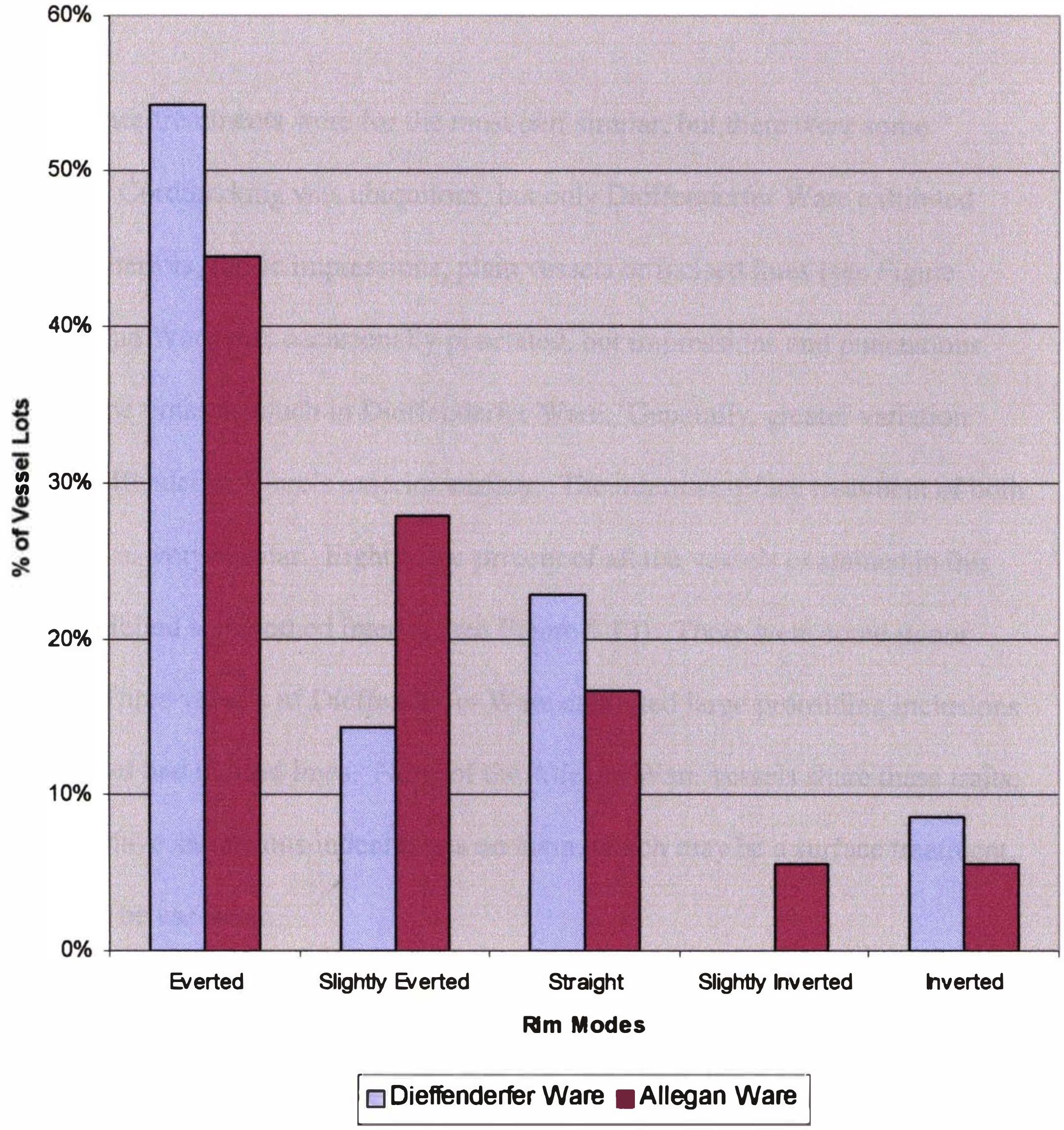


Figure 5.11 Histogram of Inter-Type Comparison of Rim Modes.

inverted or slightly inverted. Lip modes exhibited equal frequencies of flat and rounded lips.

Surface treatments were for the most part similar, but there were some differences. Cordmarking was ubiquitous, but only Dieffenderfer Ware exhibited smoothed exteriors, fabric impressions, plain vessels or incised lines (see Figure 5.12). Allegan Ware was occasionally punctated, but impressions and punctations occurred three times as much in Dieffenderfer Ware. Generally, greater variation exists in Dieffenderfer Ware's exterior surface. The interior surface treatment of both ware types was very similar. Eighty-five percent of all the vessels examined in this research exhibited a smoothed interior (see Figure 5.13). There were some minor variations. Three vessels of Dieffenderfer Ware exhibited large protruding inclusions and one vessel had incised lines. None of the Allegan Ware vessels share these traits, but six pots have anomalous indentations on them, which may be a surface treatment, but may also be use-wear.

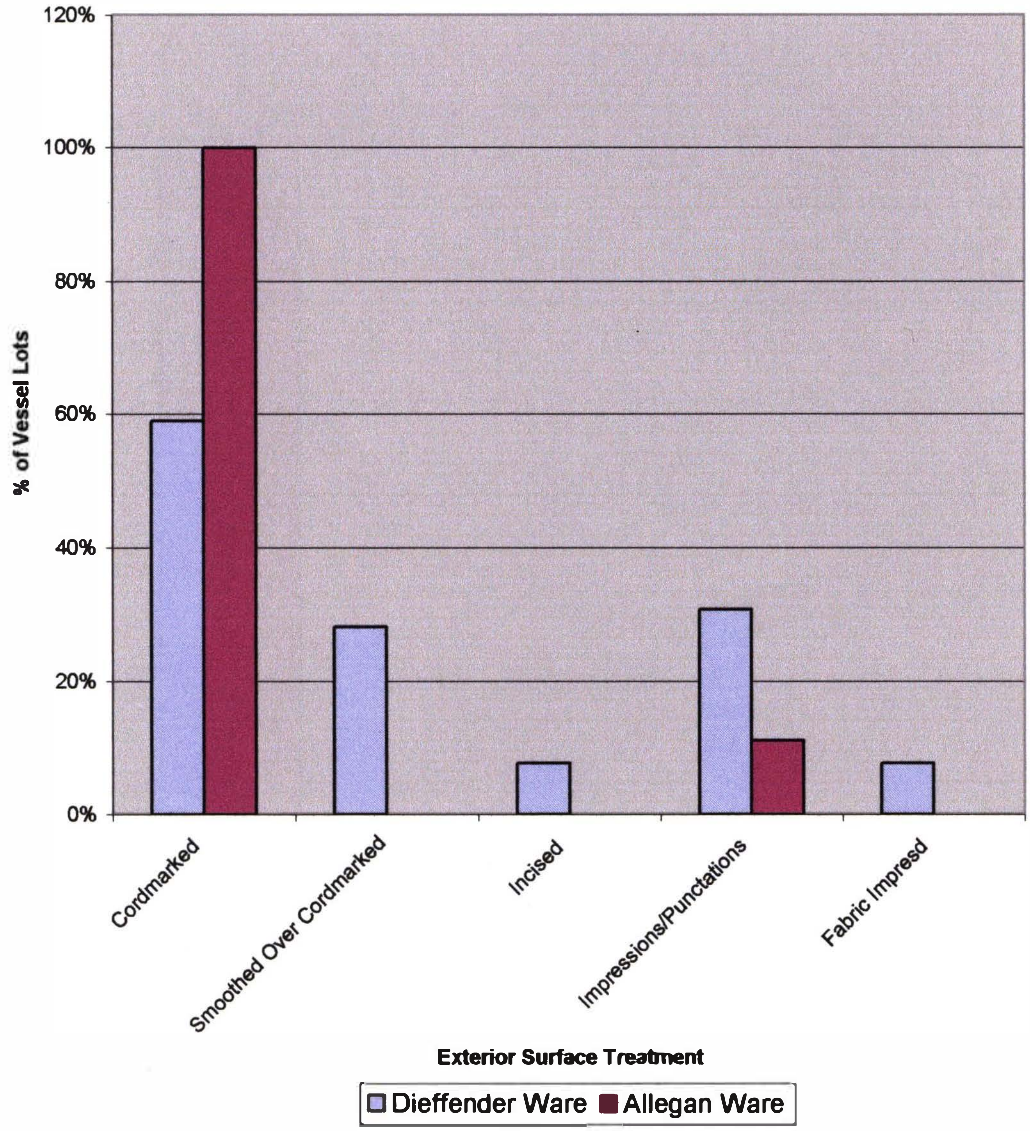


Figure 5.12 Histogram of Inter-Type Comparison of Exterior Surface Treatment.

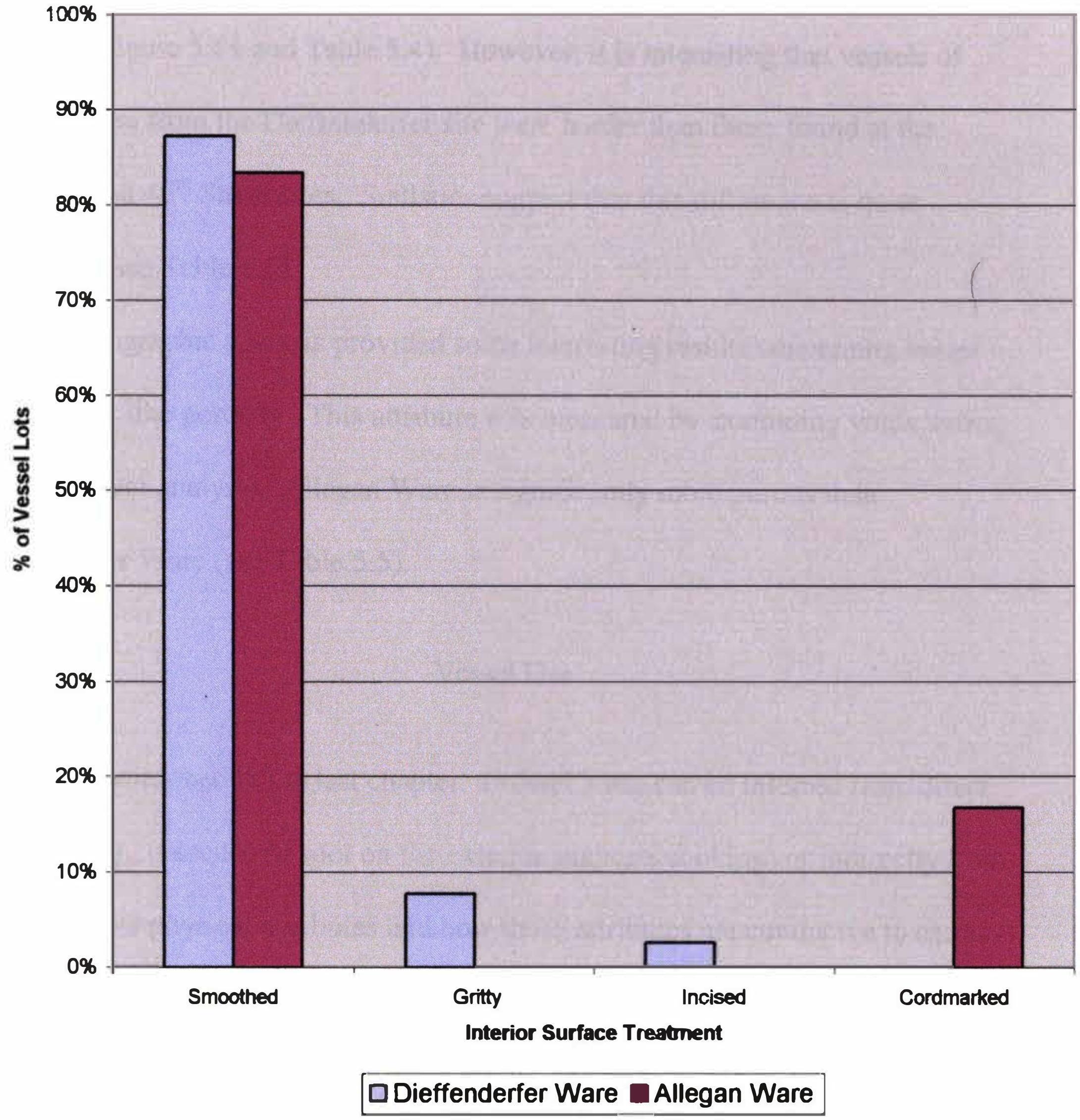


Figure 5.13 Histogram of Inter-Type Comparison of Interior Surface Treatment.

Vessel hardness was very similar in both Dieffenderfer Ware and Allegan Ware (see Figure 5.14 and Table 5.4). However, it is interesting that vessels of Allegan Ware from the Dieffenderfer site were harder than those found at the Fennville and 46th Street sites. Statistics suggest that this difference is quite significant (see Table 5.5).

Petrographic analysis provided some interesting results concerning vessel manufacture like porosity. This attribute was measured by examining voids during the point count analysis. Allegan Ware is significantly more porous than Dieffenderfer Ware (see Table 5.5).

Vessel Use

As mentioned in the last chapter, a vessel's use can be inferred from direct evidence (e.g., presence of soot on the exterior suggests cooking) or indirectly from interpreting its physical attributes and how those attributes are conducive to certain tasks. The data concerning direct evidence of vessel use is displayed hereafter, but the indirect evidence is addressed in Chapter 5. The physical manifestations of vessel use were identified as either the presence or absence of three attributes: Exterior soot, interior residues, and interior abrasions. Dieffenderfer Ware exhibited twice as much of all three attributes when compared to Allegan Ware (see Figure 5.15 and Table 5.6).

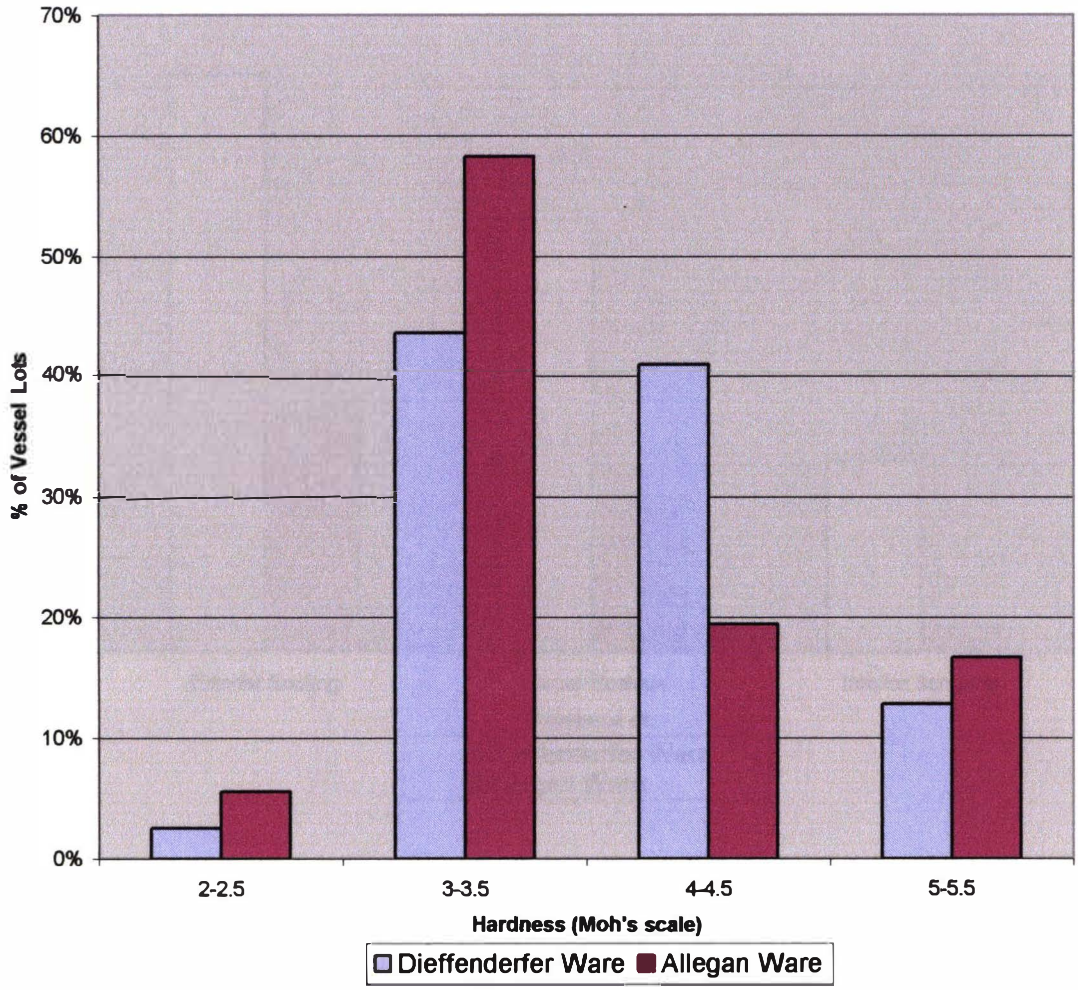


Figure 5.14 Histogram of Inter-Type Comparison of Vessel Hardness.

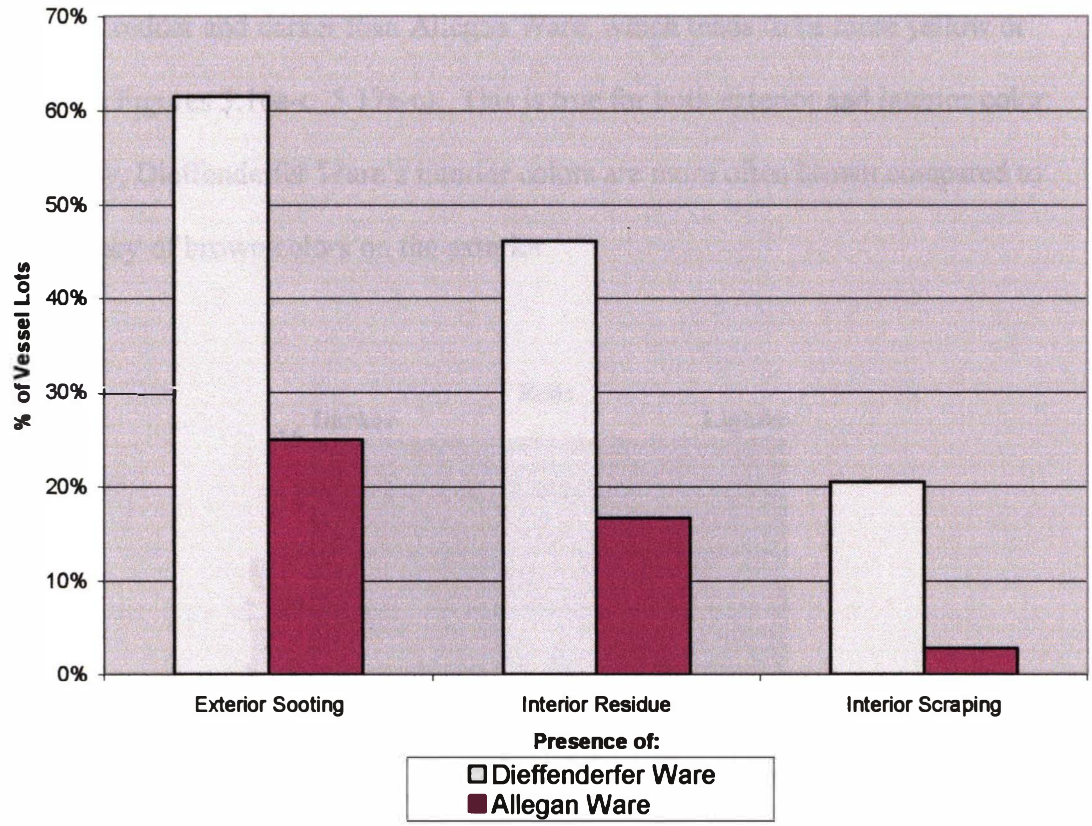


Figure 5.15 Histogram of Inter-Type Comparison of Attributes Associated with Vessel Use.

	Exterior Sooting	Interior Residue	Interior Scraping
t-test	0.001*	0.018*	0.018*

* t-tests <0.05 are significant.

Table 5.6 T-tests of Vessel Use Comparing Dieffenderfer Ware to Allegan Ware.

Vessel color can offer some insights into vessel use, but is mainly an indicator of firing temperature and environment (Rice 1987). Generally, Dieffenderfer Ware tends to be redder and darker than Allegan Ware, which tends to be more yellow or brown (see Figures 5.16a-c, 5.17a-c). This is true for both exterior and interior color. Specifically, Dieffenderfer Ware's interior colors are more often brown compared to the frequency of brown colors on the exterior.

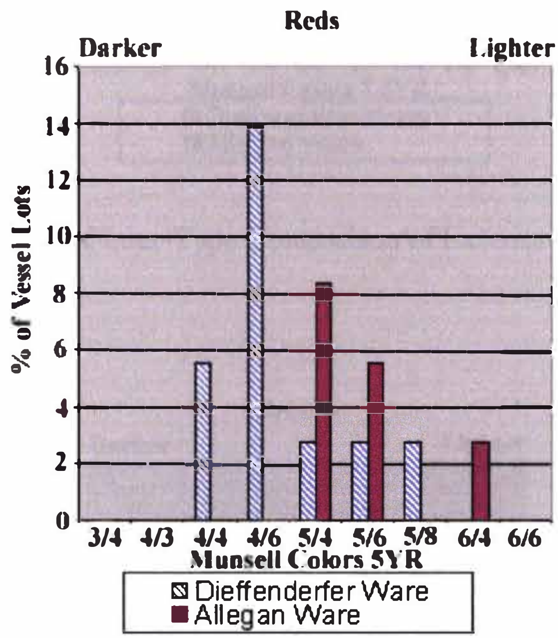


Figure 5.16a Histogram of Inter-Type Comparison of Exterior Color (5YR).

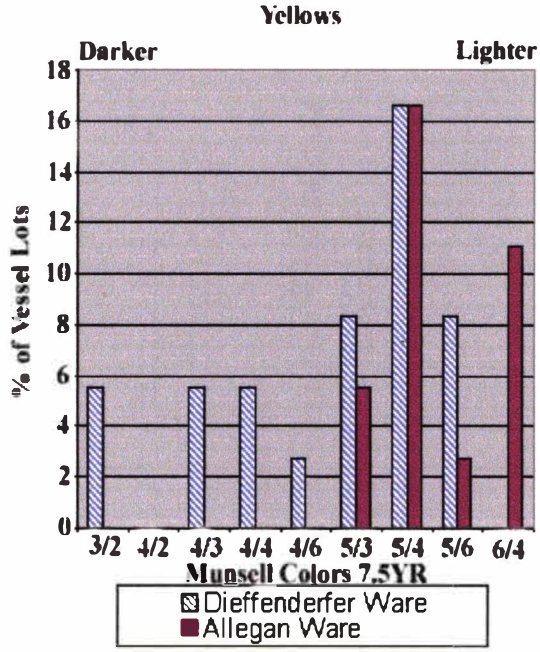


Figure 5.16b Histogram of Inter-Type Comparison of Exterior Color (7.5YR).

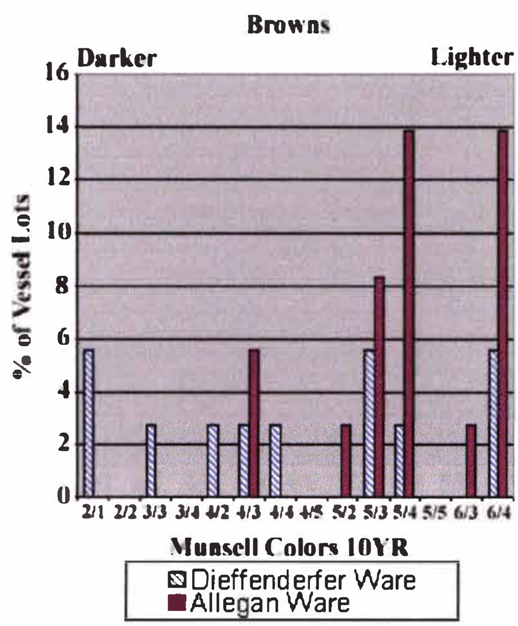


Figure 5.16c Histogram of Inter-Type Comparison of Exterior Color (10YR).

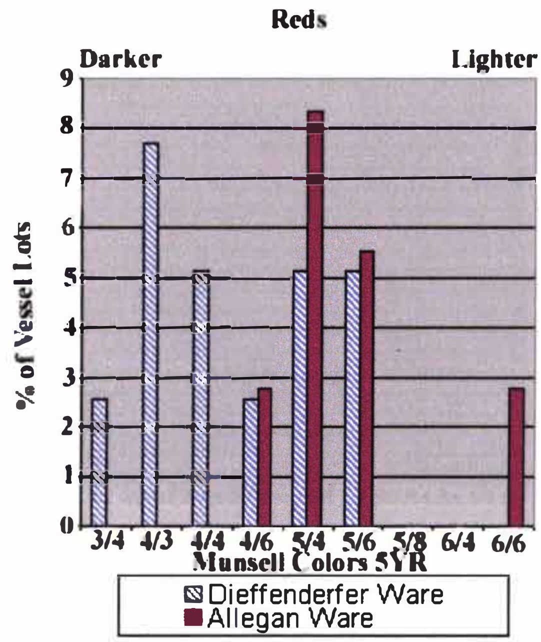


Figure 5.17a Histogram of Inter-Type Comparison of Interior Color (5YR).

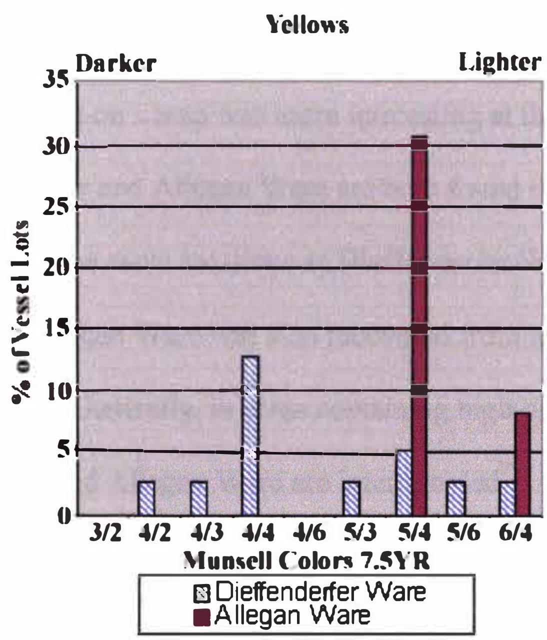


Figure 5.17b Histogram of Inter-Type Comparison of Interior Color (7.5YR).

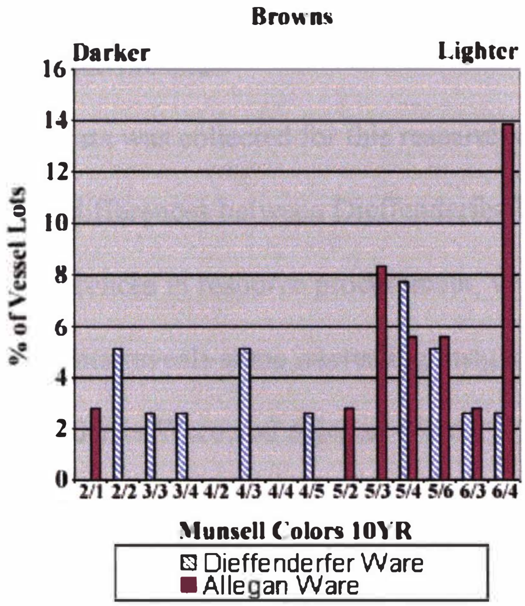


Figure 5.17c Histogram of Inter-Type Comparison of Interior Color (10YR).

Vessel Discard

Plotting the artifacts on a map was more interesting at the Dieffenderfer site because Dieffenderfer Ware and Allegan Ware are both found there. Spatially, Allegan Ware is found in the same locations as Dieffenderfer Ware. It is interesting to note that a vessel of Allegan Ware was also recovered from a feature in association with Dieffenderfer Ware. Generally, in areas containing high-densities of artifacts, both Dieffenderfer Ware and Allegan Ware are intermingled.

At the 46th Street and Fennville sites, only Allegan Ware was plotted (excluding the other types of pottery found there). Both of these sites are smaller than Dieffenderfer and the artifacts are not clustered in any areas. Another similarity between these three sites is that relatively few vessel lots (n=10) came from feature context at the Dieffenderfer site, but even fewer (n=2) were excavated from feature fill at the 46th Street and Fennville sites.

A great amount of data was collected for this research and it exhibits interesting similarities and differences between Dieffenderfer Ware and Allegan Ware. There are clear differences in resource procurement, vessel construction and use. Interpretation of this data reveals some interesting insights into the social agency of the producers of Dieffenderfer Ware and Allegan Ware.

CHAPTER VI

INTERPRETATION

This research has collected data from many different sources, and interpretations will be based on the theoretical tenants discussed in Chapter III, mainly isochrestic variation and the *chaine operatoire*. Each individual set of data represents a small piece of the larger picture, which encapsulates how this pottery was created and used by human beings. Technical choices were not made in a vacuum and the combination of similarities and differences in the archaeological record are statements about the lived experiences of the producers of Dieffenderfer Ware and Allegan Ware. Again, for the sake of organization, each stage of the *chaine operatoire* will be interpreted separately followed by a synthesis of the stages and conclusions.

Resource Procurement

Because the PIXE analysis could not produce the desired results, interpretations regarding resource procurement come exclusively from the petrographic analysis. The sample size was relatively small and intra-vessel variation could not be assessed because only one thin section was collected from each pot. However, these are common limitations in ceramic petrography, which are relatively insignificant (see Drake 2001; Garrett 1982; Porter 1984; Pretola 2000; Stoltman 1989). The petrographic analysis produced some unexpected results.

Because of the PIXE analysis and the nature of clay variation in Michigan, it seemed improbable that patterns in mineralogical data would be found. This was not the case. Significant (percent by volume) differences in paste, quartz, feldspar, olivine, hornblende, pyroxene, and chert were identified. This is strong evidence that the producers of Dieffenderfer Ware exploited clays from different sources than those used to produce Allegan Ware. This is also supported by the intra-site, inter-type differences at Dieffenderfer.

Any inter-site analysis of Allegan Ware vessels based on the thin sections lacks an adequate sample size to strongly support any argument, but the data exhibits some interesting patterns. The 46th Street site samples have significantly fewer inclusions than the other two sites. Heavy minerals, like olivine, hornblende, and pyroxene are very rare at the 46th Street and Dieffenderfer sites, but the Fennville samples consistently contain rock fragments containing hornblende, pyroxene, and plagioclase. It is interesting to note that the total number of vessels at Fennville far outnumber the other two sites. The Fennville and 46th Street sites are only separated by three miles, but the mineralogical content of their ceramic assemblage's paste is quite different. Ethnographic data has suggested that clay is typically procured from sources no more than 4 miles away (with a majority from the lower end of the range) (Arnold 1985). Generally, intra-site paste homogeneity and inter-site paste heterogeneity correlates with this ethnographic analogy suggesting that clay was typically available locally and was procured from the nearest source.

Vessel Manufacture

Vessel manufacture is a very important stage of the *chaine operatoire* if the importance of isochrestic variation is emphasized. Isochrestism suggests that style resides in instrumental form as do the ceramic characteristics that are diagnostic to social identity (i.e., social identity is recorded in how one makes a pot, not how one decorates it) (Sackett 1977, 1990). Because the social relations of the producers of Dieffenderfer Ware and Allegan Ware are an important element of this research, vessel manufacture will be scrutinized.

