A MULTIPROXY ANALYSIS OF CULINARY, TECHNOLOGICAL, AND ENVIRONMENTAL INTERACTIONS IN THE NORTHERN GREAT LAKES REGION

By

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ABSTRACT

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A novel combination of analytic methods is used to address the decades-long debate about diachronic subsistence, settlement, and social pattern changes during the Woodland period (AD 1 – 1600) in the northern Great Lakes of North America. While some have argued for dietary continuity throughout the regional Woodland, others maintain that certain specific resources—including fish, wild starchy plants, and/or maize—were more intensively exploited over time in reaction to various technological, social, and/or environmental factors. The Cloudman site (20CH6), located on Drummond Island off Michigan's Upper Peninsula in Lake Huron, is a multicomponent habitation site with two millennia of Middle Woodland, early Late Woodland, and late Late Woodland occupations, as well as a late precontact component characterized by Ontario Iroquois pottery. The ceramic assemblage is therefore ideal for diachronic assessment of alterations in diet and technology in the context of dynamic natural and social environments and is employed as a case study for the multiproxy approach.

Ceramic typological classification and AMS dating of pottery residues are used to reconstruct an occupational history of the Cloudman site by which change over time can be evaluated. Functional pottery analysis of technical properties and use-alteration traces reveals that ceramic technology and cooking techniques evolved to facilitate new subsistence and processing needs. Absorbed lipid residue analysis, and microbotanical and stable isotope analysis of adhered carbonized food residue are used in tandem to construct a chronological sequence of culinary practices, which are characterized by both continuity of certain subsistence traditions,

such as acorn and aquatic resource consumption, and transformative food choice in response to social and environmental change, including variable exploitation of maize and wild rice.

The diversity of the information captured and produced by each method highlights the importance of multiproxy dietary analyses in foodways studies for improving interpretive outcomes. Cooking and pottery technology lend further insight into adaptive decision-making and cultural tradition, and interpretations of past cuisine are further supported and enhanced through comparisons with ethnographic and ethnohistoric accounts of local indigenous cooking and diet. The rich data resulting from the complementary nature of these diverse methods demonstrates a complex interplay of technology, environment, and culturally-based decisions, and underscores the potential applications of such an analytic suite to long-standing problems in the northern Great Lakes and other archaeological contexts worldwide.

For Mom and Dad

“*Things we lose have a way of coming back to us in the end,*
if not always in the way we expect.”

– J.K.R.

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CHAPTER 1

INTRODUCTION

Introduction

Food and cooking are vital components of human survival and culture. Understanding subsistence-related behaviors and attendant technologies is important for unveiling the lifeways of past societies because of their close association to adaptive decisions, identity, social and political relationships, and ideologies. Food remains and pottery are both widely-studied artifact categories, and new analytic techniques for extracting increasing amounts of information from these data are constantly being developed and refined. Many such methods are used independently without employing them together, despite the oft-complementary nature of the data each yields. Expansion of routine pottery and dietary analyses to include a variety of analytic methods holds potential to improve interpretations of sites with limited preserved archaeological materials and amplify evidence for adaptive and social behaviors at archaeological sites across the globe. The intersection of foodways and pottery is a promising arena for multidimension research that could construct more robust interpretations about the past.

The need for multidimensional analysis of this kind is exemplified in the northern Great Lakes (i.e., Lake Superior, and northern Lake Michigan-Huron) of North America, where mobile groups left behind limited archaeological remains and preservation of organic materials is generally poor. While some scholars have argued for a transition from broad spectrum hunting-gathering to intensification of certain wild and/or cultivated resources during the Woodland period (200 BC – AD 1600), others have argued for greater or complete continuity in settlement and subsistence patterns throughout the Woodland period. The dissertation examines the issue of hypothesized changing settlement and subsistence patterns from the perspective of food processing technology, food/resource selection, and cooking methods based on a ceramic assemblage from the multicomponent Cloudman (20CH6) site near the Straits of Mackinac in the northern Lake Huron basin. The results will contribute to the growing body of data about precontact northern Great Lakes dietary behaviors and provide clarification about diachronic behavioral change in the context of social and environmental factors. They will also demonstrate the effectiveness of a novel combination of methods for examining ancient cuisine and culinary technology.

Research Context and Problem

For decades, researchers have hypothesized, based on an increasing body of data, that subsistence and settlement strategies in the northern Great Lakes underwent significant changes from the Middle Woodland (200 B.C. – A.D. 500/600) to the Late Woodland (A.D. 500/600 – A.D. 1600) periods. This includes apparent intensification of aquatic resources (Cleland 1982; Smith 2004) and certain starchy resources, such as acorns and wild rice (Dunham 2014) or maize (O’Shea 2003). Others have argued for continuity of subsistence regimes throughout the entire Woodland period (Martin 1989). Observed diachronic changes in cooking habits, evident through carbonized food patterns on ceramic cooking vessels, could corroborate the hypothesized subsistence shifts in the Late Woodland period (Kooiman 2012, 2015, 2016). If a change in diet occurred, the resources that became the foci of intensification, as well as the timing of this intensification, remain unclear.

Many have also connected the Late Woodland intensification of resources to social changes simultaneously expressed through pottery style (Brose and Hambacher 1999; Dunham

2014; McHale Milner 1998; O'Shea and McHale Milner 2002). Increasing stylistic heterogeneity throughout the Late Woodland period signal increasingly bounded group identity and localization, requiring resource intensification in the face of decreased geographic ranges of exploitation. The formation and expansion of Iroquoian groups to the east and later arrival of Europeans into the area further complicate the sociocultural and dietary history of the region.

Precontact northern Great Lakes subsistence has rarely been discussed from the perspective of foodways, which contextualizes subsistence behaviors within broader social, political, and ideological behavior (Twiss 2012). This perspective requires a wide range of inference drawn from and situated within a wide array of complementary evidence. While this study focuses on ceramic technology and the physical and proxy evidence of foods found in direct context with this technology, these evidences will be discussed within the broader social context of the northern Great Lakes, primarily through comparisons with ceramic typologies.

The intersection of subsistence and ceramic technology has long been discussed by archaeologists working in the northern Great Lakes, but recent work has explored the topic from the perspective of pottery function (Kooiman 2012, 2016; Skibo et al., 2009). Elsewhere in the Eastern Woodlands, alterations in pottery construction and composition have been connected to shifts in subsistence strategies (Braun 1983; Hart 2012; Pierce 2005). The initial adoption and subsequent alterations in vessel form and ceramic paste recipes (Chivis 2016, Stoltman 2001) could therefore be useful for distinguishing technological change enacted to accommodate new cooking and dietary requirements.

Research Objectives

This dissertation explores the long-standing issues of Woodland and Protohistoric northern Great Lakes subsistence while demonstrating the effectiveness of examining variation and change in subsistence habits and social relationships from the perspective of food processing technology, resource selection, and cooking methods. The overarching question of this research is: ***Do pottery technology, pottery use, diet, and cooking habits change over time, and if so, how do these changes relate to hypothesized transitions in subsistence, settlement, and social patterns among pottery-making groups in the northern Great Lakes region?***

Food residues extracted from pottery are analyzed both microscopically and chemically. Microbotanical, lipid residue, and stable isotope analyses are employed to examine various dimensions of the food types and recipes prepared in ceramic cooking vessels. Functional pottery analysis, which includes assessment of both technical properties and use-alteration traces, is used to assess both technological adaptations related to food cooking requirements and the methods of cooking employed by pottery-producing precontact and possible protohistoric groups. Results of the dietary and technological analyses are compared to taxonomic pottery classifications to evaluate the possible relationship of food and cooking with social identity, and then considered in context with observed culinary behaviors of local indigenous groups detailed in ethnographic and ethnohistoric accounts to enhance interpretations of past cuisine.

This unique combination of ceramic and dietary analytic methods will be applied to the ceramic assemblage from the multicomponent Cloudman site, located on Drummond Island in Lake Huron. Periodically occupied during the Middle Woodland, Late Woodland, and possible Protohistoric periods (Table 1.1), it is the ideal site for making observations on a range of variables in one place over a long period of time, thereby minimizing the effects of distance and social, political, or subsistence variation on the observed changes and allowing diachronic changes in pottery function to be related to broader adaptive and social changes. Excavation of the Cloudman site also produced a substantial pottery assemblage of suitable size for this type of analysis.

Table 1.1: Northern Great Lakes Chronology

Period	Dates
Middle Woodland	200 BC – AD 500/600
Late Woodland	AD 500/600 – 1600
early Late Woodland	AD 500/600 - 1000
middle Late Woodland	AD 1000 - 1200
late Late Woodland	AD 1200 – 1600
Protohistoric/Contact	AD 1600 - ca. 1700

Examining the ceramic assemblage from the Cloudman site from the perspectives of foodways and technology demonstrates the effectiveness of multidimensionally constructed research for providing clarification to long-standing questions using existing archaeological collections. This research, therefore, demonstrates the importance of analyzing old data from different perspectives to bring to light new information.

An Integrated Theoretical Framework

This research employs multiple methods to answer a set of diverse yet related questions, thereby necessitating the integration of several theoretical perspectives. In this case, pottery function, foodways, and pottery style are the overarching theoretical frameworks upon which the data will be laid and the interpretations constructed.

Pottery Function

Ceramic analysis has traditionally been focused on style because of its perceived social and temporal symbolism. Linton (1944) was among the earliest proponents of viewing pottery not for its symbolic and socio-ideological meaning, but instead for its role as a utilitarian household item. He states that an effective cooking pot must have certain physical characteristics to properly serve its functions, such as a mouth large enough to prevent violent overboiling and to allow access, but small enough to prevent all liquid from evaporating during the boiling process. However, Linton's contemporaries mostly ignored his argument and carried on with traditional stylistic analyses, largely to serve as frameworks for constructing chronologies and cultural spatiotemporal units prior to the advent of absolute dating.

Another mid- 20th century archaeologist, Anna O. Shepard, agreed that typological categories were the creation of archaeologists rather than of the culture being studied, and it was therefore "strange that pottery should be studied without considering its relations to the people who made it" (1968:309-310). She encouraged attention to the materials and construction techniques used to make pottery and championed the use of temper and paste properties for its classification, which she believed were better indicators of social relationships than were subjective categories. Shepard began a long tradition of compositional studies of ceramic assemblages worldwide. Her area of expertise, petrographic analysis, was practiced more commonly in Europe than in North America but become more popular in the latter following Stoltman's (1989) revised methodology (Rice 1996b). Compositional studies have now expanded to include a variety of geochemical methods for identifying the composition of both clays and inorganic temper inclusions, such as x-ray fluorescence (e.g., Ligman 2013; Morgenstein and Redmount 2005; Tykot 2016), neutron activation (e.g., Falabella et al. 2013;

Glascock and Neff 2003; Wallis et al. 2016), and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) (e.g., Druc et al. 2017; Duwe and Neff 2007; Stoner 2016).

A handful of archaeologists began investigating ceramic vessel function following Binford (1965), who distinguished between primary function (the specific use made of the vessel) and secondary function (the by-product of the social context of a vessel's manufacturer). Hally (1983) suggested that primary function could be explored through physical properties, archaeological contexts, and the alteration of vessels through use. He cites early explorations of vessel wall absorption of phosphorous and fatty acids (Condamin et al. 1976), surface accumulations of carbonized food residues (McPherron 1967), and the breakdown of vessel surfaces (Griffiths 1978; Matson 1965), which he synthesizes as explorations of ceramic vessel "use alteration."

Braun (1983) helped introduce the most recent wave of interest in pottery function, calling for archaeologists to begin to view "pots as tools," made by people to be used for a variety of functions beyond symbolizing social identity. Focused study of pottery can reveal manufacturing processes, and Braun urged the examination of mechanical performance characteristics to recognize why a vessel was constructed. He emphasized that the physical properties of a pot could have been controlled by potters in order to achieve certain desired performance characteristics; in other words, the technical characteristics of a pot have the potential to reveal what functions it was designed to fulfill.

A series of studies in the interceding decades have tested the performance characteristics of various physical properties. Rye's (1976) initial investigation into the effects of temper on various stages of manufacture set the stage for other temper studies. Bronitsky and Hamer (1986) tested the effects of tempering materials for impact and thermal shock resistance, finding all smaller-grained temper improved ceramic wall strength, and that shell temper was better for shock resistance than grit temper. Feathers (2006) found that although shell temper increases workability and overall vessel strength, its adoption in Eastern North America was not widespread until widescale agriculture was practiced, limiting fuel for fire and requiring pottery that could be fired at lower temperature, which shell tempering improves. Upton et al. (2015) found through experimental work that shell tempering did not have a nixtamalizing effect on contents cooked in vessels, as had been hypothesized by some due to its proliferation alongside maize agriculture.

Schiffer and Skibo (1987) adopted and expanded Braun's ideas under the "behavioral archaeology" theoretical framework. They refer to decisions made by potters as "technical choices," which cater to and gravitate towards the most desirable performance characteristics, sometimes at the expense of other characteristics. Performance characteristics for ceramic vessels include ease of manufacture, cooling effectiveness, heating effectiveness, portability, impact resistance, thermal shock resistance, and abrasion resistance, which can be influenced by physical characteristics such as vessel size, wall thickness, vessel shape, paste composition, temper density, temper type, etc. (Schiffer and Skibo 1987).

Behavioral archeologists conducted a set of experimental studies to explore performance characteristics of multiple technical choices. They found that surface treatment, such as slips and resins applied to the surfaces of vessels, increase heating effectiveness (Schiffer 1990) but have variable effects on abrasion resistance (Skibo et al. 1997). Organic temper, the earliest type used across the world, is thought to have been used for expedient pottery manufacture, but was later replaced by inorganic tempers as a result of its poor performance characteristics (Skibo et al. 1989).

The physical characteristics imbued by a potter onto a vessel determine what Skibo (1992, 2013) calls "intended function" (see also Schiffer and Skibo 1987, 1997). Skibo argues that while knowing a vessel's intended function is useful, archaeologists must also consider its actual function, or the ways in which people made use of a vessel, regardless of its intended function and physical capabilities. This is best achieved by looking at Hally's (1983) "use-alteration traces." According to Skibo, these include sooting, carbonization (charred food residue), attrition, and absorbed residues. These traces provide a more refined perspective of pottery use, allowing inferences about use over fire, cooking practices, cuisine, and more.

Foodways

The study of foodways has its roots in folklore studies and is a growing topic of cross-disciplinary interest in anthropology. Within archaeology, food-related research was traditionally concerned with "diet" and "subsistence," focusing on human acquisition of necessary nutrients to ensure survival. The terms "foodways" and "cuisine" set past food production, preparation, and consumption in context with politics, ideologies, and economies (Twiss 2012:357).

Examining food from an adaptive, environmental perspective has been the traditional avenue for dietary studies. Perhaps the most famous model for hunter-gatherer adaptive subsistence behavior is Binford's (1980) foraging/collecting spectrum. He identifies two major poles of subsistence-settlement strategies: foraging, which entails high residential mobility (frequent residential relocation based on resource abundance/availability) and daily procurement of food resources; and collecting, which employs logistical mobility (lower residential mobility with base camps from which task groups disperse on logistical forays) and some form of food storage. Foraging and collecting represent two extreme ends of a continuum of strategies employed by hunter-gatherers, and where groups land on this spectrum (both inter- and intra-annually) is often dependent to a large degree on environment (particularly resource distribution across time and space) and competition for resources (Binford 1980).

In temperate zones, seasonal fluctuations in resource availability require regular short-term predictive risk-buffering to counteract potential caloric and nutritional shortfalls. Speth and Spielman (1983) found that diets consisting primarily of lean protein caused heightened metabolism, requiring increasing amounts of food to maintain proper energy intake. This is important in the lean time of late winter/early spring, when plant food sources are low and wild animals are at their leanest, the consumption of the latter leading to what some hunter-gatherer groups call "rabbit starvation" (Speth and Spielman 1983). Carbohydrates and fats both counteract this effect but carbohydrates are more effective.

The role of carbohydrates is critical in predictable short-term food shortage risk buffering, and explains the importance of selecting foods for storage. The Sami of subarctic Scandinavia use the inner bark of Scots pine to add carbohydrates and fiber to their diet throughout the year and counteract the effects of protein starvations (Bergman et al. 2004). Early use of seed crops in the Eastern Woodlands has also been linked to carbohydrate storage for consumption during lean periods (Gremillion 1996, 2004).

Not only does a balance of time, energy, and efficiency influence food choice, but so does nutritional balance. Maize and beans were grown and consumed together by many late prehistoric (post-A.D. 1300) North American indigenous societies. The two crops grow well together, and beans provide protein otherwise lacking in maize-based diets (Hart 2008; Hart and Scarry 1999; Hart et al. 2002; Monaghan and Parker 2014). Maize is present rather early in portions of the Great Lakes (ca. cal 200 BC; Albert et al. 2018), and may be related to an intensification of wild rice exploitation, which like beans, is relatively rich in amino acids and would have also been a good complement to the nutritionally devoid maize (Hart and Lovis 2013). The selection of food for nutritional needs is clearly a complex process involving a mosaic of decisions, and it is further complicated by the addition of cultural factors.

The intersection between biological food requirements and cultural food preferences is best summarized by the "omnivore's paradox," which states that humans have incredible freedom and adaptability in food choices, but they also mistrust new foods. A social/cultural group's traditions of food choice and preparation (i.e., cuisine) work to resolve an omnivore's anxiety by limiting options and setting parameters for preparation (Fischler 1988:277-279). The parameters are culturally defined and vary based on accessible resources, cultural traditions, and acceptable behaviors.

Food is a culturally defined term and therefore what is conceptually accepted as food varies from group to group. Consequently, cuisine, or food culture, is used to differentiate between economic classes, ethnicity, gender, and religious beliefs, serving as a proxy representation of social diversity and identity (Twiss 2012). Food is also an integral part of everyday life. It is an avenue by which to socialize and unite families and communities, making food a physical need fulfilled in social contexts (Atalay and Hastorf 2006).

Food can serve "diametrically opposed semiotic functions" that act to both unify and divide; they can create a sense of belonging or emphasize group differences, both of which solidify identity (Appadurai 1981; M. Smith 2006). It can serve as both a cultural mediator but also as a device for "othering" (Montanari 2006), especially between groups defined by ethnicity (Jones 1997; Kalčik 1984; e.g., Barrett et al. 2001; Egan-Bruhy 2014; Scott 1996). Even when common foods are shared, food preparations and cooking methods can be used to distinguish members of a community from those of other groups (Beoku-Betts 1995) or from others of differing ethnicities or classes within their own communities (Chase 2012) as an act of dietary identity formation.

Like food selection, cooking is "related in complex and varied ways to issues of gender, work, politics, economic life, and social differentiation" (Rodríguez-Alegría and Graff 2012). Cooking techniques are often aimed at maximizing digestibility and nutritional value of foodstuffs (Wandsnider 1997), but cultural traditions or taste preferences are not always synchronous with nutritional maximization (Rodríguez-Alegría and Graff 2012). Cooking is directly related to food production, food collection, and the manufacture of cooking tools, all factors critical to the overall economy (Rodríguez-Alegría and Graff 2012), and the tools involved in cooking can also be symbolic of identity (MacLean and Insoll 1999). This situates cooking as a useful lens through which to view the intersection of resource selection and ceramic technology.

Changes in food selection and subsistence strategies are traditionally couched in terms of adaptation to new or changing environments, climatic changes, or increasing population pressure (Binford 1968; Childe 1936; Flannery 1973), but some archaeologists have begun to investigate dietary shifts from social, political, and ideological perspectives. Spielmann (2002) has argued that the mechanism driving the intensification of food production in small-scale societies is neither economic nor political, but communal ritual activity, specifically feasting and craft specialization. She claims that demand for items critical for communal ritual participation common among many small-scale societies was more critical for the development of agricultural intensification than subsistence provisioning. Hastorf and Johannessen (1994) argue that the timing and patterning of the intensification of maize production and consumption in both North and South America was not advantageous economically but instead linked to the cosmological importance of maize. In their view, maize only increased in use alongside rapid elaboration of social hierarchy, possibly because it was used by political officials for its ritual significance.

Food is a biological need, selected because of its availability, taste, abundance, and nutritional value. Yet these choices are often restricted and/or influenced by cultural factors, such as identity, cultural tradition, and ideology. This is important to consider even when studying small-scale societies for whom markers of social affiliation and cosmological beliefs can be difficult to discern.

Pottery Style

Pottery function analysis and food analyses are applied within a broader foodways framework, and as such they must be discussed in the context of social behavior including various scales and kinds of interactions. Among the mobile hunter-gatherer (-fisher) societies of the northern Great Lakes, this is often achieved via comparisons of pottery style (see Brose 1970; Dorothy 1978, 1980; Janzen 1968; McPherron 1967; Richner 1973; Stoltman 1973). Style has long been used in time-space systematics, in which style denotes both temporal affiliation and geographic spread (Sackett 1977). Given that style is connected to the time and space within which human groups behave, it is often considered symbolic, whether actively or passively, of ethnicity or identity and has been used to separate groups into “cultures” or “ethnicities” based upon ceramic stylistic differences (Peelo 2011; Rice 1996a). The conflation of archaeologically defined stylistic types and past identities/ethnicities has been criticized over the decades (Rice 1996; Sackett 1977; Shepard 1968), although geographic variation in ceramic vessel style does suggest that style is influenced by social interaction (McHale Milner 1998; O'Shea and McHale Milner 2002).

Wobst (1977) states that style, independent of technomic function (Binford 1962), serves the function of symbolic communication and information exchange. Symboling, a learned behavior, allows individuals to interact with their social environment through the medium of artifacts, often in the expression of identity through style (Wobst 1977:320). Items which are the most visible and used in arenas of interaction with other groups are the most likely to be used to communicate group affiliation, while less visible items, particularly those used within the home, are less likely to be used to carry such messages and will instead display clinal variation.

Weissner (1983) identifies two types of style: *emblemic*, which transmits a clear message about group affiliation or identity; and *assertive*, which is formal variation that carries information about personal identity, either consciously or unconsciously, but which does not directly symbolize identity. Within small-scale societies with somewhat fluid, cooperative risk-buffering relationships, the need to distinguish between groups symbolically (using emblemic style) is not as strong as in larger-scale societies with increased competition for resources. Instead, hunter-gatherer artifacts are more likely to transmit assertive style (Weissner 1983:258). Her study of San metal projectile points demonstrated stylistic differences only between non-interacting linguistic groups, which she attributes not to conscious distinction between groups but to non-overlapping social spheres. Thus, with many utilitarian items, such as projectile points and domestic pottery, style is best for interpreting spheres of interaction and less useful for more fine-grained relationships among cooperative small-scale societies.

McHale Milner (1998) and Carroll (2013) found that among pottery from the Straits of Mackinac and Southwest Michigan (respectively), the degree of visibility of stylistic elements transmit information in accordance with social distance. Low-visibility elements, such as lip shape, were shared among local groups, while higher visibility elements, such as rim shape and decoration, were shared among geographically broad but interacting groups. In both cases, stylistic similarities of high- vs. low-visibility items correlated with multiple scales of group interaction based on geographic/social distance.

According to Wobst (1977) and Weissner (1983), utilitarian pottery, because of its use in the household and subsequent low public visibility, is a medium unlikely to carry strong, emblemic messages about identity. In small-scale societies, media displaying style, such as pottery and lithics, are more likely to carry information about breadth of social interaction. In regions and time periods with high social fluidity, pottery is even less likely to convey strong or distinct markers of identity. Within societies with more restricted social boundaries and/or increased resource competition, pottery styles might become more geographically restricted and more diverse within a given region (Carroll 2013; McHale Milner 1998; Wobst 1977). In these contexts, pottery style might not be a consciously created symbol of identity but rather an assertive representation of the interactive group, in which craft traditions are shared with little outside influence, such as within the matrilineal longhouses in late precontact Iroquoia (Hart and Brumbach 2009).

Research Questions

Although disparate in their theoretical foci, these perspectives can be used together to effectively answer how pottery technology, pottery use, diet, and cooking habits change over time and explore their relationship to social and environmental transformations in the precontact northern Great Lakes**.** Pottery function plays an integral role in understanding cooking and cuisine, while pottery style can facilitate recreation of ancient social environments and build interpretations of ancient foodways. Applied to the specific problem of evolving Woodland and late precontact lifeways in the northern Great Lakes of North America, the multi-faceted perspective can extract additional data from limited archaeological remains and bring to light new information about past human behavior.

Given this framework, the specific questions to be addressed in this research are as follows:

1) Are there differences in the technical properties (i.e., thickness, rim diameter, volume, etc.) between Middle Woodland, Late Woodland, and Protohistoric period pottery?

2) Are there diachronic changes in ceramic vessel use and cooking habits evident through use-alteration traces?

3) Are there diachronic changes in subsistence strategies (and possible attendant changes in cooking habits) detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery?

4) Is there synchronic variation in ceramic vessel use, subsistence strategies, and cooking habits evident through use-alteration studies or detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery of differing typological categories?

5) How do ethnographic and ethnohistoric accounts of indigenous diet and cooking in the Great Lakes inform interpretations of ancient cuisine generated from the archaeological data?

Data generated to answer these questions will contribute valuable new insights into the ongoing discussion of resource intensification, technological adaptation, and social transformation in the precontact northern Great Lakes. Research objectives will be addressed using a series of diverse but complementary methods, including functional ceramic analysis (of technical properties and use-alteration traces), typological ceramic analysis, identification of starches and phytoliths from burned food residue, lipid residue analysis, and stable isotope analysis. Interpretations of the outcomes will be enhanced by ethnographic comparisons. The combined data will demonstrate the efficacy of a multidimensional approach to studying subsistence and technology that can be applied to archaeological assemblages from a wide variety of contexts, while also resulting in a fuller yet more nuanced picture of the dynamism of northern Great Lakes Woodland foodways.

Dissertation Organization

This dissertation is organized into nine chapters. Following this introduction to the research problem, questions, and theoretical orientation, Chapter 2 provides an overview of the archaeology and cultural history of the northern Great Lakes in the context of trends seen in Eastern North America. Chapter 3 is a discussion of the research problem and provides a background of the Cloudman site, which demonstrates its suitability for investigating the research questions. Chapter 4 will review the methods employed for this research project, including taxonomic pottery classification and functional pottery analysis, as well as lipid residue, stable isotope, and microbotanical analysis of absorbed and adhered food residues obtained from pottery. Chapter 5 will reconstruct the occupational history of the Cloudman site using taxonomic classification of the pottery assemblage and AMS radiocarbon dates. Chapter 6 reviews the functional analysis of pottery from the Cloudman site, while Chapter 7 presents the results of the various subsistence-related analyses. Chapter 8 places the research outcomes in context with ethnographic and ethnohistoric accounts of local indigenous culinary behaviors. The ninth and final chapter will provide a detailed discussion of the results, their implications for understanding northern Great Lakes subsistence and technology, and the effectiveness of this multi-tiered approach to studying past behavior.

CHAPTER 2

ENVIRONMENTAL AND CULTURAL HISTORY/BACKGROUND OF THE NORTHERN GREAT LAKES

Introduction

The northern Great Lakes region, although often overlooked in the archaeological literature, has a rich, millennia-long cultural history characterized by complex and dynamic human interactions with both their social and natural environments. Situated on the perimeter of the Midwestern United States, the archaeological history of the northern Great Lakes is integrated into the overall cultural trajectory of the region. However, a number of phenomena distinguish the northern Great Lakes from the rest of the Midwest, from environment to sociocultural trends. It is within this unique microcosm that questions concerning foodways and technological change will be considered. This chapter will detail the broader ecological and social contexts of the research problem.

Terminological clarification of geographic terms is required to properly convey the scope of the trends discussed below. The Great Lakes region constitutes land surrounding Lakes Superior, Michigan, Huron, Erie, and Ontario in northeastern North America, including portions of modern-day United States and Canada. The upper Great Lakes refers to the subset of this region lying north and west of Detroit, encompassing lands surrounding Lakes Huron and Superior, and the much of Lake Michigan. The focus of this study, the northern Great Lakes, encompasses Lake Superior and the northern portions Lake Huron and Lake Michigan and includes the Upper Peninsula of Michigan, northern Lower Michigan, parts of northern Wisconsin and Minnesota, and parts of southern coastal Ontario.

Consistent communication of dates is also required for clarity given the diachronic nature of the study. Henceforth, dates related to paleoclimatic trends will be reported as “BP” (before “present”, aka 1950). Sociocultural dates and time periods will be reported as calendrical years “BC” and “AD”, while direct radiocarbon dates will be reported in calibrated form (“cal BC” or cal AD) correlating with calendrical years, rather than in radiocarbon years.

Paleoclimate and Environmental Background

The onset of human occupation in northern Lower Michigan and the Upper Peninsula of Michigan occurred later than in other parts of the Midwest because of glacial ice coverage during the retreat of the Wisconsin ice sheet (Cleland et al. 1988, Larson and Schaetzl 2001). Michigan was deglaciated between approximately 20,000 and 9,000 BP. This deglacial phase was time transgressive, with the southern parts of Lower Michigan uncovered initially and northern Upper Michigan the final area to become ice free (Blewett et al., 2009).

The first evidence of human occupation in southern Lower Michigan appears between 12,000 and 10,000 BP, after the forest cover became more extensive thus creating an environment more amenable to human habitation (Kapp 1999; Lovis 2009; Shott and Wright 1999:61). During this time, known as the Paleoindian period, the northern Michigan environment was composed of tundra and boreal forest (Hupy and Yansa 2009) and was occupied by large herbivores such as caribou and the last of the megafauna (Holman and Brandt 2009).

Although glacial retreat from the Upper Peninsula had occurred by the beginning of the Younger Dryas, the Marquette Re-advance again covered the area with ice ca. 11,500 BP, and retreated, for the final time, ca. 9900 BP (Larson and Kincare 2009; Pregitzer et al. 2000). By this time, all of Michigan except the south shore of Lake Superior in the Upper Peninsula was ice-free (Kapp 1999). However, a long period of sparse vegetation development in northern Lower Michigan and Upper Michigan following deglaciation precluded occupation of these areas prior to 10,500 BP (Cleland et al. 1988).

What followed was a period of overall warming but frequent fluctuations in rainfall and lake levels (Kapp 1999; Larsen 1999), affecting vegetational and faunal composition (such as the extinction of megafauna) as well as human habitation patterns (e.g., Lovis et al. 2005). At this time, the eastern Upper Peninsula was covered by pine-dominated forests (Hupy and Yansa 2009). By 8000 BP, forest zones across the Eastern Woodlands were relatively similar to modern composition, with hemlock and birch trees as major components of the forest (Crawford 2011; Hupy and Yansa 2009).

For a time, the climate shifted to cooler and moister conditions, causing a decrease in pine and an increase in hemlock ca. 6800 BP (Hupy and Yansa 2009) and the rise in lake levels, resulting in the Nipissing maximum phase of Great Lakes level by ca. 5000 BP (Kincare and Larson 2009; Robertson et al. 1999). However, between ca. 4000 and 3000 BP, lake levels dropped to levels known as the Algoma Stage. This was due to a very warm, dry period known as the Mid-Holocene Climatic Optimum, which again altered the vegetation composition across the landscape (Hupy and Yansa 2009; Kapp 1999; Robertson et al. 1999).

Major ecological and biotic changes took place across the state beginning ca. 3000 BP, when the climate become moister and cooler, resulting in widespread marsh formation in the Upper Peninsula of Michigan (Kapp 1999:57). Between 3000 and 2000 BP, the forest in the eastern half of the peninsula stabilized to the hemlock-dominated forest (composed of birch, cedar, beech, and maple) that covers the region today (Hupy and Yansa 2009). Terrestrial and aquatic faunal species in the Midwest likewise became more similar to those present in the region under modern conditions around this time (Shott 1999:72). However, fluctuations in lake levels and forest compositions influenced the abundance of and accessibility to certain species throughout time, and the human advent of new technologies, such as the bow and arrow and fishing nets, also affected the species exploited (Styles 2011). The Medieval Climatic Optimum (ca. AD 900 – AD 1100), also known as the Medieval Warm Period, has been connected to widespread demographic and cultural change across North America (Foster 2012; Lovis et al. 2012), and corresponds to technological and social shifts seen across Michigan (Brashler et al. 2000).

Changes in climate and environment over such deep time segments are important for understanding past behavior, as many of the major and minor ecological changes referenced above can be correlated to settlement-subsistence patterns evident in the archaeological record. However, environment and climate are not determinate factors of sociocultural change or decision-making, but rather provide parameters that constrain variation. Although groups living in the northern Great Lakes were most certainly reactive to their environment, interactions with other groups and the development of new ideas and technologies played a part in the overall trajectory of northern Great Lakes history.

Cultural Background: Overview of Upper and Northern Great Lakes Archaeology

Pre-Woodland Periods

The first humans moved into modern-day Michigan between 10,000 to 8,000 BC (Shott & Wright 1999), commencing the Paleoindian Period. Sites dating to this period are sparse throughout Michigan. Paleoindians were highly mobile hunter-gatherers reliant on megafauna, large herbivores such as caribou, fish, and plants (Holman and Brandt 2009; Lovis 2009).

The subsequent Archaic Period (8000 BC – 1000 BC)—typically divided into Early, Middle, and Late subperiods (McElrath et al. 2009)—is an important time interval in the trajectory of foodways in Eastern North America. Four indigenous seed-bearing plants (squash, sunflower, marshelder, and chenopod), known as the Eastern Agricultural Complex (EAC), were brought under domestication in the midlatitudes of Eastern North America during the Archaic period, between 3000 and 1800 BC (Smith and Yarnell 2009). Evidence for the contemporaneous cultivation of several cultigens and cultivars were found at the Riverton Site (1800 cal BC) in southern Illinois, which was occupied by a partially mobile, small-scale society (Smith and Yarnell 2009). Thus, the development of earliest crop complex in the Eastern Woodlands was likely not the result of population pressure but instead a long-term response to a resource-rich environment (Smith and Yarnell 2009). However, there is little, if any, evidence of the EAC or any other domesticates in the northern Great Lakes region during the Archaic Period, despite their presence as far north as the Saginaw drainage basin.

Woodland Period

The Woodland period, since its inception in McKern's (1939) Midwest Taxonomic Method of classification, is generally recognized as a "stage marker" representing a suite of cultural developments between ca. 1000 BC and AD 1000/1600 in the Eastern Woodlands of North America (Anderson and Mainfort 2002). The Woodland period is most regularly associated with the advent of ceramic technology, and is typically divided into three subperiods: Early, Middle, and Late. The beginning of the Early Woodland period is generally signaled by the appearance of pottery; by ca. 500 BC, when sites containing technologically rudimentary and thick-walled "Marion" or "Schultz Thick" vessels appear in parts of the Midwest (Garland and

Beld 1999). The subsequent Middle Woodland (200 BC – AD 500/600) period is dominated in the much of the Midwest by the appearance of Hopewell, a “diverse sets of specific Middle Woodland societies, each internally bound through several diverse spheres of alliance” (Abrams 2009:172).

The northern Great Lakes of North America constitutes a unique region within the Eastern Woodlands of North America relative to the normative Woodland construct applied further to the south. Some groups occupying this northern area adopted pottery nearly a thousand years after other Midwestern societies, and therefore in the absence of an “Early Woodland,” (Mason 1970) the Middle Woodland (200 BC – AD 500/600) and Late Woodland (AD 500/600 – 1600) remain the primary temporal divisions for this area (Brose and Hambacher 1999). While groups to the south were transitioning to characteristic Woodland lifeways, such as the manufacture and use of pottery and construction of burial mounds, those in the north persisted in Archaic lifeways until the Middle Woodland period despite undoubted centuries of contact with pottery-making neighbors to the south. The Hopewell phenomenon that prevailed over much of the Midwest during the Middle Woodland had little effect on the groups living in the northern Great Lakes besides their participation in long-distance trade or down the line exchange of goods (Brose and Hambacher 1999; Martin 1999b). Southern Middle Woodland ceramics have been found as far north in Michigan as the northwestern lower peninsula (Holman 1978; Lovis 1971; Lovis et al. 1998).