The first "substage" of manufacture is clay preparation. Identifying evidence of sieving or kneading could not be specifically accomplished from data collected on maximum inclusion size and grain size analysis. However, some general statements can be made about the similarities and differences in how the producers of Dieffenderfer Ware and Allegan Ware prepared their clay. The similarity in maximum grain size suggests that large pieces of temper were most likely not being added and some similarities in clay "cleaning" existed. The quantity of voids can be caused by numerous processes including burned out organic materials and the extent of kneading during clay preparation (i.e., kneading reduces the frequency and size of voids) (Rye 1981). Assuming that these ceramic types were both open-fired in an oxidizing environment, the significant frequency of darkened cores in Allegan Ware suggests that higher concentrations of organic material were present in the clay. This is also supported by the higher quantity of voids identified in the point count analysis. Therefore, it appears that the amount of clay preparation in Allegan Ware is less. However, this does not mean that the producers of Allegan Ware were less motivated;

rather, the data represents technical choices that produce the type of pot desired by those "technicians." The results of these technical choices will be discussed further in the next section on vessel use.

Differentiating temper (i.e., inclusions added by the potter) from inclusions found naturally in clay can be very difficult, but perhaps not impossible. Both Dieffenderfer and Allegan Wares are grit tempered (i.e., sand is added to the clay). However, it would appear that more temper was being added to Allegan Ware. It is also interesting to note that chert is found exclusively in a few vessels of Dieffenderfer Ware implying that perhaps those potters were also adding chert to the clay. The significant quantity of olivine in Dieffenderfer Ware is not likely to occur naturally, thus suggesting that an additional tempering step was carried out during the manufacturing stage.

It is very difficult for individuals to change the ways in which they actually construct or form a vessel. The attributes measured to assess how pots were made included vessel wall thickness, orifice diameter, presence of collars and castellations, and rim and lip modes. The thickness of a vessel's walls evinces inferences concerning social norms as well as vessel function. Generally, the walls of Dieffenderfer Ware are thinner than the walls of Allegan Ware. The orifice diameters on Dieffenderfer Ware vessels are larger than those on Allegan Ware, which is likely to correlate with vessel size (i.e., larger orifices often correlate with larger pots [Hally 1983a]). There are dramatic differences in the presence of collars and castellations between ware types. Rim and lip modes do not exhibit significant differences. These observations suggest that the producers of Dieffenderfer Ware were interested in creating larger, thinner-walled pots, but different vessel forms were not necessary (i.e., neither Dieffenderfer Ware nor Allegan Ware can be differentiated into jars, bowls, water jugs, etc.). Collars become more prominent in Michigan during the middle to late Late Woodland (Brashler et al. 1997), but the dramatic difference in the frequency of collars between Dieffenderfer Ware and Allegan Ware, as well as the exclusive presence of castellations in the former, reflects an obvious preference for specific types of vessel construction. These attributes suggest that real differences in vessel morphology are being consciously constructed to fulfill both functional and aesthetic needs as well as being a product of *doxa* (i.e., a product of an unconscious routinte) (Bourdieu 1977).

Exterior surface treatment exhibited more variation than interior surface treatment. Generally, Allegan Ware is simpler. Dieffenderfer Ware exhibits greater intra-type variation in exterior surface treatments that includes not only cordmarking and smoothed over cordmarking, but also fabric impressed and plain. This suggests that knowledge of, and desire to finish exteriors in specific ways, which often increase functional performance as well, was substantially different in the production of Dieffenderfer Ware as compared to Allegan Ware. Exterior surface treatments, particularly decorative motifs, are more visible than other qualities like wall thickness, orifice diameter, or interior surface decoration. So the producers of Dieffenderfer Ware may have been interested in promoting their social identity (see Wobst 1977). The frequency of decoration on Allegan Ware vessels is very low, however, suggesting that signaling their identity in this manner was not important.

Interior surface treatments were similar, however. The only observed differences were in the Allegan Ware vessels with cordmarked interiors.

Data collected concerning hardness is difficult to interpret. Harder vessels imply a higher firing temperature, but this is a tenuous assumption (Rye 1981). Statistical tests suggested that Dieffenderfer Ware and Allegan Ware were similar. But the Allegan Ware (as well as all of the non-Dieffenderfer Ware vessels [e.g., Moccasin Bluff and Spring Creek Wares] on site) from Dieffenderfer was significantly harder than the Allegan Ware from the 46th Street and Fennville sites (which were consistently between 2-4 on the Moh's hardness scale [Rogers 1971]).

Firing temperature and environment, in general, can be difficult to assess. Generally, vessel color is a product of non-plastic inclusions (e.g., organic matter) and chemical reactions during the firing substage (Rice 1987; Rye 1981). Color can be a reflection of firing environment or temperature as well as prolonged exposure to heat (e.g., cooking) (Hally 1983b; Mirti 1998; Rice 1987; Rye 1981). The ubiquity of orange and black colors suggests that iron oxides and organics were present to varying degrees in both Dieffenderfer and Allegan Wares. The colors in cross-section in both pottery types are consistent with examples found in Rye (1981: 116) for open-fires (i.e., oxidizing). The absence of kilns in the Northeast suggests that pottery was fired in multi-purpose hearths (Chilton 1996). There appears to be little difference in firing practices between the producers of Dieffenderfer Ware and Allegan Ware.

There are also no observable differences pertaining to scale of production. Suites of inclusions may be suggestive of "batches" of clay, but the data is inconclusive. It is interesting that eight of nine vessels thin-sectioned from Fennville are mineralogically similar, perhaps suggesting that more pots were being produced from a nearby location. Regardless, the level of intra-type variation is similar in Dieffenderfer Ware and Allegan Ware, and the lack of patterning suggests that the scale of production was similar.

Vessel Use

There are direct ways to infer a vessel's use (e.g., presence of soot or scraping) as well as indirect ways (e.g., form is inherently related to function). Comparisons of both have suggested that Dieffenderfer Ware and Allegan Ware vessels were constructed and used differently. Interpretations concerning mobility and durability are also associated with vessel use. This stage of the *chaine operatoire* exhibits numerous differences between ware types and provides interesting insights into the everyday lives of their producers.

The presence of sooting on the exterior of a vessel is evidence that a pot has been placed over or in a fire (Hally 1983b; Rice 1987). Since the samples in this research were exclusively rim sherds, evidence of sooting in the rim area of these pots suggests that they were placed directly in a fire, as opposed to over a fire (Hally 1983b). Twice as many vessels of Dieffenderfer Ware (70%) exhibited sooting as compared with Allegan Ware (25%). This suggests that a majority of Dieffenderfer Ware pots were being placed into fires, most likely for boiling (Rice 1987).

Vessel wall thickness also indicates that Dieffenderfer Ware's thinner walls were better suited for cooking because it allows for better heat transfer (see Arnold

1985; Chilton 1996, 1998; Rice 1987; Rye 1976), although the data has some ambiguities. However, vessels of Allegan Ware did not exhibit thick walls either. Both pottery types lack differentiating characteristics that would suggest a high degree of pot specialization (i.e., a good pot is a multifunctional one). Perhaps vessel wall thickness is a mediating trait expressing preferences by the producers of Dieffenderfer Ware and Allegan Ware, albeit lacking the constraints of extremely thick or thin walls.

Evidence of stirring, scraping, mixing, or grinding can be identified, particularly on the interior below the rim (Hally 1983b; Rice 1987). Although the identification of use-wear is often difficult, especially on sherds, eight Dieffenderfer Ware vessels exhibited these signs compared to only one Allegan Ware vessel. This evidence might be construed to suggest that materials were being processed in vessels of Dieffenderfer Ware while Allegan Ware was primarily used for storage.

Because of the ambiguities previously stated concerning vessel hardness, durability is equally difficult to interpret. There was more intra-type variation in Allegan Ware, but overall both pottery wares averaged the same hardness. Increased levels of porosity in Allegan Ware also speak to vessel durability. High porosity reduces resistance to mechanical stress but increases resistance to thermal stress; however, it is not beneficial for repeated heating and cooling (because the vessel eventually loses its mechanical strength) or boiling (because water seeps into the pores, evaporates and causes cracks) (Rice 1987). High porosity is also advantageous for storing water because increased levels of permeability create condensation, which keeps water cool (Rice 1987; Rye 1976). However, it is not better for long-term storage (Rice 1987).

Ethnoarchaeology has generally found that, the smaller the pot, the shorter the use-life (Longacre 1991). Assuming a vessel's morphology is generally similar (as opposed to comparing a bowl to a jar [see Hally 1986]), orifice diameter is the best indicator of vessel size (Hally 1983a). In Allegan Ware, the orifice diameter is on average smaller than in Dieffenderfer Ware, suggesting that perhaps the producers of Allegan Ware were not interested in producing vessels that last, opting for a more expedient technology. One would think that mobile hunter-gatherers would need durable pots (see Chilton 1996, 1998), but only if they "carried" them from place to place, which is clumsy and heavy. However, because vessels of Allegan Ware are smaller, they would be easier to carry if necessary. It is possible that the producers of Allegan Ware made pottery when they got to where they were going and left it when they were done. This is supported by the petrographic analysis, which exhibits significant levels of inter-site variation and low levels in intra-site variaton in Allegan Ware (i.e., each site appears to have its own suite of minerals).

The types and density of inclusions affect a vessel's performance, too. For example, different minerals expand at different rates when heated (see Fig. 6.1). Minerals that expand too much will likely cause the vessel to crack when heated. In this figure, feldspars are similar to plagioclase and rutile, and hornblende is similar to graphite (Rye 1976). Ideally, a heated vessel's inclusions should expand at the same rate as the clay matrix (Rye 1976). Dieffenderfer Ware exhibits relatively higher quantities of olivine and feldspars as well as consisting of fewer inclusions overall.

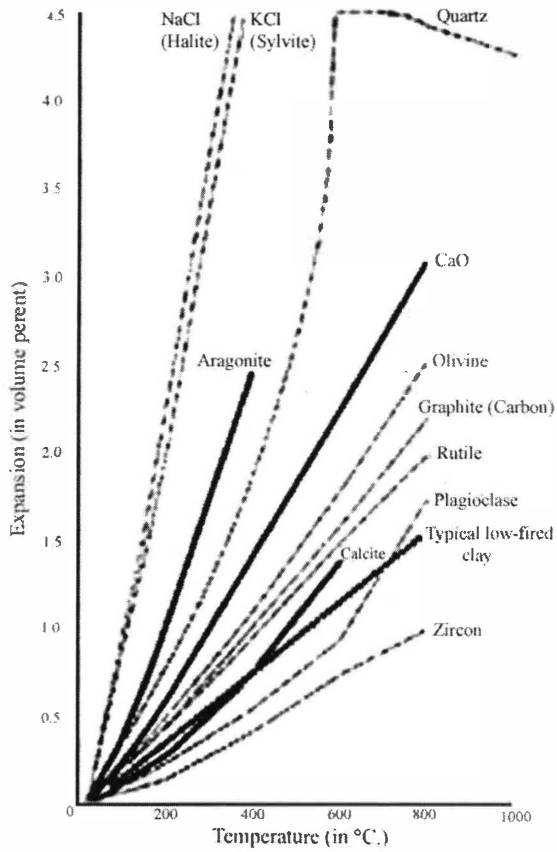


Figure 6.1 Thermal Expansion of Common Ceramic Inclusions (After Rye 1976: Figure 3).

These three traits are all desirable for cooking vessels. To the contrary, Allegan Ware exhibits higher quantities of quartz and a higher density of inclusions, both of which reduce a vessel's resistance to thermal stress. However, these traits, particularly the latter, increase a vessel's resistance to mechanical stress.

Surface treatment and decoration are not exclusively ornamental and serve some functional purposes. Not only does cordmarking increase one's ability to grip a pot (especially when it is wet), but the undulating surface is better for conducting heat and increasing a vessel's thermal shock resistance (Chilton 1996, 1998; Rice 1987). Allegan Ware, which is always cordmarked, would have been easier to transport.

Also, during occasions when the users of Allegan Ware needed to boil water or cook food, cordmarking would offset some of the thermal resistance limitations created by a higher density of inclusions (specifically quartz) and thicker walls. One might also ask, what is the significance of smoothing over a cordmarked surface (i.e., why would someone take the time to do this)? In this case, Dieffenderfer Ware's smoothed exteriors are interpreted as a decorative trait. Large, smooth pots were likely produced by people who were more sedentary (or semi-sedentary) than mobile. Surface treatments are more than just "stylistic" and functional additions constructed as an afterthought.

The data suggests that Dieffenderfer Ware and Allegan Ware were used in different ways. High frequencies of exterior sooting, interior scraping, and interior residue, as well as slightly thinner vessel walls, low overall inclusion densities but higher frequencies of heavy minerals (with low thermal expansion rates) all suggest that Dieffenderfer Ware was likely used as a processing and cooking vessel. It is also larger suggesting that more subsistence goods could be prepared (perhaps for a relatively larger group of residents) but was not easily transported (which is also suggested by the high frequency of smoothed exteriors). In contrast, Allegan Ware appears to have been used more as a storage vessel. This interpretation is supported by high densities of inclusions, particularly quartz, thick vessel walls, and little direct evidence of food processing or cooking.

Vessel Discard

Although there are more inherent ambiguities associated with vessel provenience (as opposed to vessel morphology or the petrology of clay matrix), assessments of spatial analysis can be insightful. At Dieffenderfer, different pottery wares are not spatially distinct and they are sometimes found in association with each other (e.g., Feature 4 contains both Dieffenderfer Ware and Allegan Ware). Since there are only five vessels of Allegan Ware at Dieffenderfer, and they are spread over the site in correlation with Dieffenderfer Ware, one interpretation might be that the site was sporadically occupied by Allegan Tradition groups, but was predominantly used by people whose ceramics imply a deviance from the local social and economic structures (i.e., Dieffenderfer Ware represents an intrusion). Generally, few vessels from any of the sites in this study were excavated from feature context, but Allegan Ware vessels from the 46th Street and Fennville sites were rarely found in features. This may be the result of Allegan Ware's primary use as a storage vessel as opposed to Dieffenderfer Ware's function as a cooking pot. However, the paucity of data concerning this stage of the *chaine operatoire* makes this interpretation tenuous.

Synthesis of the *Chaine Operatoire* and the Social Agency of the Producers of Dieffenderfer Ware and Allegan Ware

Documenting the differing life histories of Dieffenderfer Ware and Allegan Ware provides the best data for interpreting the social relations embedded in the artifacts. When the stages of the *chaine operatoire* are put back together again, the social picture becomes clearer. Many of the interpretations concerning technical choices are not conceived of by the potter in the same ways described in this research; rather, through observation and practice over time, potters develop the knowledge and skill required to produce the desired types of pots (Rye 1976). These “desires,” to some degree, can be identified and interpreted by archaeologists.

All of the stages, with the exception of vessel discard, exhibited more differences than similarities. Differences between Dieffenderfer Ware and Allegan Ware include mineralogical content, quantity of inclusions and voids, grain size, wall thickness, orifice diameter, presence of collars and castellations, exterior surface treatment, decorations, interior and exterior color, presence of sooting, residue, and scraping. Similarities include maximum inclusion size, rim and lip modes, interior surface treatments, hardness, and vessel discard. It is easy to see that there are more differences than similarities between Dieffenderfer Ware and Allegan Ware (see Table 6.1).

These comparisons support suggestions about the producers of these pottery types concerning the socio-economic structures that guided their lives toward different means and ends. Differences in inclusion types and density were likely conscious choices that exemplify the technical knowledge to create a “good” pot that accommodates personal and group needs. Potters creating Dieffenderfer Ware refrained from adding too much temper for numerous reasons. One of the reasons not yet discussed is that gritty clay makes it difficult to decorate pottery (Rye 1976, 1981), which was of particular importance to the producers of Dieffenderfer Ware. In contrast, higher inclusion densities, like those found in Allegan Ware, lower the necessary drying time and it follows that pots can even be produced in cold

Differences	Similarities
Mineralogical Content	Maximum Inclusion Size
Quantity of Inclusion	Rim Mode
Quantity of Voids	Lip Mode
Grain Size	Interior Surface Treatment
Wall Thickness	Hardness
Orifice Diameter	Vessel Discard
Frequency of Collars	
Frequency of Castellations	
Exterior Surface Treatment	
Decorations	
Interior Color	
Exterior Color	
Frequency of Exterior Sooting	
Frequency of Interior Residue	
Frequency of Interior Scraping	

Table 6.1 Identified Similarities and Differences between Dieffenderfer Ware and Allegan Ware

weather (Arnold 1985). Another reason for using particular inclusions was awareness of the sort of stresses that vessels would most often encounter.

In order to prepare for those stresses, potters were selective about what they added to the clay and how they constructed their pots. The producers of Dieffenderfer Ware sought vessels that could withstand repeated thermal stresses. They did this by using clays with inclusions that have low thermal expansion rates, low to moderate degrees of porosity, thinner vessel walls, and perhaps decorations. Alternatively, the producers of Allegan Ware may have best prepared for thermal stresses by constructing porous, cordmarked pottery. Even though Allegan Ware's primary function was likely storage, certain measures appear to have been taken to create a multi-purpose vessel suited to their needs.

It does not appear that resistance to mechanical stress was particularly important to these potters. Although Dieffenderfer Ware and Allegan Ware did not exhibit differences in hardness, that may be the product of the former's primary function of cooking, which would increase vessel hardness (Rice 1987). The latter contains significantly higher densities of inclusions, which was most likely a conscious effort to create a durable pot. Allegan Ware's walls, being slightly thicker, were likely another mean to a similar end.

There are some indications that Allegan Ware was easier to transport, suggesting that its producers were relatively more mobile. It is always cordmarked and vessel size (inferred from data on orifice diameter) is likely smaller; two advantageous qualities for carrying pots. An interesting observation of vessel discard may also support this claim. Ethnographic studies have suggested that the quantity of pottery does not have much to do with the number of people living on a site (Longacre 1991), although it may be the product of longer duration of on-site occupations. Keeping this mind, the occurrence of only five vessels of Allegan Ware at Dieffenderfer may be the result of those people taking their pots with them, considering the dramatic differences in vessel quantities when compared to the 46th Street and Fennville sites.

Characteristics exhibited in all stages of the *chaine operatoire* suggest that the producers of Dieffenderfer Ware and Allegan Ware were occupying the same territory, but were producing ceramics in different ways, which correlate with and reproduce the social and economic structures in which they were created. Stark differences between these two ceramic types suggest that Diefferenderfer Ware is intrusive and therefore non-local. Hence, one might expect that a non-local group would be interested in expressing its identity through exterior surface treatment and decoration (see Johnson 2000; Wobst 1977). Archaeological research of social identity and its material expressions are very complex (see Hodder 1982; Jones 1997; Shennan 1989a).

The theory used in this research reminds us that the material culture archaeologists study was originally in the hands of the people who constructed and used it. The *chaine operatoire* model outlines an artifact's life and suggests that different people will produce and use goods in different ways. Sackett (1977, 1982, 1990) suggests that ethnicity is most likely "recorded" in how an artifact is formed, rather than how it is decorated. Characteristics like cordmarking or vessel wall thickness were invariably produced by learned gestures (or actions) performed within the *habitus*. Identifying these characteristics is equivalent to identifying those gestures, which are intimately tied to social structures (i.e., learning mechanisms). By examining Allegan Ware, a known local pottery type, I establish what "normal" pottery looks like. Identifying agency in the archaeological record is not just about recording variation; it is about identifying what variation is not "normal."

Dieffenderfer Ware is certainly different than Allegan Ware. Ceramics inform archaeologists about more than just what pots looked like in the past; they also inform us about aspects of their producer's social and economic structures (see Arnold 1985). Those aspects have been documented and organized via the *chaine operatoire* model above. The producers of Dieffenderfer Ware clearly procure their resources from different areas. Although it is difficult to specifically identify temper from natural inclusions, it appears that the producers of Allegan Ware added more grit (and perhaps organic material) to their clay. Dieffenderfer Ware is morphologically different: it is collared; larger; exhibits less intra-type variation in rim and lip mode; thinner-walled; and possessed more intra-type variation in exterior surface treatments. It is also decorated differently and more often. Allegan Ware appears to have been used differently. Primarily a storage vessel (perhaps for water), Allegan Ware was probably easier to transport as well; whereas Dieffenderfer Ware was primarily a cooking vessel. These differences suggest that the producers of Dieffenderfer Ware were non-local people operating within different social and economic structures.

Part of the economic structures evident in ceramics concerns subsistence. The means of subsistence exhibited in Dieffenderfer Ware and Allegan Ware appear to be different. Dieffenderfer Ware vessels are built for repeatedly boiling water (and obviously food). A couple of kernels of corn were recovered from Dieffenderfer, indicating that maize was cooked and consumed on-site, which supports this assertion (Cremin and Desjardins 2001). This may not seem like a lot, but any corn at all is rare in Michigan at this time (Parker 1996), thus further supporting a significant difference in lifestyle. However, given the similar environments and hence similar overall subsistence goods available at Dieffenderfer, 46th Street, and Fennville, it emphasizes the differences in technical choices. In other words, even though the producers of Dieffenderfer and Allegan Ware are most likely procuring similar foods, their cooking (and likely processing) of those foods is different and evident in their ceramics.

Rogers (1971) argues that very little intra-type homogeneity in Allegan Ware from the 46th Street and Fennville sites suggests that the producers were most likely part of a patrilineal kinship system (i.e., mothers and daughters were split up after marriage, thus limiting their interaction with each other resulting in greater intra-type variation [see Deetz 1965]). Since Dieffenderfer Ware exhibits greater intra-type homogeneity (Steeby 1997), it would follow that its producers were most likely part of a matrilineal kinship system. Therefore, different kinship systems may have contributed to the variation exhibited when Dieffenderfer Ware and Allegan Ware are compared.

Algonquian and Iroquoian Technical Preferences?

Other archaeologists (e.g., Chilton 1996; Pretola 2000; Stothers 1978) have documented material differences in Algonquian and Iroquoian pottery in the Northeast. These studies are often aided by ethnohistoric sources to support their conclusions. Using these studies as models, I compared the relationship of Dieffenderfer Ware and Allegan Ware to the relationship of Algonquian and Iroquoian pottery elsewhere. I found that some correlations exist, whereas others do not.

The interpretation of Dieffenderfer Ware as a larger cooking vessel and Allegan Ware as a smaller, transportable storage vessel seems to correlate with Chilton's (1996, 1998) prescription for Iroquoian and Algonquian ceramics. Specifically, Pretola (2000) identifies olivine as a preferred temper type of Iroquoian pottery and a distinctive characteristic as such. Olivine is only found in significant quantities in Dieffenderfer Ware. Allegan Ware's high porosity increases resistance to thermal stress, but is not beneficial for repeated heating and cooling (Rice 1987: 230). This would be an advantageous trait for a multi-purpose vessel utilized by Algonquian people. The interpretation that Dieffenderfer Ware is likely produced by a matrilineal kinship system, as opposed to a patrilineal kinship system inferred from Allegan Ware, would correlate with how kinship in Iroquoian and Algonquian societies is typically organized (Chilton 1996, 1998; Rogers 1971; Snow 1994).

Chilton (1996, 1998) found that Algonquian pottery was typically harder and contained more variation in inclusions. This was because potters were mobile, made pots with clays from numerous locales, and subsequently transported them. However, intra-site homogeneity in Allegan Ware was observed. Perhaps pots are not typically carried because clay resources are readily available at the Dieffenderfer, 46th Street and Fennville sites. Inter-type vessel hardness was also similar and, as previously stated, is difficult to interpret. However, in general, there are more similarities than differences when comparing the relationships of Dieffenderfer Ware and Allegan Ware to Iroquoian and Algonquian pottery.

CHAPTER VII

CONCLUSION

Dieffenderfer Ware is an anomaly that begs for an interpretation. The interpretations offered in the last chapter are not matters of fact. They are simply one turn in the hermeneutic circle which will be reinterpreted in due time. "There's more than one way to skin a cat," is a phrase used to explain why the *chaine operatoire* model is a productive form of archaeological research (see Sillar and Tite 2000). It ideally allows archaeologists to identify numerous choices that contributed to and affected the production and use of material culture. Different potters living different lives will produce different pottery and different archaeologists using different theories will produce different interpretations.

Dieffenderfer Ware is very different from the locally produced Allegan Ware, hence the conclusion that the producers of the former are indeed non-local. But ceramics, perhaps more so than other material remains of past technologies, inform the present about a dynamic past enabled and constrained by social and economic structures. Technology, and specifically pottery, is the material manifestation of individuals acting and interacting as members of social groups. Investigation of artifacts need not involve the separation of those artifacts from the people that produced them. Research on social agency seeks to understand who those people were, how they lived, and how different people came up with different solutions to similar problems.

Archaeologists often consider decorations to be the prime indicator of social identity (or ethnicity, if you will), but Sackett (1977, 1982, 1990) has profoundly suggested that the trajectory of production (i.e., the series of steps or decisions, each choice affected by the previous one) is a better indicator. It is much more difficult to change the way one makes a pot than to change the way one decorates it. The concept of isochrestic variation (i.e., the spectrum of equivalent alternatives), applied to an artifact's entire "life" (and not just to artifact production), is the logic behind the *chaine operatoire*. If one accepts the premise that different people construct and use pottery in different ways, the *chaine operatoire* model will likely be useful in identifying those differences.

People, or agents, are not programmed to produce artifacts in specific ways and how they *are* produced not only provides insight into past technologies, but also into the social and economic structures from which they emanate. Ideas about what exactly agency is and how it applies to archaeology has often been misconstrued. Sillar and Tite (2000) describe it well in saying that agency is not so much what one individual had done, but how a group or society had adopted one technique when others could have been used. Agency (i.e., the actions of agents) can be identified through variations in the *chaine operatoire*, which represent the different choices, gestures and activities of different people. Practice theory suggests that structure and agency exist in a dialectical relationship and therefore, if the actions of agents can be identified, so can the structures (or at least aspects of them).

After examining all of the stages of the *chaine operatoire*, there are far more differences between Dieffenderfer Ware and Allegan Ware than there are similarities. Different social groups will produce and use ceramics in different ways and therefore, these differences reflect choices made by different peoples and the technical knowledge and capabilities necessary to construct a pot that "works" well. The producers of Dieffenderfer Ware preferred clays with different properties, formed their pots differently and used them differently. The clay in both pottery types was likely procured from two different sources. Dieffenderfer Ware may have been cleaned and kneaded more than Allegan ware, but more grit temper was added to the latter. The walls of Dieffenderfer Ware are thinner and are also generally larger. They are always collared and often castellated, which is in stark contrast to Allegan Ware. Dieffenderfer Ware's surfaces are generally redder and darker and often decorated while Allegan Ware was comparatively more yellow and lighter. Dieffenderfer Ware also exhibits much more direct evidence of cooking than Allegan Ware does. Thus, Dieffenderfer Ware appears to be primarily a cooking pot; its lower density of inclusions as well as its generally larger size, suggests that these vessels were less durable which likely corresponded with a semi-sedentary settlement pattern. In contrast, Allegan Ware appears to be a more multi-functional vessel and is generally smaller so as to better facilitate seasonal mobility. Sackett's (1977, 1982, 1990) theories would suggest that two ethnic groups are represented in this data.

It is possible that Dieffenderfer Ware is indeed the product of an Iroquoian intrusion, most likely stemming from southern Ontario or southeastern Michigan (see Steeby 1997). However, claims of ethnicity are riddled with complexity because social boundaries are never fixed (Jones 1997; Shennan 1989b). Ethnic identities are shifting, situational, subjective and rooted in daily practice and tradition, hence they are difficult to identify (Jones 1997). However, without debating the validity of the archaeological culture concept, this assessment of Dieffenderfer Ware, in light of other research on Iroquoian/Algonquian social and material differences, is still suggested.

This research has also supported the utility of a newly created ceramic type, Dieffenderfer Ware (Steeby 1997). Typologies are important for archaeologists to create, but they are not to be accepted and reified, but tested and augmented as new evidence is brought to bear (Arnold 1999; Chilton 1996, 1998). However, Dieffenderfer Ware's validity as a typological unit will not be confirmed until it is proven to be unique after a broad inter-site analysis.

There are other avenues of research that could help contribute to a better understanding about the producers of Dieffenderfer Ware. Inter-site comparison would be one way to correlate ceramic affinities. Steeby (1997) has already identified examples of similar ceramics at the Kline I and Worley sites. Other good places to look may be in the six sites in northern Indiana and northwestern Illinois that Stothers (1993: 11 and Stothers et al. 1994: 162-163) suggests represent an Iroquoian migration associated with the Western Basin Tradition. Also, Dobres (2000) suggests that different social groups will produce various artifact classes differently. Therefore, it would be advantageous to examine, for example, the lithic assemblage at Dieffenderfer. If Dieffenderfer Ware really represents a non-local intrusion, it should follow that the lithic assemblage at Dieffenderfer should also exhibit differences from local stone tool technologies. Other research questions worth posing would be, why were the Iroquois moving westward after A.D. 1000? What else do we know about this movement of people, goods, or ideas from Ontario and the western basin of Lake Erie? Cultural affinities should also be looked for in southeastern Michigan, particularly Dieffenderfer Ware's potential association with the Younge Tradition (Brashler et al. 1997).

This research has made some significant contributions to archaeological theory and method which will further our understandings concerning ceramic studies, Michigan pre-contact history and agency. The *chaine operatoire* has more often been used in lithic analyses (e.g., Dobres 2000; Edmonds 1990; Sellet; 1993), but has also guided some ceramic studies (e.g., Dietler and Herbich 1998; Gosselain 1998). I find the *chaine operatoire* is especially significant in the latter because it highlights the numerous choices and stages involved in the additive process of producing and using ceramics ranging from resource procurement to vessel discard. The research ideally provides an example of how the *chaine operatoire* can be utilized and carried out in Great Lakes archaeology, specifically regarding ceramic studies.

This study has also furthered an understanding of the social dynamics that existed in the southern lower peninsula of Michigan. Some of the nuances of Michigan's culture history, particularly during the Woodland period, have been described in order to provide a context for the research as well as to detail the ceramic developments that occurred during those times. This research will have contributed to Michigan's pre-contact history by creating a model for investigating other potential non-local anomalies, if one buys into the notion that social or group identity are primarily found in instrumental form rather than adjunct form.

This is the first time theories about agency or the *chaine operatoire* have been utilized in a study of Michigan archaeology. This research has provided a clear description of what agency is and how it can be examined in the archaeological record. It also has demonstrated a unique way to operationalize the *chaine operatoire*, which highlighted the human agency involved in pottery production. Other theories and methods (e.g., Sackett's [1977, 1991] concept of isochrestic variation, Chilton's [1996] and Pretola's [2000] models for differentiating Iroquoian and Algonquian pottery, and Dobres' [2000] integration of practice theory into agency and the *chaine operatoire*) were combined to create the theretical framework and research methods used in this study.

Different theories will bring to light different facets of information concerning the same artifacts. Theory provides a framework for collecting and interpreting data. Social agency, if it is to be properly researched, must be stated mentally and textually from the beginning and not impulsively added on at the end (Dobres 1995; 1999b). The conclusions of this research should, in theory, be tested and re-tested again as we move up the hermeneutic spiral advancing our knowledge of the subject. Also, these conclusions *are not* trend setting and *do not* represent the type of study that ranks higher on an imagined theoretical hierarchy in which I will later attempt to convert followers to my views. Rather, this study represents a complement to previous studies in an attempt to broaden both our understanding of Great Lakes archaeology and the *many* theoretical "lenses" archaeologists can use to study the archaeological record.