The Middle Woodland period in the northern Great Lakes (where it is sometimes referred to as the Initial Woodland, particularly among Canadian researchers) witnessed the first adoption of pottery in the region. Prior assessments dated the outset of the Middle Woodland ca. AD 1, but recent dates of early pottery in the northern Great Lakes suggests the adoption of pottery as early as 200 BC (see Albert et al. 2017). The lack of information concerning the lifeways of preceding Archaic populations that occupied the Upper Peninsula of Michigan impedes understanding of the nature of the transition to Middle Woodland settlement and social patterns. There is a lack of clear geographic attribute clustering of pottery types throughout the Middle Woodland period, which reflects a fluidity of regional populations rather than stable and formally geographically bounded social relationships (Brose and Hambacher 1999). This fluidity was necessitated by the mobility of the populations, who still relied on a broad spectrum of resources spread over large geographic ranges. Middle Woodland groups seemed to have increased aggregation at coastal villages for procurement of spring-spawning fish species; they also came together along lakeshores for limited fall fishing or along inland streams and lakes for wild-rice gathering (Brose and Hambacher 1999; Cleland 1982; Smith 2004).

Middle Woodland social fluidity is demonstrated through the large geographic distribution of Laurel ware, which is found in southern Manitoba, northern Minnesota and Wisconsin, the Upper Peninsula of Michigan, and Ontario (Janzen 1968; Stoltman 1973; Wright 1967). Ceramic types found in adjacent regions include North Bay pottery, found in the Door Peninsula of Wisconsin and the western Upper Peninsula of Michigan (Mason 1966, 1967); Goodwinian Middle Woodland wares, local to the northeastern lower peninsula of Michigan (Fitting et al. 1969); and Point Peninsula wares of southeastern Ontario (Mason 1981; Ritchie 1969). All traditions utilized coil-constructed pottery with sub-conoidal bases, and stylistic variation occurs in a continuum across the region with little regional restriction, suggesting high levels of group movement and interaction (Brose and Hambacher 1999).

The Laurel culture is typically defined by a mobile hunting-gathering-fishing lifeway, a lithic industry dominated by end-scrapers and stemmed or notched projectile points, bone-antler tools and harpoons (Stoltman 1973). Laurel pottery is grit tempered with smoothed, rarely cordmarked exterior surfaces, and upper rim surfaces often decorated with a variety of dentate stamps (Janzen 1968; Stoltman 1973). Most sites are located on islands or sandy beaches along lakeshores or river mouths, places accessible by canoes or dugouts, and most residential sites suggest occupancy by a single family or small groups of relatives (Brose and Hambacher 1999:191).

Major Middle Woodland sites in the northern Great Lakes include Naomikong Point (Janzen 1968), Winter (Bianchi 1974; Richner 1973), Gyftakis (Fournier 2007), Summer Island (Brose 1970), Cloudman (Branstner 1995), Portage (Lovis, Rajnovich, and Bartley 1998) and Arrowhead Drive (McPherron 1967), as well as Pic River (Wright 1966), Heron Bay, Michipicoten Harbor, and Sand River sites (Wright 1967) in Ontario. These sites are or were once located along the shoreline, and several are the earliest components of multi-component sites, speaking to the increased interest in occupying prime fishing locales beginning in the Woodland period.

The adoption of pottery at the outset of the Middle Woodland in the northern Great Lakes is likely indicative of some social or economic change, the nature of which is still under debate. Skibo et al. (2009) posited the adoption of pottery was prompted by the need for improved efficiency of acorn processing, as demonstrated by lipid residue analysis of both fire-cracked rock and early pottery on Grand Island. However, lipid residue analysis of Middle Woodland pottery from the nearby Naomikong Point site did not contain nut lipids (Kooiman 2012, 2016; Malainey and Figol 2015). Interior carbonization patterns found in pottery from across the Upper Peninsula suggest that vessels were routinely filled to the top during cooking (Kooiman 2015, 2016), a habit possibly carried over from a long tradition of cooking in organic vessels, which can be placed over fire without burning if filled with liquid (Speth 2015). The use of organic vessels fulfilled the needs of upper Great Lakes cooks for thousands of years, and reasons for transitioning to clay cooking pots may have varied across the region (Skibo et al. 2016).

The Late Woodland period (AD 500/600 – AD 900/1600) may be described as a time of significant economic and cultural change that varied considerably across Eastern North America; changes possibly spurred by increased populations from the Middle Woodland to the Late Woodland (Anderson and Mainfort 2002; Holman and Brashler 1999). The shared artifact styles seen among many areas during the Middle Woodland gave way to increasing heterogeneity of ceramic styles throughout the period, suggesting greater social distinction and territoriality as resources were in more demand (Braun and Plog 1982; Holman and Brashler 1999; McElrath et al. 2000).

The Late Woodland was a time of technological and subsistence change in the Eastern Woodlands. The bow and arrow made its first appearance during this time, while cultivated crops became increasingly important (McElrath et al. 2000). The adoption and dietary incorporation of domesticated plant species was gradual throughout the Woodlands, and most groups remained semi-mobile until the intensification of maize cultivation after AD 800/900. Throughout much of the Eastern Woodlands, Late Woodland period traditions were followed by a variety of new cultural manifestations, such as Mississippian, Upper Mississippian/Oneota, Fort Ancient, and Iroquoian, all marked by maize agriculture and increased sedentism (Schroeder 2004). In contrast, Late Woodland-period sociocultural practices and lifeways generally persisted until European contact in much of the upper and northern Great Lakes, although they did not remain static (Schroeder 2004).

Major Late Woodland sites in the northern Great Lakes include Sand Point (Dorothy 1978, 1980), Scott Point, Juntunen (McPherron 1967), Wycamp Creek (Lovis, Arbogast and Monaghan 2012), O'Neill (Lovis 1973), and Cloudman (Branstner 1992, 1995), mostly large coastal sites interpreted as seasonal aggregation fishing sites. However, according to Dunham (2014), smaller interior sites were just as important for the seasonal subsistence rounds, but are less visible due to their size and location in less-developed areas (e.g. the Inland Waterway sites [Lovis 1978]). While some argue that populations grew over the course of the Late Woodland period, leading to new food procurement and mobility strategies (Cleland 1982), others believe populations and settlement/subsistence strategies remained steady throughout (Martin 1989, 1999a).

Unlike the preceding Laurel Middle Woodland, Late Woodland pottery was formed by slab construction instead of coiling and frequently cordmarked. Ceramic wares from across the northern Great Lakes continued to share many stylistic attributes in the early Late Woodland period (AD 600-1000; Holman and Brashler 1999). Bowerman and Skegemog wares common to the Traverse corridor in the northeastern lower peninsula of Michigan bare resemblance to wares further to the south (Hambacher 1992; Holman and Brashler 1999). Juntunen sequence vessels, most closely associated with the Straits of Mackinac, predominate in the eastern Upper Peninsula throughout the Late Woodland period (Martin 1999a). The sequence includes Mackinac, Bois Blanc, and Juntunen wares (McPherron 1967). The earliest, Mackinac ware, is common between AD 750 – AD 1000 (Lovis 2014; McPherron 1967), and while distinct from most lower Michigan wares, it bears some resemblance to Skegemog pottery (Holman and Brashler 1999). Blackduck ware, the stylistic descendant of Laurel ware, is found across and beyond the northern Great Lakes, from Saskatchewan to Quebec, and from northern Minnesota to the Upper

Peninsula of Michigan across variable durations of time (Hamilton et al. 2007; Lugenbeal 1978; McHale Milner 1998; McPherron 1967). Blackduck closely resembles Bois Blanc ware, the second of the Juntunen sequence wares, which was manufactured in the Straits region between AD 1000-1200 (Lovis 2014; McPherron 1967).

Pottery style generally became more heterogeneous during the late Late Woodland (Holman and Brashler 1999), reflecting the social localization proposed by McHale Milner (1991, 1998). Traverse wares replace Bowerman and Skegemog pottery in the Traverse corridor, while Juntunen wares, the last of the Juntunen sequence, predominate in the Straits and eastern Upper Peninsula after AD 1200 (McPherron 1967; McHale Milner 1998). Juntunen wares display stylistic attributes that suggest interactions with Iroquoian groups of Ontario (Brashler et al. 2000; Holman and Brashler 1999; McHale Milner 1998), using similar decorative motifs but employing drag-and-jab decoration techniques rather than incising. Upper Mississippian wares also make an appearance at certain sites across the Upper Peninsula (Dorothy 1978, 1980; Holman and Brashler 1999; McPherron 1967). The increase in distinctive local pottery wares during the late Late Woodland also more frequently co-occur at coastal aggregation sites, suggesting both an increased sense of group identity and the importance of extralocal relationships during this time (Holman and Brashler 1999; McHale Milner 1991, 1998; O'Shea and McHale Milner 2002).

Iroquoian

Iroquoian-speaking people occupied portions of modern-day New York and southeastern Ontario. Iroquoian groups settled in modern-day Ontario during the late precontact and protohistoric periods include the Huron, Tionnontati (Petun), Neutral, and St. Lawrence

Iroquoians (Warrick 2000). Although the emergence of sedentary agriculturalists with pottery and a language system quite distinct from surrounding Algonquian groups caused many to believe that the Iroquoians migrated into the region, most archaeologists now believe that these groups developed *in situ* from Woodland populations (Smith 1990; Warrick 2000).

Late Woodland Princess Point groups in southern Ontario (AD 600-1000) have been interpreted as being the direct ancestors of later Iroquoian groups based on the continuity of material culture and settlement-subsistence patterns. They were among the first to experiment with maize agriculture in northeastern North America (Fox 1990a). Princess Point people lived in small year-round villages with warm season camps for hunting and gathering, since wild resources still made up most of their diet (Snow 1980a; Warrick 2000).

Immediate descendants of Princess Point are referred to as "Early Iroquois" (AD 1000-1300 [Warrick 2000; Williamson 1990]). Wright (1973) divided the early Iroquoian stage of Ontario into two distinct regional variants: the Glen Meyer branch in southwestern Ontario, and the Pickering Branch of southeastern Ontario. While the two branches are no longer considered discrete sociocultural entities, they are still recognized as distinct regional populations (Williamson 1990). Glen Meyer and Pickering peoples lived in unstable, semi-sedentary villages comprised of small longhouses and began to rely more heavily on maize (Bamann et al. 1992; Kuhn and Funk 2000). The subsequent Middle Ontario Iroquoian stage (AD 1300-1400) is marked by the growing intensification of horticulture subsistence (particularly maize cultivation). This was accompanied by the establishment of stable, year-round residences, which gradually became populated with longhouses of increasing size (Bamann et al. 1992; Kuhn and Funk 2000). Households were located in small to medium-sized villages that were widely dispersed across the landscape and were not yet incorporated into region-wide identities, as signaled by ceramic motifs (Hart et al. 2017).

The emergence of Huron populations (distinct from other Ontario Iroquoian groups, such as the Neutral and St. Lawrence Iroquois) arose ca. AD 1400, in south-central Ontario, between the Trent River, the Niagara Escarpment and Lake Ontario, an area historically known as “Huronia” (Ramsden 1990). The Huron developed as population increases solidified regional identities. Villages were autonomous and highly organized, with each matrilineage contained within a longhouse; both village and house sizes were larger than in the Middle Iroquoian period (Warrick 2000). Along with villages, farming hamlets and logistical resource extraction camps associated with the Huron have also been found (Ramsden 1990). The population migrations, social restructuring, and coalescence of smaller villages into larger ones that occurred after A.D. 1500 have been attributed to the indirect effects of European contact, although this has been disputed in recent years (Ramsden 1990). While there is some stylistic overlap between “Huron-Petun” and “Neutral” pottery, these groups are also associated with specific ceramic typologies emblematic of distinct social identities (Wright 1973).

Proto-Iroquoian and Iroquoian populations witnessed the gradual intensification of cultivated foods. Although maize first appeared in southern Quebec by 391-209 cal BC (St. Pierre and Thompson 2015), northern New York by cal AD 1 (Hart et al. 2007), and southern Ontario between cal AD 260 and AD 660, Princess Point groups only began to experiment with maize horticulture (Fox 1990a). Maize was not a significant part of the diet until the Early Iroquoian period (AD 1000-1300), when it still only constituted between 20-30% of the diet among Ontario occupants, who continued with predominantly hunter-gatherer subsistence strategies (Warrick 2000). Evidence for beans, squash, and sunflower does not surface until the middle of the 11th century; the "Three Sisters" subsistence regime (maize, beans, and squash) became dominant between AD 1300-1525, and sunflower and tobacco were also grown (Bamann et al. 1992; Kuhn and Funk 2000). Although the Huron were sedentary agriculturalists by this time, their diets were supplemented by wild game, fishing, and some wild plant resources (Williamson 1990). They may have also traded maize in exchange for fish and wild game, often via the Odawa, with northern hunting-gathering Algonquian groups as a form of risk-buffering against periodic crop failure (O'Shea 1989; Smith 1996).

The Protohistoric/Contact Period

Europeans arriving in and traveling across North America in the 16th century encountered resident Native populations and began to trade with them (Figure 2.1). The Anishinaabeg people, which includes the Ojibwe, Potawatomi, and Odawa, are believed by scholars to have originated from east of the Great Lakes, migrating west in the late 16th or early 17th century (Danziger 1978:7). This is corroborated by Anishinaabe oral tradition, which recounts their origins in the North Atlantic coast and subsequent 500-year westward migration along the St. Lawrence River, culminating in their arrival at the western end of Lake Superior by the 17th century, settling among resident Algonquian groups (Benz and Williamson 2005).

When the French arrived in Ontario in 1615, they encountered Algonquian-speaking bands of mobile hunter-gathering living adjacent to Huron territory (Fox 1990b). These people were identified as the Odawa. At the time, these groups occupied the Bruce Peninsula, Manitoulin Island, and other parts of the coast of Georgian Bay (Fox 1990b). Early historical accounts and archaeological excavation of protohistoric Odawa sites indicate that they were mobile hunter-gatherers who heavily fished and practiced marginal horticulture (Fox 1990b).

Figure 2.1: Distribution of Cultural Groups ca. 1630
(adapted from Trigger 1976:92)

Fox and Garrad (2004) argue that substantial exchange between precontact Huron-Petun groups in southern Ontario and Algonquian groups occupying the south shore of Georgian Bay (assumed to be the Odawa), commenced in the 14th century AD, and that Iroquoian-manufactured and imitation Iroquoian pottery located along the Georgian Bay region is evidence of this exchange. Archaeological sites from this time have been identified as Odawa based on Algonquian lithics and ritual signatures (e.g., dog burials), despite the Huron pottery and pipes (or locally produced copies), which are argued to be the result of trade with the Huron (Fox 1990b; Ross 1975). Proponents of this model claim hunter-gatherer Odawa groups exchanged fish for maize with the Huron (Fox 1990b, 2004). Alternatively, Warrick (2000:442) interprets these findings as evidence of early Iroquoian occupation of south Georgian Bay, mapping Middleport (AD 1330-1420) Iroquoian sites in the area.

Interactions between the Huron-Petun and the Odawa may have been hindered by linguistic differences. Northeastern North America is not considered a "strong linguistic area," or a region in which small linguistic communities have long been in constant contact and individuals are often multilingual (Mithun 1999:314). Groups living in the western Upper Great Lakes region spoke Algonquian languages in the Algic language family, while the Huron-Wyandot language belongs to the Iroquoian family. These languages would not be mutually intelligible (Mithun 1999), making communications between the Odawa and Huron difficult. Smith (1996), however, found evidence of an exchange network centered on the exchange of food items, where northern Algonquian groups, primarily the Ojibwe, traded meat to middlemen Odawa for their own consumption and for trade with Huron and Petun groups in southern Ontario, who in turn provided maize for distribution to the north. The Odawa themselves provided fish, reed mats, and other products to the system but primarily served the role of transporters of food items (Smith 1996:278).

Groups known historically as the Ojibwe (aka Ojibay, Ojibwa, Chippewa) settled in the Upper Great Lakes primarily around all shores of Lake Superior, although some migrated and settled as far as the Western Plains of Minnesota and the Dakotas (Danziger 1978:8). Odawa is a dialect of the Ojibwe language, the mutual intelligibility of which would have facilitated trade among the different Anishinaabeg groups (Mithun 1999). Most Ojibwe lived a mobile, hunter-gatherer lifestyle, following seasonal economic cycles based around subsistence activities such as fishing, hunting, and gathering, much as resident Woodland populations (Danziger 1978:9, 11-13). Anishinaabeg people in the Great Lakes retained a flexible social structure that frustrated the European traders who attempted to trade and make treaties with them (Witgen 2012).

As the Europeans moved further to the continental interior, various Iroquoian-speaking groups in the east banded together into what became known as the Iroquois Confederacy or League (Hunt 1940; Morgan 1922), which sought to protect its territory and expand it into new areas (Parmenter 2010). The Iroquois Five Nations/Confederacy, occupying modern-day New York, instigated the dispersal of the Huron from Huronia after 1649 through a series of attacks on their neighbors (Ramsden 1990). Therefore, post-1650 northern Great Lakes demographics are even more complicated due to migration and new identity formation following increased territorial pressures. Refugee Huron groups either fled east, integrated into the Five Nations Iroquois, or joined with the Tionantati (Petun) (Mithun 1999:421; White 1991). Remnants of the Huron, Tionantati, Erie, and Neutral, all defeated by the Five Nations, were collectively known at the Wyandot and together fled westward to settle near Detroit (Mithun 1999:421). Some refugee Huron groups fled further west to the lower peninsula of Michigan and Wisconsin, settling among local Anishinaabeg populations (White 1991) and creating mixed communities that are visible archaeologically (Mason 1986). Eventually, the long-distance trade and communication networks that developed facilitated the irregular spread of Western diseases, depleting Indigenous populations and interrupting the balance of power throughout Eastern North America (Milner et al. 2001).

Conclusion

The sociocultural history of the Upper Great Lakes is complex, despite the superficial appearance of simplicity when compared to the cultural histories of neighboring regions.

Precontact indigenous societies in this region had to contend with harsh climatic and environmental fluctuations and conditions. While these challenges sometimes delayed or precluded the types of cultural developments that occurred elsewhere in the southern Great Lakes, riverine Midwest and southeastern Canada, it also led to local and regionally successful adaptations and behaviors that resulted in the long-term endurance of groups occupying the region and a cultural dynamism reflected in the material culture.

The paucity of sites and artifacts resulting from low populations density and relatively poor preservation of archaeological materials contributes to the initial appearance of the Upper Great Lakes as a less interesting region of scholarly inquiry. It also makes interpretations of past behavior in the northern Great Lakes difficult. However, the collective results of the many decades of research in this region, when examined closely, reveal the complex nature of northern Great Lakes societies through time. Yet, many questions remain. The application of new analytic techniques has the potential to provide new data and inform different or standing unanswered questions, highlighting both the intriguing history of the northern Great Lakes and the scope of human flexibility and creativity in the face of social and environmental change.

CHAPTER 3

SUBSISTENCE AND TECHNOLOGY IN THE NORTHERN GREAT LAKES

Introduction

The spread of domesticates from the midsouth and Mesoamerica initially had little impact on the occupants of the Midwestwestern United States and southeastern Canada, a testimonial to the long-term stability of hunting-gathering-fishing strategies. Domesticates did eventually become the focus of subsistence for various groups, such as the Oneota, Mississippians, Fort Ancient groups, and Iroquoian societies after AD 900. Societies in the northern Great Lakes, too, initially incorporated domesticates into their diets on a limited basis. Around the time their neighbors to the south became increasingly involved in agriculture, these groups may have also sought out more productive subsistence strategies. Whether such a change occurred and, if so, which strategies were employed to increase resource productivity are the core of one of the most lingering and long-debated problems in northern Great Lakes archaeology.

Long-term subsistence change can only be investigated through diachronic comparisons of archaeological data. Prior inquiries have used various types of evidence to address the problem, but inconsistent spatial and temporal data, scales of inquiry, and limited preservation of organic materials in the northern Great Lakes have precluded a firm resolution. To avoid these issues, this study looks at change through time at a single location, the Cloudman site (20CH6), using a new suite of techniques never before employed together in the northern Great Lakes. Following the context of the history of the research problem and the background of the Cloudman site, expected outcomes to the research questions are outlined at the end of this chapter.

Research Problem

The settlement-subsistence patterns of the Woodland occupants of the northern Great Lakes has long been a topic of archaeological inquiry, and therefore much debated. Various models for Upper Great Lakes (including the northern Great Lakes) Woodland settlement-subsistence patterns have been proposed. The most prominent model for Middle Woodland subsistence centers around seasonal aggregation at coastal sites, where groups took advantage of spring-spawning fish in shallow waters using, according to Cleland (1982), the seine net. Summer Island was interpreted by Brose (1970) as a spring coastal site with evidence of a return to a generalized mixed economy following the spawning runs. These groups likely moved to different coastal sites, or to interior lakes or streams, during the remaining warm season to exploit various other seasonal resources before retreating to small interior hunting encampments for the summer (Brose 1970; Brose and Hambacher 1999).

Cleland (1982) proposed that the invention of the gill net in the Late Woodland period allowed inhabitants to exploit deep-water spawning fish, leading to a series of widespread changes marking the Middle Woodland-Late Woodland transition, including increased populations, larger and denser shoreline sites, and subsistence strategies that relied on exploitation of seasonally abundant fish and plant materials. Seasonal aggregation at coastal sites therefore also occurred in the fall, when deep-water spawning fish (such as whitefish and lake trout) could be harvested *en masse*.

Martin (1989) disputed Cleland's "inland shore fishery" model of change over time, citing a lack of evidence for increasing population size, instead attributing perceived site size increase to the palimpsest effect of repeated occupations. Questioning Cleland's evidence for the invention of the gill net at the outset of the Late Woodland period, Martin presents data suggesting some deep-water fishing occurred during the Middle Woodland period. She also disputes alteration of settlement patterns resulting from new seasonal fishing habits in the Late Woodland, arguing instead for subsistence and residential continuity throughout the Woodland period. In rebuttal to Martin, Cleland (1989) reiterates evidence supporting the intensified exploitation of fall-spawning fish during the Late Woodland and claims Martin failed to demonstrate the use of gill nets, which are necessary for deep-water fishing, during the Middle Woodland period.

In a reexamination of this issue and debate, Smith (2004) uses multiple lines of evidence to demonstrate that fall-spawning fish were exploited in the Middle Woodland, but the intensive use of gill nets to procure them in large quantities did not become common until the Late Woodland period, particularly after AD 1100 in the Lake Michigan basin and after AD 1400 throughout the rest of the Upper Great Lakes. Drake and Dunham (2004) likewise advocate for greater continuity in the use of coastal sites between the Middle and Late Woodland periods than was suggested by Cleland, but acknowledge broader shifts in social, subsistence, and settlement patterns moving forward into the Late Woodland period.

Most recently, Dunham (2014) highlights alterations in settlement, subsistence, and social structure over the course of the Late Woodland period in the Eastern Upper Peninsula of Michigan, the approximate center of the northern Great Lakes region. While early Late Woodland people were more residentially mobile and produced more homogenous ceramic styles (suggesting social homogeneity similar to that seen during the Middle Woodland), people in the late Late Woodland period (post-AD 1000) were more logistically mobile, occupied sites with greater resource diversity, exploited greater amounts of starchy resources with interior (i.e., wild rice) or patchy (i.e., acorns) geographic distribution, increased storage, and displayed greater social heterogeneity. Dunham hypothesizes these changes were in response to more dynamic lake levels resulting from the Medieval Climatic Optimum post-AD 900 (Lovis et al. 2012). Environmental and resource instability prompted the aforementioned reactions—all economic or social mechanisms of risk buffering. Reliance primarily on the exploitation of spring and fall spawning fish, as posited by Cleland, was too risky, and therefore both wild rice and acorns were exploited and stored as buffering resources against periodic fish shortages. Dunham did not find maize to have been included as a major component of even the late Late Woodland buffering mechanisms in this portion of the northern Great Lakes.

An alternative view of Late Woodland subsistence regimes states that the ceramic heterogeneity seen in the late Late Woodland is indicative of the formation of horticulturalist coastal societies (such as groups using Juntunen wares) and inland groups, who remained foragers (O'Shea 2003). This is a classic ethnographic forager-farmer interaction model often applied to the Mesolithic of Europe (Zvelebil 1986). The Great Lakes model entails coastal societies who were maize agriculturalists occupying large or major aggregation sites used for rituals and exchange of maize and other coastal resources to inland foraging groups. This interpretation is based on the finding that maize constituted 18-20% of the Juntunen diet (Brandt 1996) and the discovery of earthwork enclosures with associated storage pits in northern Lower Michigan (Howey and O'Shea 2002).

The role of domesticates and horticulture in the northern Great Lakes during the Middle and Late Woodland periods remains unclear. Whether certain Late Woodland occupants of the northern Great Lakes post-AD 1000 intensified their horticultural practices (per O'Shea 2003), or instead intensified exploitation of specific wild resources (per Cleland 1982; Dunham 2014; Holman and Brashler 1999) is still debated. Macrobotanical evidence of maize in the northern

Great Lakes is limited, confined to three Late Woodland sites located in the mildest climatic coastal areas (zones with at least 140 frost-free days required for sufficient maize growth; Yarnell 1964) (Dunham 2014:199; Egan-Bruhy 2007; Lynott 1974; McPherron 1967).

There is, however, increasing evidence for the incorporation of maize into the diet, either grown locally or exchanged in from elsewhere, obtained from microbotanical food remains in carbonized residue on pottery. Some of this evidence supports the entry of maize into the region much earlier than the macrobotanical evidence suggests. Maize starches and phytoliths have been identified in Middle Woodland contexts in northern New York (Hart, Brumbach, and Lustek 2007), southern Quebec (St-Pierre and Thompson 2015), boreal Manitoba and Ontario (Boyd et al. 2014), northern Minnesota (Burchill 2014), and the Saginaw basin of Michigan (Raviele 2010). While residues containing maize microbotanicals were dated to as early as 390 cal BC in Minnesota (Burchill 2014), Albert et al. (2017) recently found the earliest evidence of maize in the northern Great Lakes in residues from pottery at the Winter site (20DE17), which was dated to as early as cal 200 BC (Lovis et al. 2012).

Tracing the rate of maize adoption is another current avenue of inquiry, since it is demonstrated across the Americas that maize intensification often occurred centuries after its initial introduction into a region (Hastorf and Johannessen 1994). Only trace amounts of maize were found in carbonized food remains from Laurel pottery at the Winter site (20DE17), and maize was not ubiquitous among vessels examined, suggesting only casual use of the cultigen during the Middle Woodland period (Albert et al. 2017). Maize consumption at the Late Woodland Frazer-Tyra site (AD 900-1200) in the Saginaw Valley of lower Michigan varied based on age and sex (Muhammad 2010). This suggests that occupants of the site were trading for maize rather than growing it, and its acquisition and consumption was rooted in social networks and obligations rather than subsistence needs, even almost one thousand years after the arrival of maize into Michigan (Muhammad 2010).

Evidence of other domesticated cultigens in the Great Lakes region and surrounding areas is much more limited, particularly in the Middle Woodland period. Evidence of squash and beans in boreal Manitoba and Ontario was encountered only in Late Woodland contexts, later than evidence for maize in the same region (Boyd et al. 2014). Beans arrived in the upper Midwest/Great Lakes area by cal AD 1200 via the Plains, and spread into the northeastern/New England regions shortly thereafter (Hart et al. 2002; Monaghan et al. 2014). Squash, one of the cultigens domesticated in North America, was present in lower Michigan by 2300 cal BC (Monaghan et al. 2006), but does not seem to have been a significant food source in the Great Lakes until the Late Woodland period, although it may be underrepresented in the microfossil record due to problems with identification (Boyd et al. 2014). Other North American cultigens, such as marshelder, chenopod, and sunflower, which along with squash are known as the Eastern Agricultural Complex (Smith 2006), are rare in the northern Great Lakes throughout the precontact period.

Wild rice was another important starchy resource for occupants of the northern Great Lakes and surrounding regions. While not a domesticate, wild rice had to be harvested from wild stands in early fall, much like a cultivated crop (Vennum 1988). Evidence for wild rice in archaeological contexts appears in the Middle Woodland period in the Great Lakes region (Arzigian 2000; Lovis et al. 2001) and in boreal Ontario (Boyd et al. 2014). Many scholars have noted an increase in wild rice exploitation during the Late Woodland period across the Great Lakes (Dunham 2014; Moffat and Arzigian 2000), although the drier climate characteristic of the Late Woodland and subsequent reduction of wetlands at its outset may have reduced wild rice harvesting opportunities in some areas, as seen at the Schultz site in the Saginaw Valley (Lovis et al. 2001). Several have found wild rice in close association with maize following the latter's arrival into the region (Boyd et al. 2014; Hart and Lovis 2013; Raviele 2010), possibly due to the nutritionally complementary nature of the two foods (Hart and Lovis 2013).

The intensification of starchy food exploitation, whether wild or cultivated, in the Late Woodland period may be supported by ceramic use-alteration traces. Kooiman (2012, 2015, 2016) found that cooking habits varied between the Middle Woodland and Late Woodland periods in the northern Great Lakes. Patterning of interior carbonization on Middle Woodland ceramic vessels from the Naomikong Point (20CH2) and Winter (20DE17) sites indicated the prevalence of stewing, while Late Woodland vessels from the Sand Point site (20BG14) were more frequently marked with carbonization patterns indicative of boiling practices. The observed change in cooking habits has been hypothesized to signal broader dietary shifts, possibly connected to the intensification of starchy foods in the Late Woodland, which require long-term boiling or cooking to be made digestible (Braun 1983; Wandsnider 1997). However, lipid residue analysis of vessels from Naomikong Point and Sand Point revealed few differences in the foods cooked in Middle Woodland and Late Woodland vessels (Malainey and Figol 2015). At present, the role of starchy foods and the timing of the incorporation of maize, wild rice, and other cultigens in regional Woodland subsistence regimes is unknown.

Subsistence, as detailed by foodways theory (Fischler 1988; Rodríguez-Alegría and Graff 2012; Twiss 2012), is inextricably related to the specifics of settlement systems and patterns of social organization and interaction. The Middle Woodland-period populations in the northern Great Lakes were highly mobile and maintained fluid social relations and group compositions, necessitated by their reliance on a broad spectrum of resources spread over large geographic ranges (Brose and Hambacher 1999). People did, however, aggregate at coastal villages for procurement of spring-spawning fish species; they also came together along lakeshores for limited fall fishing or along inland streams and lakes for wild-rice gathering (Brose and Hambacher 1999; Cleland 1982; Smith 2004).

The Late Woodland period appears to have been a time of increasing localization in the northern Great Lakes, in which subsistence efforts were concentrated within decreased geographic ranges on productive but localized resources (including possible maize production, fishery exploitation, and certain wild resources) (McHale Milner 1991:42-43). Using ethnohistorical information and stylistic ceramic analysis of Juntunen phase (AD 1200 – AD 1450) sites in the Upper Peninsula, McHale Milner (1991) argued that Late Woodland peoples developed increasingly bounded social groups at the local level while also maintaining long-distance, extralocal social ties for risk buffering purposes in times of local food shortages. The extralocal, long-distance relationships were confirmed by the unexpected presence of "foreign" stylistic elements on Juntunen pottery (McHale Milner 1998). According to McHale Milner these social relationships were formed, maintained, and solidified through integrative events at seasonal aggregations sites.

The localization occurring in the Late Woodland may have, therefore, not only changed the nature of social relationships and subsistence behaviors but may have simultaneously forced the formation of long-distance relationships and trade networks as an alternate form and scale of spatially nested or hierarchical risk-buffering (Carroll 2013). Overall, the evidence suggests that northern Great Lakes Woodland groups increasingly employed a series of risk-buffering techniques, including shifting intensification of targeted resources (fish and starchy foods) and integrative social events, over time in response to environmental instability, particularly during the late Late Woodland.

Amelioration of risk by alterations in social, settlement, and subsistence regimes in the northern Great Lakes would have been further complicated by the entry of Europeans into Eastern North America. Movement of both Algonquian- and Iroquoian-speaking groups into the Great Lakes region required new social negotiations and relationships, which may have included further localization, the formation of bounded social identities, and a greater need for trade relationships between groups. The timing of group identity formation, group movements, and the level of trade between groups are unresolved issues requiring further archaeological inquiry.

Ultimately, the ways in which technology, diet, cooking, and social relationships relate to one another and change from the Middle Woodland through the Protohistoric period is unclear. Pottery occupies a unique position at the crossroads of subsistence and society and offers the ideal pathway by which to explore these issues together.

Case Study: Cloudman Site (20CH6)

The Cloudman site is located on Drummond Island, MI, in the Eastern Upper Peninsula of Michigan near the southern outlet of the St. Mary's River into Lake Huron (Figure 3.1). It lies on the northern bank of the Potagannissing River, occupying a series of river terraces. The site covers approximately 30,000 square meters and contains four occupational components that are both vertically stratified and horizontally separated (Branstner 1995). Branstner (1995), using relative dating of artifact styles, interpreted the timing of occupation for each component of the site: Middle Woodland (AD 0 – AD 400); Late Woodland (AD 800 – AD 1500); Protohistoric (AD 1500 – AD 1650); and two historic period homesteads (AD 1880 and 1920).