REFERENCES CITED

Arnold, D.E.
1985 *Ceramic Theory and Cultural Process*. Cambridge: Cambridge University Press.

Arnold, P.J. III
1999 On Typology, Selection, and Ethnoarchaeology in Ceramic Production Studies. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture*. E.S. Chilton, ed. pp.103-117. Salt Lake City: The University of Utah Press.

Barclay, K.
2001 *Scientific Analysis of Archaeological Ceramics: A Handbook of Resources*. Oxford: The Information Press.

Barrett, J.C.
2000 A Thesis on Agency. In *Agency in Archaeology*. M.-A. Dobres and J. E. Robb, eds. pp. 61-68. London: Routledge.

Bell, J.
1992 On Capturing Agency in Theories About Prehistory. In *Representations in Archaeology*. J.-C. Gardin and C. Peebles, eds. pp. 30-55. Bloomington: Indiana University Press.

Bettarel, R. and H. Smith
1973 *The Moccasin Bluff Site and the Woodland Cultures of Southwestern Michigan*. Anthropological Papers No. 49. Museum of Anthropology, University of Michigan, Ann Arbor

Binford, L.R.
1965 Archaeological Systematics and the Study of Culture Process. *American Antiquity* 31(2): 203-210.

Bourdieu, P.
1977 *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.

Brashler, J.G.
1978 *Boundaries and Interaction in the Early Late Woodland of Southern Lower Michigan*. Ph.D. dissertation, Michigan State University. University Microfilms, Ann Arbor, Michigan.

Brasher J.G., E.B. Garland, M.B. Holman, W.A. Lovis, and S.R. Martin
1997 Adaptive Strategies and Socioeconomic Systems in Northern Great Lakes Riverine Environments: The Late Woodland of Michigan. In *Late Woodland Societies: Tradition and Transformation Across the Midcontinent*. T.E. Emerson, D.L. McElrath, and A.C. Fortier, eds. pp. 543-579. Lincoln: University of Nebraska Press.

Braun, D.P.
1983 Pots as Tools. In *Archaeological Hammers and Theories*, J.A. Moore and A.S. Keene, eds. pp. 107-134. New York: Academic Press.

Brumfiel, E.M.
2000 On the Archaeology of Choice: Agency Studies as a Research Stratagem. In *Agency in Archaeology*. M.-A. Dobres and J.E. Robb, eds. pp. 247-256. London: Routledge.

Chilton, E.S.
1996 *Embodiments of Choice: Native American Ceramic Diversity in the New England Interior*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Massachusetts, Amherst.
1998 The Cultural Origins of Technical Choice: Unraveling Algonquian and Iroquoian Ceramic Traditions in the Northeast. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 132-160. Washington: Smithsonian Institution Press.
1999 One Size Fits All: Typology and Alternatives for Ceramic Research. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture*. E.S. Chilton, ed. pp. 44-60. Salt Lake City: The University of Utah Press.

Cleland, C.E.
1999 Cultural Transformation: The Archaeology of Historic Indian Sites in Michigan, 1670-1940. In *Retrieving Michigan's Buried past: The Archaeology of the Great Lakes State*. J.R. Halsey, ed. pp. 279-289. Bloomfield Hills, MI: Cranbrook Institute of Science.

Conkey, M.W.
1989 The Place of Material Culture Studies in Contemporary Anthropology. In *Perspectives on Anthropological Collections from the American Southwest: Proceedings of a Symposium*, A.L. Hedlund, ed. pp.13-32. Anthropological Research Paper no. 40. Arizona State University, Tempe.
1990 Experimenting with Style in Archaeology: Some Historical and Theoretical Issues. In *The Uses of Style in Archaeology*. M.W. Conkey and C.A. Hastorf, eds. pp. 5-17. Cambridge: Cambridge University Press.

Conkey, M.W. and C.A. Hastorf (eds.)
1990a *The Uses of Style in Archaeology.* Cambridge: Cambridge University Press.

Conkey, M.W. and C.A. Hastorf
1990b Introduction. In *The Uses of Style in Archaeology*. M.W. Conkey, and C.A. Hastorf, eds. pp. 1-4. Cambridge: Cambridge University Press.

Cowgill, G.L.
2000 "Rationality" and Contexts in Agency Theory. In *Agency in Archaeology*. M-A. Dobres and J. E. Robb, eds. pp. 51-60. London: Routledge.

Cremin, W.M.
1999 Upper Mississippian Adaptation: The View from Southwestern Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. J.R. Halsey, ed. pp. 265-271. Bloomfield Hills, MI: Cranbrook Institute of Science.

Cremin, W.M. and A. DesJardins
2001 Dieffenderfer: A Late Woodland "Ditched" Hamlet in Southwest Michigan. Paper Presented at the Annual Meeting of the Society for American Archaeology. New Orleans, LA.

Deetz, J.
1965 *The Dynamics of Stylistic Change in Arikara Ceramics*. Urbana: University of Illinois Press.

Dietler, M. and I. Herbich
1989 *Tich Matek*: The Technology of Luo Pottery Production and the Definition of Ceramic Style. *World Archaeology* 21(1): 148-164.
1998 *Habitus*, Techniques, Style: An Integrated Approach to the Social Understanding of Material Culture and Boundaries. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 232-263. Washington: Smithsonian Institution Press.

Dobres, M.-A.
1995 Gender and Prehistoric Technology: On the Social Agency of Technical Strategies. *World Archaeology* 27(1): 25-49.
1999a Of Paradigms and Ways of Seeing: Artifact Variability as if People Mattered. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture*. E.S. Chilton, ed. pp. 7-23. Salt Lake City: The University of Utah Press.
1999b Technology's Links and *Chaines*: The Processual Unfolding of Technique and Tradition. In *The Social Dynamics of Technology: Practice, Politics, and World Views*. M.-A. Dobres and C.R.

Hoffman, eds. pp.124-146. Washington: Smithsonian Institution Press.

2000 *Technology and Social Agency: Outlining a Practice Framework for Archaeology*. Malden, Massachusetts: Blackwell Publishers

Dobres, M.-A. and C.R. Hoffman

1994 Social Agency and the Dynamics of Prehistoric Technology. *Journal of Archaeological Method and Theory* 1(3):211-58

1999 Introduction: A Context for the Present and Future of Technology Studies. In *The Social Dynamics of Technology: Practice, Politics, and World Views*. M.-A. Dobres and C.R. Hoffman, eds. pp. 1-19. Washington: Smithsonian Institution Press.

Dobres, M.-A.. and Robb, J.E. (eds.)

2000a *Agency in Archaeology*. London: Routledge.

Dobres, M.-A. and Robb, J.E.

2000b Agency in Archaeology: Paradigm or Platitude? In *Agency in Archaeology*. M-A. Dobres and J. E. Robb, eds. pp. 3-18. London: Routledge.

Drake, E.C.

2001 *Exploring the Social Dimensions of Grog-temper Use at the Ink Bayou Site (3PU252) : a Plum Bayou Culture Site in Central Arkansas*. Master's thesis, Department of Anthropology, Western Michigan University, Kalamazoo.

Edmonds, M.

1990 Description, Understanding and the Chaine Operatoire. *Archaeological Review from Cambridge* 9(1): 55-70.

Fitting, J.E.

1965 *Late Woodland Cultures of Southeastern Michigan*. Anthropological Papers No.24. Museum of Anthropology, University of Michigan.

1970 *The Archaeology of Michigan: A Guide to the Prehistory of the Great Lakes Region*. Garden City, New York: The Natural History Press.

Fitting, J.E., J.R. Halsey, and H.M. Wobst

1968 *Contributions to Michigan Archaeology*. Anthropological Papers No. 32. Museum of Anthropology, University of Michigan, Ann Arbor.

Garrett, E.M.

1982 *A Petrographic Analysis of Ceramics from Apache-Sitgreaves National Forests, Arizona: Onsite or Specialized Manufacture?* Ph.D dissertation, Department of Anthropology, Western Michigan University, Kalamazoo.

Garland, E.B., C.P. Clark, M.J. Higgins, and K.E. Parker
1990 The Wymer Site (20BE132). In *Late Archaic and Early Woodland Adaptation in the Lower St. Joseph River Valley. Berrien County, Michigan*. E.B. Garland, ed. pp. 236-290. Lansing: State of Michigan, Michigan Cultural Resource Investigation Series, Volume 2.

Garland, E.B. and S.G. Beld
1999 The Early Woodland: Ceramics, Domesticated Plants, and Burial Mounds Foretell the Shape of the Future. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. J.R. Halsey, ed. pp. 125-146. Bloomfield Hills, MI: Cranbrook Institute of Science.

Griffin, J.B. (ed.).
1961 *Lake Superior Copper and the Indians: Miscellaneous Studies of Great Lakes Prehistory*. Anthropological Papers No. 17. Museum of Anthropology, University of Michigan, Ann Arbor.

Griffin, J.B., R.E. Flanders, and P.F. Titterington
1970 *The Burial Complexes of the Knight and Norton Mounds in Illinois and Michigan*. Memoirs of the Museum of Anthropology, No. 2. University of Michigan, Ann Arbor.

Giddens, A.
1984 *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley: University of California Press.

Goodby, R.G.
1998 Technological Patterning and Social Boundaries: Ceramic Variability in Southern New England. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 161-182. Washington: Smithsonian Institution Press.

Gosselain, O.P.
1998 Social and Technical Identity in a Clay Crystal Ball. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 78-106. Washington: Smithsonian Institution Press.

Hally, D.J.
1983a The Interpretive Potential of Pottery from Domestic Contexts. *Midcontinental Journal of Archaeology* 8(2): 163-196.
1983b Use Alteration of Pottery Vessel Surfaces: An Important Source of Evidence in the Identification of Vessel Function. *North American Archaeologist*. 4(1): 3-26.

1986 The Identification of Vessel Function: A Case Study from Northwest Georgia. *American Antiquity* 51(2): 267-295.

Halsey, J.R. (ed.).
1999 *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. Bloomfield Hills, MI: Cranbrook Institute of Science

Hegmon, M.
1992 Archaeological Research on Style. *Annual Review of Anthropology* 21: 517-536.
1998 Technology, Style, and Social Practices: Archaeological Approaches. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 264-280. Washington: Smithsonian Institution Press.

Hinsdale, W.B.
1925 *Primitive Man in Michigan*. Michigan Handbook Series, No.1. University Museum, University of Michigan, Ann Arbor.

Hodder, I.
1982 *Symbols in Action: Ethnoarchaeological Studies of Material Culture*. Cambridge: Cambridge University Press.
1986 *Reading the Past: Current Approaches to Interpretation in Archaeology*. Cambridge: Cambridge University Press.
1990 Style as Historical Quality. In *The Uses of Style in Archaeology*. M.W. Conkey and C.A. Hastorf, eds. pp. 44-51. Cambridge: Cambridge University Press.
1991 Interpretive Archaeology and Its Role. *American Antiquity* 56: 7-18.
1992a Material Practice, Symbolism, and Ideology. In *Theory and Practice in Archaeology*. I. Hodder, ed. pp. 201-212. London: Routledge.
1992b Theory, Practice and Praxis. In *Theory and Practice in Archaeology*. I. Hodder, ed. pp. 1-10. London: Routledge.
2000 Agency and Individuals in Long-term Processes. In *Agency in Archaeology*. M-A. Dobres and J. E. Robb, eds. pp. 21-33. London: Routledge.

Hoffman, C.R. and M.-A. Dobres
1999 Conclusions: Making Material Culture, Making Culture Material. In *The Social Dynamics of Technology: Practice, Politics, and World Views*. M.-A. Dobres and C.R. Hoffman, eds. pp. 209-222. Washington: Smithsonian Institution Press.

Holman, M.B. and J.G. Brashler
1999 Economics, Material Culture, and Trade in the Late Woodland Lower Peninsula of Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes Site*. J.R. Halsey, ed. pp. 212-220. Bloomfield Hills, MI: Cranbrook Institute of Science.

Holman, M.B., J.G. Brashler, and K.E. Parker (eds.).
1996 *Investigating the Archaeological Record of the Great Lakes State: Essays in Honor of Elizabeth Baldwin Garland.* Kalamazoo, MI: New Issues Press. Western Michigan University.

Holman, M.B. and R. Kingsley
1996 Territoriality and Societal Interaction During the Early Late Woodland Period in Southern Michigan. In *Investigating the Archaeological Record of the Great Lakes State: Essays in Honor of Elizabeth Baldwin Garland.* M.B. Holman, J.G. Brashler, and K. Parker, eds. pp. 341-382. Bloomfield Hills, MI: Cranbrook Institute of Science.

Ingold, T.
1993 Tools, Techniques and Technology. In *Tools, Language and Cognition in Human Evolution.* K.R. Gibson and T. Ingold, eds. pp. 337-345. Cambridge: Cambridge University Press.
1999 Forward. In *The Social Dynamics of Technology: Practice, Politics, and World Views.* M.-A. Dobres and C.R. Hoffman, eds. pp. vii-xi. Washington: Smithsonian Institution Press.

Johnson, M.
2000 Self-made Men and the Staging of Agency. In *Agency in Archaeology.* M-A. Dobres and J. E. Robb, eds. pp. 213-231. London: Routledge.

Jones, S.
1997 *The Archaeology of Ethnicity: Constructing Identities in the Past and Present.* London: Routledge.

Joyce, A.A.
2000 The Founding of Monte Alban: Sacred Propositions and Social Practices. In *Agency in Archaeology.* M-A. Dobres and J. E. Robb, eds. pp. 71-91. London: Routledge.

Kingsley, R.G.
1977 *A Statistical Analysis of the Prehistoric Ceramics from the Hacklander Site, Allegan County, MI.* Master's Thesis, Department of Anthropology, Western Michigan University, Kalamazoo. University Microfilms, Ann Arbor, Michigan.
1999 The Middle Woodland Period in Southern Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State.* J.R. Halsey, ed. pp. 148-172. Bloomfield Hills, MI: Cranbrook Institute of Science.

Krakker, James J.
1983 *Changing Sociocultural Systems during the Late Prehistoric Period in Southeast Michigan.* Ph.D. dissertation, University of Michigan. University Microfilms, Ann Arbor.

Lechtman, H.
1977 Style in Technology: Some Early Thoughts. In *Material Culture: Style, Organization, and Dynamics of Technology*. H. Lechtman and R.S. Merrill, eds. pp. 3-20. New York: West Publishing.
1993 Technologies of Power: The Andean Case. In *Configurations of Power in Complex Societies*. J. Henderson and P. Netherly, eds. pp. 244-280. Ithaca, New York: Cornell University Press.

Lemonnier, P.
1986 The Study of Material Culture Today: Towards an Anthropology of Technical Systems. *Journal of Anthropological Archaeology* 5:147-186.
1992 *Elements for an Anthropology of Technology*. Anthropological Papers No. 88. Museum of Anthropology. University of Michigan, Ann Arbor

Longacre, W.A.
1991 Ceramic Ethnoarchaeology: An Introduction. In *Ceramic Ethnoarchaeology*. W.A. Longacre, ed. pp. 1-10. Tucson: University of Arizona Press.

Luedtke, Barbara E.
1976 *Lithic Material Distributions and Interaction Patterns during the Late Woodland Period in Michigan.* Unpublished Ph.D. dissertation, University Microfilms International, Ann Arbor.

Madrigal, L.
1998 *Statistics for Anthropology*. Cambridge: Cambridge University Press.

McAllister, P.W.
1999 Upper Mississippian in Western Lower Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State.* J.R. Halsey, ed. pp. 254-262. Bloomfield Hills, MI: Cranbrook Institute of Science.

Mirti, P.
1998 On the Use of Colour Coordinates to Evaluate Firing Temperatures of Ancient Pottery. *Archaeometry* 40(1): 45-57

Moore, H.L.
2000 Ethics and Ontology: Why Agents and Agency Matter. In *Agency in Archaeology*. M.-A. Dobres and J.E. Robb, eds. pp. 259-263. London: Routledge.

Moorhouse, W.W.
1959 *The Study of Rocks in Thin Section*. New York: Harper and Brothers.

Nassaney, M.S.
2002 Social Archaeology. In *Encyclopedia of Life Support Systems*. Available online by subscription through UNESCO at the World Summit on Sustainable Development in Johannesburg, South. www.eolss.net.

Ortner, S.
1984 Theory in Anthropology Since the Sixties. *Comparative Studies in Society and History* 26:126-166.

Parker, K.E.
1996 Three Corn Kernels and a Hill of Beans: The Evidence for Prehistoric Horticulture in Michigan. In *Investigating the Archaeological Record of the Great Lakes State: Essays in Honor of Elizabeth Baldwin Garland*. M.B. Holman, J.G. Brashler, and K.E. Parker, eds. pp. 307-339. Kalamazoo: New Issues Press, Western Michigan University

Pfaffenberger, B.
1999 Worlds in the Making: Technological Activities and the Construction of Intersubjective Meaning. In *The Social Dynamics of Technology: Practice, Politics, and World Views*. M.-A. Dobres and C.R. Hoffman, eds. pp. 147-164. Washington: Smithsonian Institution Press.

Pollard, A. M. and C. Heron
1996 *Archaeological Chemistry*. Cambridge: The Royal Society of Chemistry.

Porter, J.W.
1984 Thin Section Analysis of Ceramics. In *The Robinson's Lake Site*. G.R. Milner, ed. pp. 133-170. FAI-270 Site Report 10, American Bottom Archaeology. Urbana: University of Illinois Press.

Pretola, J.P.
2000 *Northeastern Ceramic Diversity: An Optical Mineralogy Approach*. Unpublished Ph.D. dissertation. Department of Anthropology. University of Massachusetts, Amherst.

Preucel, R.W.
1991 The Philosophy of Archaeology. In *Processual and Postprocessual Archaeologies: Multiple Ways of Knowing the Past*. R.W. Preucel, ed. pp. 17-29. Center for Archaeological Investigations. Occasional Paper No. 10. Carbondale: Southern Illinois University.

Rice, P.M.
1987 *Pottery Analysis*. Chicago: University of Chicago Press.

Riley, T.J., P. Hopke, R. Martin and J.W. Porter
1994 The Diffusion of Technological Knowledge: A Case Study in North American Ceramic Analysis. In *Ancient Technologies and Archaeological Materials*. S.U. Wisseman and W.S. Williams, eds. pp. 41-58. Langorn, Pennsylvania: Gordon and Breach Science Publishers.

Rogers, M.B.
1971 *The 46th Street Site and the Occurrence of Allegan Ware in Southwestern Michigan*. Master's thesis, Department of Anthropology, Western Michigan University, Kalamazoo.

Rye, O.S.
1976 Keeping Your Temper Under Control: Materials and the Manufacture of Papuan Pottery. *Archaeology and Physical Anthropology in Oceania*. 11(2): 106-137.
1981 *Pottery Technology: Principles and Reconstruction*. Washington, D.C.: Taraxacum Inc.

Sackett, J.R.
1977 The Meaning of Style in Archaeology: A General Model. *American Antiquity* 42: 369-380.
1982 Approaches to Style in Lithic Archaeology. *Journal of Anthropological Archaeology* 1(1): 59-112.
1990 Style and Ethnicity in Archaeology: The Case for Isochrestism. In *The Uses of Style in Archaeology*. M.W. Conkey and C.A. Hastorf, eds. pp. 32-43. Cambridge: Cambridge University Press.

Sassaman, K.A.
2000 Hunter-Gatherers and Agency. In *Agency in Archaeology*. M-A. Dobres and J.E. Robb, eds. pp. 148-168. London: Routledge

Schiffer, M.B. and J.M. Skibo
1997 The Explanation of Artifact Variability. *American Antiquity* 62(1): 27-50.

Sellet, F.
1993 Chaine Operatoire; The Concept and its Applications. *Lithic Technology* 18: 106-112.

Shanks, M. and I. Hodder
1998 Processual, Postprocessual and Interpretive Archaeologies. In *Reader in Archaeological Theory: Post-Processual and Cognitive Approaches*. D.S. Whitley, ed. pp. 69-95. London: Routledge.

Shennan, S.J. (ed.)
1989a *Archaeological Approaches to Cultural Identity*. London: Routledge.

Shennan, S.J.
1989b Introduction: Archaeological Approaches to Cultural Identity. In *Archaeological to Cultural Identity*. S.J. Shennan, ed. pp. 1-30. London: Routledge.

Sillar, B. and M.S. Tite
2000 The Challenge of 'Technological Choices' for Materials Science Approaches in Archaeology. *Archaeometry* 42(1): 2-20.

Sinclair, A.
2000 Constellations of Knowledge: Human Agency and Material Affordance in Lithic Technology. In *Agency in Archaeology*. M.-A. Dobres and J.E. Robb, eds. pp. 196-212. London: Routledge.

Snow, D.R.
1994 *The Iroquois*. Oxford: Blackwell.

Spectrum Petrographics, Inc.
http://www.petrography.com

Stanislawski, M.B.
1978 If Pots Were Mortal. In *Explorations in Ethnoarchaeology*. R. Gould, ed. pp. 201-228. University of New Mexico Press, Albuquerque.

Stark, M.K.
1998a *The Archaeology of Social Boundaries*. (ed.) Washington: Smithsonian Institution Press.
1998b Technical Choices and Social Boundaries in Material Culture Patterning: An Introduction. In *The Archaeology of Social Boundaries*. M.T. Stark, ed. pp. 1-11. Washington: Smithsonian Institution Press.
1999 Social Dimensions of Technical Choice in Kalinga Ceramic Traditions. In *Material Meanings: Critical Approaches to the*

Interpretation of Material Culture. E.S. Chilton, ed. pp. 24-43. Salt Lake City: The University of Utah Press.

Steeby, M.A.
1997 *A Statistical Analysis of Ceramics from the Dieffenderfer Site (20SJ179), St. Joseph County, Michigan*. Master's thesis, Department of Anthropology, Western Michigan University, Kalamazoo.

Stoltman J.B.
1989 A Quantitative Approach to the Petrographic Analysis of Ceramic Thin Sections. *American Antiquity* 54(1): 147-160.
1991 Ceramic Petrography as a Technique for Documenting Cultural Interaction: An Example from the Upper Mississippi Valley. *American Antiquity* 56(1): 103-120.

Stothers, D.M.
1975 The Emergence and Development of the Younge and Ontario Iroquois Traditions. *Ontario Archaeology* 25: 21-27.
1978 The Western Basin Tradition: Algonquin or Iroquois? *The Michigan Archaeologist* 24: 11-36.
1993 The "Michigan Owasco" and the Iroquois Co-Tradition: Late Woodland Conflict, Conquest, and Cultural Realignment in the Western and Lower Great Lakes. *Northeast Anthropology* 49: 5-41.
1999 Late Woodland Models for Cultural Development in Southern Michigan. In *Retrieving Michigan's Buried Past: The Archaeology of the Great Lakes State*. J.R. Halsey, ed. pp. 194-211. Bloomfield Hills, MI: Cranbrook Institute of Science.

Stothers, D.M., J.R. Graves, S.K. Bechtel, and T.J. Abel
1994 Current Perspectives on the Late Prehistory of the Western Lake Erie Region and a Reply to Murphy and Ferris. *Archaeology of Eastern North America* 22: 135-196.

Tilley, C.
1999 *Metaphor and Material Culture*. Oxford: Blackwell Publishers.

Van der Plas, L. and A.C. Tobi
1965 A Chart for Judging the Reliability of Point Counting Results. *American Journal of Science* 263: 87-90.

Wiessner, P.
1990 Is There a Unity to Style? In *The Uses of Style in Archaeology*. M.W. Conkey and C.A. Hastorf, eds. pp. 105-112. Cambridge: Cambridge University Press.

White, A.M., L.R. Binford, and M.L. Papworth.
1963 *Miscellaneous Studies in Typology and Classification.* Anthropological Papers No. 19. Museum of Anthropology, University of Michigan, Ann Arbor.

Wobst, H.M.
1977 Stylistic Behavior and Information Exchange. In *For the Director: Research in Honor of James B. Griffin.* C. Cleland, ed. pp. 317-342. Anthropological Papers No. 61. Museum of Anthropology, University of Michigan, Ann Arbor.
2000 Agency in (spite of) Material Culture. In *Agency and Archaeology.* M-A. Dobres and J.E. Robb, eds. pp.40-50. London: Routledge.

Yarnell, R.A.
1964 *Aboriginal Relationships Between Culture and Plant Life in the Upper Great Lakes Region.* Anthropological Papers No. 23. Museum of Anthropology, University of Michigan, Ann Arbor.

Appendix A

Data

THESIS DATA COLLECTION SHEETS

VESSEL PROVENIENCE &
MORPHOLOGICAL MEASUREMENTS AND ASSESSMENTS

Dieffenderfer Ware

Vessel #	Type	Catalogue#	Test Unit	Provenience	Feature #
3	Dec.var.CdTlImprsd		Jones Collection		
22	Dec.var.CdTlImprsd	93-76	35	9S, 23.5E	
43	Dec.var.CdTlImprsd		Jones Collection		
58	Dec.var.CdTlImprsd	95-217	104QdB	10S, 27E	
66	Dec.var.CdTlImprsd	95-322	100	5N, 5E	13
70	Dec.var.CdTlImprsd	95-198,199	107QdA,S.ext.	8S, 31.5E	
71	Dec.var.CdTlImprsd	95-198	107QdA,S.ext.	8S, 31.5E	
63	Dec.var.Incised	95-294,314	100QdD	5N, 5E	10
44	Dec.var.Push-Pull	93-116	53	10S, 5E	4
88	Dec.var.Push-Pull		Jones Collection		
45	Dec.var.CrdTlPnctte	93-116	53	10S, 5E	4
76	Dec.var.CrdTlPnctte	95-329	111 Ext.	12N, 7.5E	17
89	Dec.var.CrdTlPnctte		Jones Collection		
4	Undec.vr.SmdCrmd		Jones Collection		
33	Undec.vr.SmdCrmd		Jones Collection		
36	Undec.vr.SmdCrmd	93-104	48	8S, 9E	
39	Undec.vr.SmdCrmd	93-116	53	10S, 5E	4
61	Undec.vr.SmdCrmd	95-208	99QdD	19S, 25.5E	
65	Undec.vr.SmdCrmd	95-334	100QdD	5N, 5E	10
69	Undec.vr.SmdCrmd	95-142	106QdD	1N, 16.5E	
73	Undec.vr.SmdCrmd	95-241	107QdD	8S, 31.5E	
75	Undec.vr.SmdCrmd	95-157	110QdB	11N, 15E	
79	Undec.vr.SmdCrmd	95-215,232,236	116QdA,123QdC		
80	Undec.vr.SmdCrmd	95-192,193	123Qd.C	6S, 29.5E	
8	Undec.vr.Crdmrkd	93-15	4	3S, 6E	
23	Undec.vr.Crdmrkd	93-87	39	8S, 27.5E	
32	Undec.vr.Crdmrkd	93-98	40 S.ext.	18S, 26.3E	
52	Undec.vr.Crdmrkd	95-30	67	8S, 27E	
59	Undec.vr.Crdmrkd	95-65	94	16N, 5E	
72	Undec.vr.Crdmrkd	95-241,244,271	107,123QdD	8S,31.5E; 6S,29.5E	
81	Undec.vr.Crdmrkd		Jones Collection		
82	Undec.vr.Crdmrkd		Jones Collection		
84	Undec.vr.Crdmrkd		Jones Collection		
85	Undec.vr.Crdmrkd		Jones Collection		
86	Undec.vr.Crdmrkd		Jones Collection		
25	Undec.vr.Plain	93-87,95-192	39, 123QdC	8S,27.5E; 6S,29.5E	
2	Undec.vr.FbcImprsd	93-6	1,E.ext; Jones	3.1S, 0.06E	
14	Undec.vr.FbcImprsd	93-36	10	11S, 10E	
24	Undec.vr.FbcImprsd	95-31,32,42,306	68Qds A,D	8S, 29.5E	9, Zone A

Dieffenderfer Ware

	in mm		in mm	in mm	in mm
Vessel #	Wl Thkns	ExtSurfcTrtmnt	CllrThkns	Collar Hgt.	Max.InclSz
3	6.6	Cd.Imp.Incsd	13.3	25.7	4.8

22	10.7	Corded.Imprsd	15.8	21.1	4.2
43	7.2	Corded.Imprsd	10.5	20.0	5.6
58	6.8	Corded.Imprsd	7.5	11.9	1.8
66	7.3	Corded.Imprsd	8.9	12.6	4.8
70	7.0	Corded.Imprsd	13.1	31.9	2.9
71	8.0	Corded.Imprsd	13.2	20.8	5.3
63	5.9	Cd.Pct.Incd	10.3	26.8	4.2
44	5.6	Corded.Imprsd	6.8	13.1	2.5
88	5.1	Corded.Imprsd	7.0	13.6	3.1
45	6.7	Corded.Pctate	10.2	15.6	3.1
76	6.1	Corded.Pctate	12.5	21.9	3
89	6.4	Corded.Pctate	9.5	19.5	4
4	7.0	Cdmrkd	9.6	30.6	5.1
33	8.2	Cdmrkd	12.5	18.7	3.3
36	na	na	10.6	18.0	3.1
39	4.5	Cdmrkd	7.8	12.7	3
61	8.3	Cdmrkd	11.8	19.0	8.7
65	na	Cdmrkd	11.0	20.5	4.2
69	11.0	Cdmrkd	14.5	24.5	4.3
73	9.0	Cdmrkd	12.8	22.8	4.3
75	7.2	Cdmrkd	14.0	30.3	3.3
79	6.7	Cdmrkd	14.0	31.9	3.5
80	6.6	Cdmrkd	14.8	30.9	8
8	na	Cdmrkd	12.3	23.1	3.7
23	na	Cdmrkd	12.0	21.5	4.9
32	6.8	Cdmrkd	11.1	17.2	3.1
52	na	Cdmrkd	11.0	22.1	4
59	na	Cdmrkd	7.8	23.0	4.2
72	7.1	Cdmrkd	10.0	27.1	7.4
81	8.0	Cdmrkd	12.2	18.4	3.2
82	8.0	Cdmrkd	9.4	18.3	2.8
84	6.7	Cdmrkd	11.5	22.1	2.8
85	na	Cdmrkd	10.9	16.6	3.2
86	6.0	Cdmrkd	11.1	32.3	3.8
25	na	Smoothed	13.9	31.3	3.2
2	9.4	FabricImprssd	13.8	38.3	7.3
14	9.8	FabricImprssd	12.0	37.1	4.6
24	7.1	FabricImprssd	14.1	27.2	4.7

Dieffenderfer Ware

Vessel #	Castellated	Collared	Rim/Lip Mode	in mm Oriface Dm.	Hardness
3	Yes	Yes	Everted/Flat	28	3.5
22	No	Yes	Everted/Flat	23	4
43	No	Yes	Everted/Flat	24	4.5
58	na	Yes	Sl.Evrt/Flat	10	3.5
66	No	Yes	Sl.Evrt/Flat	na	4.5
70	No	Yes	Sl.Evrt/Flat	24	4.5
71	No	Yes	Everted/Flat	na	3.5
63	Yes	Yes	Everted/Flat	22	3
44	No	Yes	Sl.Evrt/Flat	na	3.5
88	No	Yes	Sl.Evrt/Flat	na	3.5