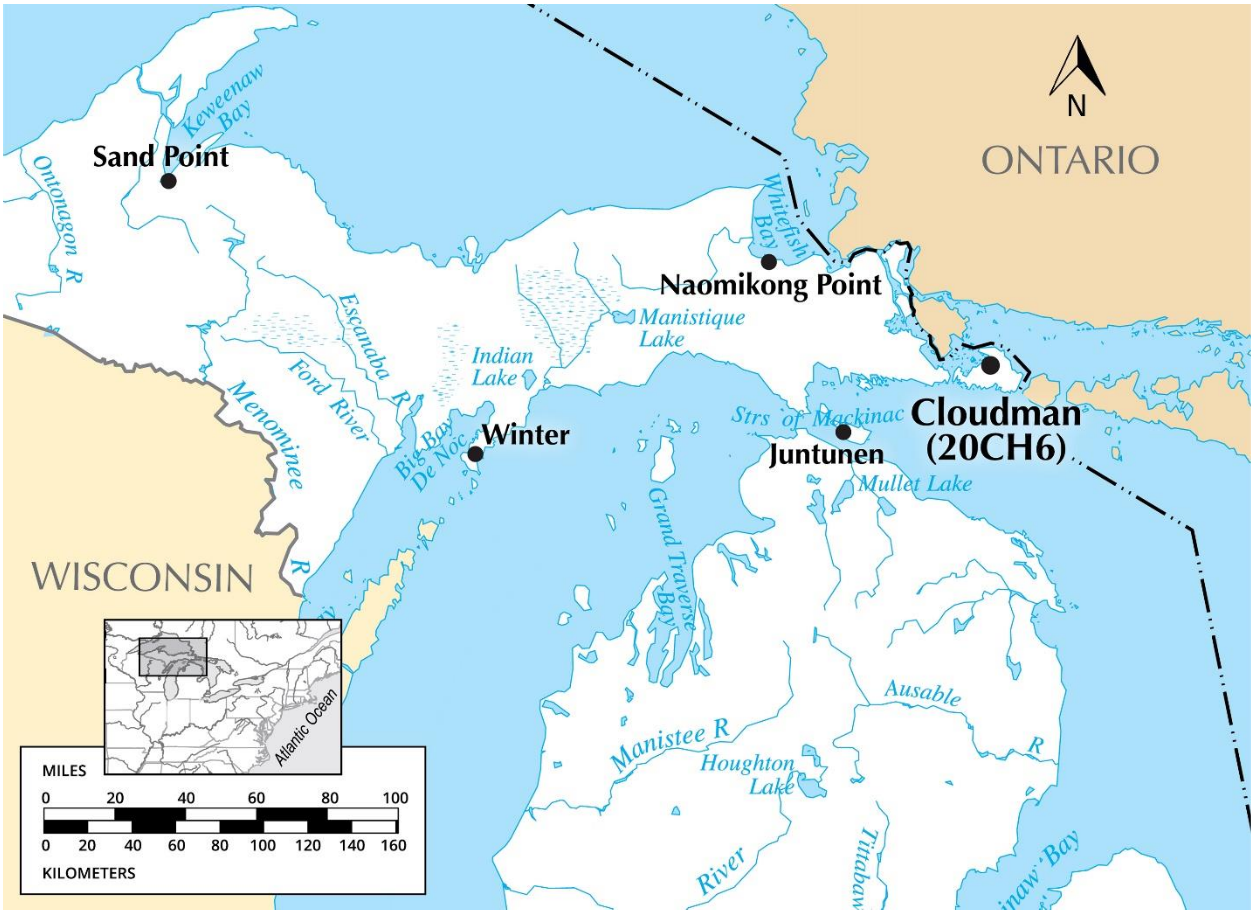

Figure 3.1: Location of the Cloudman (20CH6) Site and Other Woodland Sites

The Cloudman site also includes a large mound (possibly associated with the Middle Woodland occupation), which was the focus of amateur excavations in the early twentieth century. Hinsdale (1931) was the first to officially report the site, but a thorough assessment of the site was not conducted until 1974, when John Franzen assessed the locale as part of a survey of Chippewa County. He initially reported Cloudman as containing Middle Woodland and Historic-period components (Franzen 1975). The St. Mary's River Archaeological Project, under the auspices of Michigan State University, visited the site in 1990 and 1991 to identify its components and spatial extent. The site was excavated under the supervision of Charles Cleland and Christine Branstner of Michigan State University in 1992 and 1994, during which 102 square meters were excavated and thirty-three features uncovered (Branstner 1995). An additional unit was also excavated in 1995 by Cleland, although a report of the results from this work was not completed (Christine Stephenson, personal communication).

Gradual lowering of lake levels over time led to the formation of three distinct river terraces at the site, which roughly correspond to each of the three primary occupations (Branstner 1995:23). Middle Woodland materials are largely confined to the upper terrace (181m and above); the middle (179 – 181m) and lower (177 – 179m) terraces contain mostly Late Woodland and Protohistoric materials, respectively (Branstner 1995:23). There was only minimal spatial overlap between the different temporal occupations (Branstner 1995).

Branstner (1995) conducted preliminary analysis of the ceramic assemblage from all components of the Cloudman site, which was limited to typological categorization of pottery vessels. She sorted and identified vessels from the Middle Woodland, Middle Woodland/Late Woodland transitional, early Late Woodland, late Late Woodland, and Contact/Protohistoric periods. There were also a number of miniature vessels which were not described.

Identified Middle Woodland vessels at Cloudman are almost exclusively varieties of Laurel ware, while those vessels identified by Branstner (1995) as early Late Woodland are primarily Mackinac ware varieties. In accordance with McHale Milner (1991, 1998), late Late Woodland vessels demonstrate great stylistic diversity. Branstner was unable to assign types to 31 (72%) of the late Late Woodland vessels, which she attributed to hyper-localized styles not yet identified in the existing literature. Identifiable types included Juntunen and Algoma wares.

According to Cleland (1999), the Protohistoric component of the Cloudman site is one of the earliest sites in Michigan with evidence of European contact, with trade goods dating to approximately 1615-1630 (Branstner 1995). Branstner and Cleland interpret this component as an Odawa occupation, based on Trigger's (1976:294) mapping of the Bruce Peninsula, Manitoulin Island, and Drummond Island as "Ottawa" territory ca. 1615, which also shows trade routes between the Odawa territory and the Huron settled on the eastern shore of Lake Huron. Branstner categorized pottery in this component as non-local Ontario Iroquoian/Huron vessels as well as locally-made "Huron imitation pots" (Branstner 1995:12). More recently, 16 cobalt blue glass trade beads from the Cloudman site were sampled with LA-ICP-MS and identified as part of a pre-1700 Mg-low-P compositional group (Walder 2018), and two additional analyses of white glass beads identified the opacifier arsenic, which means that the manufacture of the bead likely post-dates c. 1670 (Hancock et al. 1997; Walder personal communication 2018). This calls into question the timing of occupation of the site during the Protohistoric period.

Drummond Island lies within the Eastern Upper Michigan regional landscape ecosystem, which is forested by northern conifers, northern hardwoods, and patches of oak (Albert, Denton, and Barnes 1986). This would have supported a variety of wild plants and animals that could be used for human exploitation. Although the region is cool with rather sandy soil, it has a relatively long growing season due to climatological amelioration from Lakes Superior, Michigan, and Huron (Albert et al. 1986). This means that the growing season would have just been long enough for maize at the Cloudman site. Additionally, the site is located close to modern wild rice stands, although it is difficult to determine the antiquity of these stands (Dunham 2014).

Some dietary and seasonality data is available for the Cloudman site based on floral and faunal remains, although it is limited. Flotation samples were taken from most features, and analysis of macrobotanical remains extracted from these samples revealed a great diversity of plant species (Egan-Bruhy 2007). Cloudman occupants ate a variety of fruits (including strawberry, raspberry, elderberry, and wild plum), nuts (such as hazelnuts, walnuts, and acorns), and seeds/cultigens such as chenopod, maize, and wild rice (Egan-Bruhy 2007). These resources would have been available during the summer and fall seasons.

Faunal remains from only two features were analyzed. Feature 26, attributed to the Late Woodland period, contained woodchuck and beaver, spring and early summer-spawning fish (northern pike, sucker, catfish, bass, perch, walleye), and fall-spawning fish (whitefish and drum) (Cooper 1996). Feature 27, associated with the Protohistoric period, contained a dog burial and most of a snapping turtle, but also contained portions of beaver, muskrat, black bear, caribou, common loon, spring/summer-spawning fish (sturgeon, pike, sucker, catfish, perch, and walleye) and fall-spawning fish (whitefush and drum). Sample sizes of various species in both features were too small to assign strict occupational seasonality, although the large proportion of sucker (39% of fish elements) from Feature 27 suggests targeted spring-spawning species exploitation. Additional and more refined data is required for more accurate interpretation of diet and site seasonality.

Large, multicomponent sites available for study in the northern Great Lakes, and particularly in the Upper Peninsula, are rare. The Arrowhead Drive/Juntunen site, Summer Island, Scott Point, and Cloudman are the only sites with substantial ceramic assemblages attributed to Middle Woodland, Late Woodland, and/or assumed Protohistoric periods; the Cloudman assemblage is the only assemblage with pottery from all three periods. This makes Cloudman an excellent if not ideal site for the investigation of the problem of changing subsistence strategies and cooking techniques throughout the Woodland Period and the impact of culture contact on foodways.

Research Expectations

Expectations for the results of the analyses were formulated prior to research. These expectations were based on background information and previous research and are outlined below:

1) Are there differences in technical properties (i.e., thickness, temper size, rim diameter) among Middle Woodland, early Late Woodland, late Late Woodland, and assumed Protohistoric period pottery from the Cloudman site?

Braun (1983) first proposed that the increased consumption of starchy seeds from the Middle Woodland to Late Woodland in the Midwest prompted technological alterations in cooking vessels. The palatability and digestibility of starchy seeds is improved by cooking them to a point of gelatinization in liquid broth, although this process requires both longer cooking times and higher temperatures (Braun 1983:116). Late Woodland vessels from western Illinois and eastern Missouri have thinner walls, smaller temper particles, and a more globular shape, which improve thermal conductivity and thermal shock resistance. Braun concluded that technical alterations to Late Woodland vessels were directly related to the incorporation of more starchy foods in the diet. Dried maize also requires long periods of boiling to make it edible and digestible. Using bulk $\delta^{13}C$ analysis, Hart (2012) also found a direct correlation between an increase in water-based maize cooking and wall thinning in Woodland vessels in central New York.

Given Dunham's hypothesized intensification of starchy food use in the Late Woodland of the eastern Upper Peninsula, it is expected that the trend of wall thinning and temper size reduction throughout the Woodland period will be reflected in the Cloudman assemblage. However, there was no significant statistical difference between vessel wall thickness and temper size of Laurel Middle Woodland vessels from Naomikong Point and the Late Woodland vessels from Sand Point (Kooiman 2012, 2016), the possible result of the geographic difference between the sites. The Cloudman site assemblage will allow an investigation of vessel wall thickness and temper size through time at a single locale. The trend of wall thinning is expected to continue into the Protohistoric period, when greater reliance on starchy foods, particularly maize, likely continued or increased, as demonstrated by ethnohistoric accounts of the Huron (Tooker 1991), Ojibwe (Densmore 1979; Hilger 1951) and Iroquois (Waugh 1973). Hart (2012) found Iroquois pottery wall thickness decreased steadily up to A.D. 1600 in New York state.

Vessel size (or vessel volume) is a less understood aspect of formal variability. Size variation has been connected to utilitarian function (Rice 1987:299), household size (Nelson 1981; Tani 1994; Turner and Lofgren 1966), and to utilitarian versus ceremonial functions (Blitz 1993; Kooiman 2012, 2016; Potter 2000). Neither McHale Milner (1998) nor Kooiman (2012, 2016) found any correlation between vessel function and vessel size (inferred from rim diameter). While there was no statistical difference in vessel size between Laurel Middle Woodland vessels (from both the Winter site and Naomikong Point site) and Late Woodland vessels originating from the habitation area at the Sand Point site, all three subsamples were significantly smaller than vessels found in mound fill contexts at Sand Point (Kooiman 2015, 2016). Vessels buried in the Sand Point mounds may have played a role in ceremonial gatherings, where larger vessels may have been required to feed large numbers of people. While a mound once existed at the Cloudman site, the location of the materials excavated from the mound is unknown, and the ceramic assemblage used for this study originated from the general occupation area of the site. Therefore, it is not expected that there will be any significant increases in vessel size from the Middle Woodland to the Late Woodland period.

The social affiliation of the Protohistoric occupants of the Cloudman site is still up for debate. Based on early dates of the trade goods from this component, Branstner (1995) and Cleland believed the site to have been occupied by Odawa groups ca. 1630; however, if the occupation was later the site may have been inhabited by Huron groups migrating westward. If the latter is true, then households may have been larger in the tradition of the longhouse (Warrick 2000), and pot sizes may be larger than in prior periods to accommodate the feeding of a great number of people.

2) Are there diachronic changes in ceramic vessel use and cooking habits evident through use-alteration traces?

Prior research has found that large proportions of the Naomikong Point and Sand Point pottery vessels were used over a fire, based on high frequencies of certain use-alteration traces, specifically exterior sooting and interior carbonization (Kooiman 2012, 2016). The most prevalent interior carbonization pattern among the Middle Woodland vessels of Naomikong Point was an even veneer of residue along the interior surface, indicative of stewing, while there was a significant increase in carbonization patterns representing boiling behaviors among the Late Woodland vessels at Sand Point.

The changing cooking styles over the course of the Woodland Period may have been necessitated by alterations in settlement and subsistence patterning suggested by Cleland (1982), Smith (2004), and Dunham (2014). The intensified exploitation of various starchy resources that require intensive boiling prior to consumption would result in these changing patterns. The Cloudman assemblage allows comparison of use-alteration patterns through time in one location with a more refined timeline. It is expected that the frequency of vessels with carbonization patterns indicative of boiling will increase throughout the post-Middle Woodland occupations of the site.

3) Are there diachronic changes in subsistence strategies (and possible attendant changes in cooking habits) detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery?

Lipid residues, stable isotopes, and microbotanical remains present in absorbed and carbonized food residues provide direct evidence of foods cooked in ceramic vessels. While they may not be representative of the diet as whole, these evidences are optimal for exploring technical change in pottery because the vessels might be altered to suit the components of the diet processed in ceramic vessels.

It is predicted that maize may appear in small amounts in the Middle Woodland period, along with other starchy foods, such as wild rice, based on previous findings in northeastern North America (Hart and Lovis 2013). The amount of starchy food is expected to increase throughout the course of the Late Woodland period, along with a possible increase in lipids indicating fatty nuts (i.e., acorns). Given that the site is positioned close to the lakeshore and on the banks of the Potagannissing River, Cloudman occupants likely had access to acorns and wild rice and may have been able to grow maize (Dunham 2014). Evidence of all three resources is expected in the microbotanical, lipids, and stable isotope results, particularly in the Late Woodland period. Maize is expected to be the predominant botanical component of food residues found in context with Iroquoian ceramic vessels given the association of contact-period Huron and Odawa with maize consumption (Smith 1996; Waugh 1973).

4) Is there synchronic variation in ceramic vessel use, subsistence strategies, and cooking habits evident through use-alteration studies or detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery of differing typological categories?

If the nature of social relationships is reflected in ceramic style, then pottery vessels can be used to examine the relationship between diet/cooking and identity. The social fluidity apparent in the Middle Woodland resulted in a broad cline of indistinct pottery styles across the Upper Great Lakes that have thwarted attempts by archaeologists to isolate spatial groupings (Brose and Hambacher 1999). Per Branster (1995), all the identified Middle Woodland vessels from Cloudman are variations of Laurel ware. Late Woodland peoples, on the other hand, seemed to have become more localized, based on both pottery styles (Milner 1991) and settlement and subsistence patterns (Cleland 1982; Dunham 2014; Smith 2004). Although pottery types may be more differentiated and geographically restricted, the need for increased extra-local interaction for risk-buffering purposes often results in a mixture of these distinct types at seasonal aggregation sites (Carroll 2013; McHale Milner 1998; see also Dorothy 1978; McPherron 1967). Early Late Woodland types at Cloudman are mostly variants of Mackinac Ware, along with a few Blackduck vessels, while the late Late Woodland assemblage is more diverse (Branstner 1995). This seems to support the increase of both localization and seasonal cooperative aggregation of distinct groups at Cloudman.

I predict that variation in technical properties and use among Middle Woodland vessels at Cloudman will be low. I also predict that results of the lipid residue, stable isotope, and microbotanical analyses will be relatively uniform across all Middle Woodland vessels, with little variation between the Laurel subtypes. If distinct identities were not being expressed through ceramic traditions, it is unlikely that there were distinct cuisines during this time as well.

I do predict an increased level of variation in the evidence for technology, cooking techniques, and diet between ceramic types used during the Late Woodland period (as compared to the Middle Woodland). Whereas these differences may not be conscious expressions of identity through cooking and food choice, they may reflect the effect of localized and nested spheres of interaction, where subsistence traditions might be more restricted in scope, and access to certain resources may be restricted as well. As Dunham (2014) points out, the availability of different starchy foods—maize, acorns, and wild rice—is restricted based on location, and individual annual yields may be highly variable. Although residential groups may have been coming together at Cloudman for coordinated large-scale fish exploitation, they also may have maintained some of their unique food and cooking preferences while inhabiting the site. Therefore, I predict increasing variation in technical properties, cooking techniques, and diet among vessels throughout the Late Woodland period.

The exact social affiliation and composition of the assumed Protohistoric occupants of the Cloudman site remains unclear, therefore predictions concerning expressions of identity are made difficult. Branstner (1995) identified Huron vessels, “imitation” Huron vessels (with poorer construction), and a number of vessels not attributable to a defined type. It is predicted that ceramic vessel technical attributes may vary, but if the social composition of the occupants was homogenous, then little variation in diet and cooking techniques is expected. If variation in diet and cooking occurs, it could be indicative of a heterogeneous population at the Cloudman site during this late occupation. Outcomes can then be compared to ethnographic and ethnohistoric accounts of group-specific culinary habits to evaluate potential ethnic associations with specific ceramic types.

5) How do ethnographic and ethnohistoric accounts of indigenous diet and cooking in the Great Lakes inform interpretations of ancient cuisine generated from the archaeological data?

This final question is auxiliary to and derived from the primary research questions but serves an important role in the overall study. Results of the archaeological analyses will be examined in the context of ethnographic and ethnohistoric accounts of foodways and cooking of societies that historically occupied regions geographically adjacent to the Cloudman site, including the Ojibwe to the west and Iroquoian groups to the east. Reference to actualistic observations of human interaction with a similar environment and suite of resources will be used to enhance the interpretive outcomes of the study. Methods of food preparation and food combinations practiced by Ojibwe and Iroquoian cooks will strengthen our understanding of the data derived from the use-alteration and dietary analyses applied to the Cloudman pottery assemblage. They may also delineate culinary differences between ethnic groups and enable recognition of identity through archaeological food remains.

Conclusion

This study follows a strong, decades-long tradition of research on subsistence and ceramics in the upper/northern Great Lakes. Although previous studies have created a substantial base of knowledge on these topics, questions about the nature of dietary, technological, and social change throughout the late precontact and contact periods remain. The use of new perspectives and techniques applied to a pottery assemblage from the multicomponent Cloudman site will enhance interpretive outcomes about the ways in which precontact peoples negotiated changing natural and social environments.

CHAPTER 4

METHODS AND DATA COLLECTION

Introduction

The multiproxy approach of this study applies diverse yet complementary analytic methods to ceramic vessels from the Cloudman site. This includes functional and stylistic ceramic analysis, and residue analysis, the latter including microbotanical, stable isotope, and lipid analyses. To evaluate the potential for taphonomic contamination of the residues, stable isotope and lipid residue analyses of soil samples taken from the matrix for the analyzed materials at the Cloudman site, were conducted for comparative purposes. The procedures carried out for each analysis are detailed below.

A majority of the analysis of the Cloudman pottery assemblage took place in the Consortium for Archaeological Research Laboratories, Department of Anthropology and MSU Museum, Michigan State University. This included the recordation of technical attributes and use-alteration traces; assessment and selection of samples for residue analysis; and collection of adhered residues for microbotanical analysis, stable isotope analysis, and AMS dating. Microbotanical analysis, conducted by Rebecca Albert, also took place in the laboratories.

The Cloudman Pottery Assemblage

Branstner (1995) grouped and identified a total of 177 vessels, excavated between 1990 and 1994, during her initial analysis of the assemblage. These vessels were numbered 1-190, with vessel numbers 68, 84, 107, 111, 119, and 92-99 unused. An additional 28 vessels were discovered in 1995 during a brief and limited excavation conducted by Cleland; these were sorted, grouped, and given vessel numbers 191-218, but never attributed to stylistic categories

(Christine Stephenson, personal communication). Rim and body sherds of each vessel were boxed and bagged together following the original analysis, reducing the chance of evaluating or sampling the same vessel twice. During re-analysis, it was discovered that Branstner's Vessels 196 and 203 were from the same vessel, as were Vessels 40 and 153, so they have henceforth been grouped together (as Vessel 196/203 and Vessel 40/153). The Cloudman assemblage consists of a total of 202 discrete identified vessels, which served as the primary unit of analysis for this research.

Principals of Pottery Function

Analysis of pottery function is detailed by Skibo (1992, 2013). He divides function into two types: intended and actual. *Intended function* is rooted in the premise that "all pots are designed to be used" (Skibo 2013:27). More specifically, potters are intentional in the decisions they make about vessel form and composition, decisions that Skibo terms *technical choices*. These choices determine the formal properties/physical characteristics of a ceramic vessel, such as shape, size, thickness, surface treatments, and paste composition (clay type and chemistry; temper type, size, and density).

Each technical property affects one or more *performance characteristics* of a vessel, or how well a vessel can perform in various circumstances. Performance characteristics include thermal shock resistance, heating effectiveness, impact resistance, permeability, and even gripability. Those most important for cooking vessels are thermal shock resistance (the ability of a vessel to resist breakage when heat is applied to it) and heating effectiveness. Some technical properties enhance certain performance characteristics while detracting from others; for example, adding temper to a paste will increase a vessel's thermal shock resistance while simultaneously decreasing its impact resistance.

Actual function entails the ways in which pottery was used, regardless of its technical properties. Actual function is inferred from use-alteration properties, which include: exterior sooting, exterior carbonization, interior carbonization, attrition, and absorbed residues. Exterior sooting forms from contact of smoke with the pottery surface, indicating the use of a vessel over fire. Exterior and interior carbonization refer to burned food residues and provide direct evidence not only of cooking but cooking methods. Various cooking methods (e.g., roasting, stewing, boiling) result in different patterns of interior carbonization. Attrition refers to the removal ceramic material through abrasive or nonabrasive processes and can occur through contact with other objects/surfaces, water vaporization, salt crystallization, and fermentation processes occurring within the vessel (Skibo 2013:122). Absorbed residues are analyzed primarily through lipid residue analysis, which examines fatty acid ratios and biomarkers (Malainey 2011).

Functional Analysis of Cloudman Pottery

Analysis of pottery function was carried out in accordance with the standards established by Skibo (1992, 2013). Distinct vessels (rim and body sherds as grouped by Branstner [1995]) were the unit of analysis. One set of measurements was taken per vessel.

Intended Function

Intended function was assessed through physical characteristics. Branster (1995) originally recorded rim diameter, paste type, paste hardness, temper size, temper type, manufacture type, thickness, lip form, lip profile, lip eversion, rim thickness, rim height, rim profile, rim eversion, surface treatment, decoration locations, and the presence of residues. The physical attributes chosen as the focus for this study were selected based on the results of prior studies of morphological changes attending alteration of cooking techniques in Eastern North American (Braun 1983; Hart 2012) and on attributes which proved significant in prior studies of pottery assemblages from the northern Great Lakes (Kooiman 2012, 2016). These properties include rim diameter, wall thickness, and temper size. Wall thickness and temper size were chosen because of their previously determined sensitivity to detecting functional change in relation to changing cooking requirements (Braun 1983; Hart 2012). Rim diameter was chosen for its relationship to overall vessel size (Blitz 1993, Kooiman 2015a; Potter 2000) and for its standard recordation in ceramic analysis. The function of rim diameter is variable and its connection to cooking effectiveness is undetermined, and therefore its role in this study is also exploratory. Since 28 vessels were not part of Branstner's original analysis, chosen characteristics were re-measured on all vessels for analytic consistency.

Rim diameter was measured using an Archmat Ceramic Radius Template. Only rim sherds large enough to comprise 5% or more of the total rim circumference of their respective vessel were recorded, resulting in rim diameter data for only 47% (94 of 202) of the total vessels. Wall thickness was measured at the lip, rim, neck, shoulder, and body, when possible. Vessels comprised of only exfoliated sherds were excluded from this data set. Temper size was averaged from three measurements per vessel. Wall thickness and temper particle size were measured using Mitutoyo Digimatic CD-6" digital calipers.

Actual Function

Assessment of actual function of pottery vessels is based on the presence of use-alteration traces. Each vessel was examined for exterior sooting, exterior carbonization, interior carbonization, and attrition. Exterior sooting can be difficult to distinguish from staining from contact with the burial environment or fireclouding that forms during the firing process; however, fireclouding occurs infrequently on vessels in the northern Great Lakes. Sooting was marked as present only when it could be positively distinguished and identified. Exterior carbonization—burned food residue occurring on the exterior surface of the vessel—sometimes has the appearance of sooting; therefore, it was only categorized as carbonization when it was located on the rim (where sooting infrequently occurs) or in cases where there was continuity with carbonization on the interior surface. Attrition, which is rare among coastal northern Great Lakes Woodland pottery assemblages (Kooiman 2012, 2015b), was not observed in the Cloudman assemblage.

Interior carbonization was recorded as present or absent, and its distribution patterning was also categorized. Presence was recorded only in cases where carbonization could be confidently identified. The categorization scheme of interior carbonization patterns from the Naomikong Point and Sand Point sites is depicted in Figure 4.1 (Kooiman 2012, 2016); however, these categories proved unsuitable for statistical analysis. These categories were condensed into three categories: Types 1 and 2, which indicate boiling; Types 3 and 4, in which the vessel was not filled to the top, but ambiguous as to whether boiling or stewing occurred; and Type 5, indicative of stewing (Kooiman 2016).

For the Cloudman pottery assemblage, the patterns could be categorized most meaningfully by the types depicted in Figure 6.2 (see Chapter 6): Type 1, which represents a distinct band of carbonization at or near the rim of the vessel, indicative of boiling; Type 2, in which carbonization covers a significant portion of the interior vessel wall, indicative of stewing (a long term, liquid reduction process); Type 3, representing the presence of a thick ring of residue around the rim of the vessel with lighter carbonization along the body of the vessel, indicating both boiling and stewing processes; Type 4, in which there is definitive carbonization on the rim but the lower extent of the carbonization along the interior is unclear; and Type 5, which signifies the presence of interior carbonization with no discernable pattern.

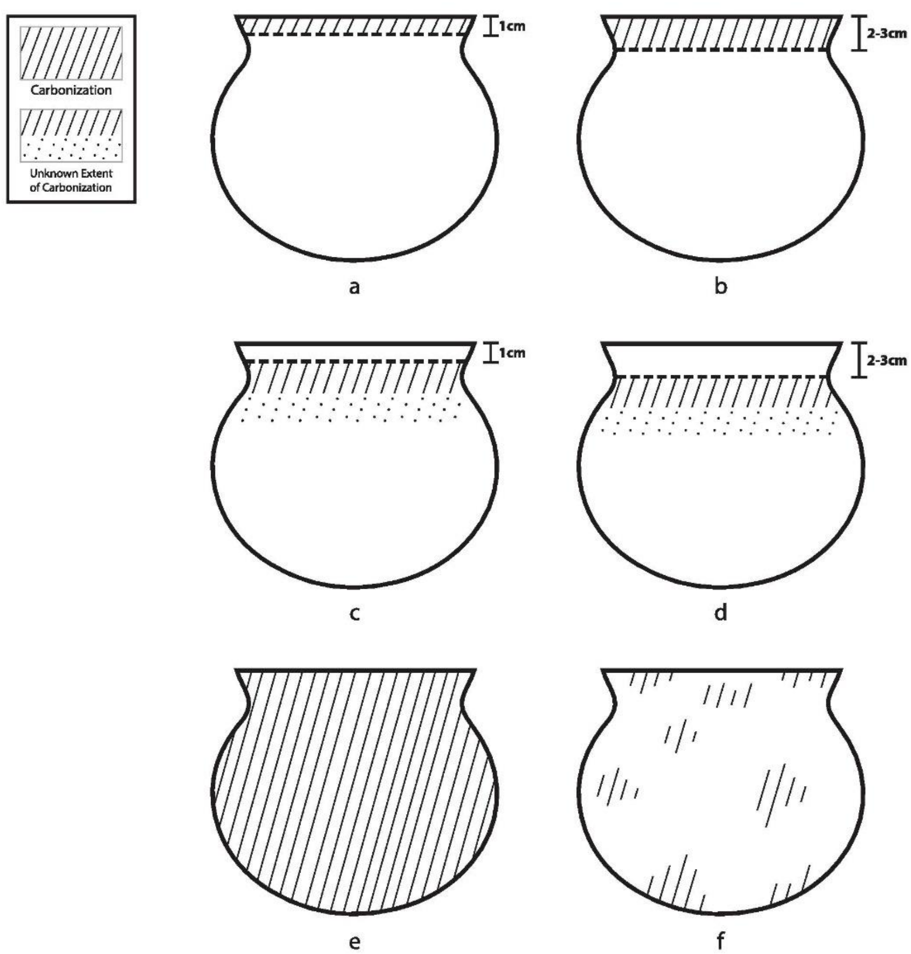

Figure 4.1: Example Interior Carbonization Pattern Categorizations
(Kooiman 2012, 2016)

Ceramic Taxonomic Classification

Branstner (1995) was able to assign 92 of 177 identified vessels from the 1992 and 1994 excavations to existing typologies. Another 49 vessels, most of which she attributed to the late Late Woodland period, were categorized as "untyped" due to their failure to fit into established categories. Another 36 vessels were classified only by their decoration (e.g., "crosshatched/impressed lip'). Branstner attributed these vessels to Middle Woodland (n=31), Middle Woodland/Late Woodland transitional (n=6), early Late Woodland (n=48), late Late Woodland (n=45), Late Woodland/Protohistoric transitional (n=4), and Protohistoric (n=34) periods. She also identified 9 miniature vessels from the Late Woodland and Protohistoric periods. An additional 28 vessels, excavated by Charles Cleland in 1995 but never officially reported, were initially identified and grouped but never assigned to stylistic typologies (Branstner-Stephenson, personal communication).

Upon review, most of Branstner's initial identifications were corroborated, and typological assignations for only 19 vessels were altered or modified. Next, the remaining untyped vessels were re-examined to determine if they fit into any established typologies. This assessment revealed the affinity of many of these untyped vessels to types from Ontario. Given the proximity of the Cloudman site to this region, an extensive perusal of literature from assemblages from Ontario was undertaken (e.g., Kenyon 1970; MacNeish 1952; Wright 1973). This deeper investigation revealed many of these untyped vessels resembled Ontario ceramic wares, particularly various Iroquoian (Huron/Wendat-Petun) wares. Additional sources (e.g., Hambacher 1992; Lovis 1973; Lugenbeal 1978) for ceramics not falling into the local Juntunen sequence yet exhibiting traditional Woodland characteristics were also consulted.

Following the reassessment of the Cloudman pottery and incorporation of miniature vessels and those vessels excavated in 1995, it was found the assemblage was composed of Middle Woodland (n=36), Middle Woodland/Late Woodland transitional (n=5), early Late Woodland (n=65), middle Late Woodland (n=5), late Late Woodland (n=47), and Ontario Iroquois (n=37) vessels. There are also five (5) general Late Woodland vessels, and two (2) not attributable to any socio-temporal style/period. A total of 29 vessels remain untyped, with all other vessels attributable to at least a ware category or marked as resembling a type or ware. A more detailed discussion of the results of the taxonomic classification will take place in the following chapter.

Microbotanical Analysis

Microbotanical analysis has recently emerged as an increasingly common method for investigating past diet and environment. Microbotanical remains include pollen, starches, and phytoliths, and may be incorporated into various forms of residue, adherance or accretion. While pollen is useful for reconstructing ancient environments, it is not typically found in contexts that can inform human food choice and consumption. Phytoliths and starches can likewise be found in the soil and used for environmental reconstruction, but they can also be collected from artifacts such as pottery and grinding stones, connecting them directly to food processing (Pearsall and Hastorf 2011). Identifiable to plant species, phytoliths and starches can tie the processing of a specific type of plant to a ceramic vessel, providing a higher level of specificity than is possible with other types of cooking residue evidence, such as lipids or stable isotopes. While not all plants yield starches or phytoliths that preserve archaeologically, many plants important for understanding subsistence in the Eastern Woodlands (i.e., wild rice, maize, and squash) have been identified in archaeological residues (see Raviele 2010; Simon 2011). Starch and phytolith analyses are highly complementary and are increasingly used in tandem. Raviele (2010) analyzed phytoliths and starches contained in adhered burned food residue in Middle and Late Woodland ceramic vessels from Michigan. The earliest residues (ca. cal 200 BC) contained maize starch, which comes from the kernel, but not maize phytoliths, which usually derive from cobs. She hypothesized this indicated a lack of cultivation activities and the use of dried maize traded from the south.

Samples for microbotanical analysis were collected from 48 discrete pottery vessels (Table 4.1). Selection of vessels for sampling was based on two criteria: presence of sufficient interior carbonized residue, and the socio-temporal association of the vessel. While 51% (n=104) of the Cloudman vessels had traces of interior carbonization, some only had thin layers of residue or residue staining. Based on standards set forth by Raviele (2010), a minimum of 0.001g was required for the collection of residue, but a minimum of 0.002g was preferred. This excluded some vessels from consideration.

Selection of samples was also based on the associated time period and stylistic typology of the vessels. Preserved adhered residue was present on Middle Woodland, early Late Woodland, late Late Woodland, and Iroquoian pottery in ample amounts for testing, in relative proportion to the size of the subassemblages. Within these larger categories, sampling from vessels of different typological categories (e.g., Mackinac Banded vs. Mackinac Punctate) were targeted to capture vessel function across the range of varieties.

Residue sampling was primarily restricted to the rim and neck; collection of residue from body sherds was only conducted if there was insufficient residue from rim/neck sherds of the

Table 4.1: Vessels Sampled for Microbotanical Analysis, Lipid Residue Analysis, Stable Isotope Analysis, and AMS Dating

Vessel	Period	Type	Micro-Botanical	Stable Isotope	Lipids	AMS
1	MW	Laurel Pseudo-scallop Shell	X	X	X	X
4	MW	Laurel Dentate Stamped	X	X		X
5	MW	Laurel Pseudo-scallop Shell	X	X		
6	MW	Laurel Dentate Rocker Stamped	X	X	X	
10	MW	Laurel Pseudo-scallop Shell	X	X		
12	MW	Laurel Dentate Stamped (oblique)	X	X		
20	MW	Laurel Dentate Stamped (oblique)			X	
22	MW	Laural Pseudo-scallop Shell	X	X		
23	MW	Laurel Banked Linear Stamped	X	X		
28	MW	Laurel Pseudo-scallop Shell	X	X		
109	MW	Laurel Banked Linear Stamped	X	X	X	
112	MW	Laurel Banked Linear Stamped	X	X		
114	MW	Laurel Banked Linear Stamped	X			
131	MW	North Bay Linear Stamp			X	
35	MW/LW	Late Laurel (cross-hatched)	X	X	X	
118	MW/LW	Untyped (cordmarked/undecorated)	X			
8	ELW	Mackinac Ware	X	X		
34	ELW	Mackinac Ware	X	X	X	
41	ELW	Mackinac Ware	X	X		
46	ELW	Mackinac Ware	X			
50	ELW	Mackinac Banded	X	X		
55	ELW	Mackinac Ware			X	
76	ELW	Mackinac Undecorated	X	X	X	
80	ELW	Mackinac Punctate	X	X	X	
81	ELW	Blackduck Banded	X	X		
88	ELW	Blackduck Banded	X	X		
100	ELW	Mackinac Punctate		X	X	
103	ELW	Mackinac Banded	X	X		X

Table 4.1 (cont'd)

Vessel	Period	Type	Micro-Botanical	Stable Isotope	Lipids	AMS
105	ELW	Mackinac Punctate	X	X		
120	ELW	Mackinac Banded	X	X		
122	ELW	Mackinac Ware (cf. Punctate)	X	X		
124	ELW	Mackinac Banded	X	X		
132	ELW	Mackinac Ware (cf. Punctate)	X	X		
173	ELW	Mackinac Banded	X	X	X	
174	ELW	Mackinac Ware (cf. Punctate)	X	X		
175	ELW	Mackinac Punctate	X	X	X	
191	ELW	Mackinac Punctate		X	X	
193	ELW	Blackduck Banded	X	X	X	X
42	MLW	Bois Blanc Ware		X		
215	MLW	Bois Blanc Ware	X	X	X	
24	LLW	"proto-Juntunen" Ware (plain)			X	
25	LLW	Juntunen Ware	X	X	X	
26	LLW	Juntunen ware	X	X		
43	LLW	Traverse Decorated v. Punctate	X	X	X	
75	LLW	Traverse Plain v. Scalloped (mini)	X	X	X	
101	LLW	Juntunen Ware	X	X	X	
102	LLW	Juntunen Drag-and-Jab	X	X		
150	LLW	Traverse Plain v. Scalloped	X	X	X	
152	LLW	Juntunen Ware (cf. O'Neil Curvilinear)	X	X		
204	LLW	Juntunen Linear Punctate	X	X	X	
205	LLW	Juntunen Linear Punctate		X		
216	LLW	Untyped			X	
36	IRO	cf. Huron Incised		X		
40/153	IRO	cf. Lawson Opposed or Methodist Point Group 7	X	X		
70	IRO	cf. Huron Incised	X	X	X	
77	IRO	Untyped			X	
146	IRO	Early Ontario Iroquoian (incised)	X	X	X	

Table 4.1 (cont'd)

Vessel	Period	Type	Micro-Botanical	Stable Isotope	Lipids	AMS
162	IRO	cf. Sidey Notched or Lawson Incised	X	X	X	X
164	IRO	cf. Huron Incised			X	
166	IRO	cf. Huron Incised			X	
179	IRO	cf. Huron Incised	X	X		
		TOTAL	48	50	30	5

same vessel. The residue was collected from the interior surface of the sherd and gently scraped onto weigh paper from each sherd (representing one vessel) with disposable scalpels. After each residue sample was weighed on a Cole-Parmer® Symmetry™ scale and placed into 15 mL plastic centrifuge tubes with screw caps and the weigh paper discarded.