45	Yes	Yes	Sl.Evrt/Flat	na	4
76	Yes	Yes	Sl.Evrt/Flat	16	2.5
89	Yes	Yes	Sl.Evrt/Flat	22	3.5
4	No	Yes	Straight/Flat	na	3.5
33	No	Yes	Sl.Inv/Flat	14	5.5
36	No	Yes	Rounded	na	5.5
39	No	Yes	Rounded	na	5
61	No	Yes	Straight/Flat	18	5.5
65	No	Yes	Straight/Flat	na	4
69	No	Yes	Straight/Flat	na	4.5
73	No	Yes	Straight/Flat	na	4
75	No	Yes	Sl.Evrt/Flat	40	3.5
79	No	Yes	Sl.Evrt/Flat	40	3.5
80	No	Yes	Sl.Evrt/Flat	28	4
8	No	Yes	Sl.Evrt/Flat	na	4.5
23	No	Yes	Flat	na	3.5
32	No	Yes	Rounded	na	4
52	No	Yes	Flat	na	4.5
59	No	Yes?	Sl.Invrt/Flat	na	4.5
72	No	Yes	Straight/Flat	30	4.5
81	No	Yes	Sl.Evrt/Flat	na	3
82	No	Yes	Sl.Evrt/Flat	na	3.5
84	Yes?	Yes	Sl.Evrt/Flat	na	5.5
85	Yes?	Yes	Sl.Evrt/Round	na	3
86	No	Yes	Sl.Evrt/Flat	na	3
25	No	Yes	Straight/Flat	28	3.5
2	No	Yes	Straight/Flat	32	4.5
14	No	Yes	Sl.Invrt/Flat	na	4.5
24	No	Yes	Sl.Evrt/Flat	30	3.5

Dieffenderfer Ware

Vessel #	Ext.Color	Int.Color
3	10YR6/4	5YR5/6
22	7.5YR5/4	7.5YR6/4
43	10YR3/3	10YR4/6
58	5YR5/6	5YR4/6
66	10YR6/4	10YR5/4
70	10YR5/4	10YR5/6
71	5YR4/3	10YR3/3
63	7.5YR5/4	5YR5/4
44	7.5YR5/4	10YR3/4
88	5YR4/6	10YR4/3
45	10YR4/4	10YR5/4
76	7.5YR5/4	10YR2/2
89	7.5YR5/3	5YR4/4
4	5YR4/4	7.5YR5/4
33	5YR4/4	5YR3/4
36	7.5YR5/6	7.5YR4/6
39	7.5YR5/6	5YR4/3
61	10YR2/1	10YR2/2
65	7.5YR3/2	5YR4/3

69	5YR4/6	5YR4/4
73	5YR4/6	10YR4/3
75	7.5YR4/3	7.5YR4/4
79	7.5YR4/3	7.5YR4/4
80	5YR5/4	7.5YR4/4
8	7.5YR5/3	7.5YR4/4
23	7.5YR4/4	7.5YR4/4
32	7.5YR5/6	7.5YR5/6
52	7.5YR5/4	7.5YR4/3
59	7.5YR4/4	7.5YR4/2
72	7.5YR5/3	7.5YR5/4
81	10YR5/3	10YR6/3
82	10YR2/1	7.5YR5/3
84	10YR4/2	10YR5/4
85	5YR5/8	10YR5/6
86	10YR5/3	10YR6/4
25	5YR4/6	5YR4/3
2	7.5YR5/4	5YR5/6
14	5YR4/6	5YR5/6
24	10YR3/2	5YR5/4

Allegan Ware Undecorated (from the Dieffenderfer Site)

Vessel #	Type	Catalogue#	Test Unit	Provenience	Feature #
42	var.UndecLip/Cllrd	93-118	53	10S, 5E	4A
49	var.UndecLip/Cllrd	93-119	53	10S, 5E	4B
64	var.UndecLip/Cllrd	95-315	100 QdD	5N, 5E	10
78	var.Undec Lip	95-182	116 QdB	6S, 31.5E	
90	var.Undec Lip		Jones Collection		

Allegan Ware (from the 46th Street site)

Vessel #	Type	Catalogue#	Test Unit	Provenience	Feature #
1	na	na	T.P. 9.1.1	na	
2	na	na	T.P. 5.1.1	na	
4	na	na	G2.1/G2.2/H2.1	na	
5	na	na	T.P. 6.1.1	na	
7	na	na		na	Feature 1.4
14	na	na	G1.1/1.2/1.3/1.4	na	Feature 5
24	na	na	B.2.5	na	
36	na	na	G.1.2	na	

Allegan Ware (from the Fennville site)

Vessel #	Type	Catalogue#	Test Unit	Provenience	Feature #
41	na	na	G-1-2	na	
92	na	na	D-3-3	na	
103	na	na	U-2-1	na	
113	na	na	T.P.12.1	na	
118	na	na	D-1-1	na	
121	na	na	U-2-5	na	
132	na	na	X-1-10	na	

135	na	na	I-1-1	na
152	na	na	D-2,E-1,E-2,E-3-1	na
RN-1	na	na	Not known	na

Presumed Allegan Ware from Fennville Site

Vessel #	Type	Catalogue#	Test Unit	Provenience	Feature #
88	na	na	E3-7, TP12-2-2	na	
94	na	na	E1-3,E1-5	na	
102	na	na	U2-6,U2-14	na	
105	na	na	W2-1	na	
107	na	na	V1-3.	na	
110	na	na	X1-7	na	
116	na	na	E2-3	na	
117	na	na	T1-5	na	
122	na	na	E2-5,E3-4	na	
123	na	na	V2-13	na	
126	na	na	W1-2	na	
127	na	na	H1-2	na	
134	na	na	V1-2	na	

Allegan Ware Undecorated (from the Dieffenderfer Site)

			in mm	in mm	in mm
Vessel #	Wl Thkns	ExtSurfcTrtmnt	CllrThkns	Collar Hgt.	Max.InclSz
42	9.5	Crdmrkd	21.425	21.5	3.3
49	8.2	Crdmrkd	8.3	30	3.3
64	7	Crdmrkd	9.1	16.1	2.5
78	7.8	Crdmrkd	na	na	3.2
90	10.4	Cdrmrkd	na	na	3.3

Allegan Ware (from the 46th Street site)			in mm	in mm	in mm
Vessel #	Wl Thkns	ExtSurfcTrtmnt	CllrThkns	Collar Hgt.	Max.InclSz
1	5.1	Cdmkd,pnctte	na	na	4.9
2	8.6	Cdmrkd	na	na	2.8
4	8	Cdrmrk,pnctte	na	na	5.3
5	7.1	Cdmkd,pnctte	na	na	2.7
7	14.2	Cdmrkd	na	na	5.1
14	9.2	Cdmrkd	na	na	2.1
24	6.8	Cdmrkd	na	na	4.1
36	8.7	Cdmrkd	na	na	3

Allegan Ware (from the Fennville site)			in mm	in mm	in mm
Vessel #	Wl Thkns	ExtSurfcTrtmnt	CllrThkns	Collar Hgt.	Max.InclSz
41	7.1	Crdmrkd	na	na	5.9
92	7.7	Cdmrkd	na	na	2.9
103	7.1	Cdmrkd	na	na	2.5
113	7.3	Crdmrkd	na	na	2.7
118	7	Crdmrkd	na	na	5.6
121	8.1	Crdmrkd	na	na	2.3
132	5.3	Cdmrkd	na	na	4.9

135	10.2	Cdmrkd,pnctte	na	na	7
152	9.7	Crdmrkd	na	na	6.2
RN-1	9.4	Crdmrkd	na	na	3.2

Presumed Allegan Ware from Fennville Site			in mm	in mm	in mm
Vessel #	Wl Thkns	ExtSurfcTrtmnt	CllrThkns	Collar Hgt.	Max.InclSz
88	7.1	Crdmrkd	na	na	4.8
94	7.3	Crdmrdk	na	na	4.3
102	7	Crdmrkd	na	na	3.7
105	6.7	Crdmrkd	na	na	3.9
107	9.2	Crdmrkd	na	na	3.7
110	6.8	Crdmrkd	na	na	5.7
116	7.2	Crdmrkd	na	na	3.4
117	6.7	Crdmrkd	na	na	1.8
122	7.1	Crdmrkd	na	na	4.9
123	6.5	Crdmrkd	na	na	5.3
126	7.6	Crdmrkd	na	na	4
127	7	Crdmrkd	na	na	2.9
134	7.2	Crdmrkd	na	na	2.9

Allegan Ware Undecorated (from the Dieffenderfer Site)				in mm	
Vessel #	Castellated	Collared	Rim/Lip Mode	Oriface Dm	Hardness
42	No	Yes	Sl.Evrt/Flat	22	6
49	No	Yes?	Evrt/Flat	21	6
64	No	Yes	Evrt/Flat	18	3.5
78	No	No	Straight/Flat	na	5
90	No	No	Sl.Invrt/Flat	na	4.5

Allegan Ware (from the 46th Street site)				in mm	
Vessel #	Castellated	Collared	Rim/Lip Mode	Oriface Dm	Hardness
1	No	No	?Sl.Evrted	18	3
2	No	No	Straight/Flat	10	4
4	No	No	Sl.Evrtd/Flat	24	3.5
5	No	No	Sl.Evrtd/Sl.Rnd	na	2.5
7	No	No	Sl.Evrtd/Flat	14	3.5
14	No	No	Evrtd/Sl.Rnded	14	3.5
24	No	No	Sl.Evrtd/Flat	na	3.5
36	No	No	Sl.Invrtd/Flat	na	5

Allegan Ware (from the Fennville site)				in mm	
Vessel #	Castellated	Collared	Rim/Lip Mode	Oriface Dm	Hardness
41	No	No	Sl.Evrtd/Flat	28	3
92	No	No	Sl.Evrtd/Flat	na	3.5
103	No	No	Sl.Evrtd/Sl.Rnd	na	3.5
113	No	No	Sl.Evrtd/Sl.Rnd	na	3.5
118	No	No	Straight/Flat	na	4
121	No	No	Evrtd/Sl.Rnded	18	3.5
132	No	No	Straight/Flat	na	3
135	No	No	Evrtd/Sl.Rnded	14	3
152	No	No	Evrtd/Flat	20	5.5
RN-1	No	No	Evrtd/Sl.Rnded	18	4.5

Presumed Allegan Ware from Fennville Site

Vessel #	Castellated	Collared	Rim/Lip Mode	in mm Oriface Dm	Hardness
88	No	No	Sl.Evrtd/Flat	22	3.5
94	No	No	Inverted/Flat	na	4
102	No	No	Sl.Evrtd/Flat	20	3.5
105	No	No	Sl.Invrtd/Flat	na	3
107	No	No	Evrtd/Sl.Rnded	14	3.5
110	No	No	Sl.Evrtd/Flat	na	5
116	No	No	Evrtd/Sl.Rnded	na	3
117	No	No	Sl.Evrtd/Flat	na	2.5
122	No	No	Straight/Flat	20	4
123	No	No	Straight/Flat	na	3.5
126	No	No	Evrtd/Flat	na	3.5
127	No	No	Invrtd/Sl.Rnded	na	3
134	No	No	Sl.Evrtd/Flat	22	4.5

Allegan Ware Undecorated (from the Dieffenderfer Site)

Vessel #	Ext.Color	Int.Color
42	10YR4/3	10YR5/6
49	10YR4/3	10YR2/1
64	10YR5/4	10YR6/4
78	10YR6/4	5YR6/6
90	5YR5/6	7.5YR5/4

Allegan Ware (from the 46th Street site)

Vessel #	Ext.Color	Int.Color
1	7.5YR5/4	5YR5/4
2	5YR5/4	5YR5/4
4	7.5YR5/4	7.5YR5/4
5	10YR5/3	10YR5/4
7	10YR5/4	7.5YR5/4
14	7.5YR5/4	7.5YR5/4
24	10YR5/3	10YR5/3
36	10YR6/3	10YR6/3

Allegan Ware (from the Fennville site)

Vessel #	Ext.Color	Int.Color
41	7.5YR5/4	7.5YR5/4
92	10YR6/4	10YR6/4
103	5YR6/4	7.5YR5/4
113	5YR5/4	5YR5/4
118	10YR6/4	7.5YR5/4
121	7.5YR5/4	5YR5/6
132	10YR5/4	10YR5/2
135	10YR5/3	10YR5/3
152	5YR5/6	10YR6/4
RN-1	7.5YR6/4	7.5YR5/4

Presumed Allegan Ware from Fennville Site

Vessel #	Ext.Color	Int.Color

88	5YR5/4	7.5YR6/4
94	7.5YR5/3	10YR6/4
102	7.5YR5/6	5YR5/6
105	7.5YR6/4	7.5YR6/4
107	10YR5/4	7.5YR5/4
110	10YR6/4	10YR6/4
116	10YR5/4	10YR5/6
117	7.5YR5/4	7.5YR5/4
122	7.5YR6/4	5YR4/6
123	10YR6/4	10YR5/4
126	7.5YR5/3	7.5YR5/4
127	7.5YR6/4	7.5YR5/4
134	10YR5/2	10YR5/3

Key: p= presence
a= absence

Dieffenderfer Ware

Vessel #	Int.SurfaceTrtmnt	Int. residue	Exterior Soot	Int.Abrasns	Featre.Ctx.
3	smooth	p (lt.brwn)	p	a	n
22	smooth	p (mttld)	p	a	n
43	smooth	p (mttld)	p	a	n
58	smooth	a	a	a	n
66	smooth	a	a	a	y
70	smooth	p (mttld)	p	a	n
71	smooth	p (black)	a	a	n
63	incised	a	p	p	y
44	smooth	p (blk,shny)	a	a	y
88	smooth	p (black)	p	a	n
45	smooth	a	p	a	y
76	smooth	p (blk,shny)	p	p	y
89	smooth	p (blk)	p	p	n
4	smooth	a	p	a	n
33	smooth	a	a	a	n
36	smooth	a	a	a	n
39	smooth	a	a	a	y
61	smooth	p (blk,shny)	p	a	n
65	smooth	a	p	a	y
69	smooth	a	p	a	n
73	smooth	p(drk brwn)	a	a	n
75	smooth	n	p	p	n
79	smooth	p (drk brwn)	p	p	n
80	smooth	a	p	a	n
8	smooth	p (blk,shny)	p	a	n
23	smooth	a	a	a	n
32	smooth	a	a	a	n
52	smooth	a	a	p	n
59	smooth	p (drk brn)	a	p	n
72	smooth	a	p	p	n
81	smooth	a	a	a	n
82	smooth	p (mttld)	p	a	n

84	smooth	p (mttld)	a	a	n
85	smooth	p (brown)	p	a	n
86	large grits (gritty)	a	p	a	n
25	smooth	a	a	a	n
2	large grits (gritty)	a	p	a	n
14	smooth	a	p	a	n
24	large grits (gritty)	p (mttld)	p	a	n

Allegan Ware Undecorated (from the Dieffenderfer Site)

Vessel #					
42	smooth	a	p	p	y
49	smooth	p (black)	p	a	y
64	smooth	p (mttld)	p	a	y
78	smooth	a	a	a	n
90	smooth	a	a	a	n

Allegan Ware (from the 46th Street site)

		p or a	p or a	p or a	y or n
Vessel #	Int.SurfaceTrtmnt	Interior Residue	Exterior Soot	Int.Abrsns	Featr.Ctx.
1	smooth	a	a	a	n
2	cordmarked	a	a	a	n
4	smooth	a	a	a	n
5	smooth	a	a	a	n
7	smooth	a	a	a	y
14	cordmarked	a	a	a	y
24	smooth	a	a	a	n
36	smooth	a	a	a	n

Allegan Ware (from the Fennville site)

Vessel #					
41	smooth	p (white)	p	a	n
92	smooth	a	a	a	n
103	smooth	a	a	a	n
113	smooth	a	a	a	n
118	smooth	a	a	a	n
121	smooth	a	a	a	n
132	cordmarked	a	a	a	n
135	cordmarked	a	a	a	n
152	smooth	p (drk brwn)	p	a	n
RN-1	smooth	a	a	a	n

Presumed Allegan Ware from Fennville Site

		p or a	p or a	p or a	y or n
Vessel #	Int.SurfaceTrtmnt	Interior Residue	Exterior Soot	Int.Abrsns	Featre.Ctx.
88	smooth	a	a	a	n
94	smooth	p (mttld)	a	a	n
102	smooth	a	a	a	n
105	smooth	a	a	a	n
107	smooth	a	p	a	n
110	cordmarked	a	a	a	n
116	smooth	a	a	a	n

117	smooth	a	a	a	n
122	smooth	p (mttld)	p	a	n
123	cordmarked	a	a	a	n
126	smooth	a	p	a	n
127	smooth	a	p	a	n
134	smooth	a	a	a	n

DESCRIPTIVE STATISTICS FOR VESSEL MEASUREMENTS

Dieffenderfer Ware

	in mm Wall Thickness	in mm Collar Thicknes	in mm Collar Height
Mean	7.3	11.4	22.8
Range	6.5	9	26.4
Stnd.Dvtn.	1.48	2.27	6.83

	in mm Max.Inclusn.Size	in mm Oriface Diametr
Mean	4.18	25.24
Range	6.9	30
Stnd.Dvtn.	1.52	8.20

Allegan Ware

	in mm Wall Thickness	in mm Collar Thicknes	in mm Collar Height
Mean	7.9	12.94	22.53
Range	9.1	12.32	5.4
Stnd.Dvtn.	1.64	7.36	7.01

	in mm Max.Inclusn.Size	in mm Oriface Diamtr.
Mean	3.89	18.72
Range	5.2	18
Stnd.Dvtn.	1.30	4.36

PIXE analysis

Dieffenderfer Ware

	Ratio 1			Ratio 2		
Vessel	TI	MN	FE	K	CA	FE
14	23.6	26.2	50.2	0	42.8	57.2
15	18.7	21.5	59.8	9.7	34.2	56.1
16	21.3	24.2	54.5	6.7	64.8	28.5
17	6.7	29.6	63.7	8.7	43	48.3
18	7.8	51.9	40.3	13.1	44	42.9
21	16.2	51.1	32.7	16	36.3	47.7
23	22.4	28.4	49.3	13.4	49.5	37.1
26	28.2	17	54.8	17.4	50.9	31.7
20	19.6	33.8	46.5	12.6	37.2	50.3
22	31	9.4	59.3	13.5	56	30.5
24	31.3	19.3	49.4	17.1	45.2	37.7
25	32	8.1	59.9	15.1	48.1	36.8
19	21.2	31.6	47.2	13.4	35	51.6
11	24.9	14.6	60.5	8	67.1	24.9
10	26.2	22.6	51.2	13.1	46.3	40.6
8	16.5	41.6	41.9	7	69.9	23.1

Dieffender fer Ware

	Ratio 3			Ratio 4		
Vessel #	RB	SR	ZR	RB	Y	FE
14	21.1	18.6	60.2	24.6	0	75.4
15	26.9	18.6	54.5	26.5	0	73.5
16	12.8	24.4	62.8	25.7	0	74.3
17	25.8	19.3	54.9	21.8	0	78.2
18	25.8	19.3	54.9	24.6	0	75.4
21	29.2	21.1	49.7	26.2	0	73.8
23	26.1	15	58.9	26.9	0	73.1
26	28	26.1	45.9	26.1	0	73.9
20	28.8	15.6	55.6	23.2	0	76.8
22	23.7	22.9	53.4	22.4	0	77.6
24	27.2	15	57.9	25.2	0	74.8
25	18.7	15.4	65.9	21.2	0	78.8
19	29.6	16.6	53.8	26.9	0	73.1
11	29	21	50	30	0	70
10	28.6	15.7	55.7	26	0	74
8	14.1	14.8	71.1	20.4	0	79.6

Allegan Ware

Vessel #		Ratio 1			Ratio 2	
5	36.2	9.6	54.2	12.7	36.9	50.4
6	37.2	11.9	50.9	18.9	53.1	28
12	29.8	4.9	65.3	0	41.3	58.7
13	83	2.8	14.2	0	90	10
9	26.6	13.1	60.2	13	50	37
4	19.7	26.6	53.7	9	26.1	64.9
27	11.9	58	30.2	11.2	55.9	32.9
28	18.1	33	48.9	11.7	34.6	53.7
30	25.8	28.4	45.9	13.7	48.6	37.7

31	31.6	27.5	40.9	18.3	46.5	35.2
32	31	19.5	49.5	15.9	51.6	32.5
33	33.7	17	49.4	14.3	45.6	40.1
34	25.5	30.8	43.7	13.8	37.9	48.3
35	21.5	25.4	53.1	11.7	39.4	49
36	26.1	23.9	50	14.6	38.6	46.8
37	30.3	12.4	57.3	15.9	43.4	40.7

Allegan Ware

Vessel #		Ratio 3			Ratio 4	
5	25.1	20.8	42.2	25.9	0	74.1
6	30.8	17.3	51.8	25.9	0	74.1
12	27.6	16.2	56.2	26.3	0	73.7
13	15.4	14.8	69.9	44.7	0	55.3
9	29.5	16.3	54.2	29	0	71
4	30.7	18	51.3	27.6	0	72.4
27	34.1	19.3	46.6	27.9	0	72.1
28	37.8	19.5	42.8	27	0	73
30	33.1	21.6	45.3	31.2	0	68.8
31	34.7	15.2	50.1	36.6	0	63.4
32	25.7	20.2	54.1	31.3	0	68.7
33	34.7	13.9	51.4	32	0	68
34	25.5	9.9	64.6	26.6	0	73.4
35	32.2	13.3	54.5	28.9	0	71.1
36	34.8	16.3	48.9	30.4	0	69.6
37	34.6	15.9	49.5	32	0	68

		Ratio 1			Ratio 2	
Vessel	TI	MN	FE	K	CA	FE
Sumnrville	15.4	52.7	32	11	45.1	43.9
Fisher-Tld	27.5	46.1	26.5	11.4	45.1	43.6
PowellPln	13.6	51.9	34.5	13.2	28.3	58.5
Unclssfd*	19.8	31.4	48.8	2.8	90.7	6.5
Arkansas Pottery						
143plnLip-	19.2	51.5	29.4	16.4	48.5	35
PlnLip -2	18.9	40.5	40.5	13.4	37.9	48.8
PlnLip -3	29.8	40.4	29.8	18.6	52.7	28.8
IncdLip -1	33	7	60	12.4	50.2	37.5
IncdLip -2	27	21.9	51.1	13.4	39	47.6
IncdLip -3	19.9	25.5	54.6	12.7	38	49.2
123-slip-1	15.2	10.1	74.7	10.3	24.2	65.5
slip-2	18.4	25.5	56.1	9.3	20.7	70
nonslip-1	21.1	12.4	66.5	11.2	30.8	58
nonslip-2	26.6	17.7	55.7	16.5	38.9	44.7

		Ratio 3			Ratio 4	
Vessel	RB	SR	ZR	RB	Y	FE
Sumnrville	20.8	17.5	61.6	20.8	0	79.2
Fisher-Tld	23.1	7.4	69.5	20.6	0	79.4
PowellPln	27.5	16.2	36.3	21.9	0	78.1
Unclssfd*	33.8	38.3	27.9	44.9	0	55.1
Arkansas Pottery						
143plnLip-	26	19.3	54.7	23.9	0	76.1

PlnLip -2	27.8	19	53.2	23.3	0	76.7
PlnLip -3	12.3	13.3	74.4	28.5	0	71.5
IncdLip -1	25.4	27	47.6	26.8	0	73.2
IncdLip -2	28.6	23	48.4	26.2	0	73.8
IncdLip -3	18.7	19.7	61.6	22.9	0	77.1
123-slip-1	No Data	No Data	No Data	No Data	No Data	No Data
slip-2	43.8	15.4	40.9	26.8	0	73.2
nonslip-1	40.2	18.2	41.6	24.9	0	75.1
nonslip-2	31.9	24.4	43.6	27.2	0	72.8

	Ratio 1			Ratio 2		
Mean	TI	MN	FE	K	CA	FE
Dieffndrfr	21.73	26.93	51.33	11.55	48.14	40.31
Allegan	30.5	21.55	47.96	12.17	46.22	41.62
Arkansas	22.91	25.25	51.84	13.42	38.09	48.51
Range						
Dieffndrfr	25.3	43.8	31	17.4	35.7	34.1
Allegan	71.1	55.2	51.1	18.9	63.9	54.9
Arkansas	17.8	44.5	45.3	9.3	32	41.2
Stndrd Dvtn						
Dieffndrfr	7.53	12.98	8.47	4.59	11.23	10.83
Allegan	15.55	13.46	12.06	5.38	14	13.19
Arkansas	5.79	14.71	14.77	2.95	10.64	13.12

	Ratio 3			Ratio 4		
Mean	RB	SR	ZR	RB	Y	FE
Dieffndrfr	24.71	18.71	56.58	24.86	0	75.14
Allegan	30.39	16.78	52.09	30.21	0	69.79
Arkansas	28.3	19.92	51.78	25.61	0	74.39
Range						
Dieffndrfr	16.8	11.3	25.2	9.6	0	9.6
Allegan	22.4	11.7	27.7	18.8	0	18.8
Arkansas	31.5	13.7	33.5	5.6	0	5.6
Stndrd Dvtn						
Dieffndrfr	5.32	3.59	6.28	2.51	0	2.51
Allegan	5.54	3.08	7.24	4.83	0	4.83
Arkansas	9.73	4.3	10.82	1.94	0	1.94

THIN SECTION DATA

Key: DSDW- = Dieffenderfer Site, Dieffenderfer Ware Vessel number -
DSAW- = Dieffenderfer Site, Allegan Ware Vessel number -
46AW- = 46th Street Site, Allegan Ware Vessel number -
FSAW- = Fennville Site, Allegan Ware Vessel number -

Grain size Analysis (Each count represents an individual grain and not point-counts)

Speciman #	Fine Sand .0625-.249	Med. Sand .25-.49 mm	Coars Snd .5-.99 mm	VryCrsSnd 1-2 mm	Gravel >2 mm
DSDW-2	503	42	17	6	2
DSDW-3	236	42	16	12	5
DSDW-8	439	60	28	9	5
DSDW-22	500	56	32	22	6
DSDW-24	364	22	12	9	3
DSDW-25	326	30	18	10	2
DSDW-33	281	47	16	14	0
DSDW-43	246	16	7	6	6
DSDW-63	302	34	13	2	0
DSDW-70	806	74	32	15	0
DSDW-72	727	67	10	3	5
DSDW-73	327	28	14	5	5
DSDW-75	592	49	25	8	1
DSDW-76	456	20	2	3	0
DSDW-79	666	41	33	8	1
DSDW-80	694	62	26	10	2
DSDW-89	438	32	3	2	2
46SAW-2	689	39	11	2	2
46SAW-7	149	15	10	7	0
46SAW-24	223	25	10	3	1
DSAW-42	779	64	25	11	9
DSAW-49	510	47	21	7	3
DSAW-64	157	16	4	5	2
DSAW-90	448	44	14	3	3
FSAW-41	1083	115	10	1	0
FSAW-105	540	62	13	6	3
FSAW-113	765	36	2	3	1
FSAW-116	597	49	5	0	2
FSAW-121	914	61	8	5	1
FSAW-122	1136	91	7	4	2
FSAW-126	1009	82	5	2	1
FSAW-152	1178	86	11	2	1
FSAW-RN1	821	44	3	5	0

Speciman #	Total # of Inclusions	Total Surface Area (in square mm)
DSDW-2	570	285
DSDW-3	311	200
DSDW-8	541	245
DSDW-22	616	295
DSDW-24	410	303

DSDW-25	386	314
DSDW-33	358	210
DSDW-43	281	231
DSDW-63	351	238
DSDW-70	927	373
DSDW-72	812	306
DSDW-73	379	227
DSDW-75	675	275
DSDW-76	481	174
DSDW-79	749	279
DSDW-80	794	312
DSDW-89	477	143
46SAW-2	743	264
46SAW-7	181	186
46SAW-24	262	174
DSAW-42	888	293
DSAW-49	588	184
DSAW-64	184	137
DSAW-90	512	186
FSAW-41	1209	218
FSAW-105	624	190
FSAW-113	807	182
FSAW-116	653	103
FSAW-121	989	230
FSAW-122	1240	216
FSAW-126	1099	207
FSAW-152	1278	235
FSAW-RN1	873	248

PETROGRAPHIC ANALYSIS
Point Count

Speciman #	ClayMatrx	Quartz	Feldspar	Plagioclase	Olivine	Hornblende
DSDW-2	607	111	94	23	70	5
DSDW-3	549	103	105	1	2	0
DSDW-8	675	203	102	0	12	0
DSDW-22	699	162	165	0	17	0
DSDW-24	918	159	163	2	0	0
DSDW-25	689	123	141	3	20	2
DSDW-33	554	171	100	0	0	0
DSDW-43	525	117	131	19	62	0
DSDW-63	662	109	24	1	0	1
DSDW-70	1001	244	176	40	8	30
DSDW-72	791	194	195	2	0	0
DSDW-73	592	129	177	0	1	0
DSDW-75	756	107	164	2	2	2
DSDW-76	523	69	27	0	0	0
DSDW-79	811	144	132	1	4	2
DSDW-80	880	174	122	3	7	5
DSDW-89	440	73	57	0	0	0
46SAW-2	750	224	46	0	0	0
46SAW-7	477	38	31	3	8	1

46SAW-24	573	59	59	0	0	0
DSAW-42	699	304	167	0	0	0
DSAW-49	435	154	111	0	0	0
DSAW-64	326	65	117	0	0	0
DSAW-90	471	166	86	0	2	0
FSAW-41	520	203	35	0	1	0
FSAW-105	377	183	40	56	3	24
FSAW-113	485	155	39	7	0	11
FSAW-116	214	143	21	15	0	14
FSAW-121	586	209	55	5	5	0
FSAW-122	432	181	64	18	3	22
FSAW-126	437	177	58	5	2	0
FSAW-152	516	199	57	14	1	10
FSAW-RN1	621	159	47	0	0	12

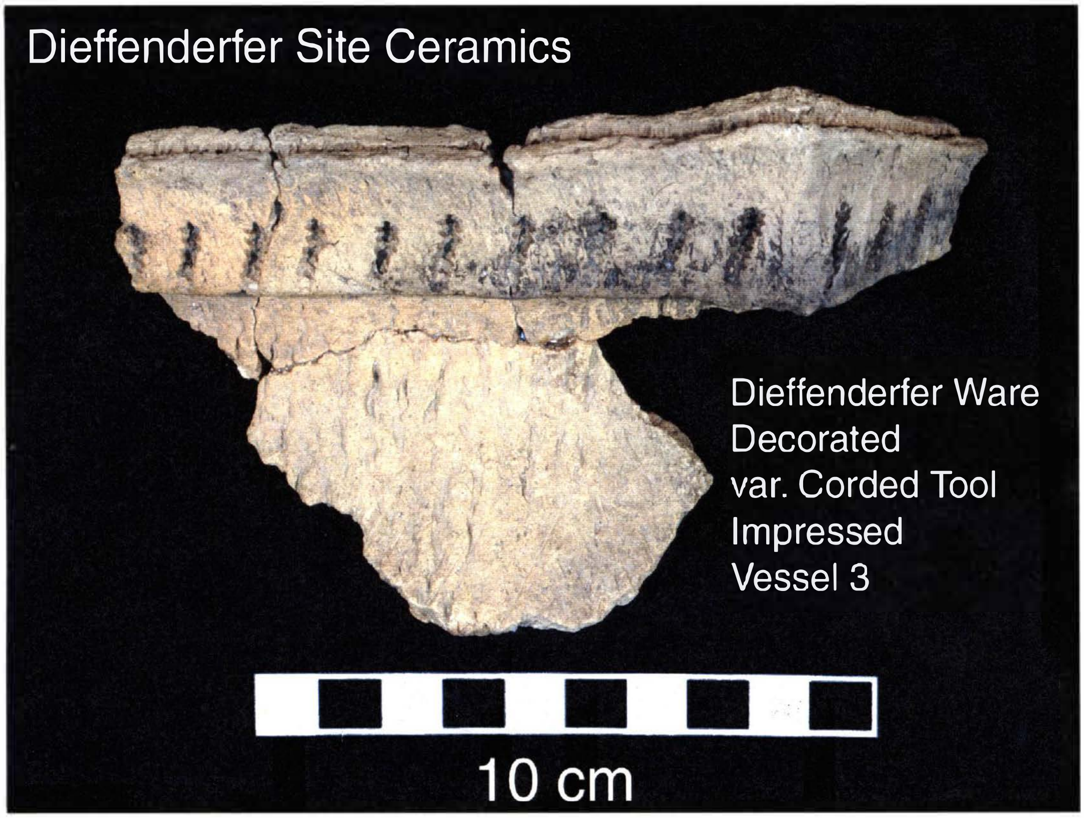
Speciman #	Pyroxene	Biotite	Muscovite	Chert	RockVoid	NaturalVds.
DSDW-2	7	2	2	0	5	23
DSDW-3	0	11	2	2	8	7
DSDW-8	1	5	5	3	10	4
DSDW-22	0	6	2	0	11	14
DSDW-24	0	0	2	0	0	11
DSDW-25	2	1	1	6	2	8
DSDW-33	0	1	2	0	2	9
DSDW-43	5	6	4	0	3	25
DSDW-63	1	1	1	6	0	6
DSDW-70	26	10	1	0	6	9
DSDW-72	0	18	5	1	1	7
DSDW-73	0	2	3	0	0	10
DSDW-75	1	26	7	1	0	13
DSDW-76	0	0	3	1	4	0
DSDW-79	7	7	0	0	2	15
DSDW-80	6	3	5	14	6	11
DSDW-89	0	4	0	0	1	17
46SAW-2	0	6	3	0	4	46
46SAW-7	3	6	1	0	5	18
46SAW-24	0	7	0	0	0	22
DSAW-42	0	5	2	0	10	53
DSAW-49	0	18	2	0	5	26
DSAW-64	0	4	1	0	1	10
DSAW-90	0	1	5	0	3	25
FSAW-41	0	0	5	0	4	30
FSAW-105	29	0	0	0	9	42
FSAW-113	2	1	5	0	2	13
FSAW-116	9	0	14	0	0	5
FSAW-121	8	14	2	0	2	25
FSAW-122	15	0	0	0	7	33
FSAW-126	17	3	0	0	0	11
FSAW-152	18	0	3	0	5	19
FSAW-RN1	1	5	0	0	2	15

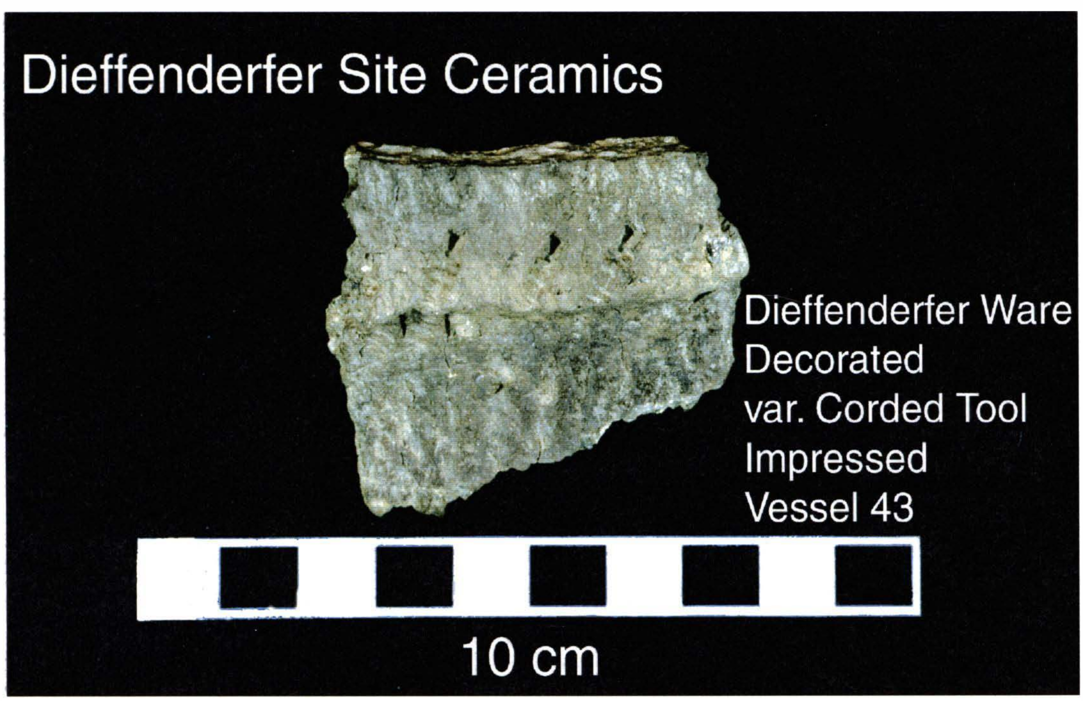
Speciman #	Unknown	Total Count	Inclsn Count
DSDW-2	21	992	343

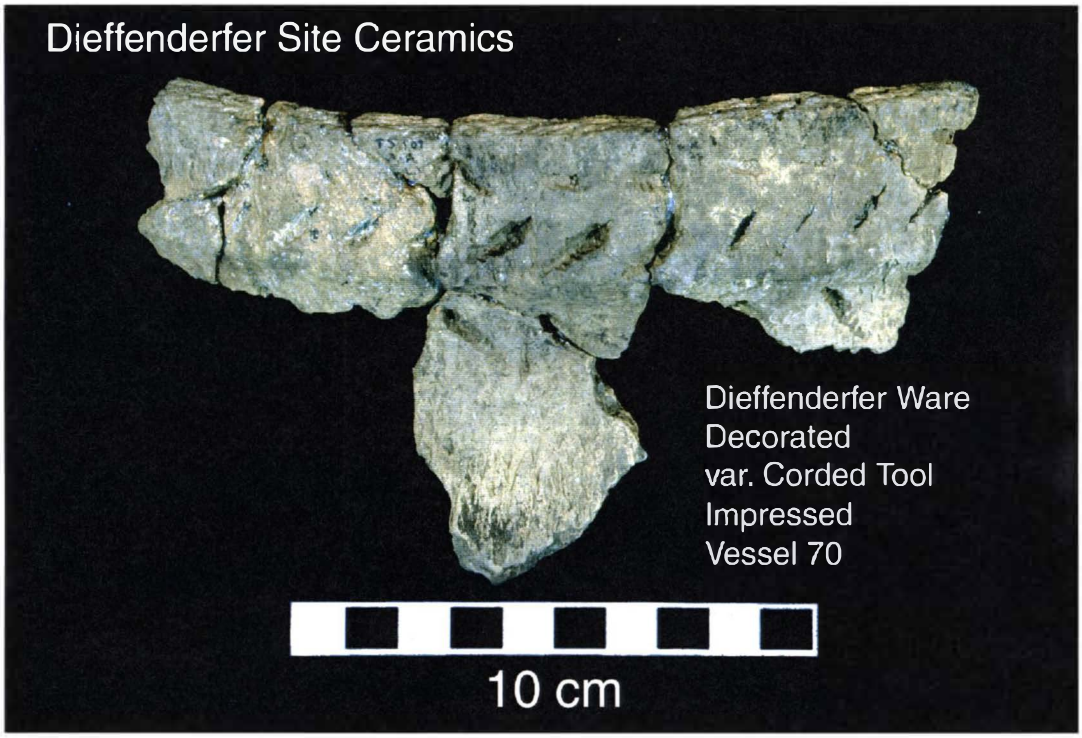
DSDW-3	6	1043	358
DSDW-8	3	1242	337
DSDW-22	5	978	305
DSDW-24	4	825	275
DSDW-25	15	854	346
DSDW-33	7	797	144
DSDW-43	14	1499	515
DSDW-63	1	1182	392
DSDW-70	7	899	320
DSDW-72	9	1033	287
DSDW-73	0	619	96
DSDW-75	3	1094	286
DSDW-76	0	1191	315
DSDW-79	2	570	134
DSDW-80	11	1020	287
DSDW-89	0	558	82
46SAW-2	0	691	122
46SAW-7	3	1170	479
46SAW-24	0	700	265
DSAW-42	0	508	192
DSAW-49	2	725	261
DSAW-64	0	759	240
DSAW-90	1	683	310
FSAW-41	3	697	219
FSAW-105	4	407	206
FSAW-113	5	860	281
FSAW-116	7	720	295
FSAW-121	0	679	244
FSAW-122	7	797	295
FSAW-126	2	839	220
FSAW-152	6	0	11
FSAW-RN1	0	0	2

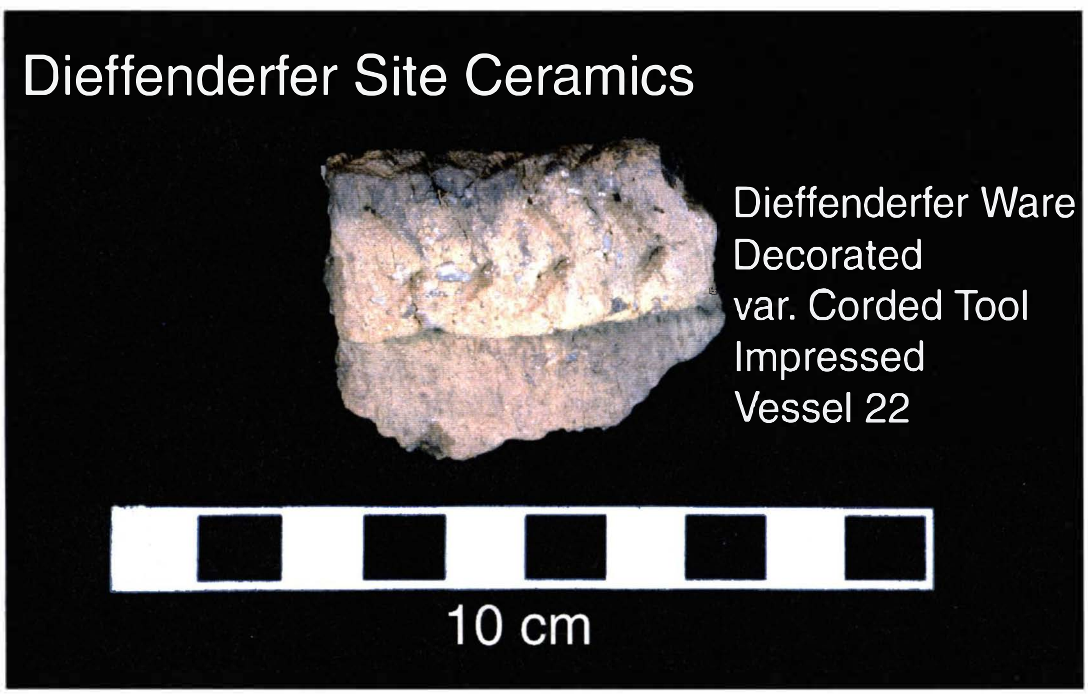
Appendix B

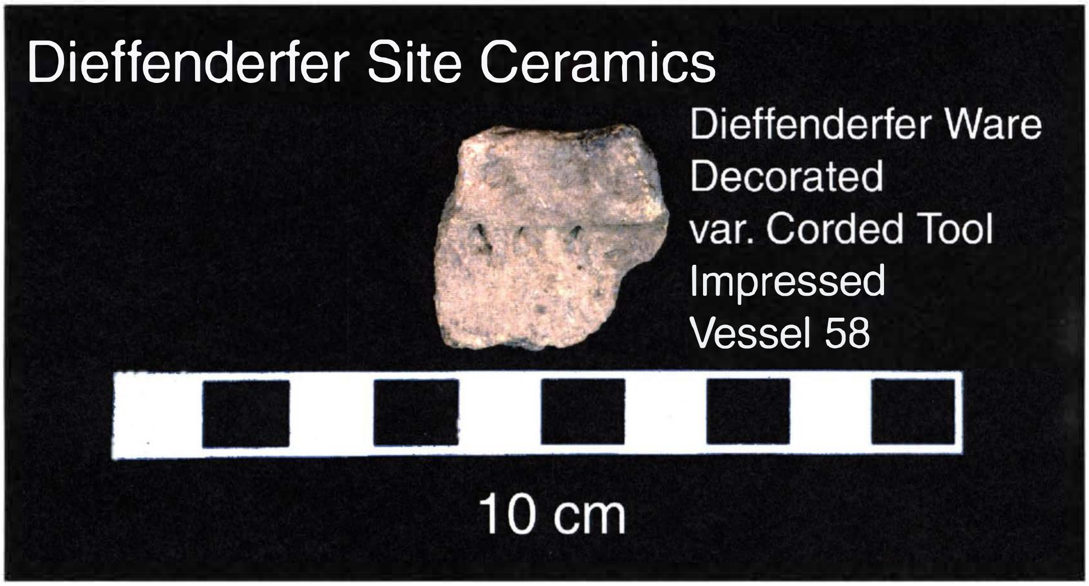
Photo-log of All Vessels Used in This Research

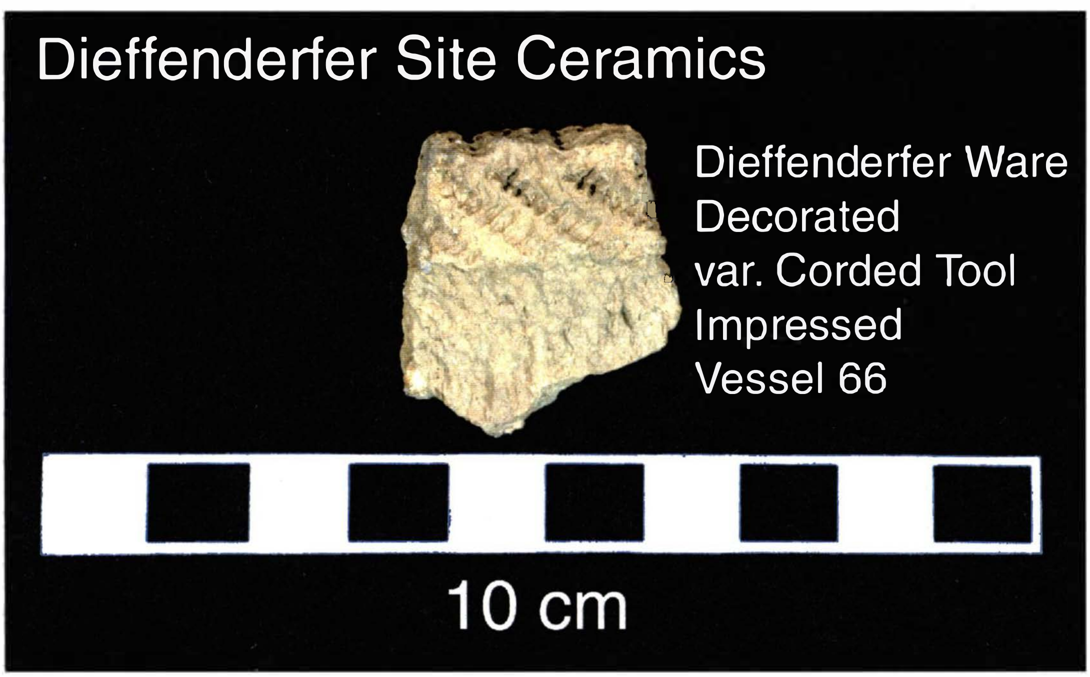

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 3
10 cm

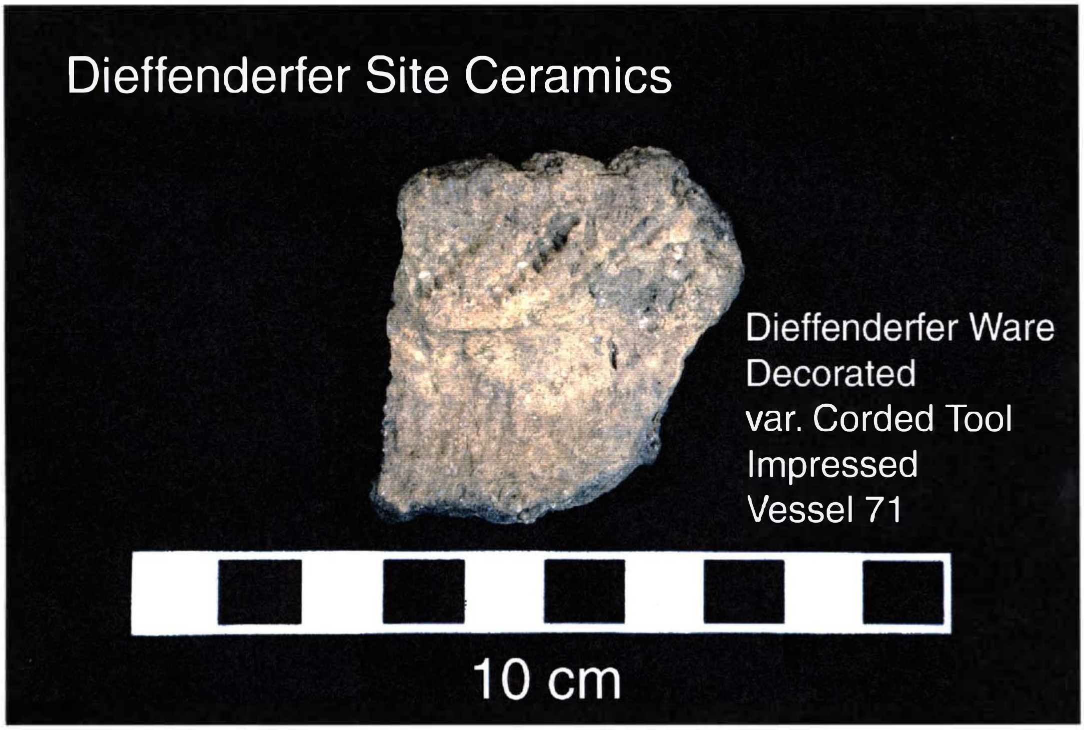

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 43
10 cm

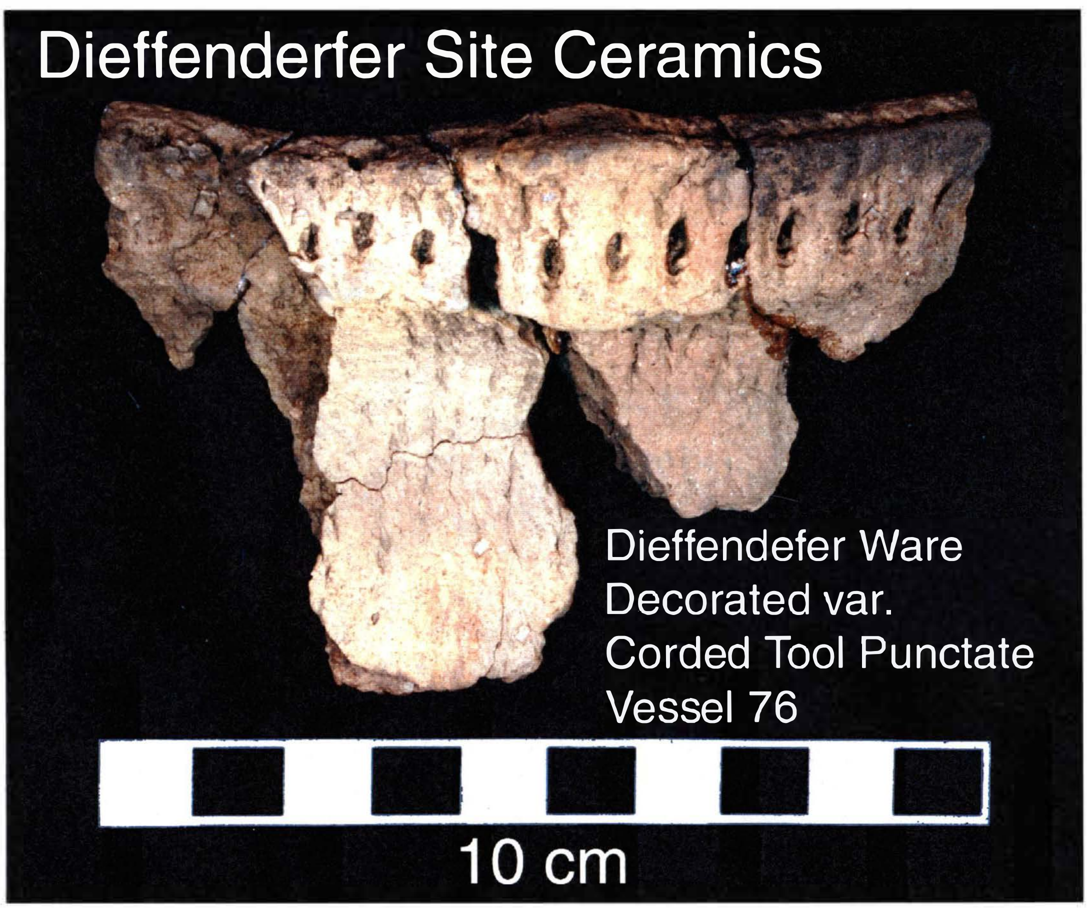

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 70
10 cm


Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 22
10 cm

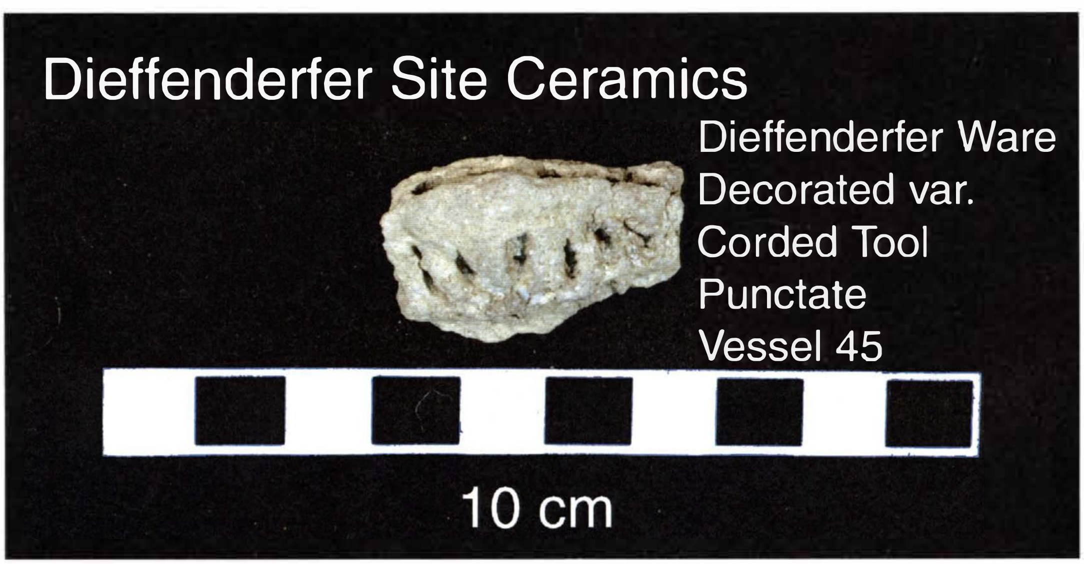

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 58
10 cm

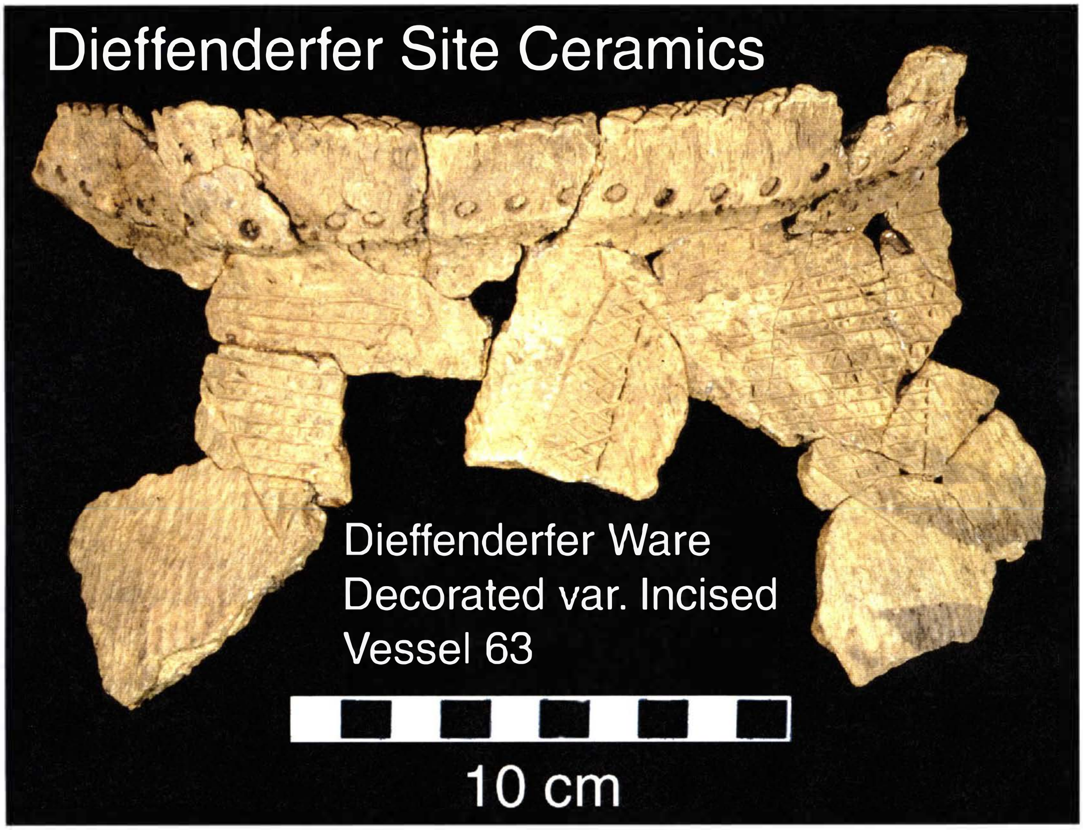

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 66
10 cm


Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Corded Tool
Impressed
Vessel 71
10 cm


Dieffenderfer Site Ceramics
Dieffendefer Ware
Decorated var.
Corded Tool Punctate
Vessel 76
10 cm

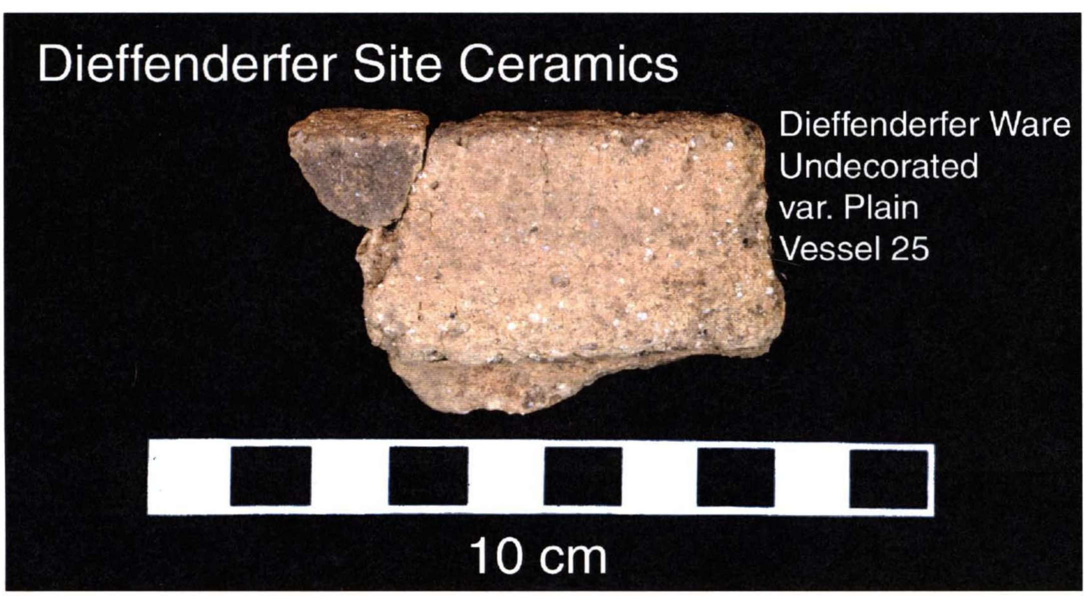

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated var. Corded
Tool Punctate. Vessel 89
10 cm

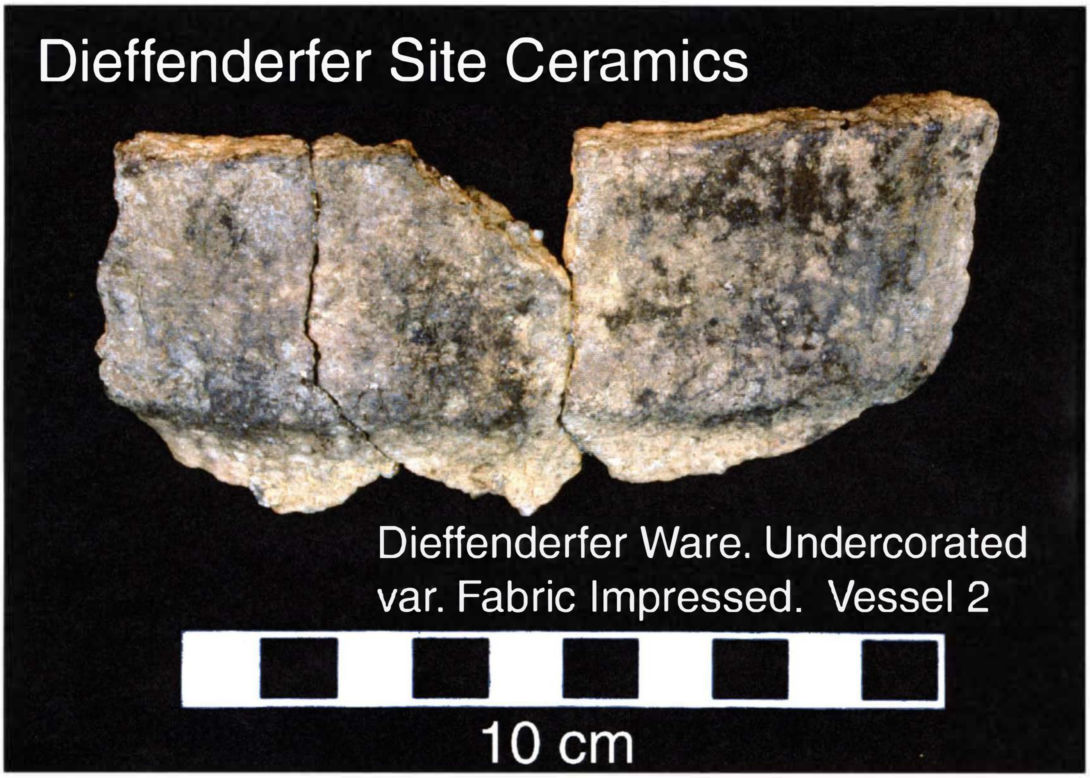

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated var.
Corded Tool
Punctate
Vessel 45
10 cm