Samples were transported to the MSU Department of Geography Quaternary Landscape Research Group Laboratory for processing. The processing procedure is as follows:

> The chemical extraction technique for extracting microbotanicals from ceramic residues follows the protocols developed by the University of Wisconsin–Duluth Archaeometry Laboratory (Archaeometry Laboratory 1989). This procedure uses a consistently heated solution of potassium chlorate ($KClO_3$) and nitric acid (HNO_3) to dissolve non-silica materials. Materials left after this procedure are phytoliths, starches, diatoms, silicified tissues, and other various non-diagnostic organic and inorganic materials. All samples were centrifuged, and thoroughly rinsed with distilled water (dH_2O) to remove any remaining potassium chlorate and nitric acid. These samples were stored in ethanol (C_2H_6O) in ½ dram glass vials. A few drops of each sample was placed on slides and were then placed on a slide

warmer to evaporate the ethanol. The sample was then mixed with Permount™ on the slide, and a slide cover was placed over the Permount™.

Samples were viewed and analyzed using Leica DM 2500™ compound microscope at 200X magnification. The Hoya polarizers were generally set very high, and a green Hoya filter was occasionally used to diminish the light intensity and search for starches. Diagnostic objects (see materials and methods) identified on the slides were photographed and their location on the slide was marked, along with a morphological description (Albert et al. 2018).

Potential contamination of the samples during processing was controlled and monitored. The samples were prepared in a sterile environment, and powder-free (starch-free) nitrile gloves were used during preparation and analysis. Control slides placed in the processing laboratory demonstrated the lack of contaminates in the collection and processing laboratories.

Stable Isotope Analysis

Stable isotope analysis in this study focused on isotopes of the standard elements Carbon and Nitrogen, which enables measurement of their ratios in adhered or absorbed food residues (Evershed et al 1999). Resultant ratios facilitate the separation of plants into three groups: legumes, non-legumous C_3 plants, and C_4/CAM plants (Hastorf and DeNiro 1985). Most plants in temperate climates are C_3 pathway plants, while tropical cultigens, such as maize, are C_4 pathway plants. This makes it possible to detect the presence of maize in human diets, especially in temperate zones such as the Midwestern United States (Schoeninger 1995). Hastorf and DeNiro (1985) were the first to apply stable isotope analysis to pottery residues for assessing past vessel contents, and it has since an increasingly common method for investigating past diet (e.g., Hart 2012; Lovis 1990; Morton and Schwarcz 2004; Taché and Craig 2015).

Samples for stable isotope analysis were collected from 50 discrete pottery vessels (see Table 4.1). Selection of vessels for sampling was based on two criteria: presence of sufficient interior carbonized residue, and the socio-temporal association of the vessel. Although 51% (n=104) of the Cloudman vessels had traces of interior carbonization, some only had thin layers of residue or residue staining. A minimum sample of 0.0015g was required by ISGS for analysis. Residue for microbotanical analysis and stable isotope analysis was collected from the same vessels simultaneously. An additional two samples (from Vessels 100 and 191) were collected for isotope analysis but not microbotanical analysis due to time and budgetary restrictions.

Selections for sampling were also based on the associated time period and taxonomy of each vessel. Preserved adhered residue was present on Middle Woodland, early Late Woodland, late Late Woodland, and Ontario Iroquois pottery in ample amounts for testing, in relative proportion to the size of the subassemblages. Within these larger categories, sampling from vessels of different regional archaeological types (e.g., Mackinac Banded vs. Mackinac Punctate) were targeted for sampling to capture vessel function across the range of varieties. Procedures for sampling were the same for collection of residues for microbotanical analysis (see previous section).

Residue samples were then sent to the Illinois State Geological Survey for bulk $\delta^{13}C$ and $\delta^{15}N$ isotope analysis. Samples were analyzed using a CE Instruments NC 2500 Elemental Analyzer in series with a ConFlo IV universal interface coupled to a Delta V Advantage Isotope Ratio Mass Spectrometer. Samples were compared with NIST and IAEA Standard Reference Materials (USGS 40, USGS 41, IAEA NO-3) for precision and accuracy, while Methionine and

USGS 40 were used as the standard reference materials for elemental composition. Analytical precision for $\delta^{13}C$ was $\pm$ 0.05 ‰ and is reported relative to Vienna Pee Dee Belemnite (VPDB). Analytical precision for $\delta^{15}N$ was $\pm$ 0.13 ‰ and is reported relative to Air (Shari Effert-Fanta, personal communication).

Lipid Residue Analysis

Lipids, or fatty acids, are present in both plant and animal tissue and provide direct evidence of food processing for consumption (Malainey 2011). They are effective for ancient dietary assessment because they are present in almost all human food, they maintain high stability with increased temperatures, and decomposition is minimal when compared to carbohydrates or proteins (Röttlander 1990). Absorbed lipid residues can be extracted from archaeological materials associated with cooking and food processing, such as ceramic vessel walls or cooking and grinding stones. They can be analyzed and assessed based on fatty acid composition/ratios, the presence of certain biomarkers, or by measuring the stable isotope values of lipid components. Components are generally separated with some form of gas chromatography: gas chromatography with a flame ionization detector (GC), gas chromatography with mass spectrometry (GC/MS), or gas chromatography-combustion-isotope ratio analysis (GC-C-IRMS) (Malainey 2011:201). Once the components are separated, the origins of the lipids present can be identified.

Sampling for lipids can be affected by three factors: accumulation, preservation, and contamination (Malainey 2011). Lipids are differentially accumulated into the ceramic material of a cooking pot based on vessel portion. Accumulation is generally low in the base of the vessel, while lipids are most plentiful near the rim of the vessel, or just below the level to which the vessel was regularly filled (Charters et al. 1993; Charters et al. 1997). Preservation of lipids is also optimal in the upper portions of a vessel (Malainey 2007). Contamination derives either from the burial environment or from archaeological processing (Malainey 2011:205). The densest accumulation of lipids occurs in the interior of a pottery vessel, where contamination from the burial environment is generally negligible (Condamin et al. 1976; Röttlander 1990). Standard processing of pottery for lipid analysis therefore involves the removal of exterior surfaces and sampling from the interior portion of the wall only.

A total of 30 pottery sherds were selected from the Cloudman site assemblage for lipid residue analysis (see Table 4.1). Criteria for selection included: sherd weight, vessel portion, the presence of adhered residue on the vessel, and temporal association of the vessel. Analysis of fatty acid ratios requires sherds with a minimum weight of 7g for the purposes of sufficient sampling. As noted above, lipid accumulation and preservation are optimal in the upper portions of vessels; therefore, sherds originating from the neck or shoulder portions of the vessels were favored in the selection of samples. Curatorial concerns also called for the selection of neck and shoulder sherds containing no portion of the rim, although in a few cases the only sherd available for analysis were rim sherds. Sherds from vessels exhibiting adhered residue were favored over vessels exhibiting no visible residue. Adhered residue is a certain indicator that the vessel was used for cooking and increases the likelihood of abundant absorbed residue. Vessels lacking visible residues may have been employed in food processing and may contain absorbed lipids in cases where food was cooked in the vessel but never burned, or where the vessel was cleaned either by the original user or washed during archaeological lab processing. However, some vessels may have never been involved in cooking foods, either used for storage or simply breaking during the firing process and entering the archaeological record before it was used.

Vessels associated with each occupation period of the Cloudman site were sampled. However, differential preservation of vessels from each time period affected the sampling. Early Late Woodland vessels were the most numerous and the best preserved, with ample numbers of sherds of sufficient size from the upper portions of the vessels. Middle Woodland vessels, based on age and decoration, generally had smaller sherds, many of which did not meet the minimum size for lipid analysis. Additionally, these vessels did not have as many body sherds associated with the rim sherds used for vessel categorization when compared to other subassemblages. Selected sherds were sent to the Archaeological Residue Analysis Laboratory at Brandon University in Brandon, Manitoba, for analysis. Processing and analysis was conducted by Mary Malainey and Timothy Figol. HT-GC and HT GC-MS analysis on a Varian 3800 gas chromatograph and a Varian 4000 mass spectrometer was used to determine fatty acid ratios used in identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11 and C18:2). Ratios from the Cloudman site samples were then compared against known ratios of plants and animals common to northern North America. Detailed preparatory and analytic procedures of the lipid residues are outlined in Appendix C.

AMS Dating

Accelerator mass spectrometry (AMS) dating allows detection of carbon-14 in small samples of organic matter. This makes it ideal for directly dating adhered pottery residues (Lovis 1990). Although some have argued that the processing of freshwater fish in ceramic vessels could introduce old carbon into food residues (aka the Freshwater Reservoir Effect), thereby affecting dating outcomes (e.g., Fischer and Heinemeier 2003; Philippssen et al. 2010), recent studies have demonstrated that the effect is minimal (Hart et al. 2013; Heron and Craig 2015; Lovis and Hart 2015).

Carbonized residue from five pottery vessels from the Cloudman site were selected for direct AMS dating. Sample selections were based on vessel type to clarify both the occupational chronology of the site and the regional ceramic chronology (Table 4.2; see Table 4.1). A Laurel Dentate Stamped vessel (V4) was selected because of the lack of late Laurel dates in the northern Great Lakes, while a Laurel Pseudo-Scallop Stamped vessel (V1) was anticipated to provide additional information about the timing of the Middle Woodland occupation at Cloudman. The timing of the occurrence of Blackduck pottery in the eastern northern Great Lakes is unclear, so one Blackduck vessel (V193) was sampled. While regional chronologies for the late Late Woodland pottery types are well established (Lovis 2014; McHale Milner 1998), the early Late Woodland chronology is less clear. A Mackinac Banded vessel (V103) was selected to situate this type within the regional ceramic chronology and to clarify the timing of the early Late Woodland occupation of the Cloudman site. Finally, an Iroquoian vessel (V162) closely resembling either Lawson Opposed or Sidey Notched vessels was selected to date the presence of Iroquoian/Wendat-Petun occupants or trade vessels at the Cloudman site. Prior dating of this most recent occupation of the site was based solely on relative dating of various trade goods.

Table 4.2: Pottery Vessels Sampled for AMS Dating of Carbonized Residue

Vessel No.	Period	Type	Wt. (g)
1	MW	Laurel Pseudo-Scallop Stamp	0.0185
4	MW	Laurel Dentate Stamped	0.0073
103	ELW	Mackinac Banded	0.0044
193	ELW	Blackduck Banded	0.0142
162	IRO	cf. Lawson Opposed or Sidey Notched	0.0154

Collection of residues from the selected vessels followed the same procedures as for stable isotope and microbotanical analyses (see above). Samples were required to weigh at least 0.004g, with ideal weight of 0.005-0.010g preferred. The five Cloudman site samples were graphitized in the Carb, Water, and Soils Lab of the USDA-FS Northern Research Station in Houghton, Michigan. The radiocarbon measurements were conducted at the Keck Carbon Cycle AMS Facility, Earth System Science Department, University of California Irvine.

Soil Samples

The sole field component of this study involved collection of soil samples from the Cloudman site. A primary concern with testing pottery residues is contamination from the soil/burial environment. The purpose of the soil samples was to assess the potential of contamination of absorbed and adhered food residues on pottery via the burial environment. Morton and Schwarcz (2004) found the humic contamination of stable isotope assays negligible, but ^{15}N levels can be elevated by both natural manure fertilizers or synthetic denitrified fertilizers (Chang et al. 2002), the latter of which has been found to elevate ^{15}N levels in modern-day fish samples in rivers contaminated with fertilizer runoff (Brugam et al. 2017). As fertilizer spread on the ground could likewise contaminate buried artifacts, the chance for a false negative for aquatic resources is possible. Stable isotope analysis of soil samples from archaeological sites can serve as indicators of contamination of the burial environment and artifacts found within it. Contamination of absorbed lipid residues from the burial environment is generally of less concern, as Condamin et al. (1976:199) found it to be negligible. However, soil samples for comparative lipid residue testing were collected for analytic rigor and to affirm the reliable use of lipid residue analysis without concern for contamination.

I visited the Cloudman site on July 21, 2017, when Gary Cloudman, the landowner, showed me where the excavations had taken place. Based on his outline of the limits of excavation and the site description provided by Branstner (1995), I identified the three terraces descending towards the Potagannissing River (Figure 4.2). Using a soil probe with a core sampler, I took small core soil samples at three points across each terrace, spanning the limits of the prior excavations. The area was never formally farmed and therefore did not have a plowzone, and most of the cultural material excavated at the site was contained within the uppermost two soil horizons. Samples from both strata were taken at each sampling locale, in accordance with the stratum descriptions detailed by Branster (1995). Each sample was wrapped in tin foil and placed in a labeled plastic canister.

Figure 4.2: Terracing at the Cloudman Site (20CH6)

A total of 12 soil samples were selected for submission to ISGS for carbon and nitrogren stable isotope analysis (Table 4.5). Samples were selected from across the site and from different strata, with some preference for subsoil. Both strata of the easternmost edge of Terrace 3 were selected because of their proximity to a modern-day garden bed, in which, according to the land owner, maize is occasionally grown. These samples were therefore the most likely to be contaminated from both modern-day corn signatures, as well as possible nitrogen contamination from fertilizers.

Table 4.3: Soil Samples from the Cloudman Site Selected for Stable Isotope Analysis

Sample No.	Context	Wt (g)
T2-S1-2	Terrace 2, Stratum 1, Center	2.3927
T2-S2-2	Terrace 2, Stratum 2, Center	2.7298
T3-S1-1	Terrace 3, Stratum 1, East	2.1282
T3-S2-1	Terrace 3, Stratum 2, East	3.6903
T1-S2-3	Terrace 1, Stratum 2, West	3.0748
T1-S2-2	Terrace 1, Stratum 2, Center	2.9083
T3-S2-3	Terrace 3, Stratum 2, West	3.5073
T2-S2-3	Terrace 2, Stratum 2, West	3.1991
T1-S1-2	Terrace 1, Stratum 1, Center	3.2733
T1-S2-1	Terrace 1, Stratum 2, East	2.7410
T3-S2-2	Terrace 3, Stratum 2, Center	5.7370
T2-S2-1	Terrace 2, Stratum 2, East	4.7282

An initial four samples were sent unprocessed to ISGS, where the samples were dried and pulverized. The remaining eight samples selected for isotope analysis were laid out to dry in the MSU Anthropology and Archaeology Laboratories. They were then taken to the labs at the MSU Department of Geography, Environment, and Spatial Sciences and pulverized in a Fritsch Pulverisette 0 vibratory micro mill and sieved through a No. 60 geological sieve, placed in 15mL centrifuge tubes with screw caps and weighed. Equipment was carefully cleaned between the processing of each sample. Another three soil samples were selected for lipid residue analysis (Table 4.6). Samples of a minimum of 10g were sent to the Archaeological Residue Analysis Laboratory at Brandon University for processing and analysis (see Appendix C). A selection of four soil samples will be sampled and processed for microbotanical analysis in forthcoming research.

Table 4.4: Soil Samples from the Cloudman Site Selected for Lipid Residue Analysis

Sample No.	Context	Wt. (g)
T2-S1-2	Terrace 2, Stratum 1, Center	13.59
T2-S2-2	Terrace 2, Stratum 2, Center	17.03
T3-S1-1	Terrace 3, Stratum 1, East	12.14

Conclusion

The methods detailed above are either historically common or are becoming increasingly popular in archaeological practice. Stylistic pottery analysis, functional pottery analysis, microbotanical analysis, stable isotope analysis, and lipid residue analysis are strong methods for analyzing past human diet- and technology-related behaviors. However, they are most frequently employed independently, providing discrete sets of data that limit interpretations. The use of a wide variety of pottery analyses can expand interpretive potential and provide a more holistic view into the past. The next three chapters will detail the results of the aforementioned analyses. Data yielded from all methods will then be discussed together, demonstrating the efficacy of multiproxy research for investigating past foodways and technology.

CHAPTER 5

REGIONAL CERAMIC TAXONOMY AND CHRONOLOGY, AND THE OCCUPATIONAL HISTORY OF THE CLOUDMAN SITE

Introduction

Exploration of diachronic change requires situating units of analysis in time. In this case, the units of analysis are Cloudman pottery vessels and their residues. Construction of an occupational history of the Cloudman site allows identification and isolation of the pottery assemblage subsets for use in comparative and statistical analyses of technical properties, use-alteration traces, and chemical and microscopic food signatures. While adhered residues from pottery vessels can be directly dated using AMS, this method is cost prohibitive. Relative dating of vessels using spatio-temporal taxonomic typologies based on stylistic properties provides a cost-effective and time-tested means of creating temporal groupings that facilitate examination of diachronic change. This analysis relies primarily on relative dates provided by taxonomic categorizations of pottery, although a small set of AMS-dated vessels provides absolute dates for anchoring the relative chronologies.

Pottery Taxonomy

Stylistic properties and taxonomic categorization of Cloudman site pottery vessels have been discussed at length by Branstner (1995). The goal of the present study was to review original classifications in comparison to more recent literature and create the most accurate portrayal of the occupational history of the Cloudman site and the social relationships of the people who lived there. Many of the classifications below are a reiteration of the work done by Branstner (1995) and points of classificatory divergence are distinguished. Appendix A presents both Branster’s categorizations and the final categorizations used in this study.

One challenge encountered during the taxonomic assessment of the Cloudman ceramic assemblage was the admixture of Ontario Iroquoian or Iroquoian-like wares into the otherwise Woodland/Algonquian assemblage. At the outset of taxonomic re-assessment, the chronological association of the Iroquoian pottery was unclear. As discussed in Chapter 3, Branstner (1995) initially associated Ontario Iroquoian wares with a protohistoric Odawa occupation relatively dated to ca. AD 1630. However, an AMS date confirms the presence of Ontario Iroquoian pottery at the Cloudman site in the 1400s (see below), and Iroquoian wares associated with earlier periods were identified throughout the classification process. This suggested a potential temporal overlap between Ontario Iroquoian and certain Woodland/Juntunen-sequence vessels.

Aside from chronological significance, pottery style is also symbolic of sociocultural affiliations. Stylistic differences between Iroquoian and Woodland pottery are, in most cases, quite distinct, despite their temporal overlap, evidence of production by people of distinct social or cultural traditions. Although most of Cloudman pottery vessel subsets, such as “Middle Woodland,” are applied here as spatiotemporal categories, it is recognized that the category “Ontario Iroquoian/Iroquoian” conflates sociocultural with spatiotemporal associations, resulting in what is here called a “socio-temporal” categorical subsets. However, given the clear stylistic differences between late Late Woodland and Iroquoian vessels, they will be grouped and described separately.

Another challenging factor was variation in vessel completeness. Some vessels are represented by a single rim sherd (or, in some cases, a highly distinctive neck/shoulder sherd), while others are represented by dozens of sherds comprising large portions of the vessels (although there are no whole vessels in the assemblage). This variation often affected taxonomic categorization. Early Late Woodland vessels generally had the most complete vessels rims and the most associated body sherds, while vessels from other time periods were often represented by small rim sherds or rim sections. The latter limited the specificity of typological categorization.

Taxonomic Classification

The Cloudman assemblage consists of 202 identified, distinct minimal vessels (Table 5.1; see Appendix G for images of select vessels). The largest subassemblage is comprised of vessels associated with the early Late Woodland period, with sizable Middle Woodland, late Late Woodland, and Iroquoian subassemblages. The remaining vessels either possess stylistic attributes that appear transitional between primary subassemblages or lack distinctive attributes that associate them with a specific subassamblage.

Table 5.1: Cloudman Pottery Vessels by Socio-Temporal Association

Socio-Temporal Association	Ct.	Regional Dates
Middle Woodland (MW)	35	200 BC - AD 500/600
Middle/Late Woodland (MW/LW)	7	AD 500/600 - AD 700
Early Late Woodland (ELW)	62	AD 700 - AD 1000
Middle Late Woodland (MLW)	5	AD 1000 - AD 1200
Late Late Woodland (LLW)	49	AD 1200 - AD 1600
General Late Woodland (LW)	5	AD 600 - AD 1600
Ontario Iroquoian (IRO)	37	AD 1200 - AD 1650
Unknown	2	N/A
Total	**202**	

A number of miniature vessels (n=11) are included in the Cloudman assemblage. Although often disregarded as “children’s pots,” several of the miniature vessels from Cloudman are very finely constructed and show clear stylistic elements of established typological categories. Miniature vessels are included in vessel counts for each time period, but the miniature vessel subassemblage as a whole is summarized and described at the end of this section since they were excluded from Branstner's original vessel descriptions.

The assemblage is described below, presented in chronological order of socio-temporal affiliations and then grouped by type. The following descriptions are not meant to be comprehensive and merely highlight the distinguishing characteristics of the vessels by which they were categorized. More detailed morphological and compositional details of Cloudman pottery types and vessels can be found in Branstner (1995).

Middle Woodland Ceramic Subassemblage

The Middle Woodland pottery subassemblage (n=35) is largely homogeneous, consisting mostly of Laurel ware vessels and two North Bay vessels (Table 5.2; Figures G1-G14).

Laurel Ware (n=32) Varieties of Laurel ware at the Cloudman site include Banked Linear Stamped (Vessels 23, 109, 110, 112, 113, 114), which are decorated with oblique stamps created by a plain tool. A single Dentate Rocker Stamped (Vessel 6) is distinguished by oblique dentate stamping on the interior and exterior rim with horizontal rows of dentate rocker stamping on the body. Dentate Stamped vessels (4, 12, 13, 17, 19, 20, 59) exhibit vertical, horizontal or oblique stamping with a notched tool on the exterior rim surface. Pseudo-scallop Shell vessels (1, 2, 5, 7, 9, 10, 14, 15, 18, 22, 28, 169) are decorated along the entire upper body using push-pull stamping, a technique resulting in a pattern resembling scallop shell stamping, and many have a single row of punctates along the rim. Laural Plain vessels (3 and 91) are undecorated, while a single Laurel Trailed vessel (Vessel 16) is decorated with a vertical trailed motif. The above type descriptions are based on the original definitions by Janzen (1968).

Table 5.2: Middle Woodland Vessels by Type

Type	Ct.
Laurel Banked Linear Stamped	6
Laurel Dentate Rocker Stamped	1
Laurel Dentate Stamped	7
Laurel Plain	2
Laurel Pseudo-scallop Shell	13
Laurel Trailed	1
Laurel Ware, untyped	2
North Bay Cordmarked	1
North Bay Linear Stamp	1
Untyped	1
Total	**35**

Re-evaluation was consistent with Branster's (1995) classifications except in a few cases. Vessel 30 was originally categorized as Laurel Incised, but it was instead classified as a general late Laurel vessel (see below). Vessels 39 and 144 were both originally untyped. Vessel 144 displays hallmarks of coil manufacture with a fine, sandy paste. It has a smoothed rim and oblique tool impressions on a rounded lip, which allows it to be broadly categorized as Laurel Ware. Vessel 39 is a miniature vessel also classified as Laurel Ware, described below with other miniature vessels.

North Bay (n=2) The Middle Woodland subassemblage includes two North Bay vessels (131 and 142). These were both originally categorized as untyped. North Bay pottery was first identified at the Heins Creek and Mero sites on the Door Peninsula of Wisconsin and is "usually thick, heavy, and extremely crude" (Mason 1966), distinguishing it from its more finely-made Laurel counterparts. Vessel 131 is North Bay Linear Stamped, with notched tool stamping on the rim and the lip. Vessel 142 is North Bay Cordmarked, with deep vertical cordmarking on a vertical rim with a squared lip.

Untyped (n=1) Vessel 201 is an untyped miniature vessel and is described below with the other miniature vessels.

Middle Woodland/Late Woodland Transitional Subassemblage

A small subset of vessels (n=7) appear transitional between Middle Woodland and Late Woodland types (Table 5.3; Figures G15-G17). Three vessels (30, 35, and 170) are Late Laurel wares. Vessels 30 and 35 have broader lips than classic Laurel with straighter rim profiles than is common among Mackinac wares, exhibiting characteristics which straddle the temporal divide. Vessel 30 has a row of vertical incised lines directly below the exterior lip, a row of possible fingernail impressions on the interior rim, and incised crosshatching on the squared lip. Vessel 170 has three rows of oblique linear stamping with crosshatching on the body below. Vessel 35 has cord-wrapped stick impressions on a broad lip, a slightly everted rim, a row of double punctates (possibly made with the distal end of a phalanx of a small mammal), and crosshatched incising over a cordmarked body. Incising is present in low quantities at many Laurel sites (Brose 1970; Janzen 1968; Stoltman 1973; Wright 1967) and some vessels exhibiting this motif are classified as Laurel Incised, a type that generally occurs late in the Laurel sequence (Stoltman 1973). Vessel 35 appears more similar to Mackinac in overall style, but also displays the cross-hatched incising, more evidence in support of the late occurrence of this decorative element.

Vessels 33, 118, and 171 are untyped but possess characteristics that merge both Middle and Late Woodland features. Vessel 118 displayed a thin, rounded lip, vertical rim, and cordmarking on the exterior, defying established taxonomic categories and straddling the characteristics between typical Middle Woodland and Late Woodland wares. Vessel 171 has vertical punctate decoration on the exterior and vertical cord-wrapped stick impressions on the interior rim, exhibiting a slightly everted rim but with a thin, rounded lip, again suggesting a time of manufacture during the Middle-Late Woodland transition and prohibiting taxonomic classification. Vessel 197 has straight rim profile, a square, flattened lip extruded to the exterior, which was then smoothed flat over a cordmarked exterior surface. It bears strong resemblance to North Bay Cordmarked wares, but is composed of a coarser paste than typical of Middle Woodland pottery.

Table 5.3: Miscellaneous Woodland and Unknown Vessels

Temporal Affiliation	Type	Ct.
Middle/Late Woodland Transition	Late Laurel	3
	Untyped	4
	Total	**7**
Middle Late Woodland	Blanc Blanc Ware	4
	Untyped (cf. Bois Blanc Ware)	1
	Total	**5**
General Late Woodland	Untyped, ELW/MLW	1
	Untyped	4
	Total	**5**
Unknown	Untyped	**2**

The most intriguing of these transitional vessels is Vessel 33, which has a vertical rim, a flattened lip, large grit particles, smoothed-over vertical textile impressed exterior surface, double cordwrapped-object punctates, and a thin, folded-over flap resembling an incipient collar. The paste, grit, and rim orientation are more in alignment with Middle Woodland manufacture, while the decorative elements are more common in the Late Woodland. Overall, the vessel most closely resembles Blackduck or Sandy Lake wares from northern Minnesota (Jill Taylor-Hollings, personal communication). The vessel does not fit into any established typological categories, but may be incipient Blackduck ware. The aforementioned vessels post-date the other Laurel types present in the assemblage, representing an ephemeral human presence at the Cloudman site after the primary Middle Woodland occupation.

Early Late Woodland Ceramic Subassemblage

The early Late Woodland pottery vessels (n=62) comprise 31% of the overall Cloudman assemblage, representing the largest subassemblage. The category includes Mackinac, Blackduck, and Bowerman wares (Table 5.4; Figures G18-G40). Although the early Late Woodland subassemblage is slightly more stylistically diverse than the Middle Woodland subassemblage, the variation is limited.

<u>Mackinac Ware</u> (n= 56) Mackinac wares predominate within the early Late Woodland assemblage. Mackinac Punctate vessels (21, 53, 80, 100, 105, 123, 139, 175) were identified by Branstner (1995), and Vessels 191 and 196/203, not included in her analysis, have also been placed in this category. Mackinac Punctate vessels have outflaring rims with exterior decoration restricted to a single or double row of punctates (McPherron 1967). A number of vessels (106, 122, 132, 137, 138, 141, 174) closely resembled Mackinac Punctate but were not complete enough for confident classification.

Branstner (1995) identified nine Mackinac Banded vessels (50, 78, 103, 108, 120, 121, 124, 172, 173). Vessel 192, which was not included in Branstner's original analysis, was also categorized as Mackinac Banded. This type is defined by complex designs in horizontal or diagonal bands of decoration bordered by rows of punctuations at the top and bottom (McPherron 1967). An additional vessel (V137) closely resembled Mackinac Banded.

Mackinac Undecorated, which have the everted rim and splayed lip hallmarks of Mackinac but lack exterior decoration (McPherron 1967) includes Vessel 76, as identified by Branstner, and Vessel 52, originally untyped, which is a miniature vessel and is described later in this chapter. Eight vessels (116, 125, 128, 129, 147, 168, 176, 198) closely resembled Mackinac Undecorated but are not complete enough for confident classification. Another fifteen full-size vessels (8, 2, 32, 41, 46, 49, 55, 61, 72, 87, 126, 127, 130, 181) and two miniature vessels (83 and 202) were broadly categorized as Mackinac ware.

Vessels 189 and 194 represent late Mackinac ware (ca. AD 1000). Vessel 189 is relatively thin and has a lip that is an amalgamation of the thickened lip of Mackinac wares and the braced rim of Bois Blanc. The rim is almost vertical, like Bois Blanc, with a hint of Mackinac-like eversion. Vessel 194 displays the thickened lip, rim eversion, and punctates of Mackinac but has multiple bands of decoration, with thinner and more rounded lip than is typical of Mackinac ware, suggesting a time of manufacture late in the sequence.

<u>Blackduck Ware</u> (n=4) The early Late Woodland assemblage also includes four (4) Blackduck Banded vessels, characterized by horizontal bands of cord-wrapped stick impressions under a row of punctates (McPherron 1967). Branstner (1995) identified two Blackduck Banded vessels (81, 88) and more tentatively classified Vessel 117 as either Laurel or Blackduck. This vessel has cord-wrapped stick impressions on a broad lip and exterior decoration of a row of round punctates superior to three bands of horizontal cord-wrapped stick impressions, characteristics more closely aligned with Blackduck Banded. Vessel 193, which was not included in the 1995 analysis, clearly displays the hallmarks of Blackduck.

Table 5.4: Early Late Woodland Vessels by Type

Type	Ct.
Mackinac Banded	10
Mackinac Punctate	10
Mackinac Undecorated	2
Mackinac Ware (cf. Banded)	1
Mackinac Ware (cf. Punctate)	6
Mackinac Ware (cf. Undecorated)	8
Mackinac Ware, untyped	17
Late Mackinac Ware	2
Blackduck Banded	4
Bowerman Plain v. Cordmarked	1
Untyped	1
Total	**62**

Bowerman Ware (n=1) Vessel 199 is Bowerman Plain variety Cordmarked, with the straight rim, flat lip, and fine vertical cordmarking that are the hallmarks of the type (Hambacher 1992). This type was identified at the Skegemog Point site in northern lower Michigan and is considered generally contemporaneous with Mackinac wares (Hambacher 1992: 91).

Untyped (n=1) Vessel 63 is a miniature vessel that appears to have been manufactured during the Early Late Woodland period but remain untyped. It is detailed later in the chapter in the section on miniature vessels.

Early/Middle Late Woodland Transition (n=1) Vessel 200 is an untyped vessel with a flared, everted rim with deeply-impressed oblique cord-wrapped stick impressions on the lip, vertical cord-wrapped stick impressions on the interior rim, unusually small, round punctates on the exterior rim, and smoothed-over cordmarking on the body. These elements are an amalgamation of Mackinac and Bois Blanc characteristics, suggesting it was manufactured in the early Late Woodland to middle Late Woodland period (see Table 5.3; Figure G41).

Middle Late Woodland Ceramic Subassemblage

The initial assessment of the Cloudman site occupational history excluded a middle Late Woodland component (Branstner 1995). Re-evaluation of some of the originally untyped vessels identified a small number of vessels (n=5) with strong affinities to Bois Blanc ware, which are associated with the middle Late Woodland period at the Juntunen site (AD 1000-1200; McPherron 1967).

<u>Bois Blanc Ware</u> (n=5) Five vessels are categorized as or show strong affinities to Bois Blanc ware (see Table 5.3; Figure G42-G43). Bois Blanc is characterized by thickened rims (by folded-over lips or by the addition of a strip/fillet), castellations, and cord-wrapped object decoration (McPherron 1976:104). These vessels described below all possess the characteristic thickened rims that are the hallmark of Bois Blanc but lack cord-wrapped object impressions or apparent castellations (McPherron 1967). However, the rim morphologies are clearly Bois Blanc despite the non-traditional decorative elements.

Vessel 42 has a slightly inverted rim with a square lip, two horizontal bands of cord impressions below the lip, a fillet with oblique cord impressions, and at least one more horizontal band of cord impression below the fillet. Vessel 158 has a slightly inverted braced rim with a lip displaying widely spaced vertical linear tool impressions over a smoothed exterior rim. Vessel 215 has an inverted, wedge-shaped rim with two faint horizontal bands of cord impressions on both the interior and exterior rim surfaces, and possible vertical cord-wrapped stick impressions just below the interior lip. Vessel 73 has the characteristic fillet/braced rim of Bois Blanc, the surface of which appears fabric impressed or impressed with a paddle wrapped loosely with cord, a surface treatment occasionally seen on Bois Blanc vessels (McPherron 1967:106). A fifth vessel, Vessel 31, strongly resembles Bois Blanc ware, displaying a braced rim, but the paste and manufacture quality are poor, possibly representing an expedient vessel.

Late Late Woodland Ceramic Subassemblage

The greatest stylistic variation occurs among the late Late Woodland ceramic subassemblage (n=49). While the majority of the subassemblage is comprised of Juntunen ware, it also includes Traverse ware and a number of vessels of such stylistic singularity that they remain untyped (Table 5.5; Figures G44-G55).

<u>Juntunen Ware</u> (n=25) Branstner (1995) initially categorized only three vessels (101, 102, 143) as Juntunen ware, but a re-assessment demonstrates that many of the late Late Woodland vessels that were left untyped displayed some characteristics of Juntunen ware. Furthermore, a number of vessels from the 1995 excavation, which were not included in Branstner's report, were clearly Juntunen vessels. Juntunen ware is characterized by the nearly universal presence of true collars and decoration of linear punctates or drag-and-jab techniques, with little to no use of cord impressions or incising (McPherron 1967:111).

A "proto-Juntunen vessel" (Vessel 24), likely manufactured ca. AD 1200, has "peaking" on the rim (an incipient castellation common among Bois Blanc) with a vertical rim shape, but has a tall, thin collar and a smoothed exterior surface, which is common later among Juntunen wares. Juntunen Linear Punctate vessels (204, 205, 206, 209, 211, 212) are characterized by smoothed surfaces, true collars, and decoration by closely spaced but separate punctates (McPherron 1967:111). Juntunen Drag-and-Jab vessels (44, 45, 89, 102, 143) are distinguished by vertical rims, collars, castellations, and push-pull decorative motifs (McPherron 1967:113).

Another twelve (12) vessels (25, 26, 47, 60, 86, 101, 115, 133, 210, 213, 214, 218) could be classified as Juntunen ware but were not complete enough for further categorization.

Table 5.5: Late Late Woodland Vessels by Type

Type	Ct.
Juntunen Linear Punctate	6
Juntunen Drag-and-Jab	5
Juntunen Ware (cf. Jab-and-Drag)	1
Juntunen Ware (cf. Linear Punctate)	2
Juntunen Ware (cf. Plain)	1
Juntunen Ware	8
Proto-Juntunen Ware	1
Late Juntunen Ware (cf. O'Neil Curvilinear)	1
Traverse Decorated v. Punctate	3
Traverse Plain v. Scalloped	5
Traverse Ware	2
Untyped (cf. Juntunen Ware)	1
Untyped (cf. O'Neil cup)	1
Untyped	12
Total	**49**

One “Late Juntunen” vessel bears affinity to pottery from the O’Neil site in northern lower Michigan. Vessel 152 is a late variety of Juntunen ware (post-1400) resembling O’Neil Curvilinear, a style late in the Juntunen sequence characterized by curved cord impressions superior to punctate decoration (Lovis 1973).

Traverse Ware (n=10) The greatest disparity between the original analysis by Branstner (1995) and the present study was in the attribution of Late Woodland Algonquian pottery not belonging to the Juntunen sequence. Branstner originally believed ten (10) vessels resembled Algoma ware, a type established by Thor Conway in Ontario but never fully described in the literature. His most detailed description of the type likens it to “Dumaw Creek ware,” which, along with Algoma ware, display “scalloped lips and various modes of decoration” (Conway 1977:21). The vagueness of this type description made it an inadequate category for type attribution. Algonquian wares with scalloped lips have been more recently categorized and described in detail by Hambacher (1992) as Traverse ware. This type is based on the assemblage from the Skegemog Point site in northern lower Michigan and is generally contemporaneous with Juntunen ware, dating to AD 1100-1550/1600 (Hambacher 1992). Therefore, all of the formerly categorized Algoma vessels have been recategorized as Traverse ware except for Vessel 177, which was recategorized as untyped.

Five (5) vessels (69, 75, 104, 150, 190) are categorized as Traverse Plain variety Scalloped. They are characterized by a scalloped lip, straight to everted rim profiles, and smoothed exterior surfaces (Hambacher 1992:176). Three (3) vessels are classified as Traverse Decorated variety Punctate (Vessel 43, 56, 67). They are characterized by smooth exteriors, flat lip forms and profiles, smooth lip surfaces, and slightly everted collared rims with simple punctate exterior decoration (Hambacher 1992:198-199). Vessels 149 and 165 were classified as Traverse ware because of their scalloped lips but were not complete enough for more specific typological attribution.

<u>Untyped</u> (n=14) Despite the review of existing literature, fourteen vessels either remained outside of existing typological categories or did not have enough vessel material present to be properly categorized. These vessels displayed sufficient paste and morphological characteristics to conclude that they were manufactured during the late Late Woodland period. Of particular note among these is Vessel 54, a miniature vessel that closely resembles a cup from at the O’Neil site. As with Vessel 152 above, the cup V54 resembles is associated with late precontact/early

contact period trade items (Lovis 1973). This cup is described below in the section detailing miniature vessels in the assemblage.

General Late Woodland Ceramic Vessels

Four pottery vessels (65, 85, 180, 184) show hallmarks of manufacture during the Late Woodland period, such as everted rims, cord-wrapped stick impressions, smoothing, square and flattened lips, and, in one case, brushing, but they lack visible characteristics associating them with early, middle, or late Late Woodland groups (see Table 5.3).

Ontario Iroquoian Ceramic Subassemblage

Branstner (1995) originally identified eighteen (18) Huron pottery vessels, four (4) of which she believed were of Algonquian/Odawa manufacture, attempts to mimic Huron forms. An additional two (2) vessels were believed to resemble Lalonde High Collar. Reassessment of these vessels confirmed their identification as Ontario Iroquoian or Iroquoian-like (n=37; Table 5.6; Figures G56-G65). Additionally, a number of vessels previously left untyped or thought to be late Juntunen wares were found to more closely resemble Ontario Iroquoian wares. The nature of the presence of such vessels at the Cloudman site is contentious, and therefore definitive categorization of vessels into established typologies was avoided.

<u>Early Ontario Iroquoian</u> (n=2) Vessels 145 and 146 were originally categorized as possible late Juntunen varieties, but upon re-examination were found to be decorated with incising rather than the drag-and-jab method associated with Juntunen wares. Vessel 146 has opposed incising on a collar-less, everted rim, with a row of punctates on the rim/shoulder margin and incised decoration on the lip. The shoulder of the vessel is cordmarked. Vessel 145 is identified from a

smaller sherd lacking the shoulder and shoulder margin, but it is otherwise identical to V146 besides the absence of lip incising. The combination of opposed incising and cordmarking on the body suggests these vessels fall in the range of Early Ontario Iroquoian wares, likely manufactured between AD 1200 and 1300 (William Fox, personal communication).

Table 5.6: Ontario Iroquoian Vessels by Type

Type	Ct.
Early Ontario Iroquoian ware	2
cf. Huron Incised	22
cf. Ripley Plain	3
cf. Lawson Opposed	1
cf. Lawson Opposed or Methodist Point Ware	2
cf. Lawson Incised or Huron Incised	1
cf. Lawson Incised or Sidey Notched	1
Untyped	5
Total	**37**

cf. Huron Incised (n=22) The majority of the Iroquoian vessels can be categorized as closely resembling Huron Incised (Vessels 36, 62, 70, 74, 79, 82, 155, 156, 159, 160, 161, 163, 166, 167, 178, 179, 182, 183, 185, 186, 187). Huron Incised vessels are characterized by oblique or vertical incised line decoration on short, outflaring collars with straight or convex interior rim surfaces (MacNeish 1952:34). This type is generally associated with Wendat-Petun groups. Vessels 167 and 182 are miniature vessels detailed later in the chapter.

cf. Ripley Plain (n=3) Vessels 64, 135, and 151, previously untyped, closely resemble Ripley Plain. Ripley Plain is notable for its smooth surfaces and lack of decoration, and it is generally associated with the Wendat,-Petun and the Neutral of southern Ontario (MacNeish 1952).

cf. <u>Lawson Ware</u> (n=5) Several vessels bear close resemblance to Lawson wares, specifically Lawson Incised (V136, V162) and Lawson Opposed (V154, V40/153, V157). Vessel 162, originally categorized as Huron Incised, displays a concave rim interior and incising on the lip that are not typical of that type. Incised collars with concave rim interiors are more common of Lawson Incised (Birch and Williamson 2012; MacNeish 1952), while the castellation, closely-spaced oblique incised lines, well-defined collar, and incised lip are more characteristic of Sidey Notched (MacNeish 1952). Residue from V162 was AMS dated to cal AD 1420-1446. Sidey Notched pottery, while usually associated with Wendat-Petun groups living in closer proximity to the Cloudman site, generally dates to AD 1550-1650 (William Fox, personal communication), while Lawson Incised, a type associated with the Neutral, have been associated with materials dating to AD 1400-1500 in New York (Fink 2013:71). Vessel 136 displays broadly-spaced, vertical incising, resembling either Lawson Incised and Huron Incised; however, it lacks both the distinct channeled or concave interior of Lawson (instead possessing a crudely interior-extruded lip) and the defined collar of Huron Incised.

Vessels 40/153 and 157 lack intact lips required for accurate typological classification, but both are collared and incised. Possibly deriving from the same vessel, both are decorated with opposed oblique incising on the collar, two horizontal incised lines along the bottom edge of the collar, and a row of small punctates just below the collar. Without the horizontal incising, these could be categorized as Lawson Opposed (Macneish 1952), but with these lines they are a closer visual match with vessels from the historic Huron/Wendat site of Methodist Point (Kenyon 1970). Vessel 154 also strongly resembles Lawson Opposed, with a thin collar and opposed oblique incising on the collar underscored by punctates. However, the lip is not present, preventing identification of the diagnostic channeled/concave rim.

Untyped (n=5) Several vessels (38, 48, 68, 77, 188) had characteristics that associated them with Iroquoian manufacture, such as incising, collars, smoothed exterior surfaces, and squared lips, but lacked enough definitive characteristics to be further categorized.

Unidentified Affiliation

Two vessels could not be confidently attributed to a specific time period or cultural affiliation. Vessel 195 consists of a single rim sherd too small to display characteristics associating it with a period of manufacture. Vessel 148, however, is a unique vessel that is likely quite late in the occupational sequence of the Cloudman site, but remains a stylistic anomaly. It is smoothed and peaked with a row of punctates with at least three rows of cord impression below on the rim and a very fine cording or fabric impression on a squared lip. The paste is very hard and contains a low density of temper. Its style fits neither fully with Juntunen nor Iroquoian and may represent some amalgamation of both Algonquian and Iroquoian decorative traditions.

Miniature Vessels

Branstner (1995) identified miniature vessels in the Cloudman assemblage but excluded them from the original assemblage descriptions. Miniature vessels are often classified as practice pots made by children, but several of the Cloudman miniature vessels show craftsmanship and decorative organization equal in quality to their full-sized counterparts. A total of 11 miniature vessels were identified in the Cloudman assemblage (Table 5.7; Figures G69-G79). Although included in the type counts and summaries above, a more detailed account of these vessels was warranted. Vessels were categorized as "miniature" if their orifice radius was less than 10 cm.

Middle Woodland (n=2) Vessels 39 and 201 display hallmarks of manufacture during the Middle Woodland period. Vessel 39 is Laurel ware, with horizontal bands of oblique stamping and a narrow, squared lip with a stamped lip. It is not as finely made as other Laurel vessels, its interior surface crudely smoothed, but it contains a fair amount of grit temper, suggesting it may have been constructed for a purpose rather than as a training vessel for a child. Vessel 201 is untyped, made of fine paste with cross-hatched incising on a thickened exterior rim with a rounded lip. It displays evidence of coil manufacture, placing it solidly in the Middle Woodland. It is a very small, shallow vessel, and may be a local imitation of a Hopewellian Middle Woodland vessel more common to the south in Michigan.

Table 5.7: Miniature Vessels by Type

Socio-Temporal Association	Type	Ct.
Middle Woodland	Laurel Ware	1
	Untyped, Hopewellian	1
	Subtotal	**2**
Early Late Woodland	Mackinac Punctate	1
	Mackinac Undecorated	1
	Mackinac Ware	2
	Untyped	1
	Subtotal	**5**
Late Late Woodland	Traverse Plain v. Scalloped	1
	Untyped (cf. O'Neil cup)	1
	Subtotal	**2**
Iroquoian	cf. Huron Incised	2
	Subtotal	**2**
TOTAL		**11**

Early Late Woodland (n=5) Almost half of the miniature vessel assemblage is associated with the early Late Woodland period. Two vessels could be attributed to specific types: Vessel 53 is Mackinac Punctate; Vessel 52 is Mackinac Undecorated. Both have the hallmark everted rims and exterior cordmarking of Mackinac ware, and both are thin-walled and very finely made. Vessel 53 also has faint staining along the top of the interior rim, suggesting it may have been used for cooking.

An additional two vessels, 83 and 202, can be generally categorized as Mackinac ware. Vessel 83 is thin-walled with an everted rim, two rows of punctates on the exterior and one row on the interior. Although thin, it is rather crude and may represent a child's pot. Vessel 202 is very fine and thin, with what appears to be fabric impressions on the exterior surface and along the exterior lip. The rim is everted, and fine, round punctates on the interior rim that were pushed through to create exterior bosses. The delicate nature of the decoration suggests it was made by an experienced potter. Vessel 63 is untyped but associated with the early Late Woodland period because of its splayed lip with oblique cord-wrapped stick impressions and punctates on the exterior rim. However, it appears rather crudely made and lacks much visible temper, and therefore may be a child's pot.

Late Late Woodland (n=2) Miniature vessels manufactured in the late Late Woodland period include Vessel 54, which is 8 cm in diameter and 8 cm tall with straight sides and a rounded bottom. There is no exterior surface treatment or decoration, but there are small punctates pressed downwards into the anterior surface of the lip. This vessel closely resembles a cup found at the O'Neil site in context with late prehistoric/early protohistoric artifacts (Lovis 1973). Vessel 75 is Traverse Plain variety Scalloped Lip. It has a smoothed, everted rim with cordmarking beginning at the neck, creating the neck/body zoning typical of Traverse wares

(Hambacher 1992). Vessel 75 also has a ring of thick interior carbonization around the rim and was therefore used for cooking. Its manufacture and use suggest construction by a skilled potter.

Ontario Iroquoian (n=2) Two miniature vessels were categorized as Iroquoian. Vessel 167 has a very short (<1cm), vertical collared rim with oblique incising. It is thick, crude, and heavily tempered. Vessel 182 is collared with faint vertical incising and has no visible temper. Both most closely resemble Huron Incised and may represent pots made by children.

Pottery Age

The diachronic nature of the research questions necessitates both absolute and relative dating of pottery from the Cloudman site. AMS dating of carbonized food residue adhered to pottery permitted direct association of foods cooked in vessels to specific dates, while relative dating of vessels based on style creates a more robust chronology of site occupation. Drawing on both types of data, a general history of the Cloudman site is constructed and presented.

AMS Dates

Carbonized residue was collected from five (5) vessels from the Cloudman site and submitted for AMS dating (Table 5.8). Two Middle Woodland vessels, a Laurel Dentate (V4) and a Laurel Pseudo-scallop vessel (V1), produced similar age ranges, but the radiocarbon dates are significantly different at 95% confidence (Stuiver et al. 2018) and demonstrate that there were at least two distinct Middle Woodland occupations: the first, represented by a Laurel Dentate Stamped vessel, occurred ca. cal AD 87; the second, represented by a Laurel Pseudo-scallop Stamped vessel, took place around cal AD 127. The Cloudman site may have been used as a short-term resource extraction camp to which small groups returned repeatedly throughout the early decades of the Middle Woodland period. The radiocarbon results also indicate that Laurel Dentate Stamped pottery precedes Pseudo-scallop Stamped pottery in the local taxonomic chronology.

Radiocarbon age ranges for a Mackinac Banded vessel (V103) and a Blackduck vessel (V193) closely overlapped, proving statistically significant at 95% confidence with a mean pooled age of 1092 ± 11 cal BP, placing the primary early Late Woodland occupation ca. cal AD 957 (Stuiver et al. 2018). The date for the Blackduck vessel is particularly important since this type is found from Saskatchewan to Ontario, and from Minnesota to Michigan, and has been variably dated to ca. AD 900-AD 1500 across this geographic expanse (McPherron 1967:97). The date obtained from Vessel 193 pinpoints the timing of the use of Blackduck wares in the eastern Upper Peninsula and supports McPherron's (1967:100) hypothesis that Blackduck was present at the nearby Juntunen site between AD 800-1100.

Table 5.8: AMS Dates from Carbonized Pottery Residue Samples

Sample No.	UCIAMS#	Vessel No.	Type	Radiocarbon Age (^{14}C BP)	Calibrated Age (2σ)*	Median Probability
Cloudman 1	187416	4	Laurel Dentate Stamped	1915±15	AD 59-126 (1.0)	cal AD 87
Cloudman 4	187417	103	Mackinac Banded	1085±15	AD 941-997 (0.688)	cal AD 968
Cloudman 6	190514	162	cf. Sidey Notched/ Lawson Incised	475±15	AD 1421-1445 (1.0)	cal AD 1433
Cloudman 7	190515	1	Laurel Pseudo-Scallop Stamp	1870±15	AD 80-180 (0.895)	cal AD 127
Cloudman 8	190516	193	Blackduck Banded	1100±15	AD 938 - 987 (0.577)	cal AD 946

*Stuiver et al. 2018

Finally, V162, which is an Iroquoian vessel resembling either Lawson Incised or Sidey Notched, dated to cal AD 1433. This pre-dates the normal time span for Sidey Notched vessels, which were commonly produced between AD 1550-1650 (William Fox, personal communication). Lawson wares were produced somewhat earlier, and Lawson Incised has been associated with materials dating to AD 1400-1500 in New York (Fink 2013:71). Ontario Iroquoian vessels (including those associated with the Wendat, Petun, and Neutral) consistently appear west of Ontario after AD 1400, overlapping with the Late Juntunen subphase (AD 1400 – AD 1600) (McHale Milner 1998:214; see also McPherron 1967).

Relative Dating

Relative dating based on stylistic relationships corroborates and enriches the Cloudman site occupational timeline. There is little evidence to support a human occupation of the site prior to the Laurel Dentate Stamped vessel AMS median age of cal AD 87. The assemblage does contain two North Bay vessels, and residues from a North Bay Plain vessel at the Winter site on the Garden Peninsula produced an AMS date with a median probability of cal BC 113, significantly earlier than the Cloudman Laurel dates. However, North Bay Cordmarked and North Bay Punctate vessels from the Winter site produced median probability ages of cal AD 82 and cal AD 155, respectively (Albert et al. 2018; Lovis et al. 2012; Richner 1973; Stuiver et al. 2017), which are consistent with the Cloudman Laurel occupations.

Three late Laurel ware vessels at the site, along with four other vessels that appear transitional between Middle and Late Woodland, suggest an additional, if brief, occupation sometime between cal AD 500-700 (Lovis 2014). It is unclear whether the site was occupied between AD 200 and AD 500.

A second intensive occupation of the site took place in the Early Late Woodland period. The ceramic assemblage includes both Mackinac Punctate and Mackinac Banded vessels. Mackinac Punctate was generally manufactured between AD 700-900 in the Upper Great Lakes, while Mackinac Banded is commonly dated to AD 850-1000 (Lovis 2014). Dates from the Mackinac Banded and Blackduck Banded tightly overlap and suggest a substantial occupation between AD 900 and AD 1000 (Lovis 2014), although the presence of Mackinac Punctate vessels at the site could represent an additional and somewhat earlier occupation. Only five small Bois Blanc rim sherds represent the middle Late Woodland, and although there was no intensive occupation of the Cloudman site between AD 1000-1200, the site was still utilized during this period, if but briefly.

The Late Precontact period (AD 1200 – 1600), comprises the most complicated span of the Cloudman site occupation, and includes both late Late Woodland and Ontario Iroquoian pottery. A "proto-Juntunen" vessel from ca. AD 1200 is the earliest of these vessels. Juntunen Linear Punctate vessels (n=6) were commonly manufactured between AD 1200-1300, while Juntunen Drag-n-Jab (n=5) generally dates to AD 1300-1400 (Lovis 2014). Although the late Late Woodland pottery included in this analysis are most closely associated with the time period between AD 1200 and AD 1400, these varieties were also manufactured in small quantities afterwards (Lovis 2014; McHale Milner 1998; McPherron 1967). Two late Juntunen vessels closely resembling vessels from the Late Precontact/Early Contact component of the O'Neil site, suggest a late, post-AD 1500 presence of Algonquian peoples and ceramic vessels on the site. Traverse ware (n=10) is largely contemporaneous with Juntunen wares, dating to AD 1100 – AD 1550/1600 (Hambacher 1992). The Cloudman site was frequently and repeatedly occupied by local groups from AD 1200 until the arrival of Europeans, although the intensity of Algonquian occupation post-AD 1400 appears limited.

Further complicating the Late Precontact history of the Cloudman site, Ontario Iroquoian vessels also begin to appear at the site post-AD 1200. Two Early Ontario Iroquoian vessels represent the earliest of these "foreign" wares, which were likely manufactured between AD 1200-1300. Vessel 162, which resembles either Lawson Incised or Sidey Notched, was AMS dated to cal AD 1420-1445. Four other vessels resembled Lawson ware, which has been associated with materials dated to AD 1400-1500 in New York (Fink 2013:71), although the timing of their presence west of Ontario is unclear. Huron Incised, to which a substantial number of Cloudman vessels bear resemblance (n=22), normally date between AD 1500-1650 (William Fox, personal communication). Overall, the presence of Ontario Iroquoian vessels at the site generally post-dates AD 1400.

Although most of the Juntunen vessels at the site likely pre-date most of the Iroquoian vessels at the site, there is temporal overlap between the two assemblages. The two Early Ontario Iroquoian vessels are contemporaneous with Juntunen Linear Punctate, while at least two vessels represent late Juntunen wares manufactured post-AD 1400. The distinct styles and cultural affiliations of Juntunen and Iroquoian wares, and their general temporal separation validates their treatment as distinct analytic subsets.

In summary, primary occupations of the Cloudman site, represented by the largest proportions of the overall pottery assemblage include the earlier part of the Middle Woodland period (AD 0-200), the early Late Woodland period (AD 800-1000), the late Late Woodland period (AD 1200-1400), and Ontario Iroquoian occupation (AD 1400-1600). Again, it is important to note that it is still unclear whether the post-AD 1400 occupants of the site would have identified as Iroquoian or whether they were Algonquians (i.e., proto-Odawa) using Iroquoian pottery. Smaller, secondary occupations of the site in interstitial periods and are indicated in Table 5.9. Pottery from the primary occupations will be used as the primary data subsets in the analyses of subsequent chapters because the secondary subassemblages would yield very small sample sizes.

Table 5.9: Occupational History of the Cloudman Site, Derived from Relative and Direct Dating of Pottery

Century	**Woodland**	**Iroquoian**
100-0 BC	?	-
AD 0-100	**X**	-
AD 100-200	**X***	-
AD 200-300	?	-
AD 300-400	?	-
AD 400-500	?	-
AD 500-600	x	-
AD 600-700	x	-
AD 700-800	x	-
AD 800-900	**X**	-
AD 900-1000	**X***	-
AD 1000-1100	x	-
AD 1100-1200	x	-
AD 1200-1300	**X**	x
AD 1300-1400	**X**	?
AD 1400-1500	x	x*
AD 1500-1600	x	**X**

X= primary occupation
x= secondary occupation
?= possible but unknown period of occupation
*associated AMS date

Conclusion

The re-evaluation of taxonomic categorization of the Cloudman pottery assemblage was largely in accordance with the original analysis conducted by Branstner (1995). The primary discrepancy between the former and present studies was in the identification and timing of the later site occupations. Ontario Iroquoian pottery was originally associated with an early contact-period occupation of the site (ca. AD 1630) by Odawa traders, but both relative and AMS dating indicate many of these vessels were manufactured and used at the site prior to this time, mostly between AD 1400 and AD 1600, but also as early as AD 1200. The uncertain identity of the manufacturers and users of these wares and their possible overlap with late Late Woodland Juntunen pottery requires further investigation to clarify the late occupational history of the Cloudman site. For the purposes of this study, the late Late Woodland and Ontario Iroquoian subassamblages will be treated as separate analytic subsets.

Contextualization of the Cloudman vessels within established chronologies for regional ceramic taxonomies permitted construction of a solid occupational history of the site, supported and detailed by a small set of direct AMS dates. Pottery from the most intensive occupations (Middle Woodland, early Late Woodland, late Late Woodland, Ontario Iroquoian) identified through the work presented in this chapter will serve as the primary analytic subsets for explorations of pottery function (Chapter 6) and cuisine (Chapter 7) at the Cloudman site.

CHAPTER 6

POTTERY FUNCTION

Introduction

The establishment of a site chronology through traditional ceramic taxonomic classification of the Cloudman assemblage permitted the implementation of a second approach to pottery analysis emphasizing vessel function. Although occasionally constructed for symbolic or ceremonial use, most ceramic vessels were made for the utilitarian functions of cooking, serving, and storage. Pottery function can be evaluated through technical properties, a vessel's characteristics chosen by the potter to suit its intended purpose, and use-alteration traces, which reveal how a vessel was used. Properties related to function can be sensitive to changes in food-processing requirements and cooking methods, reflecting diachronic alterations in pottery use and dietary habits when set against the site chronology established in the previous chapter. Synchronic variation of vessel function can signal communication of group identity through food selection and cooking styles in addition to pottery style.

This chapter will evaluate both technical and use-alteration properties of the Cloudman site pottery vessels, followed by discussions of intended and actual ceramic function. Function will be assessed synchronically to explore the relationship between pottery use and identity, and diachronically to answer research questions concerning pottery technology and use in relation to culinary transformations.

Technical Properties and Intended Function

The three technical properties chosen as the focus of this study were temper size, rim diameter, and vessel thickness. Temper size and vessel thickness have proven sensitive measures of technical variability in relation to foodways transformations (Braun 1983; Hart 2012). Rim diameter has demonstrated variability in the northern Great Lakes and beyond (Blitz 1993; Kooiman 2012, 2016; Potter 2000), although the significance of vessel size in relation to function is complex and unclear. Examination of vessel size in relation to other technical properties and cooking requirements could clarify its functional role among Woodland vessels; it therefore serves an exploratory purpose in this study

The temporal overlap in construction and use of late Late Woodland and Ontario Iroquoian vessels (as discussed in Chapter 5) creates an analytical issue. These subassemblages clearly represent two distinct pottery traditions and social/cultural groups, but it is unclear if the Ontario Iroquoian pottery represents the physical presence of Iroquoian people at the Cloudman or if they were Iroquoian trade items used by Woodland/Algonquian groups. If the latter, then there may be little if any difference in the way vessels from both taxonomic categories were used.

Temper size

Temper size influences the performance of a pottery vessel. Both vessel strength and thermal shock resistance of fired vessels increased with the decrease in temper particle size (Bronitsky and Hamer 1986). Cooking vessels are expected to be constructed with smaller temper particles to increase their use-life over the fire. Temper size has been found to decrease over time in parts of the Eastern Woodlands in correlation with increased processing of starchy foods (Braun 1983), including maize (Hart 2012), because these foods require high-temperature, long-term boiling to become palatable (Wandsnider 1997). However, a prior study in the northern Great Lakes found no significant difference in temper size between Middle Woodland from the Naomikong Point site and the Late Woodland Sand Point site (Kooiman 2016). These sites are geographically separated by considerable distance, and the Cloudman assemblage provides an opportunity to explore the potential for diachronic temper size change at a single site.

Table 6.1 shows mean temper size among the primary analytic subsets. Average temper size shows a small initial increase in early Late Woodland, followed by a decrease in late Late Woodland and Iroquoian vessels. A Welch's unpaired T-test, a non-parametric analysis used to compare independent samples of unequal variances and sample sizes, was used to determine the statistical relationships between average temper size of vessels (Table 6.2). The slight increase in mean temper size between Middle and early Late Woodland vessels proved insignificant. Despite the 500-year time gap between the primary Middle Woodland occupation and the early Late Woodland occupation at the Cloudman site, temper size remained relatively consistent.

However, in a comparatively short span of time between the early Late Woodland and the Late Late Woodland occupations, temper underwent a significant size reduction. Early Late Woodland vessel temper is significantly larger than late Late Woodland and Iroquoian temper, and Middle Woodland temper is similarly significantly larger than Iroquoian temper. This abrupt change in temper size after a millennia of consistency signals a major shift in temper selection in the middle of the Late Woodland period. Following this shift, temper size remains consistently small after AD 1200.

Table 6.1: Mean Temper Size by Subset

Subset	Mean (mm)	n
Middle Woodland	1.49	33
Early Late Woodland	1.58	58
Late Late Woodland	1.34	48
Ontario Iroquois	1.26	35

Table 6.2: Temper Size Relationships (Welch's Unpaired T-Test)

Subset	**Middle Woodland**		**Early Late Woodland**		**Late Late Woodland**	
	*p**	df	*p*	df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.2842	84	---	---	---	---
Late Late Woodland	0.0755	66	**0.0030**	103	---	---
Ontario Iroquois	**0.0045**	62	**0.0001**	93	0.1907	76

*two-tailed
α=0.05

Rim Diameter

A total of 88 vessels, 43.6% of the total vessel assemblage, had rim segments sufficient in size for diameter measurements. A plot of rim diameters shows a roughly normal distribution (Figure 6.1) with an overall mean of 19.27 cm. The average rim diameter for Middle Woodland vessels was 17cm, smaller than the averages for early Late Woodland, late Late Woodland, and Iroquoian vessels (Table 6.3). A Welch's t-test confirmed that Middle Woodland rim diameters were significantly smaller than early Late Woodland rim diameters (Table 6.4). Meanwhile, early Late Woodland, late Late Woodland, and Iroquoian assemblages were almost statistically identical. The results demonstrate a significant increase in orifice diameter during the Middle Woodland-Late Woodland transition.

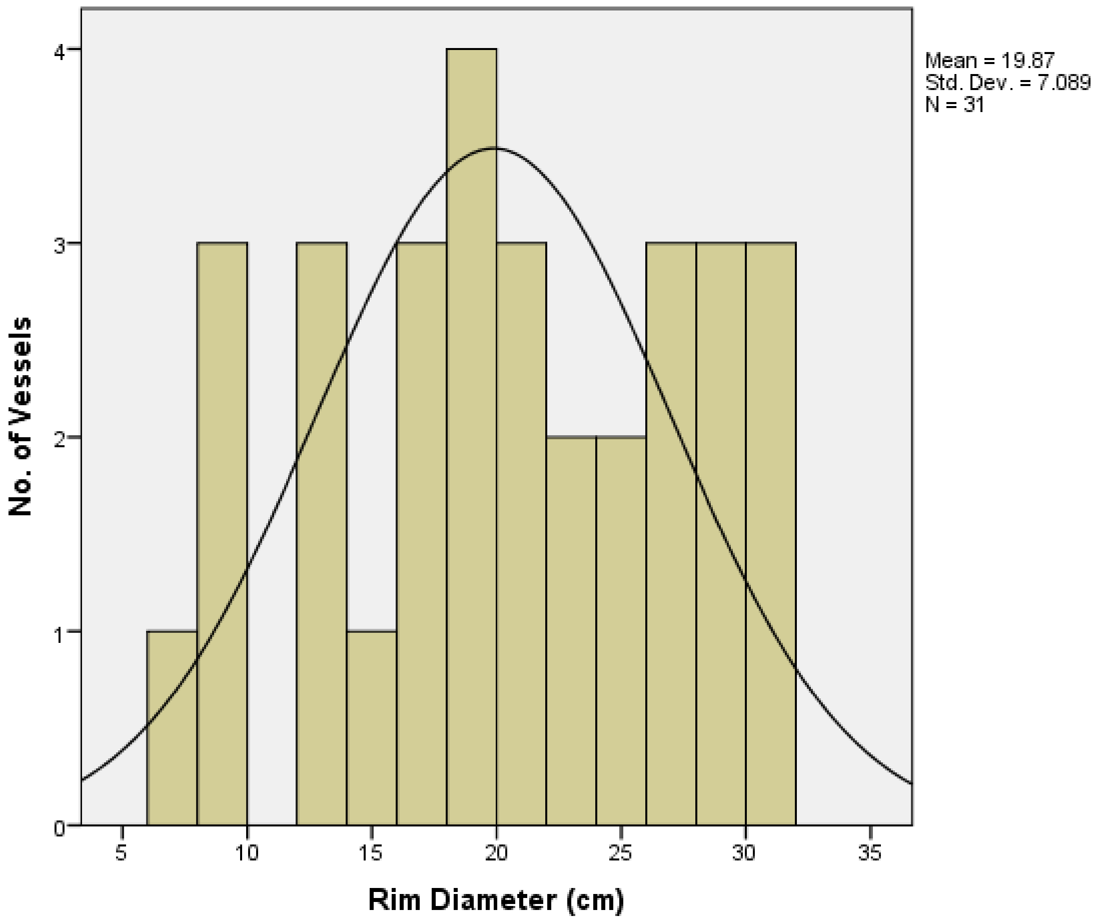

Figure 6.1: Rim Diameter Frequencies of the Cloudman Pottery Assemblage

Table 6.3: Mean Rim Diameter by Subset

Subset	**Mean (cm)**	**n**
Middle Woodland	17	16
Early Late Woodland	20	41
Late Late Woodland	19	17
Ontario Iroquois	20	14

Table 6.4: Rim Diameter Relationships (Welch's Unpaired T-Test)

Subset	Middle Woodland		Early Late Woodland		Late Late Woodland	
	*p**	df	*p*	df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	**0.0448**	30	---	---	---	---
Late Late Woodland	0.1651	23	0.8396	21	---	---
Ontario Iroquois	0.0822	22	0.9439	20	0.8226	25

*two-tailed
α=0.05

Vessel orifice (rim) diameter is an aspect of pottery morphology that is not fully understood. Rim diameter is often used as a proxy for vessel volume/size, but only a handful of studies in North America have demonstrated the relationship between the two measures (Blitz 1993; Parker and Kennedy 2010; Potter 2000; Shapiro 1984). Statistical relationship between rim diameter and vessel volume in Late Woodland vessels from the Upper Great Lakes have been previously demonstrated (Kooiman 2015a), but a similar test among Middle Woodland and Iroquoian vessels has yet to be carried out. Although overall morphologies of these three categories of ceramic vessel differ, the disparities are not drastic enough to preclude using rim diameter as a proxy for size/volume for Middle Woodland and Iroquoian vessels.

Still, the significance of vessel volume/size is largely unknown and likely variable through space and time. Size may be related to utilitarian function (Kobayashi 1994; Rice 1987:299), social function (Blitz 1993; Potter 2000), and/or household size (Nelson 1981; Tani 1994; Turner and Lofgren 1966). The pottery assemblage from the Laurel Middle Woodland site of Naomikong Point was statistically significantly smaller than Late Woodland vessels from the site of Sand Point; however, at Sand Point, Late Woodland vessels from habitation contexts were significantly smaller than vessels from mound contexts at the site and statistically equivalent to the Middle Woodland vessels from Naomikong Point (Kooiman 2016). Ethnoarchaeological studies have also shown that there is a clear size distinction between daily cooking pots and ceremonial cooking pots (Kobayashi 1994). Therefore, context of use (utilitarian vs. ceremonial) may be one reason for size variation among pottery vessels in the northern Great Lakes.

A burial mound was once present at the Cloudman site, but it was excavated in the early 20th century and the whereabouts of associated artifacts are unknown (Branstner 1995). All of the measured pottery vessels derived from the primary habitation zone, and the function of the site is undifferentiated between the components. Therefore, the diachronic size variation at Cloudman is probably not associated with context of use. The increase in vessel size over time could be linked to several factors: new cooking techniques and/or foods may have been better accommodated by larger vessels; increased group size my have necessitated larger vessels to accommodate feeding more people; or decreased mobility may have allowed for greater energy investment in manufacturing larger vessels that no longer needed to be carried from site to site. At present, the reason for diachronic vessel orifice/vessel size variation remains unclear.

Vessel Thickness

Pottery wall thickness was measured on the lip, neck, shoulder, and body (Table 6.5). Lip thickness increases, as expected, from the narrow-lipped Middle Woodland vessels, to the splayed-lip early Late Woodland vessels, and then decreases slightly with the collared, squared-lipped late Late Woodland and Iroquoian vessels. Neck thickness steadily increases through time, likely correlated with the proliferation of collared wares post-AD 1200. Shoulder thickness varies greatly through time, initially decreasing from the Middle Woodland to the early Late Woodland, then increasing in the Late Late Woodland, and decreasing among Iroquoian vessels, which had the thinnest average shoulders overall. Body thickness decreases from the Middle Woodland to the Late Woodland, then increases again among Iroquoian vessels. These trends run counter to predictions that vessel wall thickness would steadily decrease over time. Sample sizes for both shoulder and body thickness were small, however, with few vessels complete enough to include these portions for measurement, affecting the overall accuracy of thickness comparisons.

Statistical analysis was used to determine the significance of observed thickness variations. Lip thickness was considered less sensitive to change based on cooking needs, so it was excluded from statistical scrutiny. Miniature vessels were excluded from thickness calculations because of their disproportionate distribution through time and the potential for their inclusion to skew the data. A Welch's T-test was employed to examine the relationships between analytic subsets.