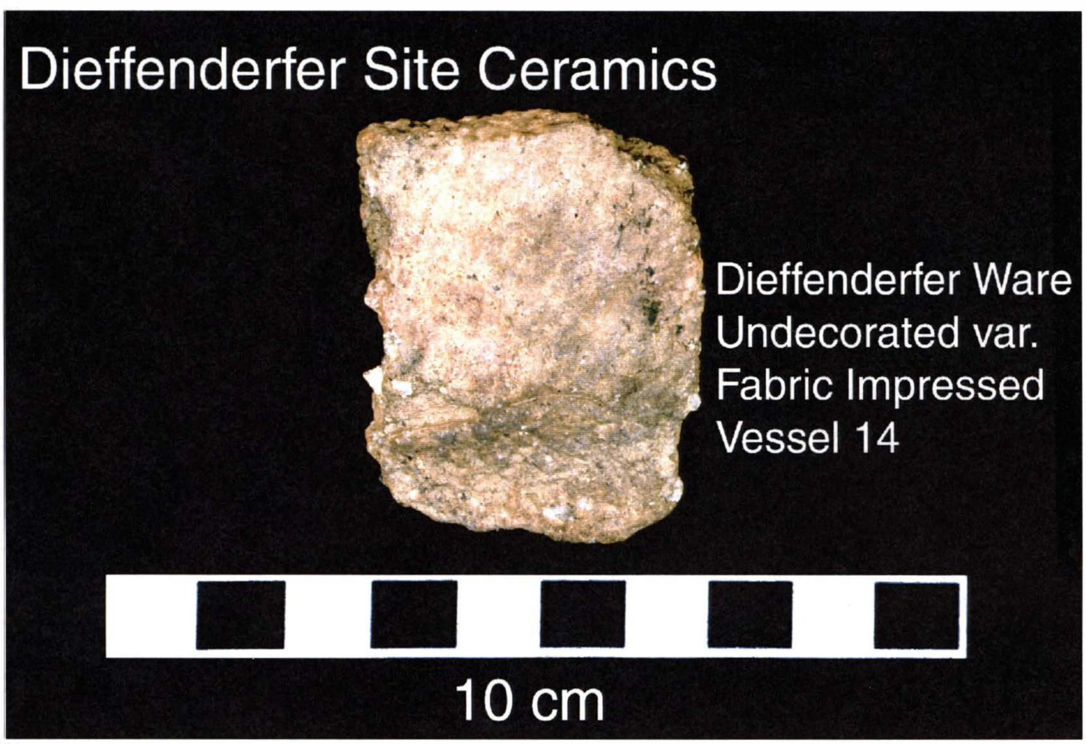

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated var. Incised
Vessel 63
10 cm

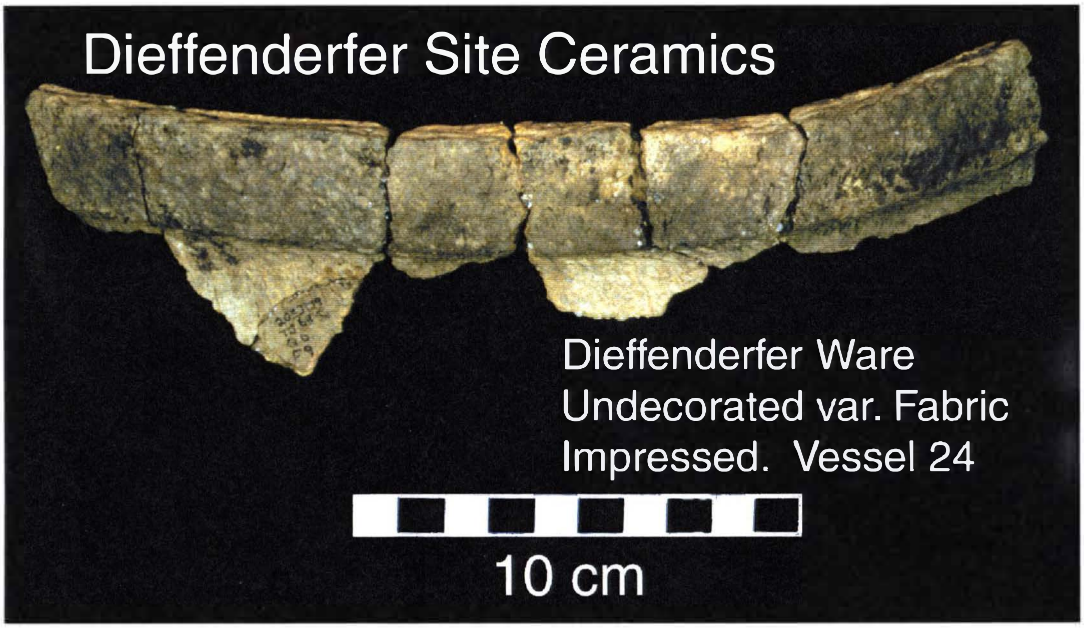

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Push-Pull
Vessel 44
10 cm

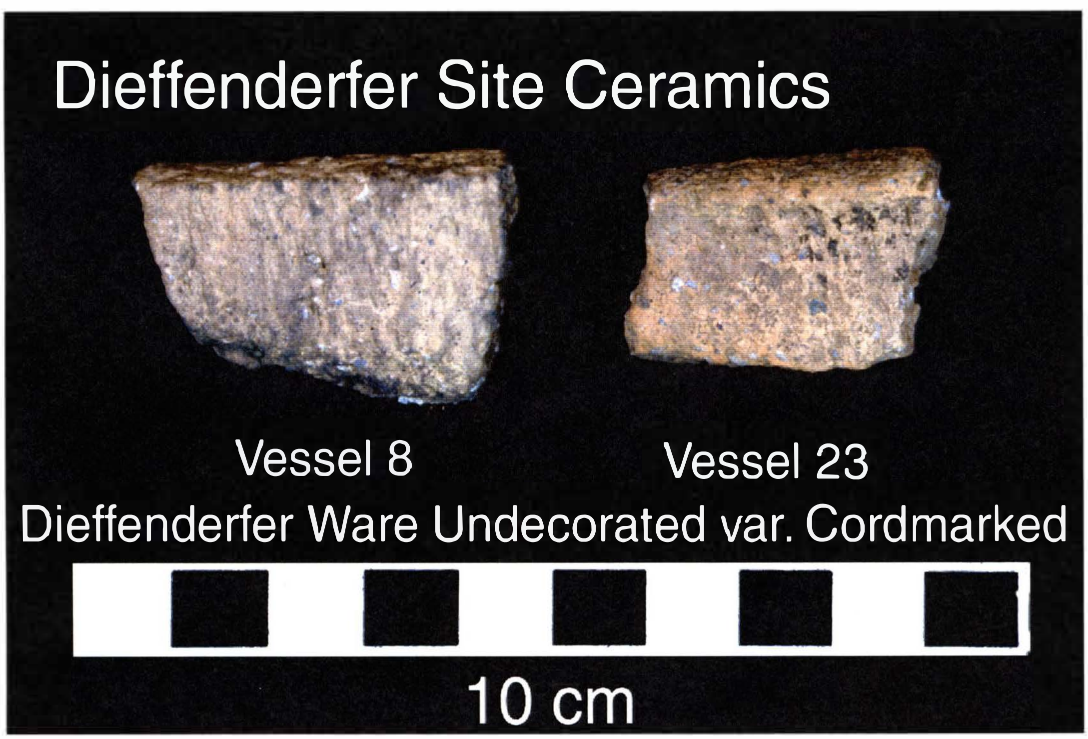

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Decorated
var. Push-Pull
Vessel 88
10 cm

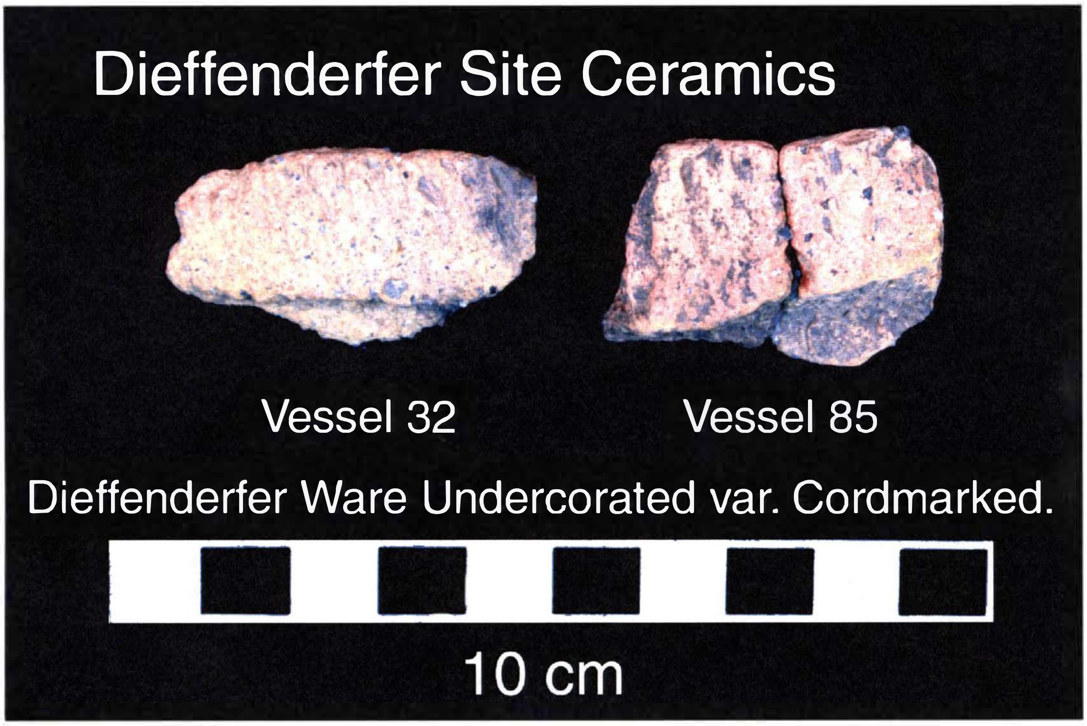

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated
var. Plain
Vessel 25
10 cm

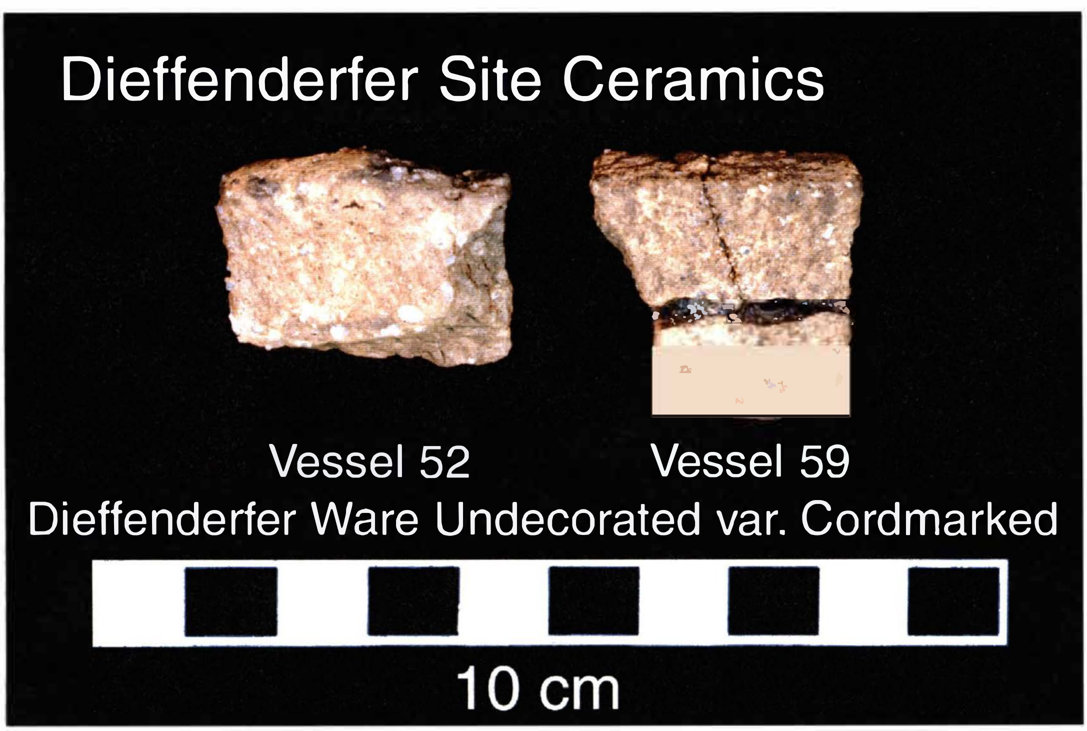

Dieffenderfer Site Ceramics
Dieffenderfer Ware. Undercorated
var. Fabric Impressed. Vessel 2
10 cm

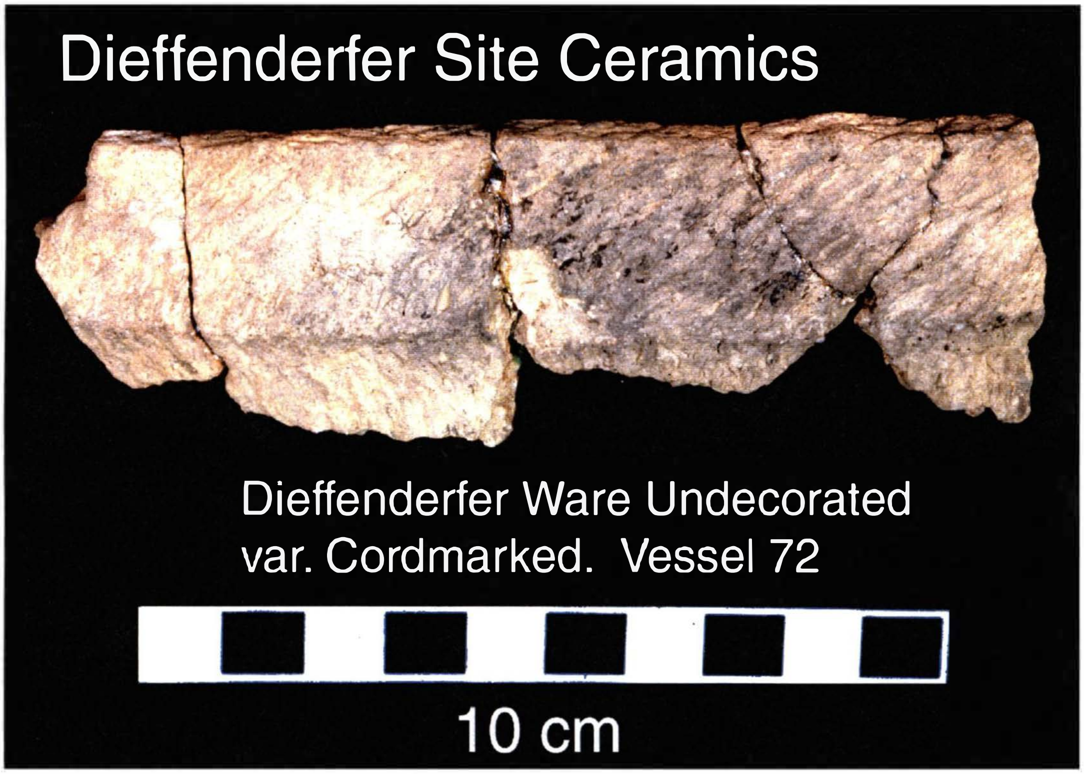

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated var.
Fabric Impressed
Vessel 14
10 cm

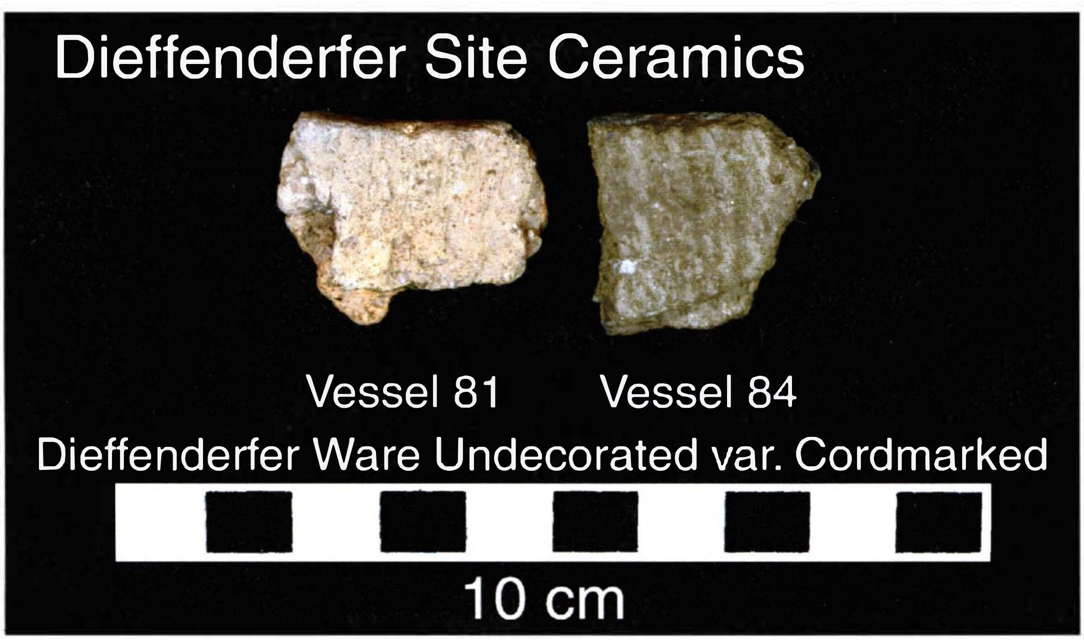

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated var. Fabric
Impressed. Vessel 24
10 cm

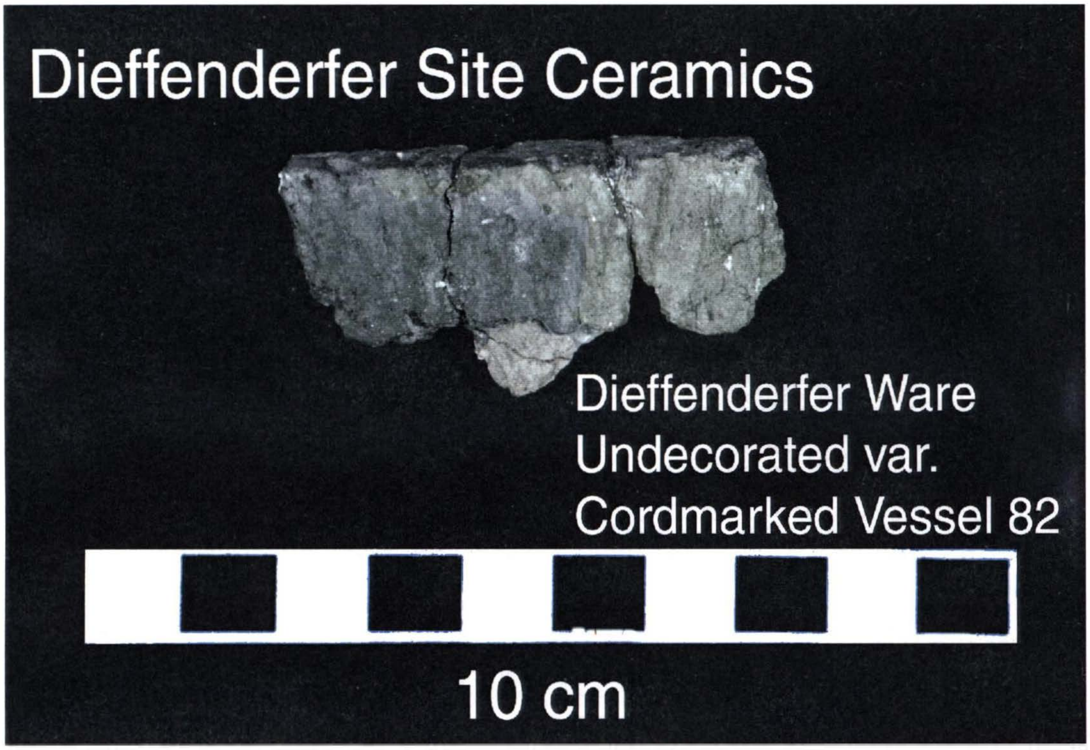

Dieffenderfer Site Ceramics
Vessel 8
Vessel 23
Dieffenderfer Ware Undecorated var. Cordmarked
10 cm


Dieffenderfer Site Ceramics
Vessel 32
Vessel 85
Dieffenderfer Ware Undercorated var. Cordmarked.
10 cm


Dieffenderfer Site Ceramics
Vessel 52
Vessel 59
Dieffenderfer Ware Undecorated var. Cordmarked
10 cm

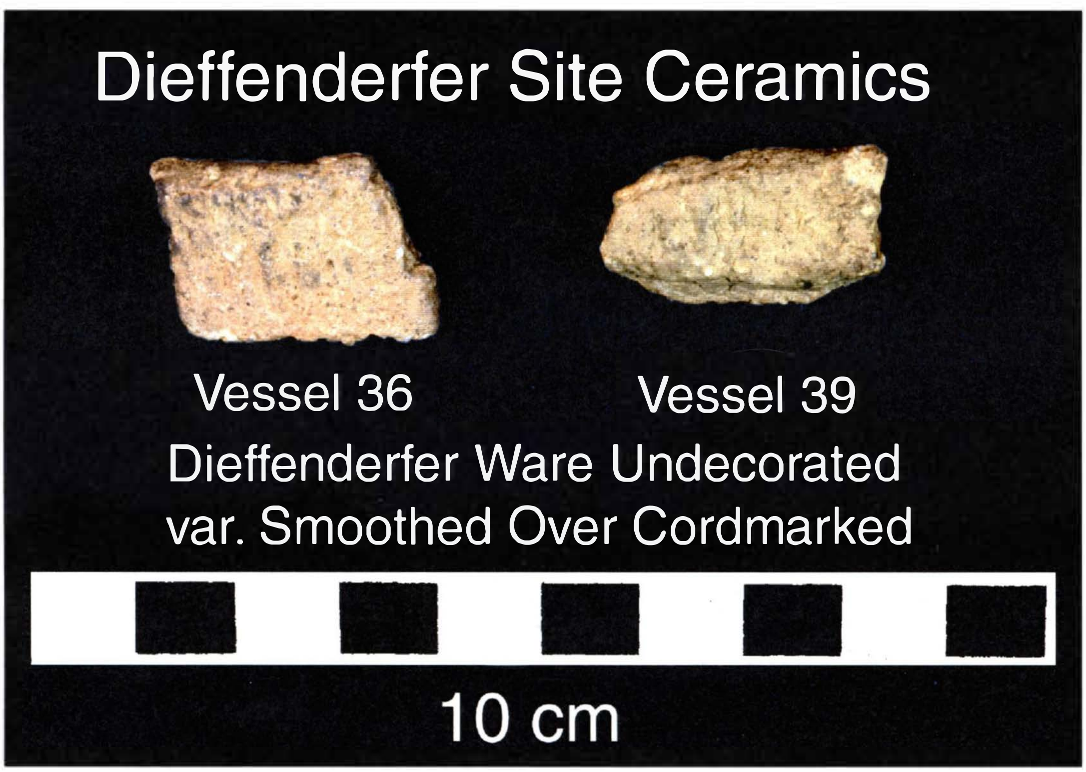

Dieffenderfer Site Ceramics
Dieffenderfer Ware Undecorated
var. Cordmarked. Vessel 72
10 cm

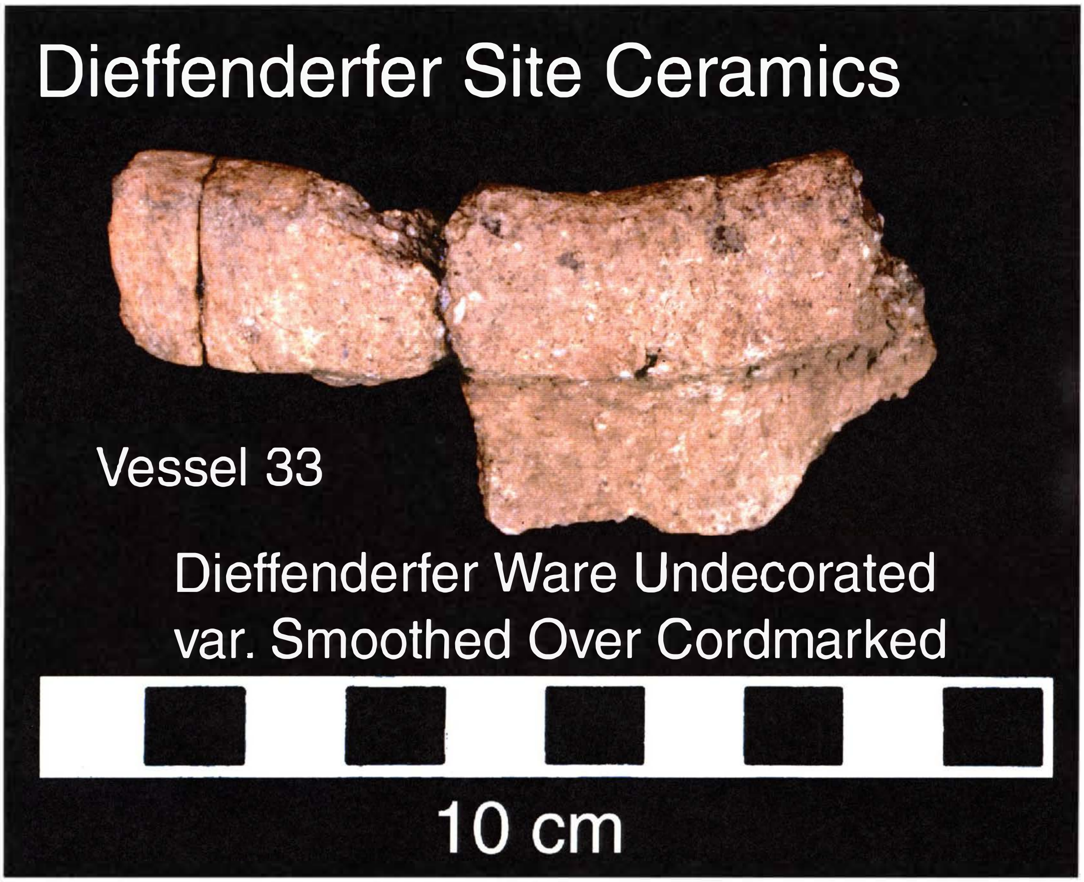

Dieffenderfer Site Ceramics
Vessel 81
Vessel 84
Dieffenderfer Ware Undecorated var. Cordmarked
10 cm

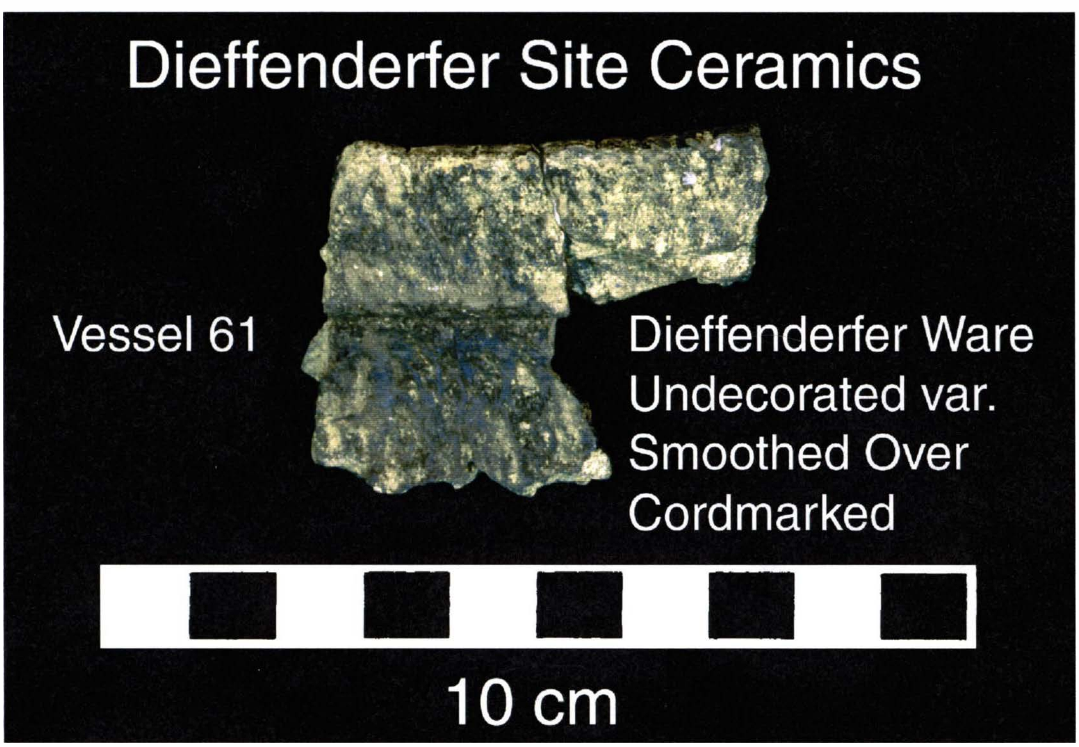

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated var.
Cordmarked Vessel 82
10 cm

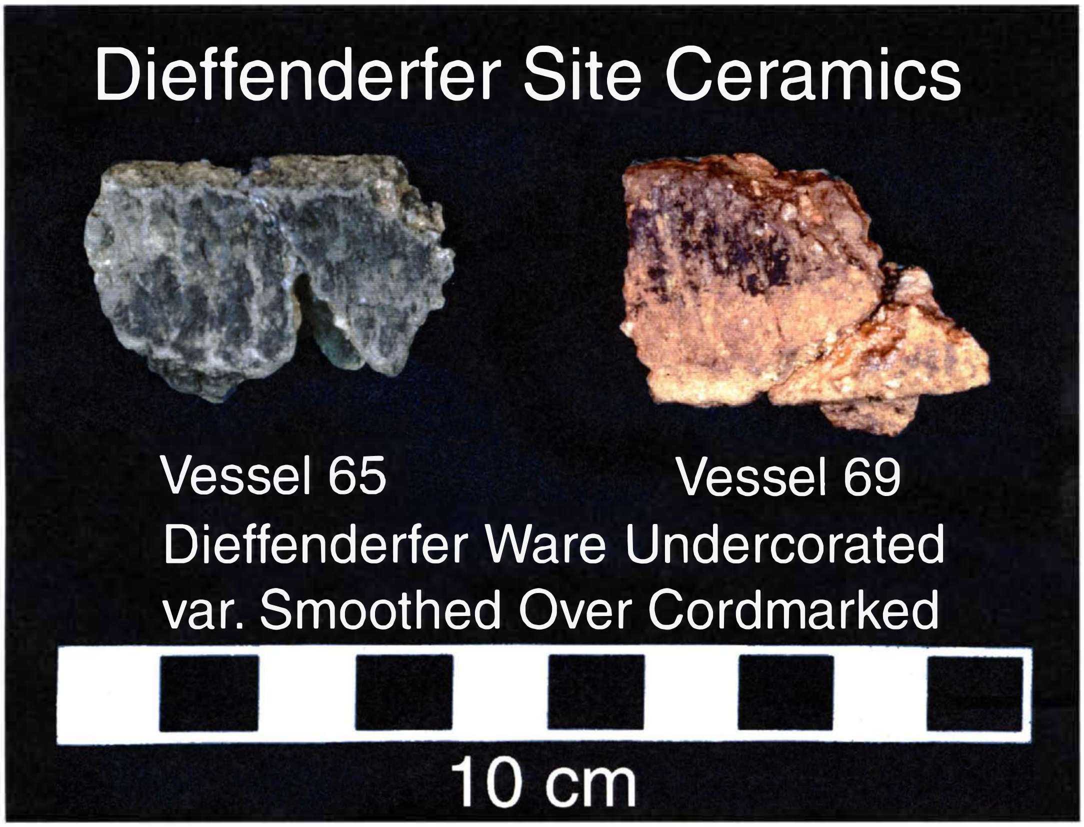

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated var.
Vessel 86 Cordmarked
10 cm