The most significant differences manifested in neck thickness (Table 6.6). Middle Woodland and early Late Woodland vessel necks have statistically identical thicknesses, while vessels from both subsets were significantly thinner than Late Late Woodland and Iroquoian vessels. Late Late Woodland and Iroquoian vessel neck thickness was also significantly different, despite their similar mean thicknesses. Shoulder thickness and body thickness revealed fewer significant differences between analytic subsets (Tables 6.7 and 6.8)

Hart (2012) recorded vessel thickness through time among Iroquoian vessels in New York. He notes that vessel thickness is often affected by vessel size and controlled for this variation by dividing thickness by diameter. Following Hart's procedures, neck thickness and averaged neck/shoulder thickness were corrected by rim diameter (Table 6.9), which reduced sample sizes by restricting inclusion to only vessels with rim diameter measurements. In both cases, thickness decreased between the Middle Woodland and early Late Woodland, then increased moving into the late Late Woodland, and decreased again among the Iroquoian vessels.

Table 6.5: Vessel Wall Thickness by Subset

Subset	Lip Mean (cm)	Lip n	Neck Mean (cm)	Neck N	Shoulder Mean (cm)	Shoulder N	Body Mean (cm)	Body n
Middle Woodland	4.43	35	6.1	33	6.79	9	7.4	6
Early Late Woodland	8.51	61	6.36	57	6.43	25	6.11	9
Late Late Woodland	7.2	46	7.85	45	8.02	19	6.7	7
Ontario Iroquois	6.98	30	7.84	27	5.94	7	9.12	4

Table 6.6: Neck Thickness Relationships (Welch's Unpaired T-Test)

Subset	Middle Woodland *p**	Middle Woodland df	Early Late Woodland *P*	Early Late Woodland df	Late Late Woodland *p*	Late Late Woodland df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.2527	84	---	---	---	---
Late Late Woodland	**0.0001**	68	**0.0004**	72	---	---
Iroquoian	**0.0001**	97	**0.0001**	53	**0.0344**	68

*two-tailed
α=0.05

Table 6.7: Shoulder Thickness Relationships (Welch's Unpaired T-Test)

Subset	Middle Woodland		Early Late Woodland		Late Late Woodland	
	*p**	df	*p*	df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.6920	17	---	---	---	---
Late Late Woodland	0.0617	25	**0.0150**	27	---	---
Ontario Iroquois	0.7246	8	0.6758	7	0.1104	9

*two-tailed
α=0.05

Table 6.8: Body Thickness Relationships (Welch's Unpaired T-Test)

Subset	Middle Woodland		Early Late Woodland		Late Late Woodland	
	*p**	df	*P*	Df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.4722	9	---	---	---	---
Late Late Woodland	0.4803	8	0.9068	7	---	---
Ontario Iroquois	0.2707	7	0.0830	5	0.1002	6

*two-tailed
α=0.05

Table 6.9: Corrected Thickness (Thickness/Rim Diameter)

Subset	Neck + Shoulder		Neck	
	Mean	n	Mean	n
Middle Woodland	0.45	8	0.40	16
Early Late Woodland	0.37	24	0.37	41
Late Late Woodland	0.52	13	0.49	17
Ontario Iroquois	0.37	6	0.41	14

Table 6.10: Corrected Vessel Neck Thickness Relationships (Welch's Unpaired T-test)

Subset	Middle Woodland		Early Late Woodland		Late Late Woodland	
	*p**	df	*p*	df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.5589	23	---	---	---	---
Late Late Woodland	0.2349	30	**0.0496**	23	---	---
Ontario Iroquois	0.8987	27	0.4497	20	0.2785	28

*two-tailed
α=0.05

Table 6.11: Corrected Average Neck + Shoulder Thickness Relationships (Welch's Unpaired T-Test)

Subset	Middle Woodland		Early Late Woodland		Late Late Woodland	
	*p**	df	*p*	df	*p*	df
Middle Woodland	---	---	---	---	---	---
Early Late Woodland	0.5656	8	---	---	---	---
Late Late Woodland	0.5718	11	0.0546	17	---	---
Ontario Iroquois	0.6427	11	0.9786	5	0.2567	8

*two-tailed
α=0.05

Corrected neck and neck/shoulder thicknesses were subjected to Welch's t-tests to evaluate significant differences between analytic subsets (Tables 6.10 and 6.11). After correction, it was apparent that there was no longer a significant difference in neck thickness between Middle Woodland vessels and later vessels. The critical factor, therefore, is vessel size—Middle Woodland vessels are significantly smaller than Late Woodland and Iroquoian vessels and therefore thinner in accordance with size.

Overall, these results do not follow predicted trends of thinning over time. The only significant increase in vessel thickness occurs during the late Late Woodland period, when, according to predictions, vessels should have become thinner to accommodate increased processing of starchy foods. Because neck thickness yielded the largest samples sizes, this might be an outcome of the advent of collars. Collars become more common among Juntunen and Iroquoian pottery vessels. Although neck thickness was measured below collars, the need for structural support of the collar would manifest in thicker vessel necks. Neck thickness of Traverse ware vessels, which lack collars, were significantly thinner than contemporaneous Juntunen ware vessels ($p=0.0005$, $df=25$) but were not significantly different from early Late Woodland vessels ($p=0.461$, $df=10$). The lack of body sherds associated with identified vessels, which were the focus of this study, affected a true assessment of vessel thickness of the areas that would be most influenced by a potter's actions to improve heating effectiveness. Temporal attribution of body sherds not associated with identified vessels is dubious at best, so this was not pursued. The level to which neck and shoulder thickness relate to overall vessel thickness should be a topic of future inquiry.

Synchronic Technical Variation

Technical properties within the primary analytic subsets were investigated to assess synchronic variability. Contemporaneous taxonomic types could represent separate social groups with distinct stylistic traditions. Functional variability could mirror stylistic variability, signifying different pottery construction traditions and perhaps even different functional requirements if culinary habits vary according to group identity. Rim diameter, thickness (averaged from neck and shoulder thickness measurements), and temper (averaged from three measurements per vessel) of pottery vessels from each typological category were compared to investigate the question of synchronic intended function variability. Only types comprising large portions of their respective subassemblages were chosen for comparison; other types with small sample sizes are excluded from the discussion below.

Three major distinct pottery types were present in the Middle Woodland subassamblage (Table 6.12). Variation among all three technical properties among the types was low. This is unsurprising given that all three types are variations of Laurel ware. Relationships of these properties between types were assessed using Welch's T-test, which revealed no statistical differences. Pottery construction techniques appear consistent across all Middle Woodland taxonomic types.

Variation in technical properties slightly increases between types in the early Late Woodland subset. AMS dates from a Mackinac Banded and a Blackduck Banded vessel revealed extremely close contemporaneity (see Table 5.8), although Mackinac is a local ware and Blackduck has a broader distribution and is more common to regions north of the Upper Peninsula. Most apparent is the difference in mean temper size, with Blackduck temper smaller on average than Mackinac Banded. However, this difference was not statistically significant. Mackinac Punctate ware, which generally pre-dates but also temporally overlaps with Mackinac Banded, had a smaller mean temper size. However, comparisons of all physical properties between various early Late Woodland types demonstrated no statistically significant differences.

Juntunen ware was the most common among the late Late Woodland subset, although vessels allowing for more specific categorization were limited in number. Therefore, all Juntunen vessels (including Drag-and-Jab and Linear Punctate) were grouped together in a single analytical set, and compared against Traverse ware vessels, which also comprised an analytical set (see Table 6.12). These two wares are generally contemporaneous but differ greatly in form and style. Although rim diameter and temper size of Juntunen and Traverse vessels are not statistically different, there is a significant difference in thickness (p=0.0004, df=25). As discussed above, thickened necks and shoulders may have been required to support the thick, collared rims that are the hallmark of Juntunen ware. Traverse vessels, on the other hand, lack collars and would therefore not require thickened upper body walls.

Finally, Iroquoian vessels were grouped by vessels resembling Huron Incised and those resembling various Lawson wares (see Table 6.12). These were the largest groupings within the subset, and represent wares associated with disparate Iroquoian groups (Wendat-Petun vs. Neutral). Rim diameter could not be compared because the Lawson group had a sample size of one. Vessel thickness and temper size were statistically identical.

Overall, synchronic variation of technical properties within all time periods was low. Middle Woodland vessels are, as predicted, particularly consistent, but technical variability also remained low among later pottery subassemblages. Thickness measures of late Late Woodland Juntunen and Traverse wares was the sole significantly different factor, a result most likely related to the distinct rim styles characteristic of these wares. Although the small sample sizes available for most of these comparisons may have affected the statistical analyses, there is an apparent synchronic consistency in the ways pottery vessels at the Cloudman site were constructed, regardless of decoration and style.

Table 6.12: Technical Properties of Vessels by Type/Ware

Subset	Pottery Type	Rim Radius		Thickness*		Temper	
		Mean	n	Mean	n	Mean	n
Middle Woodland	Laurel Banked Linear Stamped	22	2	5.41	6	1.5	6
	Laurel Dentate Stamped	19.5	4	6.25	8	1.41	7
	Laurel Pseudo-scallop Shell	15	5	6.31	13	1.46	13
Early Late Woodland	Blackduck Banded	22.5	4	6.52	4	1.37	4
	Mackinac Banded	20	8	6.94	11	1.82	11
	Mackinac Punctate	21.1	10	6.78	15	1.56	15
Late Late Woodland	Juntunen Ware	21.2	9	8.47	22	1.39	23
	Traverse Ware	16	4	6.05	9	1.29	10
Ontario Iroquois	cf. Huron Incised	21.8	8	7.79	17	1.22	20
	cf. Lawson Ware	27	1	7.82	3	1.25	5

*average neck+shoulder

Intended Function Summary

Middle Woodland pottery vessels were overall the most technologically distinct among the Cloudman assemblage. Middle Woodland pots were generally small, thin pots with large temper particles relative to thickness. Although vessel size significantly increased in the early Late Woodland, thickness and temper size remained relatively consistent with Middle Woodland properties. Late Late Woodland potters continued to construct larger but thicker pots with significantly smaller temper particles. Iroquoian vessels, although displaying very different decorative techniques, were statistically identical to late Late Woodland vessels in their technical properties, aside from a slight reduction in thickness. Late Woodland and Iroquoian potters preferred larger vessels, although the functional advantage of greater vessel volume is still unclear. Further exploration of vessel use, cooking, and diet may provide answers to this question. After AD 1200, there is clear evidence for intentional use of significantly smaller temper particles, a decision that could reflect new food processing requirements entailing more intensive cooking techniques. The diachronic trends in technical variation contrasts with synchronic consistency of the same properties, suggesting that contemporary social groups did not enact social identity through distinctive pottery construction techniques.

Use-Alteration Traces and Actual Function

The functions fulfilled by a pottery vessel in the past can be accessed through use-alterations traces, or the physical and chemical changes that indicate the various processes in which the vessel was involved throughout its life history (Schiffer and Skibo 1987, 1997). Use-alteration traces include exterior sooting, exterior carbonization, interior carbonization, attrition, and absorbed residues (see Chapter 4). Sooting and carbonization are direct evidence of a vessel's use over fire, from which the function of cooking can be inferred. Food residues are absorbed in the vessel walls during food processing and storage and show the direct relationship between specific foods and individual pottery vessels. Attrition involves removal of the pottery surface through various physical and chemical processes; however, this was not detected in any of the Cloudman pottery assemblage and will not be further discussed. Absorbed food residues will be summarized and discussed separately in Chapter 7.

The Cloudman pottery assemblage was assessed for the presence of exterior sooting, exterior carbonization, and interior carbonization. Patterning of interior carbonization was also categorized and recorded to identify distinct cooking techniques. Presence and patterning of use-alteration traces are compared both diachronically and synchronically to identify trends and changes in pottery use at the Cloudman site. Together, these data provide insight into the actual function of Cloudman pottery vessels.

Exterior Sooting

Sooting on the exterior of a pottery vessel forms when smoke from a fire adheres to the ceramic surface and is an important indication of a vessel's involvement in cooking. Sooting most commonly forms around the bottom and lower sides of a vessel, where the vessel comes in contact with smoke from the fire (Skibo 1992, 2013). Only 10% of the overall Cloudman pottery assemblage displayed exterior sooting (Table 6.13). Sooting was most frequent on early Late Woodland vessels, the subset containing the most complete and partial vessels. As previously discussed, vessels from other subsets are often represented only by rim or upper body sherds, where exterior sooting is unlikely to be present. Therefore, sooting is probably underrepresented among the identified vessels in the Cloudman assemblage, which overall have few associated body sherds and even fewer basal sherds. While a review of body sherds not associated with identified vessels would likely reveal a higher frequency of sooting at the site, it would be difficult to associate these sherds with a specific occupation and would therefore not contribute to the study of diachronic pottery function.

Exterior Carbonization

Burned food residue on the exterior surface of a pottery vessel is another indicator of involvement of a vessel in cooking. Foodstuffs burned onto the outside of a cooking pot can be the result of pouring/spilling or boiling-over. Exterior carbonization was positively identified on approximately 15% of all vessels (see Table 6.13). Exterior carbonization is most likely to appear on the upper portions of a vessel and is, therefore, likely not underrepresented. However, only a small proportion of cooking events would be expected to result in exterior carbonization, so frequencies observed within the Cloudman assemblage align with expectations.

Table 6.13: Frequency of Use-Alteration Traces by Subset

Subset	**Exterior Sooting**		**Exterior Carbonization**		**Interior Carbonization**	
	Ct.	%	Ct.	%	Ct.	%
Middle Woodland	0	0.0	2	5.7	16	45.7
Middle/Late Woodland	0	0.0	1	14.3	4	57.1
Early Late Woodland	14	22.6	10	16.1	34	54.8
Middle Late Woodland	1	20.0	0	0.0	3	60.0
Late Late Woodland	2	4.1	11	22.4	28	57.1
Ontario Iroquois	4	10.8	7	18.9	21	56.8
Total	21	**10.4**	31	**15.3**	106	**53.0**

Interior Carbonization

Food residue burned onto the interior surface of the pot is the most important evidence of the involvement of a vessel in cooking. The mere presence of interior carbonization is direct proof that resource processing took place within the vessel, and the patterning (discussed below) and microbotanical/chemical composition (see Chapter 7) of the residue is vital to reconstructing cooking and food selection habits.

Over half of all identified vessels from the Cloudman site displayed interior carbonization (see Table 6.13), suggesting that a high proportion of vessels were involved in resource processing. Interior carbonization is consistently present through time, occurring on 45% to 60%

of vessels from each subset. Cooking appears to be the primary function of pottery vessels during all occupations of the Cloudman site.

Despite its relatively high frequency, interior carbonization is still likely to be underrepresented in the assemblage. Differential preservation of residues on pottery surfaces is evident on vessels with portions that refit; in many cases, one sherd is stained with carbonization while an adjacent sherd is not. Discrepancies could result from variations in post-depositional taphonomic processes or archaeological lab processing. Ancient pottery cleaning habits may also affect the preservation of adhered interior residues. Some vessels may have never been used at all. The fail rate of firing pottery in open fire can be as high as 100% (Rice 1987:173), so vessels without use-alteration traces may represent vessels that broke during manufacture, causing overrepresentation of vessels lacking carbonization. However, it is plausible that pots lacking visible interior residues were used as storage vessels.

Habitual Cooking Behaviors

Vessels with interior carbonization were further categorized based on the patterning of residue along the vessel wall. Carbonization location and patterning inform interpretations of past cooking habits and methods and are rooted in ethnoarchaeological observations (see Kobayashi 1994; Skibo 1994). Both the level at which vessels are filled and the patterning of the interior carbonization are useful indicators cooking traditions, such as habitual vessel use and modes of cooking.

<u>Vessel Fill Levels</u> The presence of carbonization on the uppermost portions of the interior surface is almost ubiquitous among Cloudman site pottery vessels. In many cases, residue extended all the way to the lip; in others there was a half- to one-inch buffer between the residue

line and the lip. This pattern indicates high fill-levels during cooking. This is consistent with patterning found in other northern Great Lakes sites (Kooiman 2012, 2016), and stands in contrast to habits found in other regions of the world, where cooking pots are often filled two-thirds full to prevent boiling-over (Kobayashi 1994; Skibo and Blinman 1999), a costly mistake that would waste food and douse the hearth fire.

Several ethnographic sources note that organic skin or birchbark vessels can be placed directly over the fire without burning as long as they are kept full (Densmore 1979; Wallis and Wallis 1955; Waugh 1973), potentially representing a habitual behavior extended to pottery vessels, which were adopted in the region after millennia of cooking in organic vessels. In this case, boil-overs may not have been as costly a mistake as in other regions, such as Colorado (see Skibo and Blinman 1999), where population density is higher and access to wood resources is more limited than in the northern Great Lakes.

Another explanation for observed filling behavior is technology-based. According to Erik Vosteen, a local Michigan potter who experiments with making pottery of local clays in the style of Woodland vessels, low-fired pottery vessels also tend to potlid along the water line because of the temperature differential between the liquid and the air above it. Filling the vessel could have reduced potlidding along the critical shoulder zone of the vessel and reduced vessel breakdown and/or prevented vessel fracture, prolonging the life of the vessel. Potlidding was not frequently observed in the Cloudman pottery assemblage, so this technique may have functioned well for local cooks.

Considering that many vessels in the Cloudman assemblage are represented solely by rim sherds, it is possible that fill lines along the shoulder of the vessel are present but not observable in the sample. However, defined fill lines at the vessel shoulder were not observed in any of the partial vessels in the assemblage.

Interior Carbonization Patterns Although cooks at the Cloudman site consistently filled vessels to the top during the cooking process, the cooking techniques employed were varied. Figure 6.2 illustrates the five patterns observed in the Cloudman assemblage, which signify different modes of cooking. Pattern 1 (Figures 6.2a, 6.3) represents residue restricted to a distinct ring around the rim of the vessel. This pattern is consistent with boiling, a wet-cooking mode in which the aqueous nature of the vessel contents prevent adherence of food particles the ceramic surface, except at the water line, where both small starchy and fatty food particles accumulate and burn in this high-temperature zone (Skibo 1992, 2013). Pattern 2 (Figures 6.2b, 6.4) represents residue distributed over most or all of the interior surface of the pot, which most likely represents stewing, a long-term liquid reduction process. Stewing gradually removes much of the water from the food mix, allowing more food particles to come into contact with the vessel wall and become charred when exposure is prolonged. Dry mode cooking techniques, such as parching or roasting, can also leave thick residue deposits across the vessel surface, although this is usually restricted to either the very bottom or to one side of the pot (Skibo 1992, 2013). Roasting often takes place with a vessel placed on its side and neither interior carbonization nor exterior sooting patterns observed in the Cloudman assemblage are consistent with this behavior. However, given the lack of complete vessels from the Cloudman site, it cannot be stated that pottery vessels were never used for roasting/parching, although this pattern was not observed at other northern Great Lakes sites with more complete or partially-reconstructed vessels (Kooiman 2012, 2016).

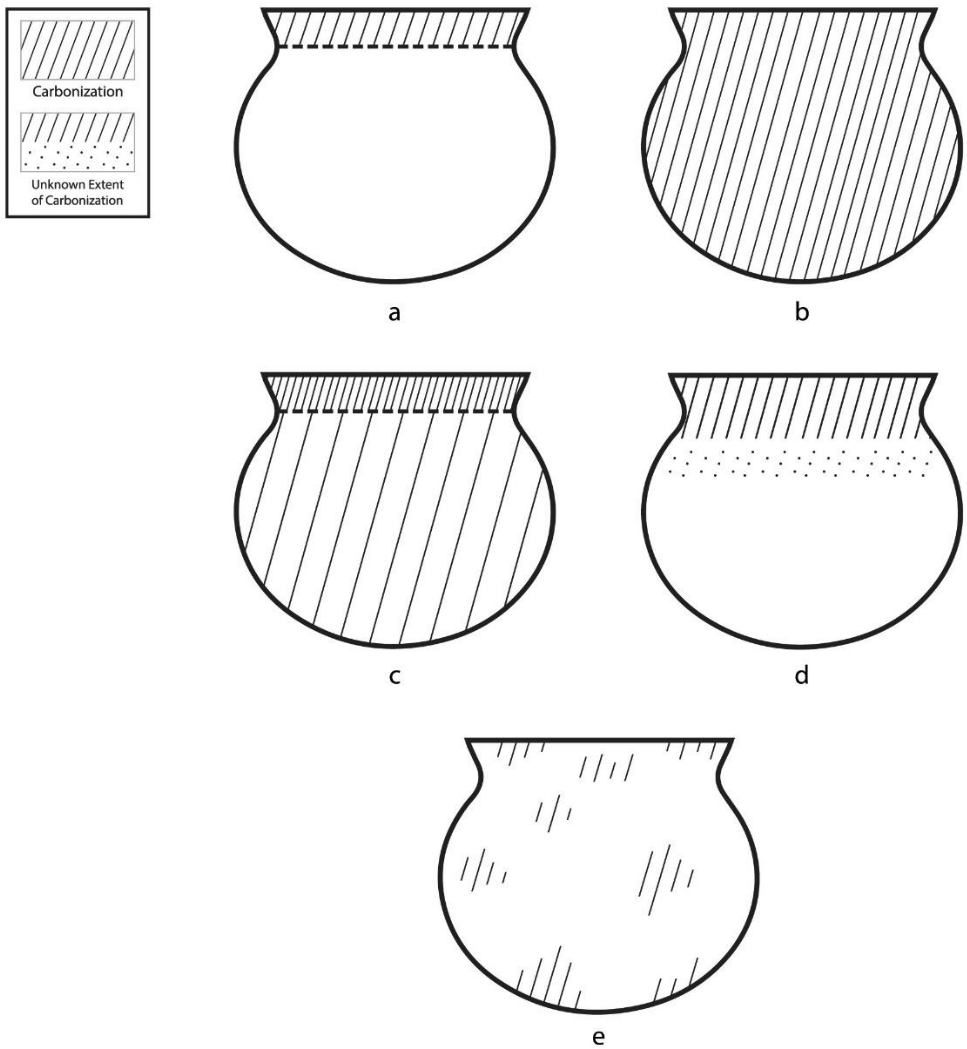

Figure 6.2: Interior Carbonization Patterns for the Cloudman Site (20CH6) Pottery Assemblage: a) Type 1 (boiling); b) Type 2 (stewing); c) Type 3 (boiling + stewing); d) Type 4 (possible boiling or stewing; e) Type 5 (no discernable pattern)

Figure 6.3: Interior Carbonization Pattern 1 (Boiling)

Figure 6.4: Interior Carbonization Pattern 2 (Stewing)

Figure 6.5: Interior Carbonization Pattern 3 (Boiling + Stewing)

Interior carbonization Pattern 3 (Figures 6.2c, 6.5) represents a ring of thick carbonization around the rim with a thinner layer of residue covering the remaining interior surface, indicative of a single vessel involved in both boiling and stewing of foods. This pattern has not been previously observed in the northern Great Lakes (Kooiman 2012, 2016). Vessels displaying only one type of carbonization pattern could signify the designation of vessels for specific purposes (e.g., boiling pots vs. stew pots), or that stewing events obscured evidence of prior boiling episodes. Vessels could have also been washed and scrubbed between uses, the pattern present archaeologically representing only the last mode of cooking for which the pot was used. The newly observed Pattern 3, however, is a clear indicator of multiple cooking events taking place in the same vessel: one or more intensive boiling episodes resulting in thick residue deposition, distinct from thinner residues representing less-intensive prior or subsequent stewing events.

Pattern 4 (Figure 6.2d) was used to categorize cases in which interior carbonization is visible along the rim of the vessel but the extent of the residue below the rim is indeterminate.

This pattern could represent either boiling or stewing. In most cases there is not enough of the rim present to determine whether or not the residue distribution distinctly stops at or near the base of the rim (boiling) or continues further down the side of the interior vessel surface (stewing). Pattern 5 (Figure 6.2e) represents patchy interior carbonization on the vessel surface with no discernable pattern.

Table 6.14 shows the frequency of each interior carbonization pattern by primary analytic subset. The most frequent pattern among all subsets is Pattern 4, largely due to the fragmentary nature of the assemblage, which precludes proper assessment of the distributional extent of residues on many vessels, especially those represented by small rim sherds. Unfortunately, Pattern 4 has very little analytic meaning aside from demonstrating the prevalence of vessel filling behaviors. Pattern 5 likewise holds little analytical significance. Subsequent discussion will therefore focus on Patterns 1-3 (Table 6.15, Figure 6.6), which more clearly represent specific cooking behaviors.

Table 6.14: Interior Carbonization Pattern Frequency by Subset

Pattern Category	**Middle Woodland**		**Early Late Woodland**		**Late Late Woodland**		**Iroquoian**		**Totals**	
	Ct.	%	Ct.	%	Ct.	%	Ct.	%	Ct.	%
1	2	13	8	24	6	24	4	19	20	21
2	5	31	4	12	2	8	2	10	13	14
3	0	0	4	12	4	16	4	19	12	13
4	4	25	14	41	10	40	9	43	37	39
5	5	31	4	12	3	12	2	10	14	15
Total	16	100	34	100	25	100	21	100	96	100

Among Middle Woodland vessels, Pattern 2 (stewing) is the most frequent interior carbonization pattern. This is consistent with prior assessments of Middle Woodland cooking, where stewing predominates and boiling is less frequently represented (Kooiman 2012, 2016). However, the fragmentary nature of the Middle Woodland vessels resulted in a small sample size (n=7) of vessels with clear carbonization patterns, thereby affecting analytical outcomes. Pattern 3 was not observed among Middle Woodland vessels, and clear signatures for boiling were observed in only two vessels.

Pattern 2 is much less frequent among the early Late Woodland, late Late Woodland, and Iroquoian subsets, in which Patterns 1 and 3 predominate. Both boiling and boiling/stewing methods increased in frequency at the outset of Late Woodland and carried on until the contact period. As previously observed in the northern Great Lakes, boiling seems to become a more frequent cooking technique during the later periods, although stewing habits continue through all occupations.

Table 6.15: Primary Interior Carbonization Pattern Frequency by Subset

Pattern Category	Middle Woodland		Early Late Woodland		Late Late Woodland		Ontario Iroquois	
	Ct.	%	Ct.	%	Ct.	%	Ct.	%
1	2	**29**	8	**50**	6	**50**	4	**40**
2	5	**71**	4	**25**	2	**17**	2	**20**
3	0	**0**	4	**25**	4	**33**	4	**40**
Total	7	100	16	**100**	12	100	10	100

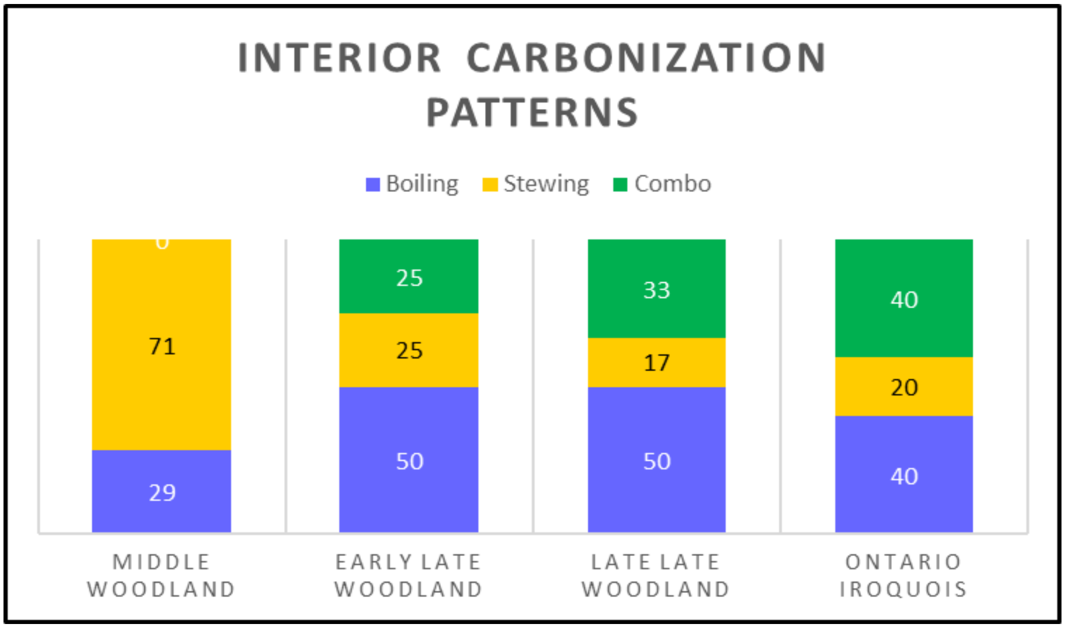

Figure 6.6: Proportions of Interior Carbonization Patterns by Subset

To assess the statistical significance of patterns suggested in the raw frequencies, the data was subjected to a Kruskal-Wallace test. Kruskal–Wallis is a non-parametric, one-way analysis of variance by ranks that evaluates whether *k* independent samples are from different populations (Siegel 1956). The results of the Kruskal-Wallis show no significant differences in the distributions of interior carbonization patterns between analytic subsets (Table 6.16). The small sample sizes may have influenced this outcome, and although none of the differences are statistically significant, it can be observed that the Middle Woodland subset is statistically more different from early Late Woodland, late Late Woodland, and Iroquoian subsets than they are from each other. In fact, these latter subsets are close to statistically identical. The evidence is still indicative of an overall shift in cooking behaviors after AD 500.

Table 6.16: Interior Carbonization Pattern Relationships (Kruskal-Wallis)

Subset	Middle Woodland (*p**)	Early Late Woodland (*p*)	Late Late Woodland (*p*)
Middle Woodland	---	---	---
Early Late Woodland	0.094	---	---
Late Late Woodland	0.183	0.838	---
Ontario Iroquois	0.072	0.732	0.710

*two-tailed
α=0.05, df=2

Synchronic Variation of Interior Carbonization Patterns Variability of cooking styles between contemporary pottery types could indicate distinct culinary traditions associated with social or cultural identity. As with synchronic variation of technical properties (see above), assessment of synchronic variation is limited by small sample sizes. Table 6.17 shows the proportions of vessels within the major typological categories of each primary analytic subset exhibiting interior carbonization Patterns 1, 2, and 3. The most drastic difference is apparent in the Middle Woodland subset, in which two-thirds of the Laurel Banked Linear Stamped vessels with clearly patterned interior carbonization exhibited Pattern 1 (boiling), whereas Pattern 2 (stewing) was the only pattern present among Laurel Dentate Stamped and Laurel Pseudo-Scallop Shell vessels. The samples sizes, however, are too small for statistical analysis and interpretations about specialized vessel use.

Fewer differences between types are apparent in early Late Woodland, late Late Woodland, and Iroquoian subsets. Again, sample sizes are too small to determine whether cooking styles varied significantly between stylistic types. Conclusions about synchronic variation in cooking and pottery use are therefore limited.

Table 6.17: Interior Carbonization Pattern Frequency by Type/Ware

Subset	Pottery Type		Pattern 1		Pattern 2		Pattern 3	
		n	Ct	%	Ct	%	Ct	%
Middle Woodland	Laurel Banked Linear Stamped	3	2	66.7	1	33.3	0	0
	Laurel Dentate Stamped	1	0	0	1	100	0	0
	Laurel Pseudo-scallop Shell	2	0	0	2	100	0	0
Early Late Woodland	Blackduck Banded	1	0	0	0	0	1	100
	Mackinac Banded	4	2	50	1	25	1	25
	Mackinac Punctate	5	3	60	1	20	1	20
Late Late Woodland	Juntunen Ware	8	2	25	4	50	2	25
	Traverse Ware	4	1	25	1	25	2	50
Ontario Iroquois	cf. Huron Incised	3	1	33.3	0	0	2	67.7
	cf. Lawson Ware	3	0	0	2	67.7	1	33.3

Actual Function Summary

Use-alteration traces present on the Cloudman site pottery vessels allow several insights into the actual function of ancient pottery. Over half of all vessels contained interior carbonization, strong evidence that the primary function of pottery at the Cloudman site was for cooking. Although the proportion of the assemblage with exterior sooting, another good indicator of cooking function, is low, this may be the result of the low frequency of identified vessels with associated body sherds, where sooting is most likely to occur. As with other Woodland vessels found throughout the northern Great Lakes, cooking vessels at the Cloudman site were filled nearly to the top, a routine potentially carried over from cooking with organic vessels, or a conscious choice for limiting potlidding during the cooking process.

Interior carbonization patterns, while not significantly different between analytic subsets, still change in accordance with previous observations of cooking change in the Middle and Late Woodland periods (Kooiman 2012, 2016). Clear boiling signatures are proportionally low in the Middle Woodland, a period during which there is also a complete absence of clear evidence that the same vessels were employed in both boiling and stewing. Larger proportions of early Late Woodland, late Late Woodland, and Iroquoian vessels displayed boiling and dual-use patterns. Changes in patterning frequencies among Cloudman pottery vessels supports the hypothesis that cooking styles changed over time, and that boiling became an increasingly important means of food processing during the Late Woodland/Late Precontact period.

As with technical properties, synchronic variation between distinct types within the same analytic subsets was low. Sample sizes were too small for detectable or meaningful distinctions. The matter of differential pottery use based on group identity will require more data for accurate assessment.

Discussion

Results of functional analysis of pottery from the Cloudman site demonstrate the tension between tradition and innovation among Woodland and Late Prehistoric peoples. Pottery construction, pottery use, and cooking methods were altered to suit new needs and new generations, albeit slowly and subtly. Middle Woodland vessels were relatively small with large temper in relation to thickness. Early Late Woodland pots maintained thicknesses similar to their Middle Woodland predecessors, but gained in overall size/volume. The upper portions of late

Late Woodland vessels grew thicker while grit temper particles became significantly smaller. The same properties also characterize Ontario Iroquoian vessels.

Vessel size variation could be associated with several factors. Middle Woodland groups were the first to use pottery vessels despite being generally mobile with malleable social structure (Brose and Hambacher 1999). Their mobile nature may have constrained the construction of vessels to sizes manageable during travel. As attraction and attachment to "persistent places," or locales repeatedly occupied and used for intensive resource extraction, increased throughout the Late Woodland period (see Dunham 2014, 2017), vessels may have been constructed for *in situ* use and stored for future use at the site. This would have given potters the freedom to make larger pots. If, as Cleland (1982) claimed, occupation of coastal aggregation sites increased in size and duration during the Late Woodland, the larger vessel size could have also grown according to needs. The early Late Woodland vessels assemblage is the largest at Cloudman (n=49), suggesting either larger or more prolonged occupations after AD 700/800.

Potters continued to construct larger vessels post-AD 1200, but they also began incorporating significantly smaller temper into ceramic pastes. Smaller temper improves both impact resistance and thermal shock resistance (Bronitsky and Hamer 1986), the latter integral for maintaining vessel integrity during heat-intensive and/or long-term cooking events. Smaller temper particles also provide greater green phase (pre-firing) ceramic strength (Chu 1968; Rice 1987:362), facilitating the often more complex decorations and collars common to Juntunen and Iroquoian vessels.

Thinner walls allow for greater heating effectiveness during cooking. Middle Woodland vessels are significantly thinner than Late Woodland and Iroquoian vessels, but when thickness was corrected for rim diameter (a proxy for vessel size), it was clear that the thin walls of Middle Woodland vessels was a consequence of their overall smaller dimensions. Neck/shoulder thickness significantly increased among late Late Woodland vessels compared to their early Late Woodland predecessors. Body thickness would be the most important factor in heating effectiveness, and an underrepresentation of body sherds among the identified Cloudman vessels affected the sample size for effectively assessing the evolution of this characteristic through time. The relationship between neck/shoulder thickness and body thickness is unclear. The transition from the everted-rim profile of early Late Woodland vessels to the collared wares characteristic of both late Late Woodland and Iroquoian vessels would require thickened neck and shoulder to support the thick, heavy rims. Therefore, observations of variation in thickness within the Cloudman assemblage seem more closely related to size and style rather than cooking function.