Dieffenderfer Site Ceramics
Vessel 4
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

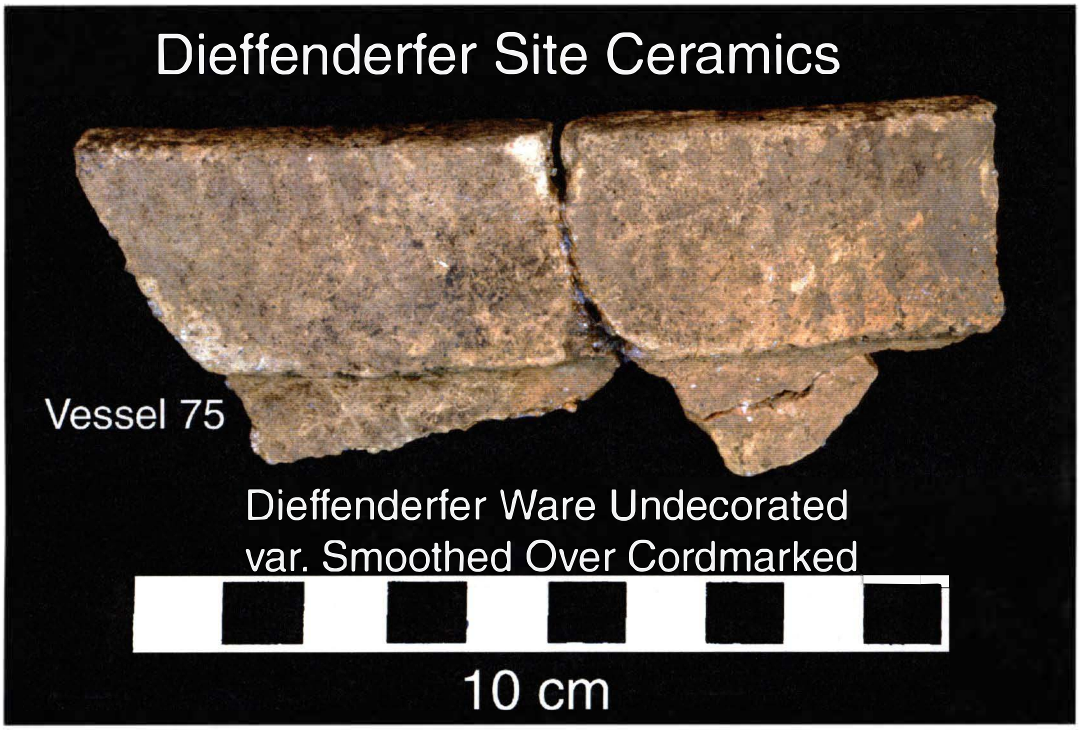

Dieffenderfer Site Ceramics
Vessel 36
Vessel 39
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

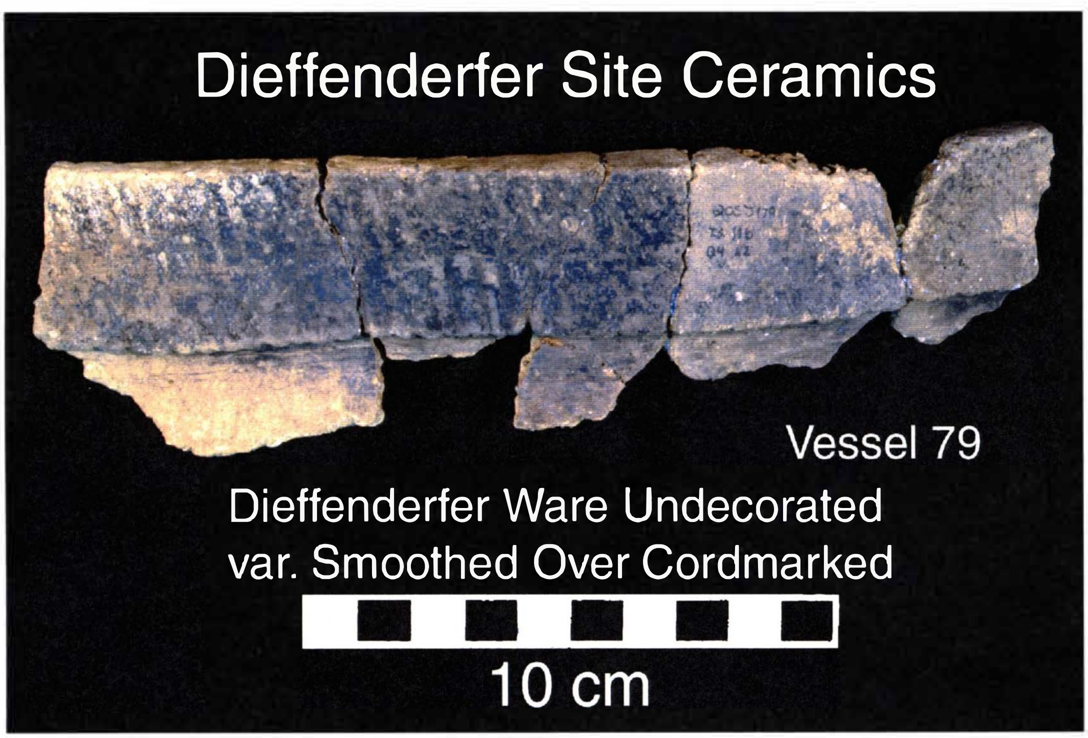

Dieffenderfer Site Ceramics
Vessel 33
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

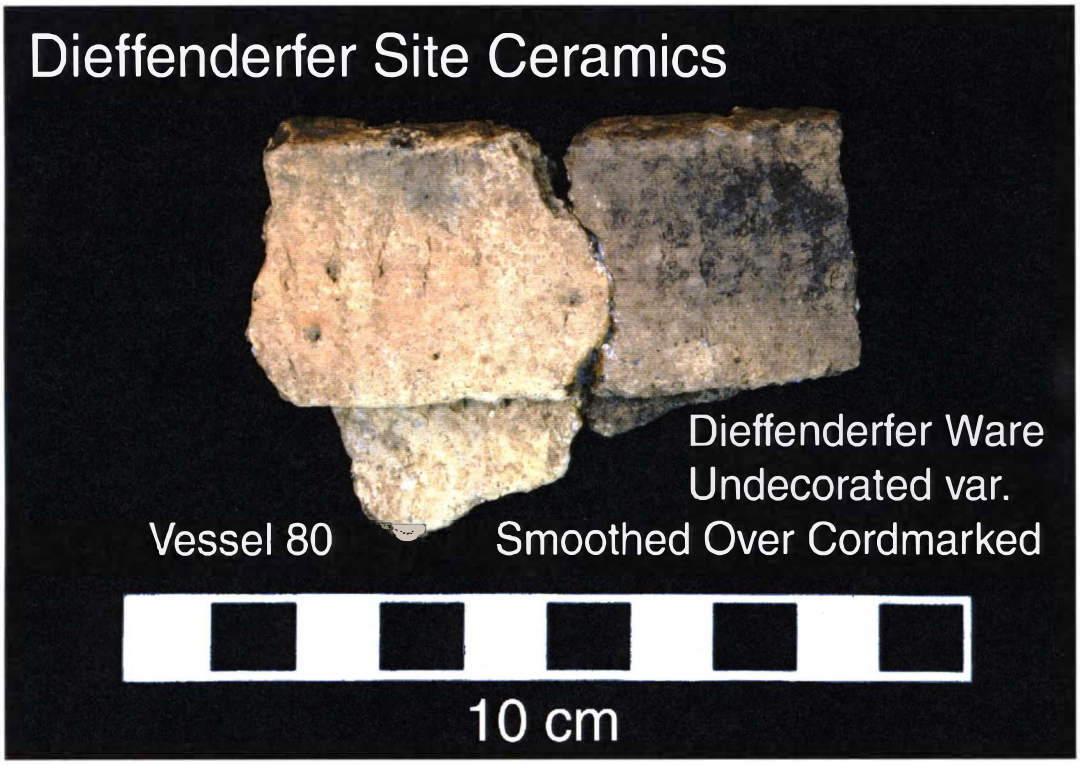

Dieffenderfer Site Ceramics
Vessel 61
Dieffenderfer Ware
Undecorated var.
Smoothed Over
Cordmarked
10 cm


Dieffenderfer Site Ceramics
Vessel 65
Vessel 69
Dieffenderfer Ware Undercorated
var. Smoothed Over Cordmarked
10 cm

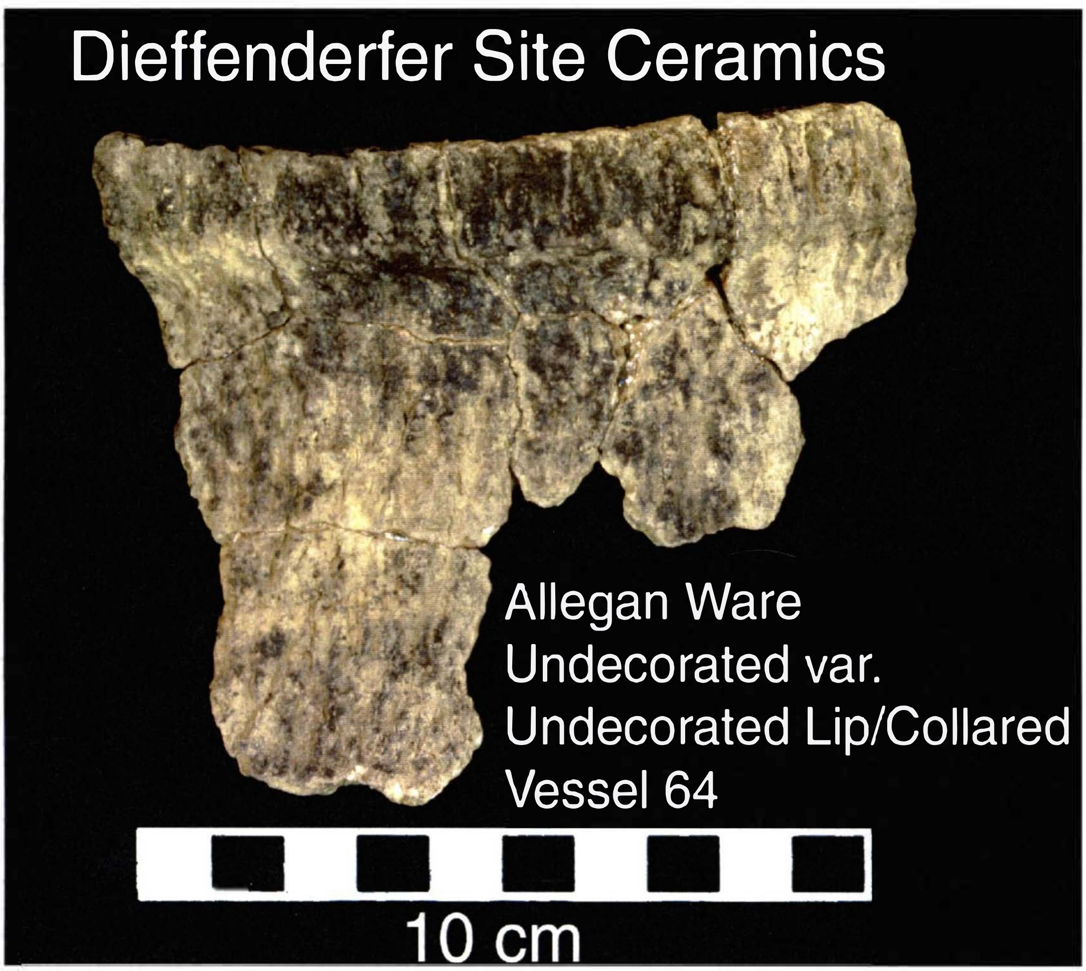

Dieffenderfer Site Ceramics
Vessel 73
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

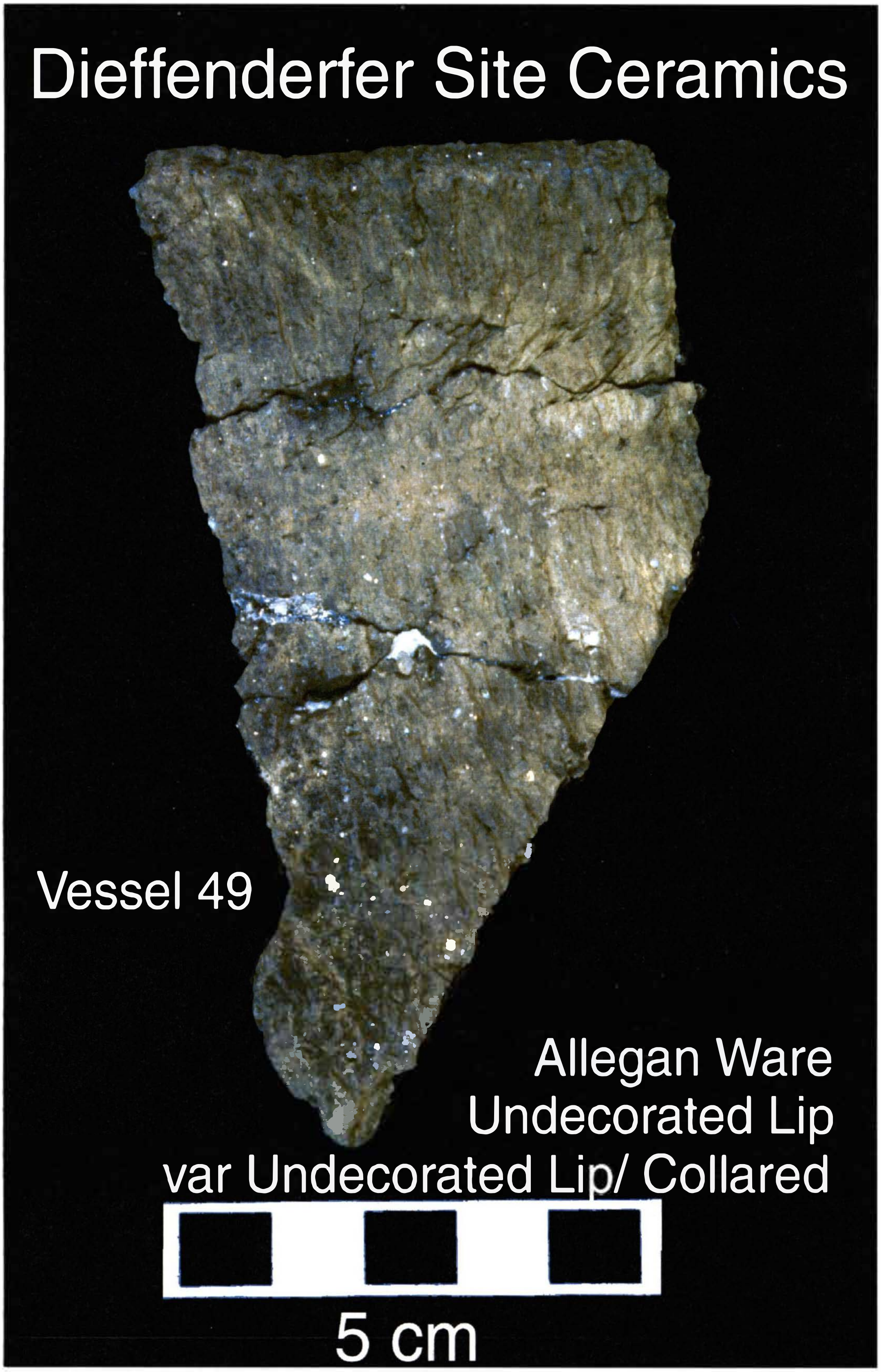

Dieffenderfer Site Ceramics
Vessel 75
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

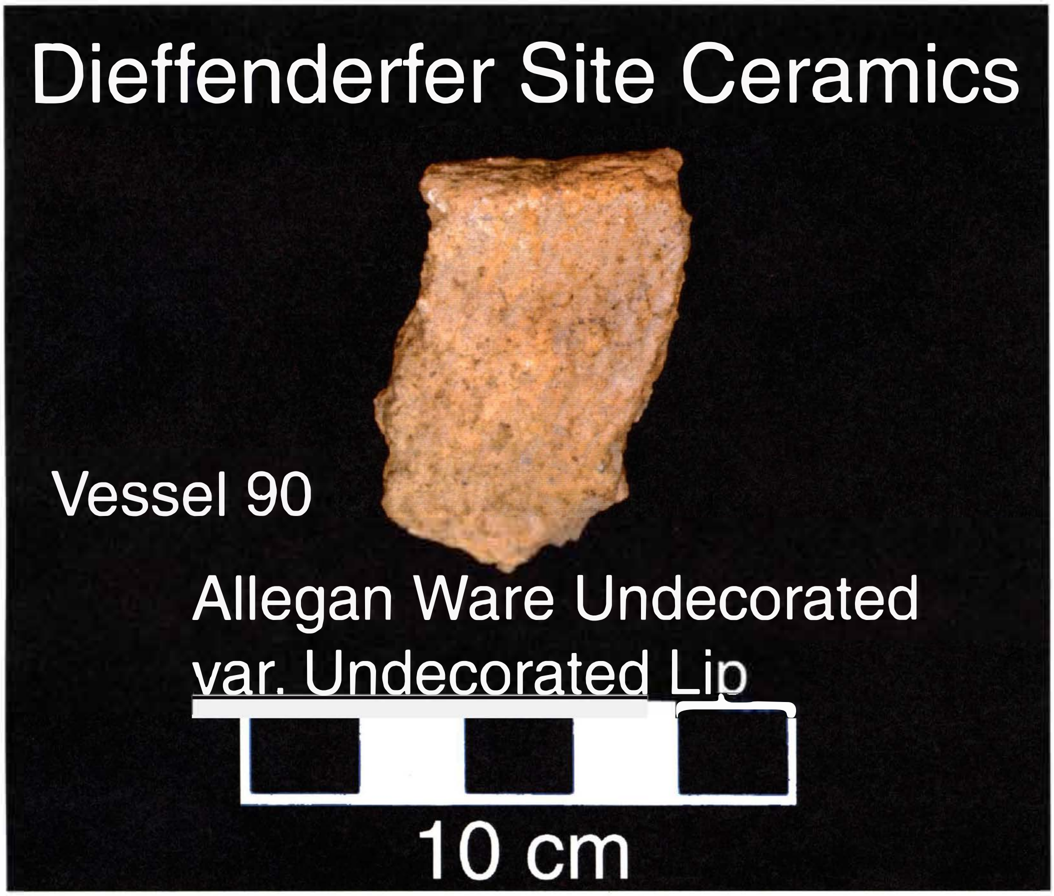

Dieffenderfer Site Ceramics
Vessel 79
Dieffenderfer Ware Undecorated
var. Smoothed Over Cordmarked
10 cm

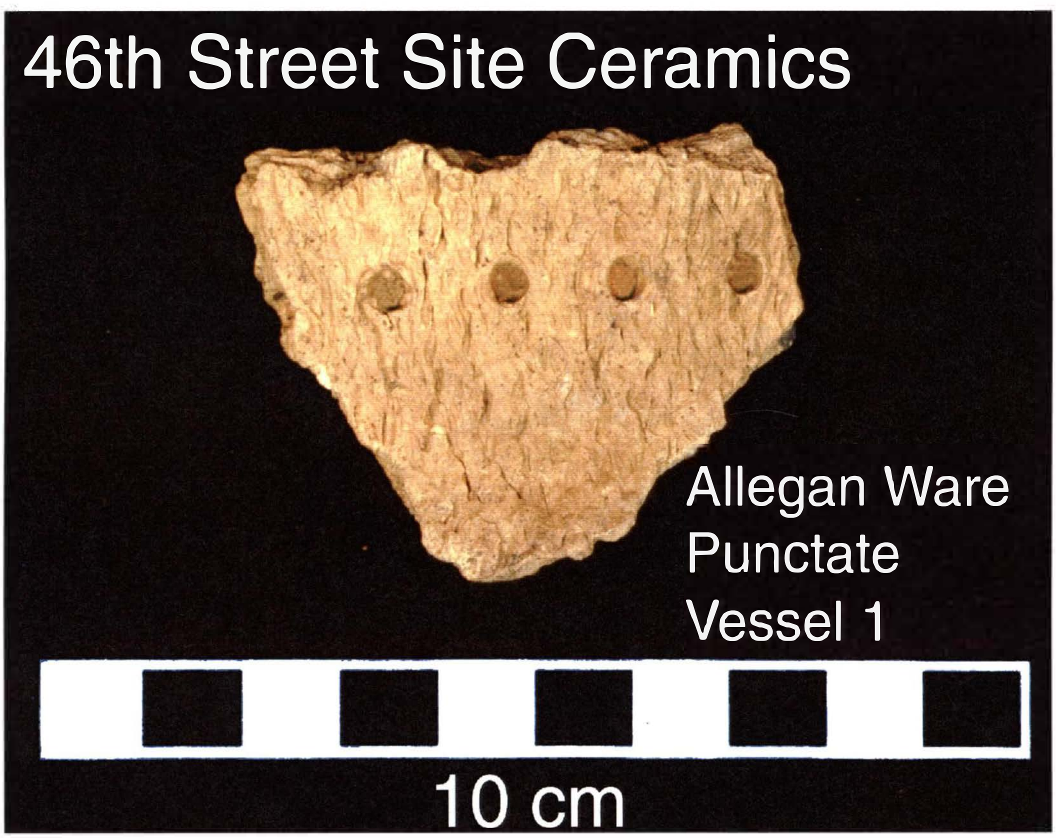

Dieffenderfer Site Ceramics
Dieffenderfer Ware
Undecorated var.
Vessel 80
Smoothed Over Cordmarked
10 cm

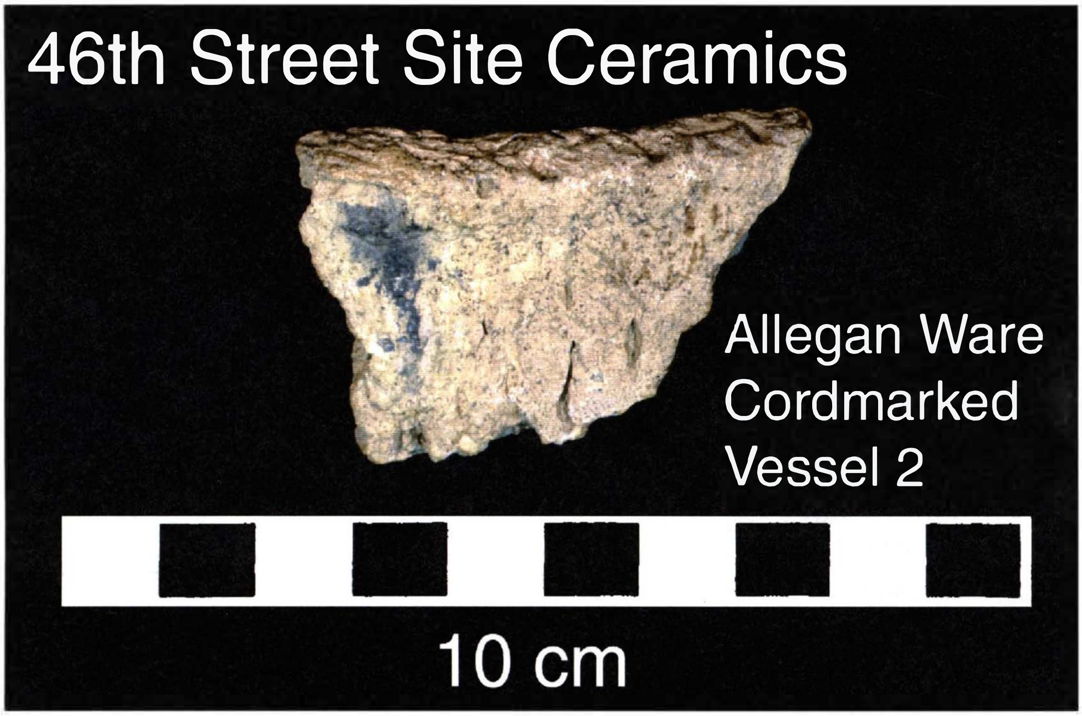

Dieffenderfer Site Ceramics
Vessel 42
Allegan Ware Undecorated var.
Undecorated Lip/Collared
10 cm

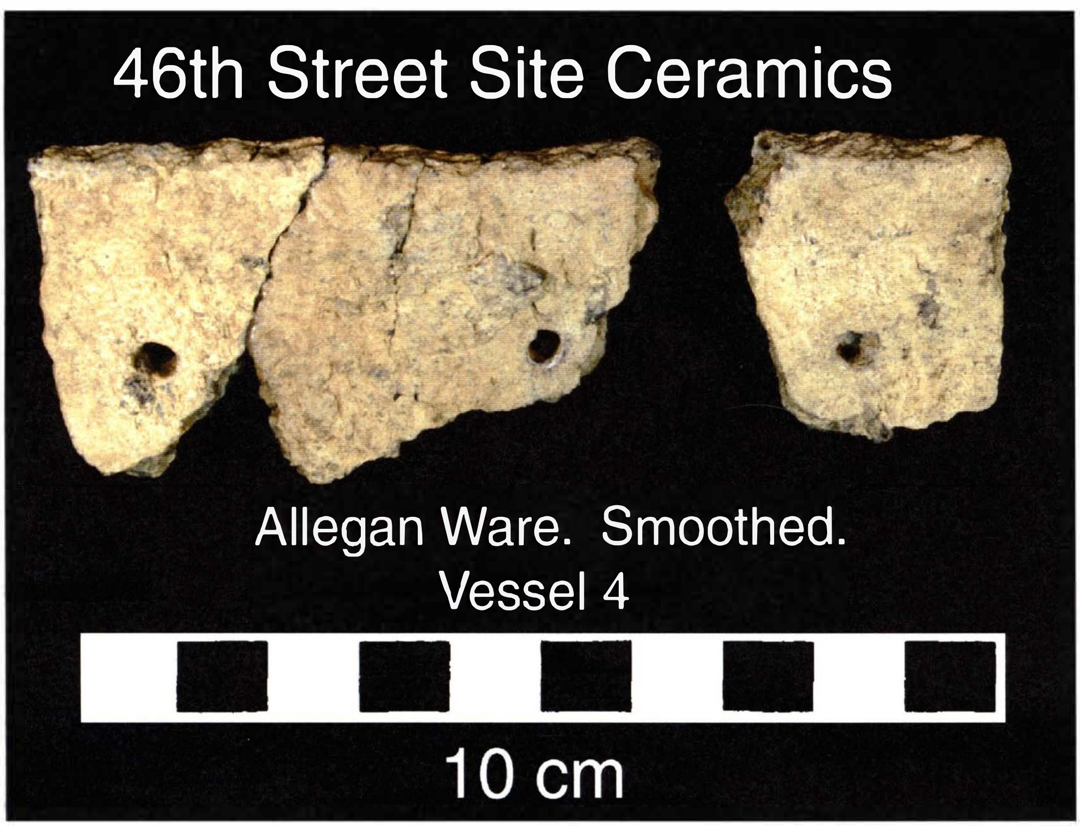

Dieffenderfer Site Ceramics
Allegan Ware
Undecorated var.
Undecorated Lip/Collared
Vessel 64
10 cm


Dieffenderfer Site Ceramics
Vessel 49
Allegan Ware
Undecorated Lip
var Undecorated Lip/ Collared
5 cm


Dieffenderfer Site Ceramics
Vessel 90
Allegan Ware Undecorated
var. Undecorated Lip
10 cm