Changes in cooking techniques are apparent, if subtle. Middle Woodland vessels were less frequently engaged in boiling-only cooking events, and signs of using Middle Woodland vessels for both boiling and stewing are completely absent. Clear signatures for boiling and boiling/stewing cooking techniques increase in relative frequency among early Late Woodland vessels and remain consistent throughout subsequent occupations of the site. Small sample sizes preclude statistical support of the observed frequencies.

Synchronic variation of both technical properties and use-alteration traces was limited. This is also due in part to the small sample sizes, and a region-wide survey of northern Great Lakes pottery assemblages would be required to obtain sufficient data. It must also be noted that although many types within the primary subsets overlap in time, they are not entirely synchronic. Mackinac Punctate, for example, generally occurs earlier (AD 700-900) than Mackinac Banded (AD 850-1000) (Lovis 2014), and therefore do not represent full contemporaneity. Rather, they likely represent evolving stylistic techniques among related descendant groups rather than separate social groups occupying the same space and time.

Conclusion

The evolution of pottery technology and use at the Cloudman site both aligns and contrasts with outlined expectations. The greatest distinctions fall between Middle Woodland and Late Woodland/Iroquoian pottery. Although vessel size was not predicted to change, Middle Woodland vessels were smaller, with vessel size increasing in size in the early Late Woodland and remaining consistent thereafter. These smaller vessels were employed in stewing more frequently than boiling, a cooking style that, as predicted, increases in frequency through time. Although boiling becomes more frequent and vessel size increases around the same time, it is presently unclear whether these two factors are connected by intentional choice to fulfill a particular function, or if both are the results of greater social and behavioral changes occurring at the outset of the Late Woodland period. A significant decrease in temper size, which has been associated with increased processing and consumption of starchy foods, including maize, does not appear in vessels until after AD 1200, subsequent to changes in both vessel size and cooking habits.

Technological variability of pottery is often associated with changes in subsistence, as processing needs change in relation to food types. The next chapter will address questions of subsistence and cooking at the Cloudman site with a discussion of pottery residue composition. The combination of lipid residue, stable isotope, and microbotanical analyses provide direct evidence of foods cooked in pottery vessels, allowing closer associations between dietary, technological, and cooking style changes.

CHAPTER 7

FOOD SELECTION AND COOKING AT THE CLOUDMAN SITE

Introduction

Holistic depictions of past food choice and processing techniques derived from multiple lines of archaeological evidence allow for reconstructions of ancient cuisine and a nuanced view of past identity and adaptive decision-making. Archaeological food residues, both adhered and absorbed, link specific foods directly to processing tools and techniques, informing interpretations of synchronic and diachronic variation in food choice and cooking. This chapter assesses diet and cooking behaviors at the Cloudman site using stable isotope, lipid residue, and microbotanical analyses of adhered and absorbed food residues associated with ceramic cooking vessels. The results will be used to assess the degree of diachronic dietary change, especially in relation to hypotheses arguing for intensified use of aquatic (Cleland 1982), wild starchy (Dunham 2014), and/or domesticated (O'Shea 2003) resources in the northern Great Lakes throughout the Woodland period. Synchronic variation in food choice in relation to group identity will also be discussed. Finally, the outcomes of each method will be evaluated in context with each other to identify strengths and shortcomings of each, formulating best practices for evaluating diet from pottery residues. Images of all vessels included in residue analyses can be found in Appendix G.

Carbon and Nitrogen Stable Isotope Analysis

Intensified exploitation of both fish and maize at coastal sites but primarily autumn season coastal sites during the Late Woodland period have been proposed by Cleland (1982) and

O'Shea (2003), respectively. Nitrogen and carbon stable isotope ratios have been used to identify aquatic resources and maize in carbonized food residues (e.g. Craig et al. 2013; Hart et al. 2003; Lovis 1990; Morton and Schwarcz 2004; Taché and Craig 2015). Stable isotope analysis is thus well-suited for informing questions about diachronic variation in aquatic and terrestrial fauna, trophic levels, and maize exploitation. Carbonized food residue was collected from the interior rims of 50 identified vessels, selected from all periods of occupation of the Cloudman site. The samples were sent to the Illinois State Geological Survey Prairie Research Institute for analysis of bulk stable isotope values of $\delta^{15}N$ and $\delta^{13}C$ (Appendix B).

Nitrogen Isotopes

The results of stable isotope analysis of Cloudman site residue samples revealed consistently enriched $\delta^{15}N$ values (Table 7.1, Figure 7.1), with a mean of 11.69‰. $\delta^{15}N$ values higher than 9‰ are associated with processing of high-trophic-level aquatic products, as observed in experimental cooking residues (Craig et al. 2007; Craig et al. 2013; Morton and Schwarcz 2004). Only residues from two vessels (V88, a Blackduck Banded vessel, and V179, an Iroquoian vessel) fell below this threshold.

Table 7.1: Mean $\delta^{15}N$ and $\delta^{13}C$ Values of Cloudman Pottery Residues by Subset

Subset	Mean $\delta^{15}N_{Air}$	$\delta^{13}C_{VPDB}$	n
Middle Woodland	11.87	-25.78	11
Middle/Late Woodland	13.28	-21.78	1
Early Late Woodland	11.74	-25.60	20
Middle Late Woodland	10.96	-24.54	2
Late Late Woodland	11.98	-26.01	10
Iroquoian	10.72	-25.93	6

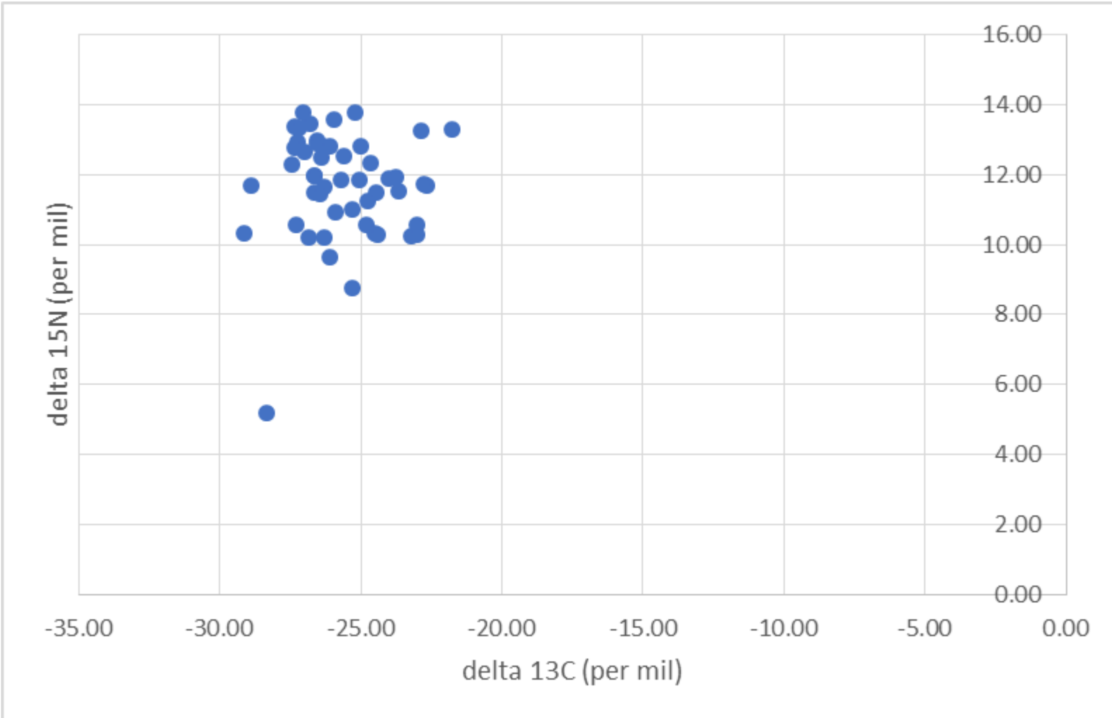

Figure 7.1: Plot of $\delta^{15}N/\delta^{13}C$ Values of Cloudman Pottery Residues

Diagenesis associated with the surrounding matrix has been invoked as a possible source of error in isotope studies. Potential contamination of the soil from nitrogen rich fertilizers was considered a possible factor in these results, but an interview with Gary Cloudman, whose family has owned the land surrounding the Cloudman site for over one hundred years, revealed that intensive agriculture has never taken place on the property. Stratigraphic profiles from excavation corroborate this account, demonstrating the lack of a plow zone (Ap horizon) at the site (Branstner 1995). To further evaluate the potential for contamination from the soil matrix, a total of 12 soil samples were taken from across the site and subjected to stable isotope analysis. These samples were consistently less $\delta^{15}N$ enriched than samples deriving from pottery, averaging 8.41‰ (Table 7.2, Figure 7.2). Only one sample reached levels of nitrogen enrichment similar to the pottery residues samples. When subjected to an unpaired T-test, $\delta^{15}N$ levels of the pottery residue samples and the soil samples proved extremely significantly different (p=0.0001, df=60). Nitrogen contamination of pottery residues from the site matrix is, therefore, unlikely.

Table 7.2: δ^{15}N Values, Cloudman Soil Samples

Sample	Context	$d^{15}N_{Air}$
T1-S1-2	Terrace 1, Stratum 1	8.70
T1-S2-1	Terrace 1, Stratum 2	8.79
T1-S2-2	Terrace 1, Stratum 2	8.86
T1-S2-3	Terrace 1, Stratum 2	7.47
T2-S1-2	Terrace 2, Stratum 1	8.89
T2-S2-1	Terrace 2, Stratum 2	8.12
T2-S2-2	Terrace 2, Stratum 2	7.25
T2-S2-3	Terrace 2, Stratum 2	7.32
T3-S1-1	Terrace 3, Stratum 1	8.26
T3-S2-1	Terrace 3, Stratum 2	9.16
T3-S2-2	Terrace 3, Stratum 2	5.80
T3-S2-3	Terrace 3, Stratum 2	12.27

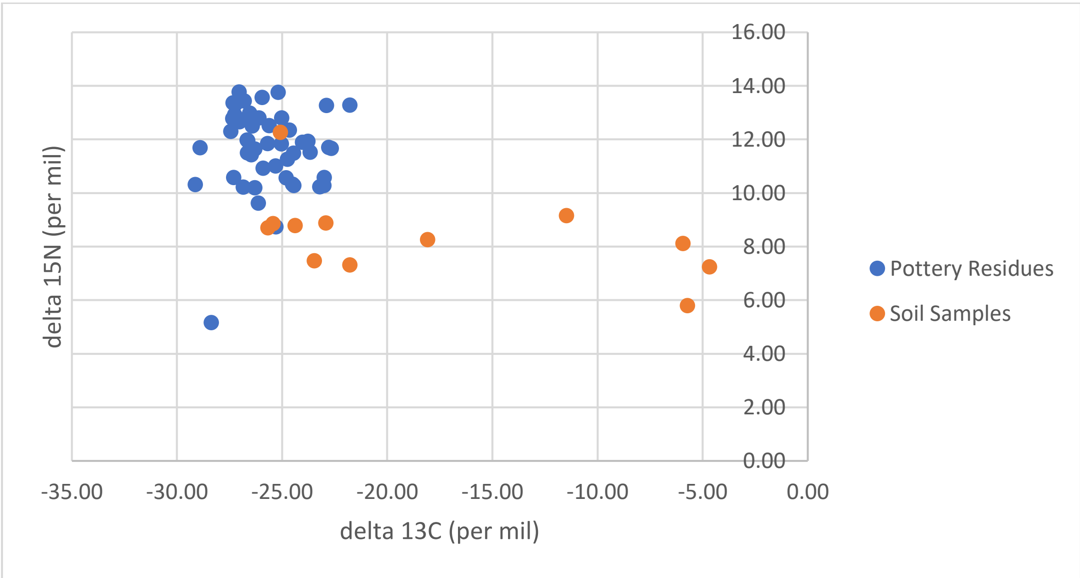

Figure 7.2: Plot of δ^{15}N/δ^{13}C Values of Cloudman Pottery Residues vs. Soil Samples

Eliminating the possibility of contamination, nitrogen enrichment of the Cloudman pottery residues can be directly associated with foods processed in the vessels. Aquatic resources produce higher $\delta^{15}N$ values than terrestrial resources, and nitrogen isotope ratios also display a "trophic-level effect," where a consumer will be enriched 2 to 4‰ higher that the source of dietary protein (Shoeninger 1985; Schwarcz and Schoeninger 1991). Nitrogen levels of aquatic vertebrates can be 6 to 8‰ higher than terrestrial vertebrates of equivalent trophic levels (Schoeninger 1995:85), and therefore high trophic-level fish (fish that consume other fish) will produce among the highest $\delta^{15}N$ values (Van der Merwe et al. 2003). The enriched nitrogen isotope signatures from the Cloudman samples appear indicative of high-trophic-level aquatic resources, which in the Upper Great Lakes would include spring-spawning fish such as pike, perch, and walleye, and fall-spawning species such as whitefish and lake trout (Vander Zanden et al. 1997).

The location and high proportion of faunal remains derived from fish (Cooper 1996) suggest that the Cloudman site was used as a base for fishing activities. In this context, the presence of chemical signatures that may represent fish in pottery food residues is unsurprising. However, prior research found that habitual processing of fish in pottery vessels across the upper Great Lakes was not common (Kooiman 2016; Lovis and Hart 2015; Malainey and Figol 2015; Skibo et al. 2016), although others have argued the opposite (Taché and Craig 2015).

To further evaluate the association of elevated $\delta^{15}N$ values of the Cloudman residue samples with high-trophic-level fish, isotope data from other studies with isotope measures for various remains and resources were sought for comparison. Katzenberg (1989) assessed the $\delta^{15}N$ and $\delta^{13}C$ values of bone collagen collected from archaeological faunal samples from the Kelly-Campbell site in southern Ontario (Figure 7.3). The plotted values for fowl and mammals, including bear, deer, and dog, fell below the nitrogen delta values observed in the Cloudman samples. Closest to the Cloudman $\delta^{15}N$ values were fish, including walleye and the lower-trophic level species pickerel and sucker, as well as two raccoon samples. Raccoons are omnivores known to eat large amounts fish, which could lead to $\delta^{15}N$ enrichment of bone collagen.

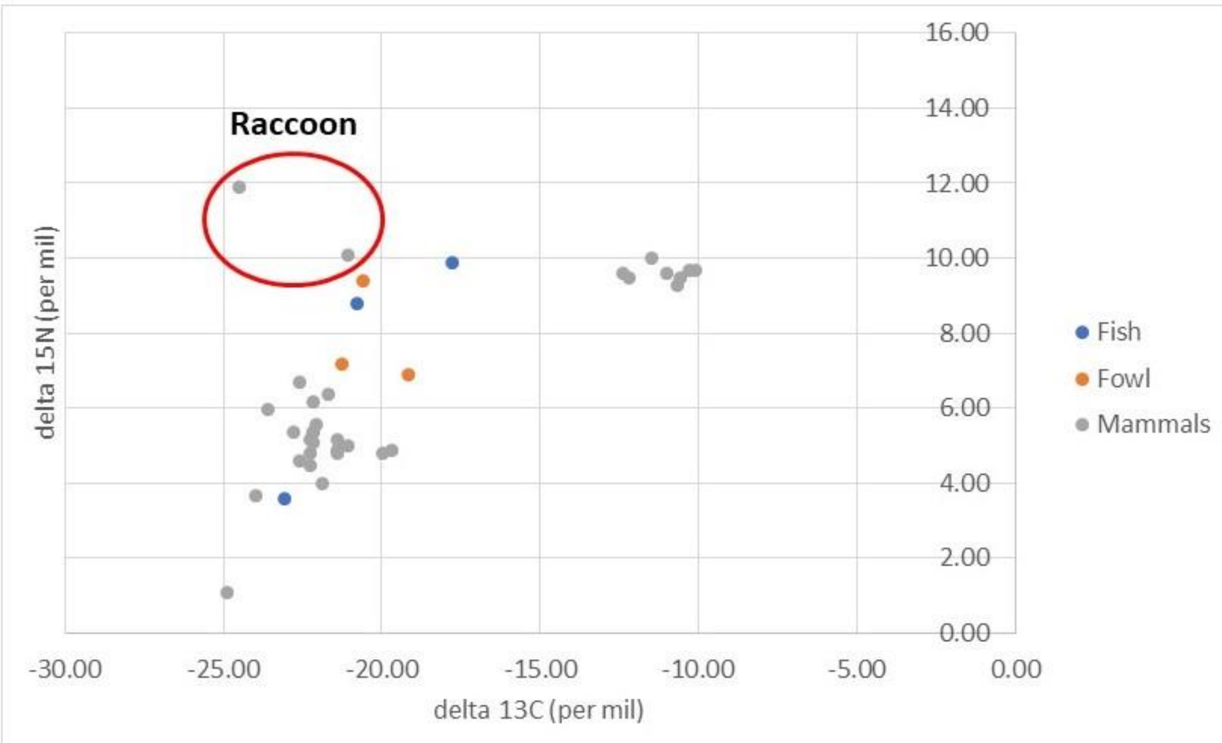

Figure 7.3: Plot of $\delta^{15}N/\delta^{13}C$ Values of Archaeological Faunal Samples, Kelly-Campbell Site, Ontario (Katzenberg 1989)

Table 7.3: Relationship between $\delta^{15}N$ Values of Cloudman Pottery Residue Samples and Other Archaeological and Biological Samples (Unpaired T-test)

Sample	p	df
Archaeological fish remains (SW Ontario)	0.2232	55
Modern fish remains (Lake Michigan)	0.101	58

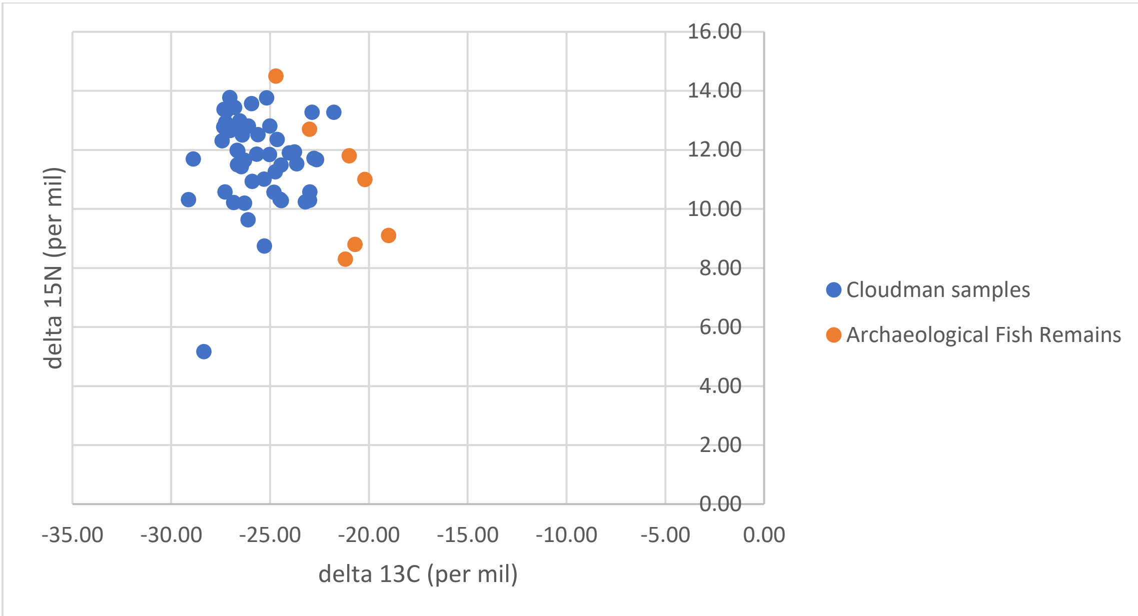

Figure 7.4: Plot of $\delta^{15}N/\delta^{13}C$ Values of Cloudman Pottery Residues vs. Archaeological Fish Remains from Southern Ontario (Van der Merwe et al. 2003) and Belgium (Fuller et al. 2012)

Archaeological remains of high trophic-level fish (including lake trout, whitefish, pike, and walleye) from sites in southern Ontario (Van der Merwe et al. 2003) and Belgium (Fuller et al. 2012) also lie within the range of $\delta^{15}N$ values from the Cloudman pottery samples (Figure 7.4) and are statistically undifferentiated from Cloudman pottery residue $\delta^{15}N$ values (Table 7.3). Isotope values taken from modern-day perch and trout samples from Lake Michigan also have equivalent $\delta^{15}N$ values (Turschack 2013; Figure 7.5; see Table 7.2) and strongly suggest that the $\delta^{15}N$ values of the Cloudman residues represent fish. Royer et al (2017) found that boiling fish can actually increase $\delta^{15}N$ values by 2‰, which would bring the range of the of the fish from the referenced isotopic studies even more closely in line with the Cloudman residue values. Finally, experimentally-processed high-trophic-level aquatic resources have observed $\delta^{15}N$ values of 9 ‰ or greater (Craig et al. 2007; Craig et al. 2013; Morton and Schwarcz 2004), a threshold exceeded by 96% of the Cloudman residues.

Human bone collagen samples from both Woodland and Iroquoian archaeological sites in southern Ontario with $\delta^{15}N$ values between 11.8 - 12.5‰ have been interpreted as indicating diets comprising significant amounts of high trophic-level protein sources, most likely fish (DeWar et al. 2010; Schwarcz et al. 1985; Vander Merwe et al. 2003). The $\delta^{15}N$ values of Cloudman pottery residues are similar to those derived from bone collagen of individuals from Ontario and average $\delta^{15}N$ values for individuals from the nearby late Late Woodland Juntunen site, located in the Straits of Mackinac, as depicted in Figure 7.6 (Brandt 1996; DeWar et al. 2010; Schwarcz et al. 1985; Vander Merwe et al. 2003). Human bone collagen is typically between 2-4‰ enriched in nitrogen compared to dietary components (including cooked food remnants) due to the fractionation factor between a consumer and its food (Ambrose and DeNiro 1986; Morton and Schwarcz 2004; Shoeninger 1985; Schwarcz and Schoeninger 1991), so the

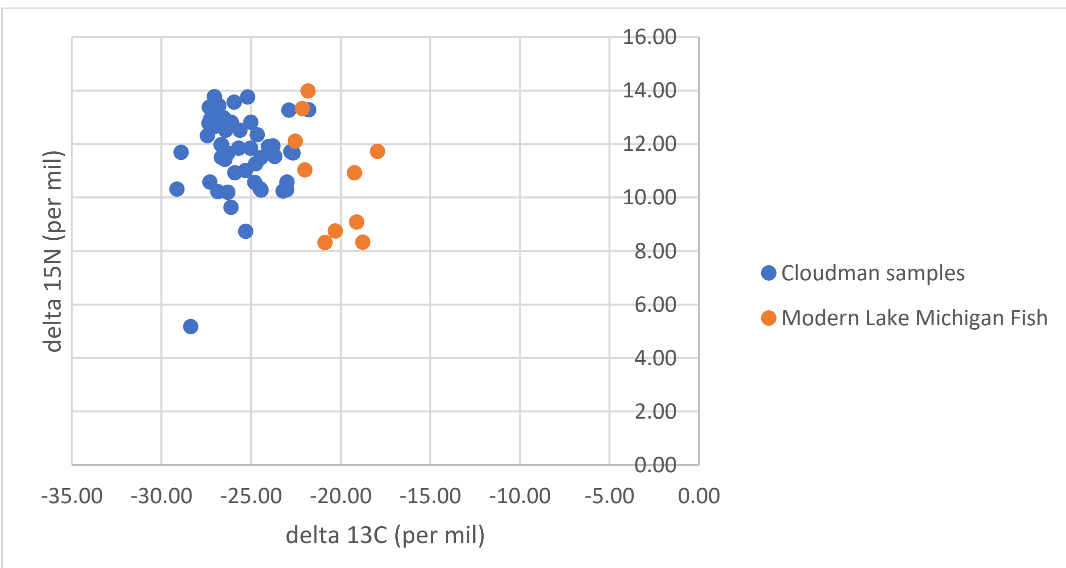

Figure 7.5: Plot of $\delta^{15}N/\delta^{13}C$ Values of Cloudman Pottery Residues vs. Modern Fish Samples from Lake Michigan (Turschack 2013)

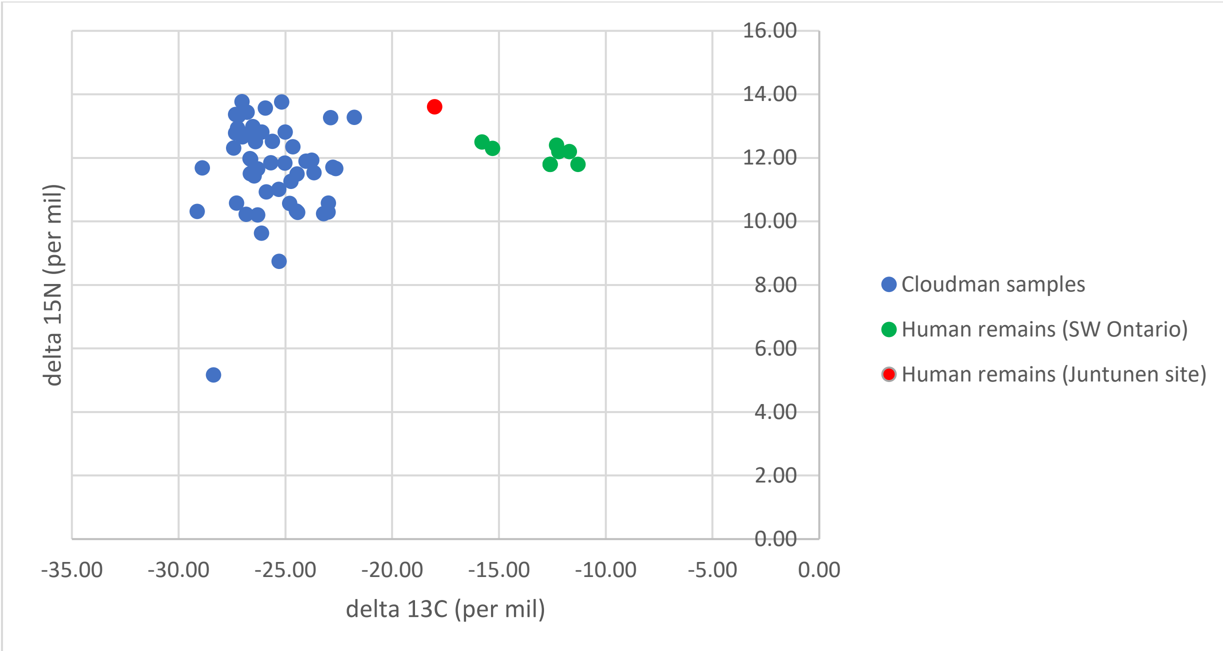

Figure 7.6: Plot of $\delta^{15}N/\delta^{13}C$ Values of Cloudman Pottery Residues vs. Human Bone Collagen of Woodland & Iroquoian Individuals with Aquatic Resource-Rich Diets (Brandt 1996; DeWar et al. 2010; Schwarcz et al. 1985; Vander Merwe et al. 2003)

residues from Cloudman may represent food mixes comprised of even greater levels of dietary protein derived from high-trophic-level sources in comparison to the average diets of the individuals sampled for bone collagen.

Aquatic plants can also yield high $\delta^{15}N$ values, although these values vary based on geographic location. In the San Fransisco Bay of California, $\delta^{15}N$ ranged from -3.4 to 17.4‰ and $\delta^{13}C$ ranged from -32 to -12.4, clustering at levels slightly less enriched in both carbon and nitrogen than the Cloudman residues (Cloern et al 2002). In Spain, $\delta^{15}N$ values freshwater aquatic plants fell in the range of 5.2 to 20.1‰ (with a median of 3.5‰ [Chappuis et al. 2017]), while freshwater plants in subarctic Canada produced $\delta^{15}N$ values in the range of -5.4 to 7.4‰ (Milligan et al. 2010). The $\delta^{15}N$ values from the subarctic are especially low compared to those of the Cloudman residues, showing geographic variability that may also be influenced by the geomorphological type of the body of water in which plants grow (Chappuis et al. 2017). It cannot be ruled out that processing of aquatic plants may have also contributed to the $\delta^{15}N$ enrichment of the Cloudman samples, although no aquatic plant remains were present in the microbotanical assemblage at the site (Egan-Bruhy 2007). Further exploration of isotope values for aquatic plants in the northern Great Lakes is required to clarify future isotopic interpretations (see Methodological Considerations below).

Overall, the stable isotope values of the Cloudman samples display considerable consistency at the site through time. Figure 7.7 shows the lack of distinguishable clustering of isotope ratios by subassemblage, a similarity reflected in the mean $\delta^{15}N$ values of each subset (see Table 7.1). The ubiquity of elevated delta values in 48 of 50 total vessels sampled, across all subassemblages and without visible clustering is solid evidence for a long tradition processing of aquatic resources, possibly high-trophic-level fish, in pottery throughout all occupations of the Cloudman site.

Cleland's (1982) fall fishery model includes increased exploitation of deep-water fall spawning fish species, such as lake trout and whitefish (high trophic-level species), during the Late Woodland period. To support Cleland's hypothesis, an observed increase, steady or of shorter duration, in pottery residues with elevated $\delta^{15}N$ values over time would be necessary. However, high trophic-level fish were exploited in both the spring and fall (Cleland 1966), so species, and therefore seasonality, cannot be attributed based on the isotope data alone. However, the consistency of the nitrogen isotope data demonstrates that acquisition, processing, and consumption of aquatic resources, including high-trophic-level fish, were important activities throughout the 1400-year occupational history of the Cloudman site.

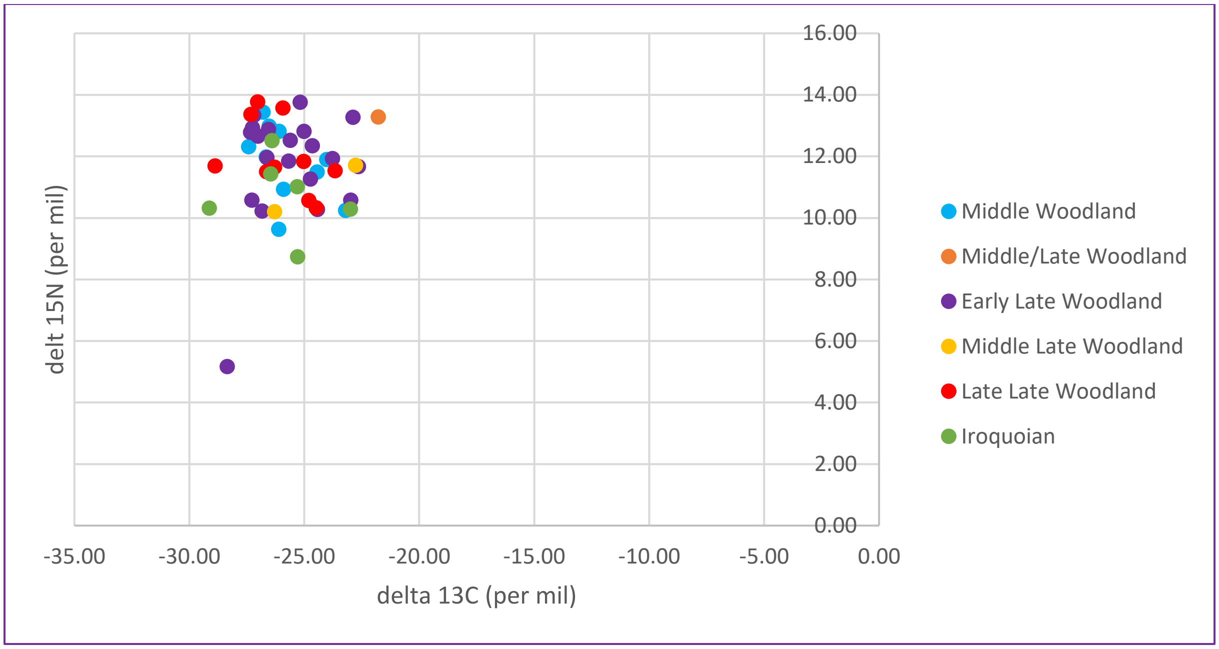

Figure 7.7: Plot of $\delta^{15}N/\delta^{13}C$ Values of Cloudman Pottery Residues by Subset

Carbon Isotopes

Intensification of maize horticulture by groups occupying coastal zones of the northern Great Lakes in the late Late Woodland period has been hypothesized by O'Shea (2003). Dunham (2014) found that maize was consumed but was not a significant starchy resource for late Late Woodland groups in the eastern Upper Peninsula of Michigan. Instead, they focused on acorn and wild rice exploitation to obtain starch, a critical component of diet.

Past standards interpret $\delta^{13}C$ values above -22‰ as indicative of the presence of maize in adhered food residues (Hastorf and DeNiro 1985), while more current standards associate maize with $\delta^{13}C$ values closer to -17.4‰ (Katzenberg and Pfeiffer 1995). As shown in Table 1, average $\delta^{13}C$ values for all but one of the analytic subsets are well below that threshold. Bone collagen from archaeological human remains of Late Woodland and Iroquoian groups in southwest Ontario show both elevated nitrogen and carbon delta values (see Figure 7.6), which are reflective of diets heavy in high-trophic-level fish and maize, respectively (DeWar et al. 2010; Schwarcz et al. 1985; Vander Merwe et al. 2003). The $\delta^{15}N$ values of these samples are roughly congruent with those of the Cloudman samples, while the $\delta^{13}C$ values are quite distinct, falling in the range between -10 to - 17‰. The mean $\delta^{13}C$ values of human bone collagen samples from the Juntunen site lie between those of the Ontario and Cloudman samples. Brandt (1996:70) suggests, based on observed $\delta^{13}C$ values, that maize made up only 18% of the Juntunen occupants' diet. The carbon enrichment of the Cloudman pottery residue samples are not high enough to indicate intensive maize processing; however, the results do not entirely preclude the presence of maize in pottery residues (see Methodological Considerations below).

Lipid Residue Analysis

Detection of a wide array of both plants and animals processed in pottery cooking vessels is best attained through lipid analysis of absorbed food residues. Sherds from a total of 30 vessels were submitted to the Archaeological Residue Analysis Laboratory at Brandon University in Brandon, Manitoba for lipid residue analysis (see Table 4.3). Full results of the analysis can be found in Appendix C (Malainey and Figol 2018). Frequencies of food/content category in vessels by analytic subset are summarized in Table 7.4. Missing from this table are V35, a Late Laurel vessel from the Middle Woodland/Late Woodland transition, which contained only decomposed nut oil, and V215, a Bois Blanc vessel from the Middle Late Woodland period, which contained decomposed nut oil, low fat-content plants, and animal product.

Nut processing was common at the site throughout all occupations (Figure 7.8, see Table 7.4). However, there is an increase in the frequency of vessels used for nut processing over the course of the Middle Woodland, early Late Woodland, and late Late Woodland, during which

Table 7.4: Frequencies of Lipid Categories by Subset

Lipid Category	Middle Woodland		Early Late Woodland		Late Late Woodland		Iroquoian	
	Ct	%	Ct	%	Ct	%	Ct	%
Decomposed Nut Oil	3	60.0	7	77.8	7	87.5	3	50.0
Large Herbivore	0	0.0	2	22.2	0	0.0	1	16.7
Moderate High Fat Food	1	20.0	0	0.0	0	0.0	0	0.0
Medium Fat Content Food	1	20.0	1	11.1	2	25.0	1	16.7
Low Fat Content Plants	2	40.0	5	55.6	4	50.0	4	66.7
Animal Product	3	60.0	5	55.6	5	62.5	3	50.0
Possible Animal Product	1	20.0	0	0.0	1	12.5	2	33.3
Possible Plant Product	0	0.0	1	11.1	1	12.5	0	0.0
Conifer Product	0	0.0	1	11.1	1	12.5	1	16.7
Possible Conifer Product	0	0.0	2	22.2	1	12.5	2	33.3

87.5% of sampled vessels contained nut lipids, with a sudden decrease in frequency (50%) among Iroquoian vessels. A Kruskal-Wallis test, however, determined there was no significant differences in these frequencies (p=0.430, df=3), underlining the consistent processing of nuts during all occupations of the Cloudman site. However, acorns may have increased in importance during the Late Woodland period and became somewhat less important during later occupations of the site based on the raw frequencies of nut oils.