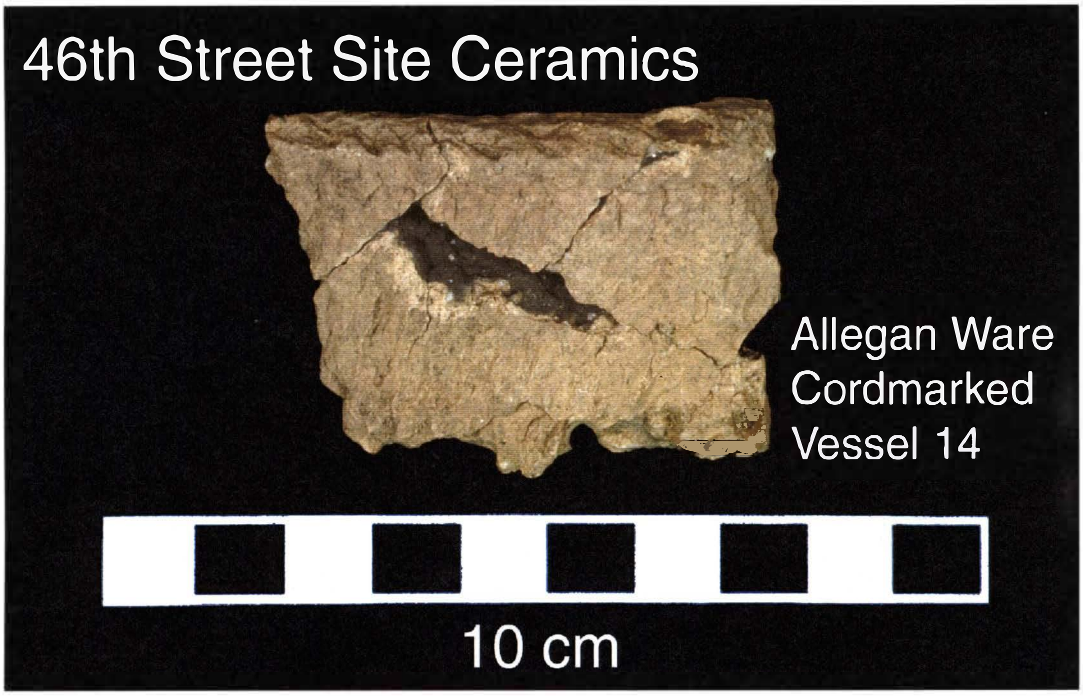

46th Street Site Ceramics
Allegan Ware
Punctate
Vessel 1
10 cm


46th Street Site Ceramics
Allegan Ware
Cordmarked
Vessel 2
10 cm


46th Street Site Ceramics
Allegan Ware. Smoothed.
Vessel 4
10 cm

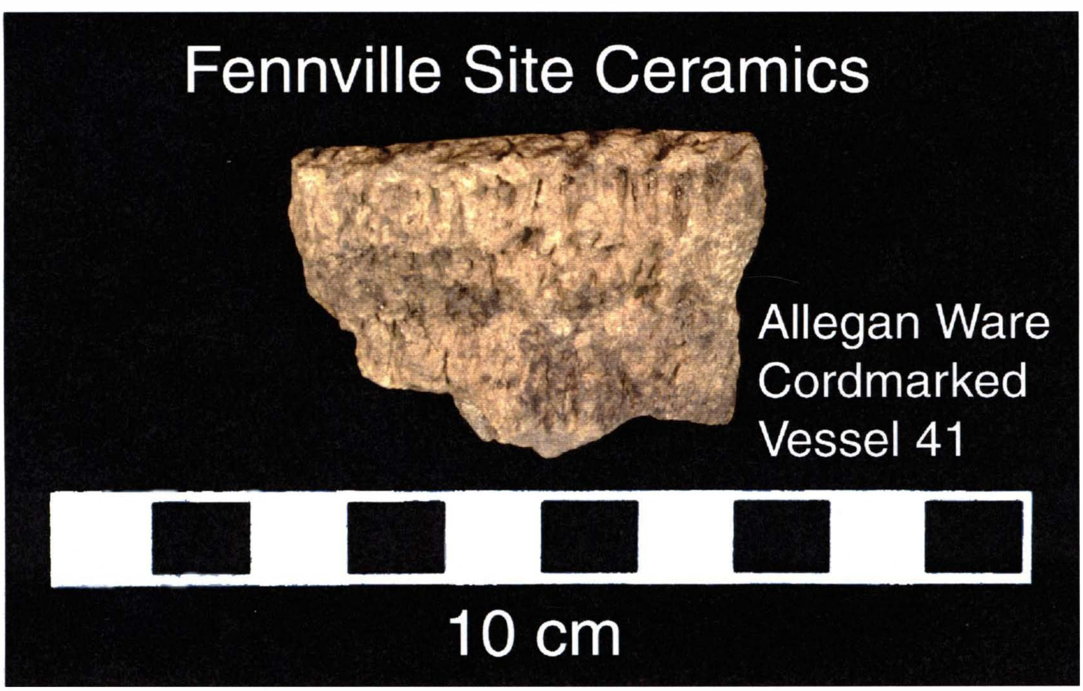

46th Street Site Ceramics
Allegan Ware
Punctate
Vessel 5
5 cm

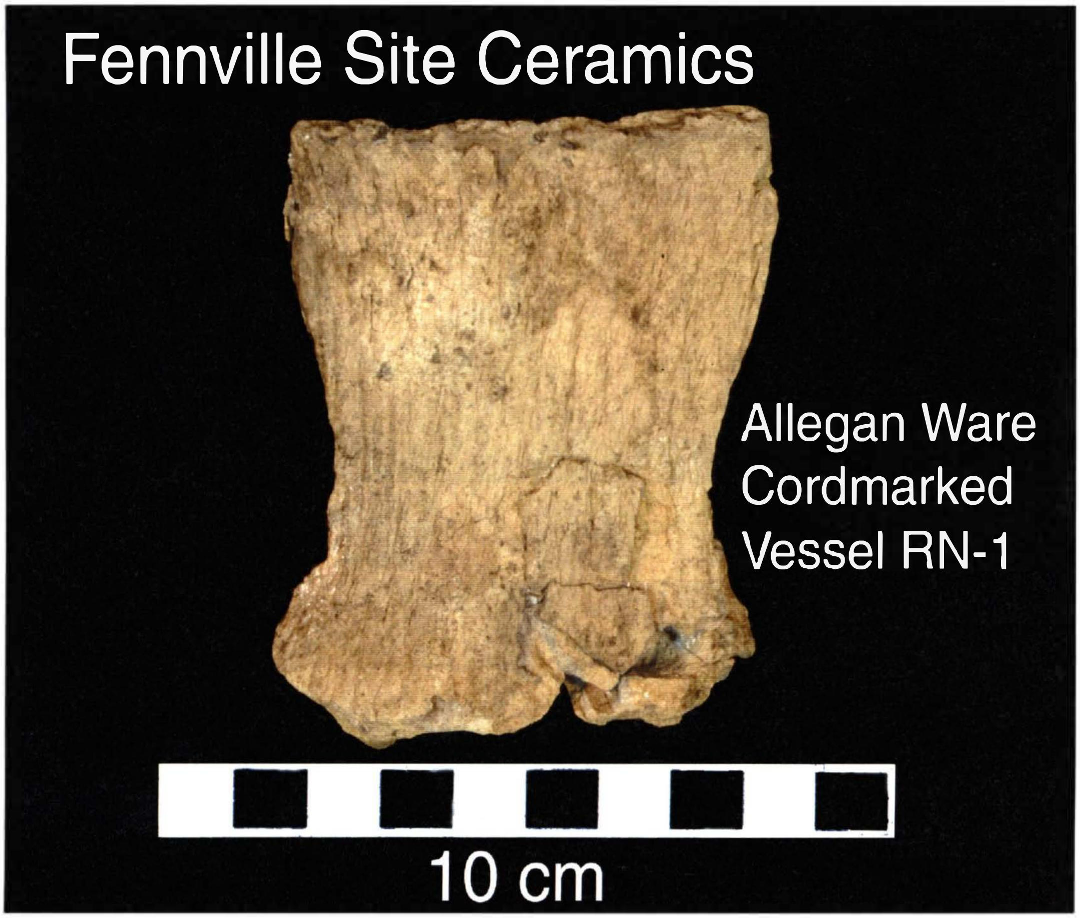

46th Street Site Ceramics
Vessel 7
Allegan Ware
Cordmarked
10 cm

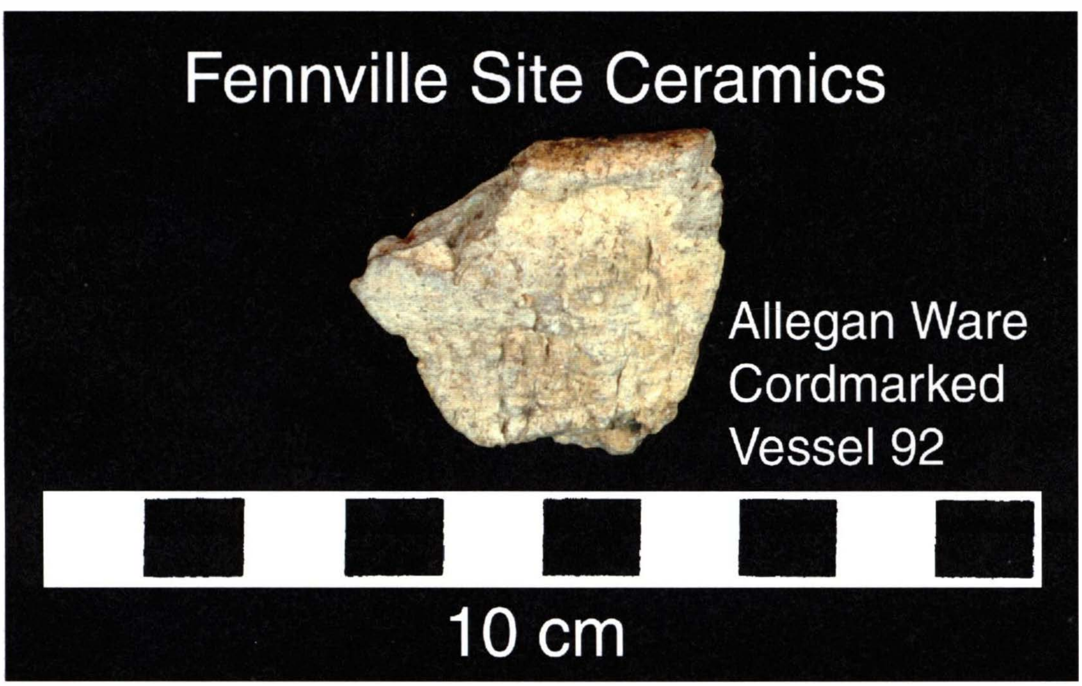

46th Street Site Ceramics
Allegan Ware
Cordmarked
Vessel 14
10 cm

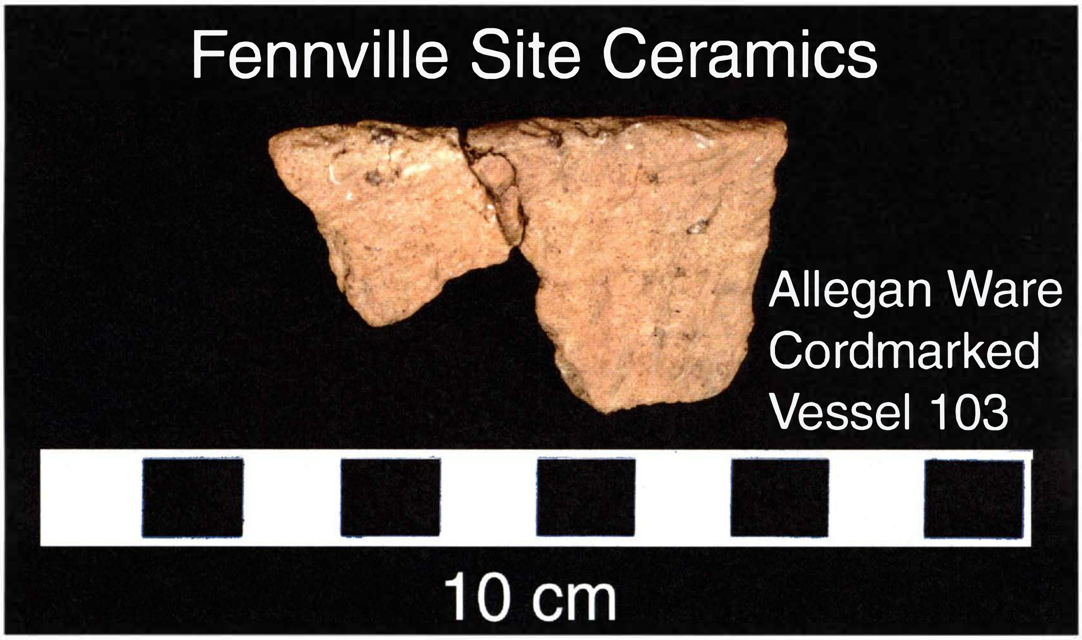

46th Street Site Ceramics
Allegan Ware
Cordmarked
Vessel 24
10 cm

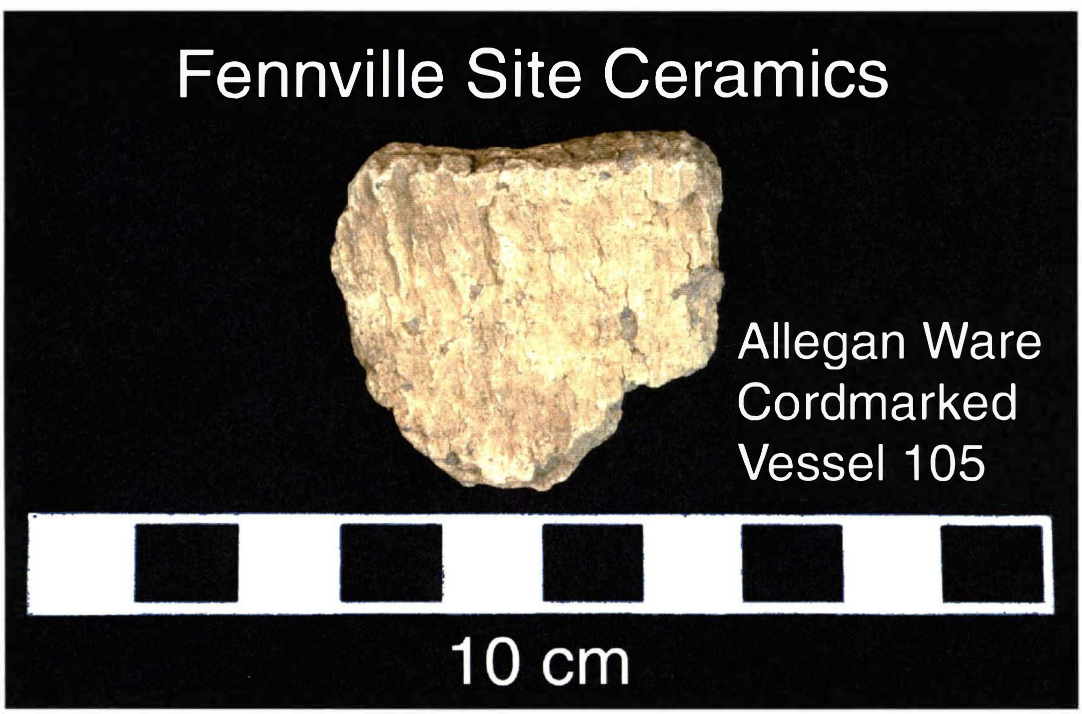

46th Street Site Ceramics
Allegan Ware
Cordmarked
Vessel 36
10 cm

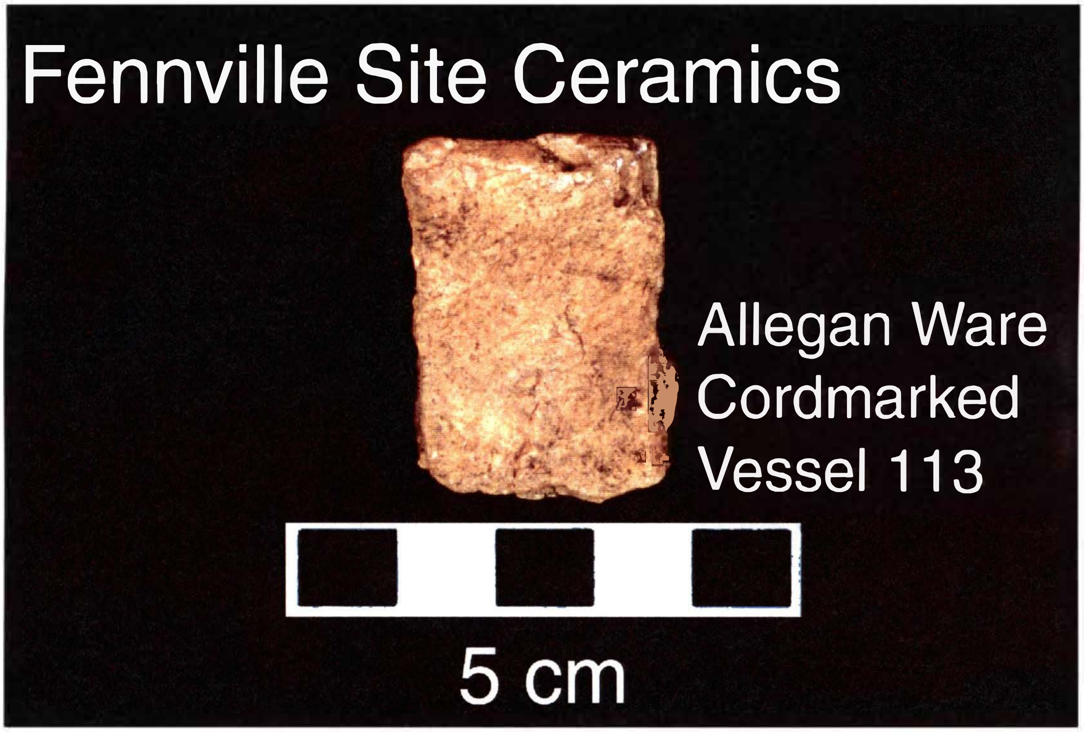

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 41
10 cm

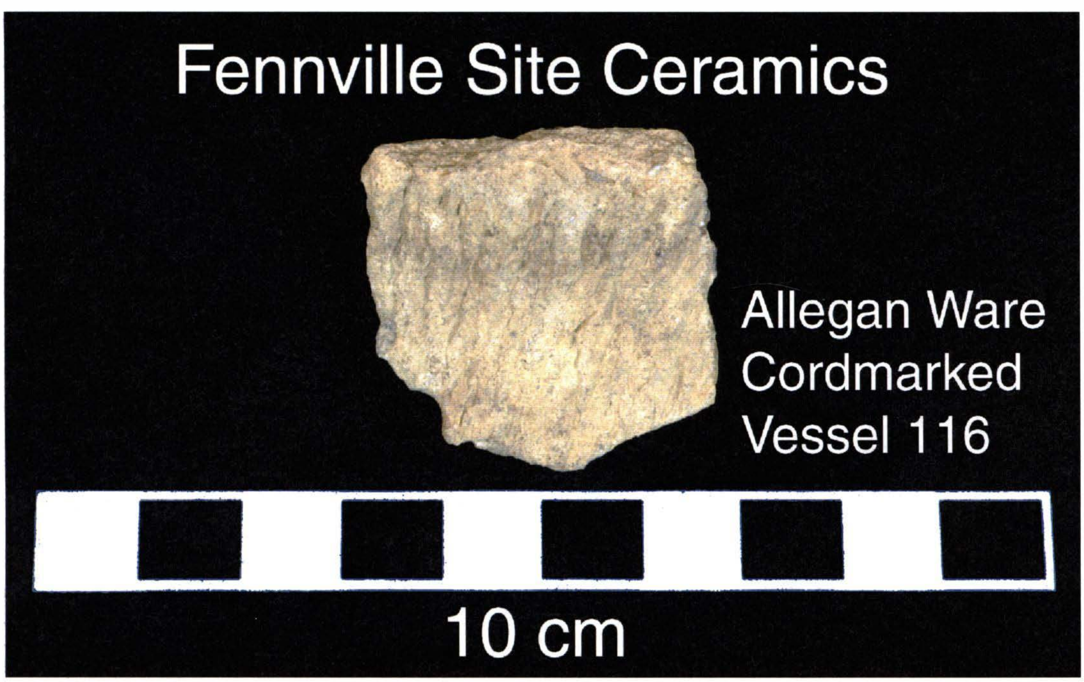

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel RN-1
10 cm

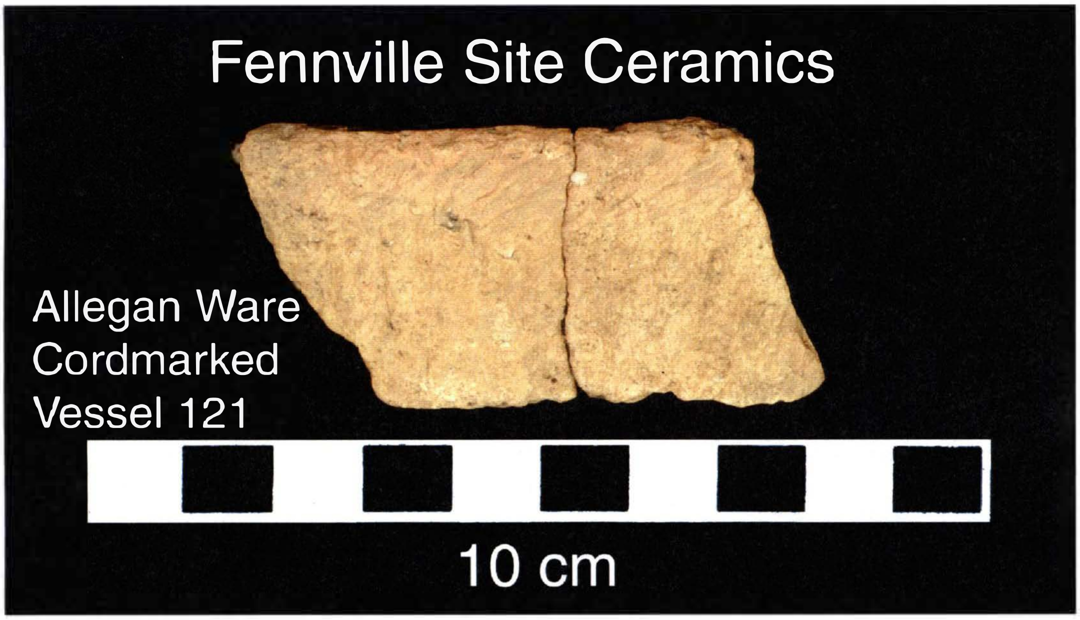

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 92
10 cm


Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 103
10 cm

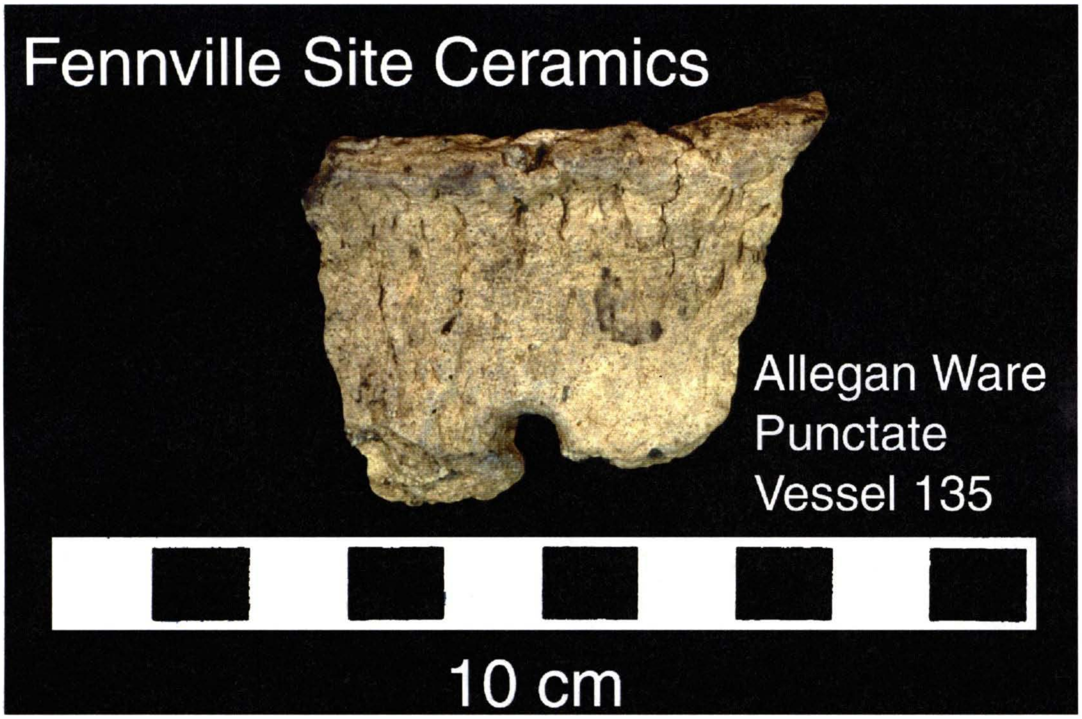

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 105
10 cm

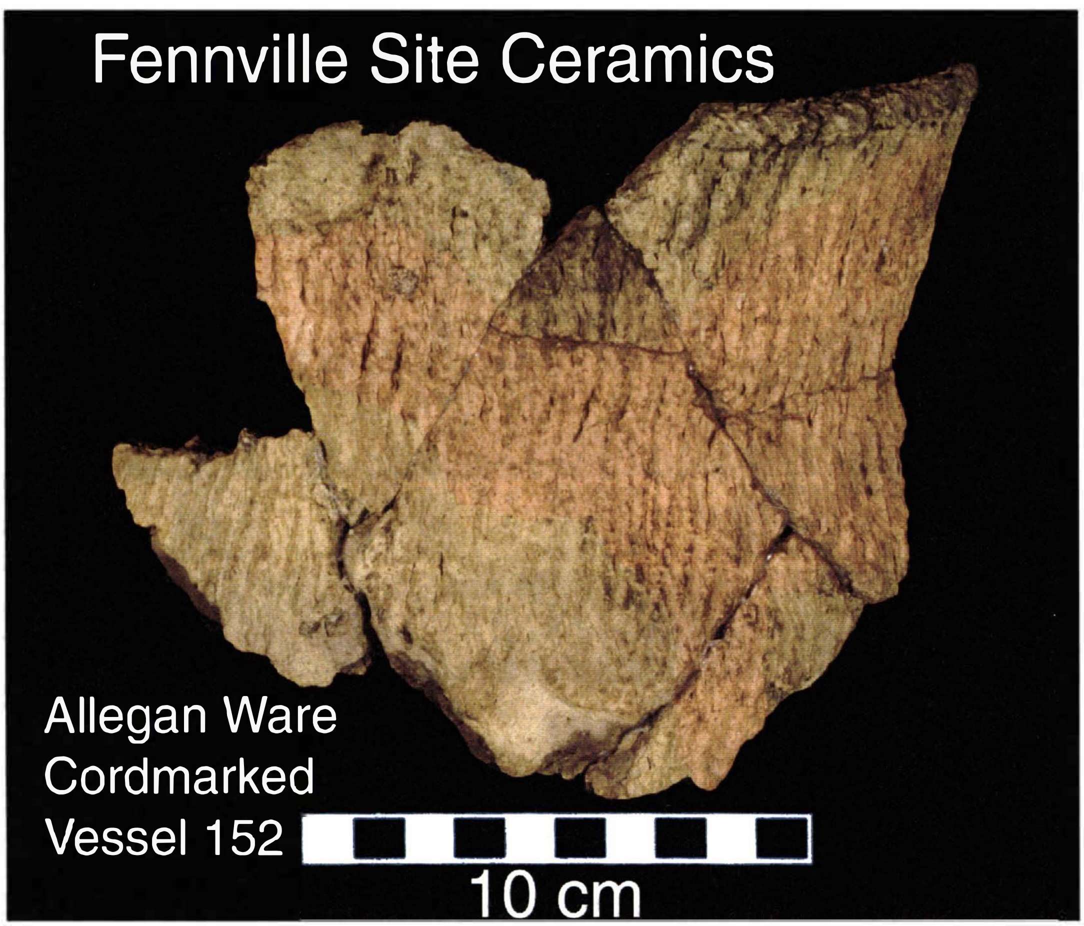

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 113
5 cm

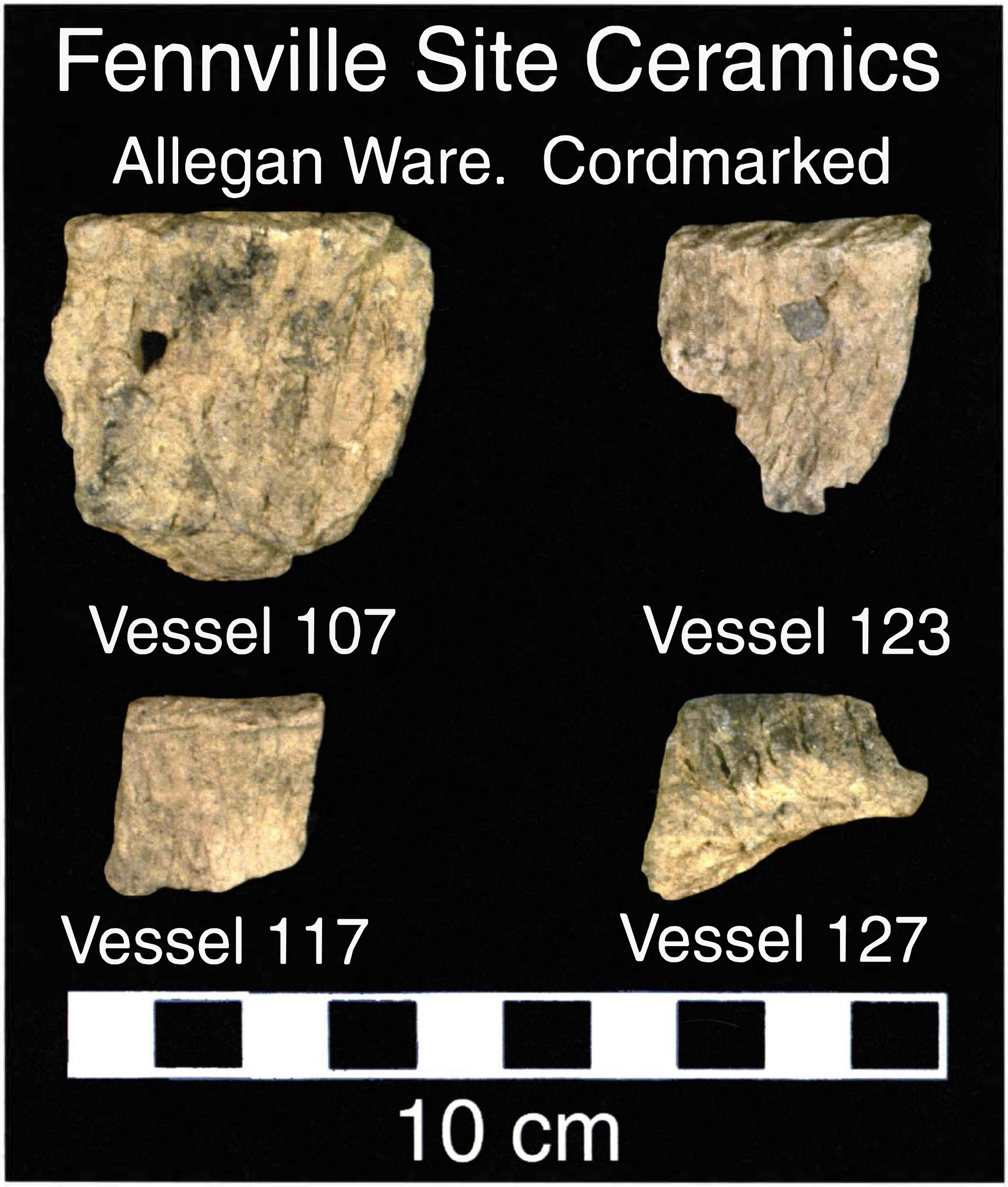

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 116
10 cm


Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 121
10 cm

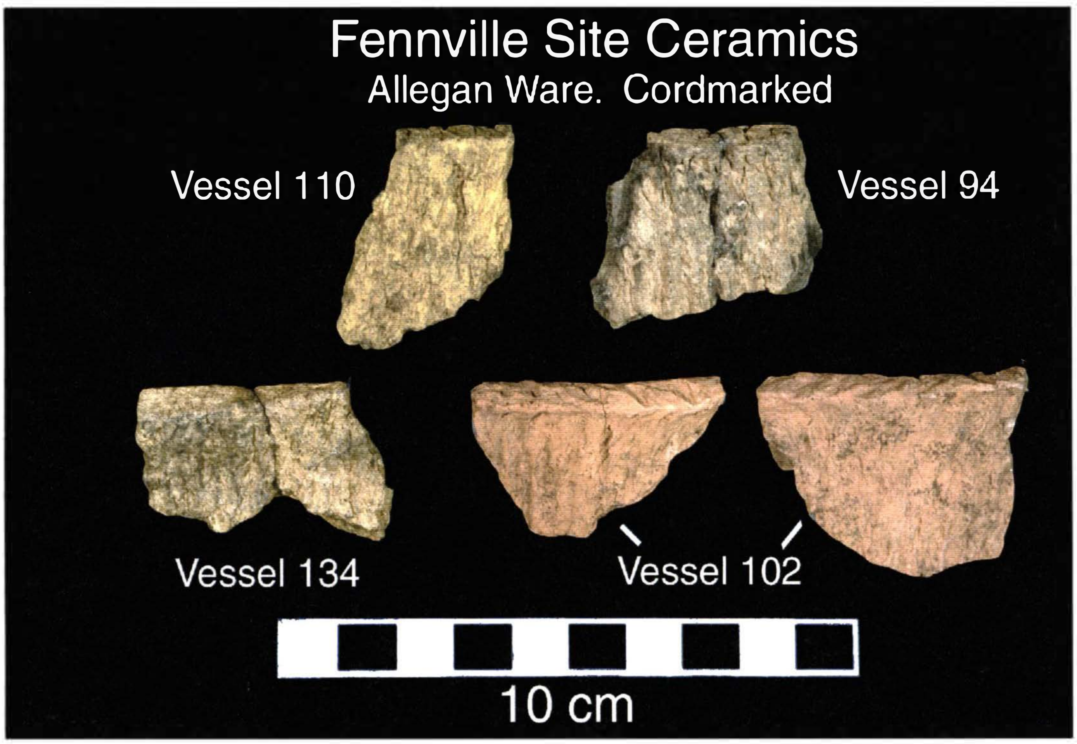

Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 122
10 cm


Fennville Site Ceramics
Allegan Ware
Punctate
Vessel 135
10 cm


Fennville Site Ceramics
Allegan Ware
Cordmarked
Vessel 152
10 cm



Fennville Site Ceramics
Allegan Ware. Cordmarked
Vessel 107
Vessel 123
Vessel 117
Vessel 127
10 cm


Fennville Site Ceramics
Allegan Ware. Cordmarked
Vessel 110
Vessel 94
Vessel 134
Vessel 102
10 cm