Ethnographic accounts of Ojibwe groups consistently report the use of acorns, and rarely reference other types of nuts (Densmore 1979; Hilger 1959). Densmore (2005:307) lists hazelnut (*Corylus americana*) in a table of plants used as foods but does not discuss them further in text, as she does with acorns. Hazelnut, butternut/white walnut (*Juglans cinerea*), and acorn are referenced as nuts consumed by the Ojibwe in Yarnell (1964:63, 67). Acorns are the only nut mentioned by Tooker (1991:62) as a common food among the Wendat/Huron, and Waugh (1973:123) describes Iroquois utilization of a variety of nuts (such as hickory, walnut, butternut, hazelnut, beechnut, chestnut) but emphasizes acorns.

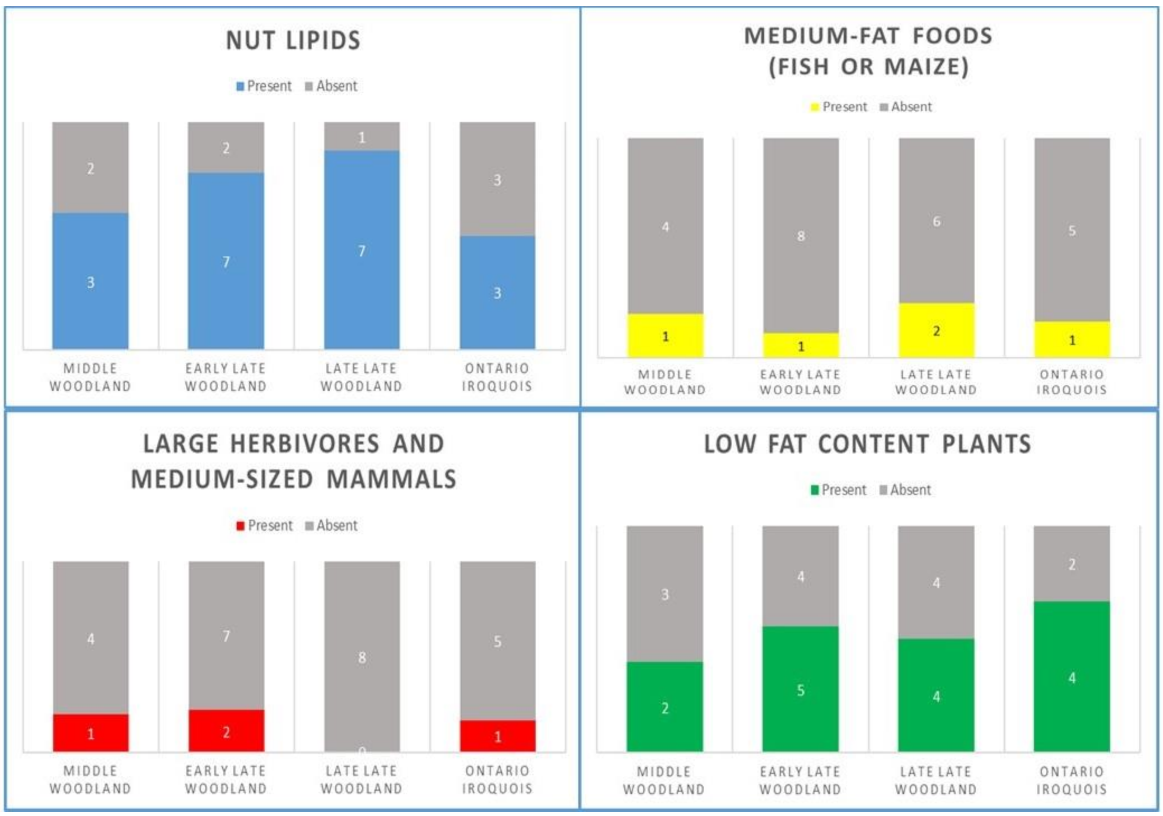

Figure 7.8: Primary Lipid Categories by Subset

Acorns and hazelnuts and are the most common nuts in the eastern Upper Peninsula (Comer et al. 1995; Dunham 2009, 2014; Voss and Resnicek 2012). Macrobotanical remains from Late Woodland and "Protohistoric" features at Cloudman reveal that acorn remains account for 84% of total nut specimens and 75% of total nut weight (Egan-Bruhy 2007), but small amounts of hazelnut and butternut were also present. Presettlement vegetation at the Cloudman site consisted of spruce, fir, and cedar forest, suggesting that these nuts were not necessarily gathered in the immediate vicinity of the site (Comer et al. 1997). Across to the south side of the Potagannissing River (opposite the Cloudman site), the vegetation transitions to aspen-birch forest, where hazelnut (part of the birch family) would have been available. Beech-sugar maple-hemlock forest dominate significant portions of the interior site, where acorn-producing oaks (of the beech family) would have been abundant (Comer et al. 1995, 1997). These evidences suggest that the decomposed nut oil in the lipid residues most likely represent acorns, although other nuts, particularly hazelnut, may have contributed to the signatures. The Cloudman site was either a very important acorn/nut processing locale, or processed acorns/nuts were an overall integral component of Woodland cuisine.

Frequencies of the remaining food/content categories are relatively consistent across all analytic subsets, suggesting relative dietary consistency through time. Signatures for large herbivores (such as white-tailed deer) are relatively infrequent, appearing in residue from only three vessels. Moderate high-fat foods were only clearly detectable in a single Middle Woodland vessel. This signature is indicative of medium-sized mammals (Malainey and Figol 2018). Animals of this category consumed by historic-period Ojibwe and Iroquoian groups include beaver, porcupine, skunk, woodchuck, muskrat, and hare (Hilger 1959; Rogers 1962; Waugh 1973). While Ojibwe cooks sometimes boiled meat, spit-roasting was also common (Densmore 1979; Hilger 1959; Roger 1962), which may have been the primary methods of meat processing at the Cloudman site. Medium fat content foods include maize and fish. These were identified in low frequencies in every analytic subset (see Table 4), detected in only 17% of vessels sampled.

The category of “low fat content plants” includes berries, roots, and greens. Berries found in macrobotanical remains at the Cloudman site include hawthorn, strawberry, cherry, wild plum, raspberry, elderberry, and grape (Egan-Bruhy 2007). Other berries/fruits commonly used by historic-period Ojibwe groups include juneberry, bearberry, cranberry, currant, blackberry, and blueberry (Densmore 2005:307). Roots common in Ojibwe diets were wild ginger, wild bean, Jerusalem artichoke, and bugleweed, as well as aquatic roots like arrowhead and bulrush (Densmore 2005:307). Leaves of aster, creeping snowberry, wintergreen, and hemlock were also used (Densmore 2005:307). Low fat content plants would also include wild rice, which was recovered in the macrobotanical remains from Late Woodland features at the site (Egan-Bruhy 2007). Wild rice was central to northern Great Lakes subsistence economies during the historic period (Densmore 1979, 2005; Hilger 1959, Vennum 1988), but it cannot be distinguished from other low fat content foods in lipid residue analysis, requiring other methods of detection.

The sole non-food category apparent in the lipid signatures is conifer product. Probable or possible conifer product appears in eight total vessels. Signatures for conifer product are completely absent from Middle Woodland vessels and appear minimally in every other subset. Pine resin may have been applied to the interior of the vessel to reduce permeability, as observed in precontact pottery from New York (Reber and Hart 2008) and among modern pottery-producing societies with low-fired, unglazed wares (Aronson et al. 1994; Kobayashi 1994; Skibo 2013).

Cluster analysis was used to explore associations between vessels with similar lipid content. Jaccard’s coefficient of association was used because it omits joint absences of a variable to calculate similarity (Aldenderfer and Blashfield 1984). The variables included for this test include: nut lipids, large herbivore, moderate-high fat animal, medium fat content food, low fat plants, animal product, and conifer product. The categories of possible animal product, possible plant product, and possible conifer product were excluded. Figure 7.9 displays

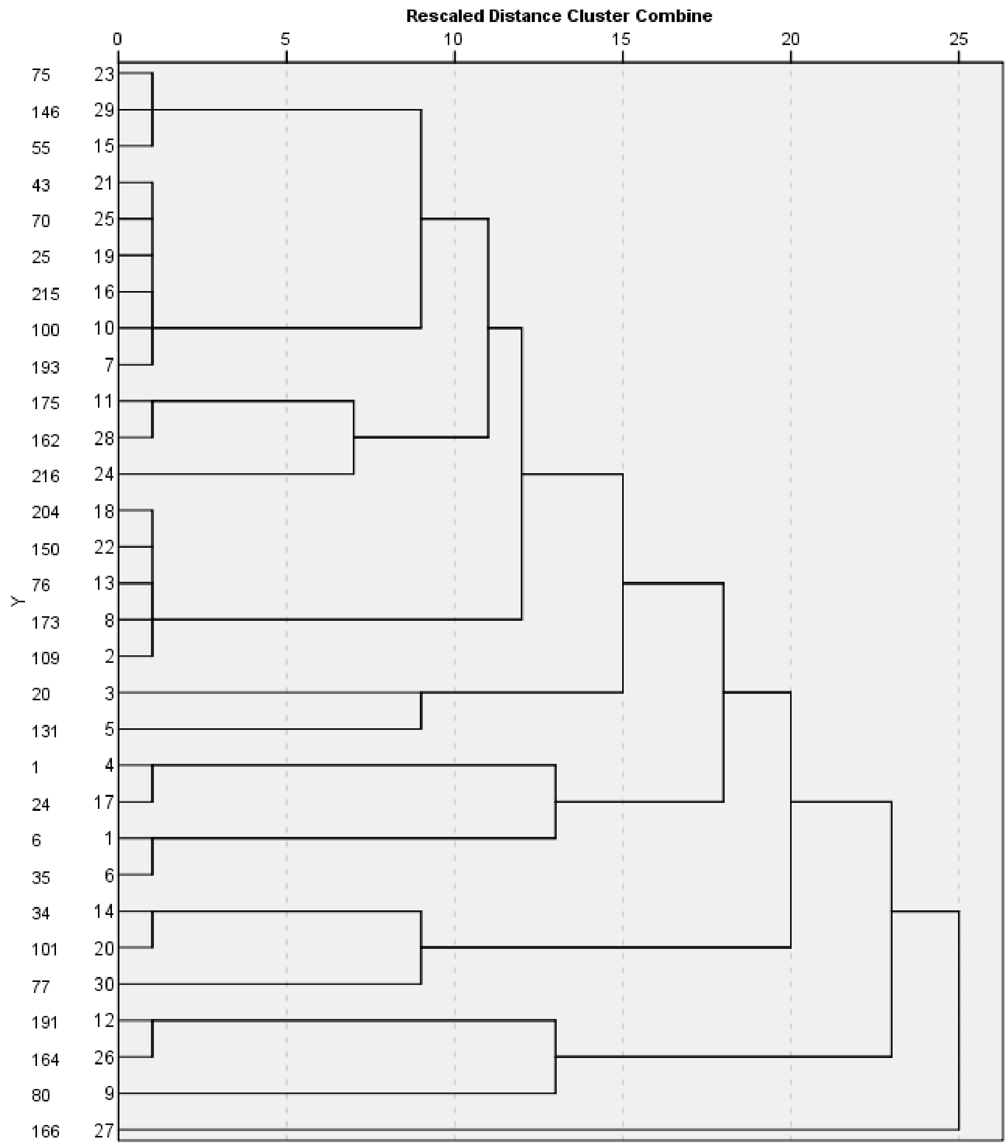

Figure 7.9: Dendrogram Showing Average Linkage (Between Groups) of Vessels by Lipid Content using Jaccard's Coefficient (vessel numbers: left column; distance: right column)

associations between all sampled Cloudman vessels according to chosen variables, revealing three distinct vessel clusters. The clusters show no time-trends and cluster vessels with primarily non-specific food groups (Table 7.5). Processing of some combination of nuts, plants, and animals appears common, although whether foods were processed together in the same cooking events or in separate cooking episodes in the same vessel is not clear.

Table 7.5: Vessel Clusters by Lipid Content (Jaccard's Coefficient)

Vessel	Subset	Type	Lipid Content
		CLUSTER 1	
55	ELW	Mackinac Ware	Nut oil, Low fat content plants
75	LLW	Traverse Plain v. Scalloped	
146	IRO	Early Ontario Iroquoian	
		CLUSTER 2	
100	ELW	Mackinac Punctate	Nut oil, Low fat content plants, Animal product
193	ELW	Blackduck Banded	
215	MLW	Bois Blanc Ware	
25	LLW	Juntunen Ware	
43	LLW	Traverse Decorated v. Punctate	
70	IRO	cf. Huron Incised	
		CLUSTER 3	
109	MW	Laurel Banked Linear Stamped	Nut oil, Animal product
76	ELW	Mackinac Undecorated	
173	ELW	Mackinac Banded	
150	LLW	Traverse Plain v. Scalloped	
204	LLW	Juntunen Linear Punctate	

To test for potential contamination of pottery lipid residue samples via the burial matrix, three soil samples collected from the Cloudman site were submitted for lipid residue analysis (see Malainey and Figol 2018, Appendix C). One sample deriving from the upper stratum of the lowest terrace yielded signatures typical in natural soils (Table 7.6). Samples from the middle of the central terrace, located in the heart of the site, contained lipids deriving from potential cultural activities—specifically, the processing of high-fat foods. High-fat lipid saturation, indicated by relative C18:1 isomer content, was highest in the sample from the second soil stratum, or subsoil. Malainey and Figol (2018) suggest this could be indicative of an activity area where high fat foods were processed. This sample, 17KMS32, contained a relative C18:1 composition of over 53%, much higher than ratios in any of the pottery samples. Relative C16:0

composition, which is indicative of decomposed nut oil, was low in the soil samples relative to those in the pottery samples. When C18:0 degrades, it turns into C16:0, so the high-fat content of the pottery sherds suggests the lipid content is from cooked/processed fatty foods rather than from exposure to unprocessed fats in the surrounding soil matrix. Past studies have found that contamination of pottery lipids by the burial environment is generally negligible (Condamin et al. 1976; Röttlander 1990), and the results from Cloudman lend additional support to this conclusion.

Table 7.6: Cloudman Site Soil Sample Lipid Content

Sample No.	Context	Lipid Types
17KMS31	Terrace 2, Stratum 1, Center	natural & possible cultural
17KMS32	Terrace 2, Stratum 2, Center	cultural (high-fat foods), natural
17KMS33	Terrace 3, Stratum 1, East	natural

Outcomes of the lipid residue analysis reveal that nut processing was very important at the Cloudman site during all occupations. Various terrestrial mammals and low fat content plants were also important components of the Cloudman residents' diets. Medium fat content foods, such as fish and maize, were present in lipid signatures but infrequent. Animal and plant products were routinely cooked in the same vessels, so there were no obvious food-specific cooking functions for ceramic cooking pots at the Cloudman site.

Microbotanical Analysis

Although limited to the identification of certain plants, microbotanical analysis provides the greatest degree of specificity of all the food identification methods used in this study, allowing classification at the species level. Adhered food residues sampled from 48 Cloudman pottery vessels were subjected to microbotanical analysis (see Table 4.1). Analysis was conducted by Rebecca Albert, the full results of which are reported in Appendix D.

Phytoliths from maize, wild rice, and squash and starches from maize and squash were identified in the Cloudman samples (Table 7.7). All three food groups were represented in nearly all analytic subsets, processed and consumed at the site consistently or periodically throughout the entire 1500-year occupational history of the site. The results underscore the deep historical importance of these foodstuffs to indigenous groups in the northern Great Lakes and distinguish the Cloudman site as an important exploitation or processing locale for all three resources.

Table 7.7: Number of Vessels Containing Maize, Wild Rice, and Squash Microbotanicals by Subset

Subset	n	Maize	Wild Rice	Squash
Middle Woodland	12	5	2	2
Middle/Late Woodland	2	1	1	0
Early Late Woodland	19	5	1	3
Middle Late Woodland	2	0	0	0
Late Late Woodland	9	0	4	3
Iroquoian	4	2	4	2
Total	**48**	**13**	**12**	**10**

The presence of maize, wild rice, and squash at the site from the outset of occupation (ca. AD 100) is a significant discovery. Maize has been reported in the Upper Peninsula of Michigan by cal 200 BC (Albert et al. 2018), in Minnesota, central New York, and southern Quebec by cal 300 BC (Burchill and Boyd 2015; Hart, Brumbach and Lusteck 2007; St-Pierre and Thompson 2015), and in the Saginaw drainage of lower Michigan by AD 1 (Raviele 2010). At the

Cloudman site, maize starch was encountered in residues from Vessel 4, a Laurel Dentate Stamped vessel which produced an AMS date of cal AD 60-125, yet another line of evidence supporting the early use of maize in the northern Great Lakes region.

The microbotanical results also offer some of the earliest evidence for regional exploitation of wild rice and squash. Although neither plant was detected in either of the Middle Woodland vessels subjected to AMS dating, they occur in vessels of the same taxonomic typologies. A wild rice phytolith was detected in V5, identified as a Laurel Pseudo-scallop Shell vessel; a similar vessel dated to cal AD 80-214. Squash phytoliths were identified in residue from Vessel 12; a nearly identical vessel produced an associated AMS date of cal AD 60-125.

Although wild rice appears in the paleoecological record in northeastern Minnesota by 7000 BC and northwestern Ontario by 4100 BC (Boyd et al. 2013; Huber 2001), evidence for widespread human exploitation of wild rice is not apparent until the Middle Woodland period, when archaeobotanical remains appear at sites from Minnesota to Ontario (Arzigian 2000; Boyd and Surette 2010; Boyd et al. 2014; Burchill and Boyd 2015; Hart and Lovis 2013; Surette 2008). Wild rice seeds from the Laurel Big Rice Lake site in northeastern MN have been dated to as early as cal 172 BC (1σ; Valppu 2000:36). In the lower peninsula of Michigan, wild rice remains were found in association with materials dated to cal AD 90-383 (1σ) at the Schultz site in the Saginaw basin (Lovis et al. 2001), and at the Dunn Farm site, near the Leelanau Peninsula (Ford and Brose 1975), where a related burial was dated to cal AD 534-635 (1σ; Brose and Hambacher 1999; Stuiver et al. 2018). Few other early contexts for wild rice in the region have been directly dated. The dates from the Cloudman site are therefore among the earliest for wild rice in the northern Great Lakes.

Squash was an unexpected component of the food mixes at the Cloudman site. Archaeological squash remains have been found in Pennsylvania dating to cal 5064-4336 BC (2σ), lower Michigan circa cal 2300 B.C. (Monaghan et al. 2006), southeastern Minnesota from 580 BC (Perkl 1998), and the central Mississippi River valley circa AD 434-613/681-889 (Hart, Brumbach, & Lusteck 2007). Squash has rarely been encountered in the northern Great Lakes. *Cucurbit* microbotanicals were found in residues from Vessel 12, a Laurel Dentate-Stamped vessel. Another Laurel Dentate-Stamped vessel (V4) produced an AMS date of cal AD 60-125, providing some of the only and earliest evidence for squash exploitation in the Upper Peninsula of Michigan.

Besides the early and persistent presence of maize, wild rice, and squash at the Cloudman site, the frequency at which each species is present varies between occupations (Table 7.8; Figure 8.10). Contrary to expectations, the frequency of maize reduces over time. Present in 42% of Middle Woodland vessel residues, it occurs in only 26% early Late Woodland residues and is absent from late Late Woodland samples. Although there is evidence of moderate maize consumption among late Late Woodland populations in lower Michigan (Brandt 1996; Muhammad 2010) and casual maize consumption by late Late Woodland occupants of the nearby Juntunen site (Brandt 1996), maize does not seem to have been an important component of diet at the Cloudman site at this time. Maize does, however, reappear in Ontario Iroquois vessel residues, occurring in half of the samples.

Conversely, the frequency of both squash and wild rice increase through time. Wild rice underwent the greatest change in frequency, represented in only 5% of early Late Woodland samples but present in over half of the late Late Woodland and Ontario Iroquoian samples. Frequencies of maize, wild rice, and squash were compared between the primary analytic subsets using a Kruskal-Wallis analysis of variance (Table 7.9). The only significant difference was between the early Late Woodland and the late Late Woodland subsets. Maize was more common than wild rice in the early Late Woodland samples, while maize was absent, supplanted by wild rice in the late Late Woodland period, signaling a drastic change in starchy foods utilized between these two occupations.

Table 7.8: Frequencies of Microbotanical Species by Subset

Species	Middle Woodland		Early Late Woodland		Late Late Woodland		Iroquoian	
	Ct	%	Ct	%	Ct	%	Ct	%
Maize	5	42	5	26	0	0	2	40
Wild Rice	2	17	1	5	4	44	4	80
Squash	2	17	3	16	3	33	2	40

Figure 7.10: Microbotanical Frequencies of Maize, Wild Rice, and Squash by Subset

Table 7.9: Microbotanical Frequency Relationships between Subsets (Kruskal-Wallis)

Subset	Middle Woodland (*p)	Early Late Woodland (p)	Late Late Woodland (p)
Middle Woodland	---	---	---
Early Late Woodland	0.777	---	---
Late Late Woodland	0.069	**0.044**	---
Iroquoian	0.409	0.218	0.368

*two-tailed
α=0.05, df=2

Cluster analysis was used to explore associations between vessels with similar microbotanical content. Jaccard's coefficient of association was applied to the data to evaluate within-group similarity (Figure 7.11). Unlike the lipid residue clusters, which were generalized and not temporally significant, the microbotanical clusters are distinct and show diachronic trends of resource exploitation and cooking, particularly when the groupings are displayed with corresponding interior carbonization patterns (Table 7.10). Cluster 1 consists of vessels with residues containing only maize microbotanical remains. These include only Middle Woodland vessels with interior carbonization patterns representing stewing, and early Late Woodland vessels with interior carbonization pattern indicative of boiling. This supports the observation that maize may have been more important at the Cloudman site during the Middle and early Late Woodland periods than in later occupations.

Within Cluster 1, there is an apparent diachronic shift in the way that maize is cooked. Within Middle Woodland vessels, maize processing is associated with stewing; it may have been used primarily as flour/meal added to soups and stews to thicken them. In the early Late

Woodland, the vessels used for processing maize show signatures for boiling, suggesting that cooks at this time may have begun engaging in nixtamalization, a processing technique in which

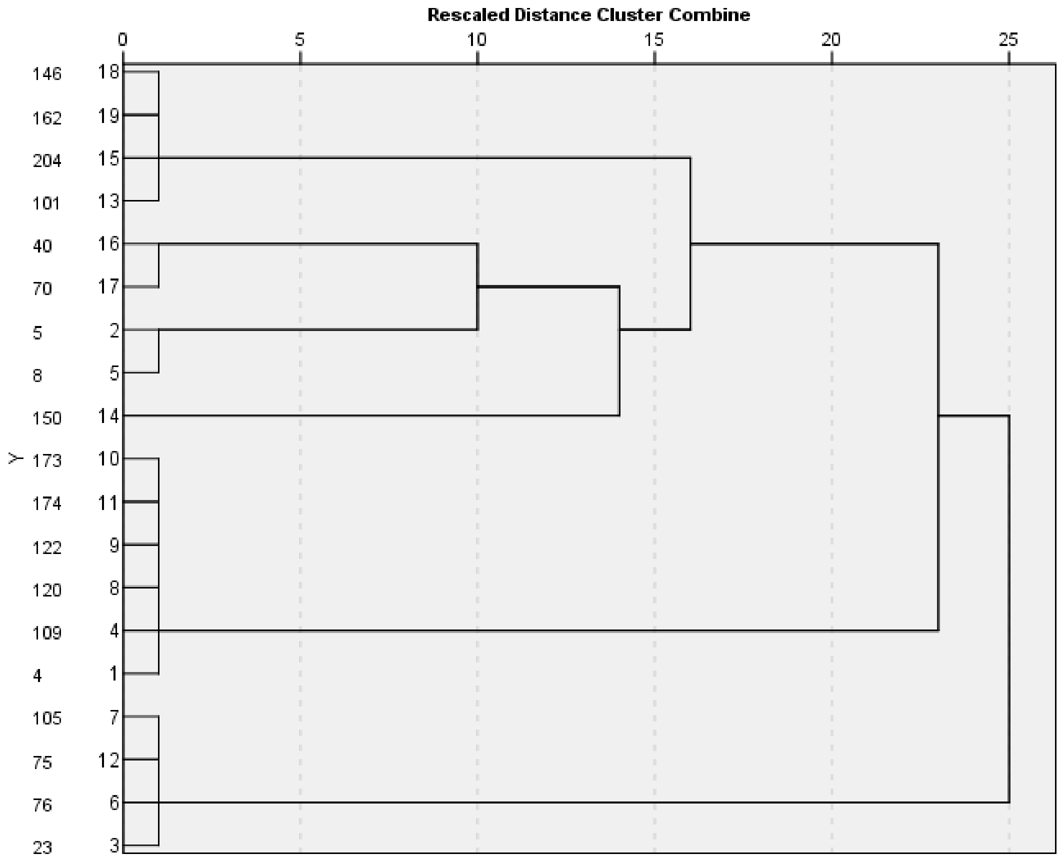

Figure 7.11: Dendrogram Showing Average Linkage (Between Groups) of Vessels by Microbotanical Content using Jaccard's Coefficient
(vessel numbers: left column; distance: right column)

maize is boiled with hard wood ash, breaking down the pericarp and improving grain palatability (Lovis et al. 2011). This process can also mask maize signatures in stable isotope assays, explaining the lack of δ^{13}C enrichment of Cloudman samples (Lovis et al. 2011).

Cluster 2 includes vessels with residues containing only wild rice phytoliths, which is restricted to late Late Woodland and Ontario Iroquoian vessels, additional evidence for the increased importance of wild rice to the subsistence regime at the Cloudman site post-AD 1200.

As in Cluster 1, there is an associated diachronic shift in wild rice cooking styles. Among late Late Woodland vessels, only stewing was employed in processing of the rice (and other

Table 7.10: Vessel Clusters by Microbotanical Species Content (Jaccard's Coefficient)

	Vessel	Period	Type	Maize	Wild Rice	Squash	IC Pattern
Cluster 1	4	MW	Laurel Dentate Stamped	1	0	0	2
	109	MW	Laurel Banked Linear Stamped	1	0	0	2
	120	ELW	Mackinac Banded	1	0	0	1
	122	ELW	Mackinac Ware (cf. Punctate)	1	0	0	1
	173	ELW	Mackinac Banded	1	0	0	1
	174	ELW	Mackinac Ware (cf. Punctate)	1	0	0	1
Cluster 2	101	LLW	Juntunen Ware	0	1	0	2
	204	LLW	Juntunen Linear Punctate	0	1	0	2
	146	IRO	Early Ontario Iroquoian	0	1	0	3
	162	IRO	cf. Sidey Notched or Lawson Incised	0	1	0	3
Cluster 3	23	MW	Laurel Banked Linear Stamped	0	0	1	1
	76	ELW	Mackinac Undecorated	0	0	1	3
	105	ELW	Mackinac Punctate	0	0	1	3
	75	LLW	Traverse Plain v. Scalloped (mini)	0	0	1	3
Cluster 4	5	MW	Laurel Pseudo-scallop Shell	1	1	0	2
	8	ELW	Mackinac Ware	1	1	0	2
Cluster 5	40	IRO	cf. Lawson Opposed or Methodist Point Group 7	1	1	1	2
	70	IRO	cf. Huron Incised	1	1	1	3

contents), which is surprising given that wild rice requires extensive boiling before it is edible. Users of Iroquoian vessels, on the other hand, processed food mixes containing wild rice through a combination stewing/boiling method.

Clusters 3 and 4 include vessels involved in the processing of squash or a combination of maize and wild rice, respectively. There are no obvious diachronic trends within these clusters besides the emergence of a culinary tradition combining maize and wild rice, a nutritionally-complementary food mix that emerged in the Middle Woodland, in accordance with previous observations (Boyd et al. 2014; Hart and Lovis 2013; Raviele 2010). This combination appears associated with stewing (Cluster 4) while the processing of squash is associated with boiling/stewing practices throughout the Late Woodland occupations (Cluster 3).

Cluster 5 may be connected to an important historical culinary development. This cluster includes the only vessels with microbotanical evidence for maize, wild rice, and squash. The traditional “Three Sisters” subsistence regime characteristic of Iroquoian groups includes maize, squash, and beans, and is believed to have emerged post-AD 1300 (Bamann et al. 1992; Hart 2008; Kuhn and Funk 2000). Boyd et al. (2014) found that in areas where wild rice was available, beans tended to be less important because the two foods are nutritionally similar. The use of maize, squash, and wild rice together in vessels dating to post-AD 1400 signals the emergence of the Three Sisters culinary tradition at the Cloudman site with the opportunistic substitution of local wild rice for beans.

Tandem Dietary Analysis Results

In total, residues from 61 vessels were subjected to one, two, or all three dietary analyses (Appendix E). Twenty (20) vessels were subjected to all three analyses, resulting in one of the largest and richest data sets of its kind. Residues from only 5 vessels lacked any identifiable foods remains, while an additional 14 contained signatures for only one food category (aquatic resources, in the case of 12 of these samples), and all 17 of these samples were subjected to only one or two of the analyses. The 20 samples subjected to all three analyses tested positive for at least two food groups, attesting to the combined analytic strength of these methods. It also highlights the multipurpose nature of the vessels used at the Cloudman site, which were employed to process a variety of foods.

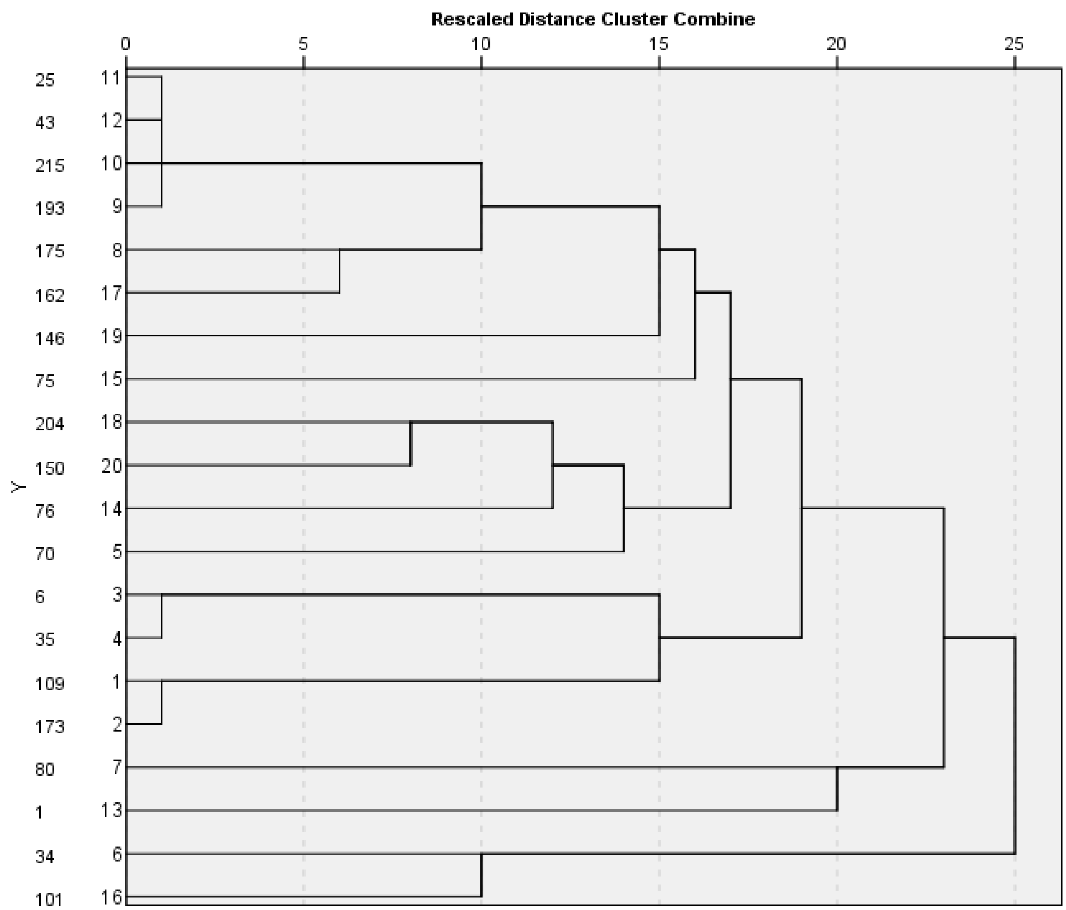

Figure 7.12: Dendrogram Showing Average Linkage (Between Groups) of Vessels by Lipid and Microbotanical Content using Jaccard's Coefficient
(vessel numbers: left column; distance: right column)

Table 7.11: Vessel Cluster by Lipid and Microbotanical Content (Jaccard's Coefficient)

Vessel	Period	Type	Foods
25	LLW	Juntunen Ware	Nut oil, Low fat content plants, Animal products, Aquatic resources
43	LLW	Traverse Decorated v. Punctate	
215	MLW	Bois Blanc Ware	
193	ELW	Blackduck Banded	

To evaluate possible clustering of food remains inferred from microbotanical and lipid residue analyses, Jaccard's coefficient of association was again used to evaluate within-group similarity (Figure 7.12). Stable isotopes were excluded from this evaluation because of the uniformity of the results. The analysis identified a single cluster of vessels from varying time periods containing generalized, rather than specific, food categories (Table 7.11). The test did not associate maize, squash or wild rice with any other major food group. Although diachronic trends in the use of different wild and cultivated crops are apparent, there are no associated trends for identifiable or specific food combinations.

Seasonality at the Cloudman Site

Cumulative results of the three dietary analyses provide a wealth of information about subsistence at the Cloudman site. The food categories most frequently identified at the site include high-trophic-level fish, nuts/acorns, wild rice, squash, and maize. As discussed in Chapter 3, both spring- and fall-spawning fish species were identified in faunal remains from Late Woodland and "Protohistoric" features (Cooper 1996), although the high-trophic levels of the fish as implicated by elevated $\delta^{15}N$ values are more closely associated with deep-water, fall-spawning fish, such as whitefish. Fishing probably took place at the site during both the spring and the fall. Hilger (1959:125) observed that in the fall, fishing "became a seasonal occupation" where groups relocated to fish specifically for winter storage. Fish "seemed to come near shore in November, just before the lakes froze" (Densmore 1979:125), the most intensive period of fishing routinely taking place in late fall.

Archaeological plant remains indicate intensive use of the site during the late summer and fall. Hazelnut, butternut, and acorns were all present in the macrobotanical remains (Egan-Bruhy 2007) and nut lipids featured prominently in lipid signatures from the majority of vessels sampled. Hazelnut is harvested in August and September, acorn in September and October, and butternut in October (Yarnell 1964). Wild rice is harvested in late August or early September (Hilger 1959:147; Vennum 1988). Maize and squash are also harvested in the fall.

Foods represented in pottery residues suggest intensive fall occupation of the Cloudman site, where residents lived from late August until November, using the site as a central residential locale from which logistical forays for hunting, fishing, and gathering activities could be conducted. Small-scale horticulture involving cultivation of maize and squash may have also taken place at the site. This does not preclude a spring occupation, as many species of fish and animals could be acquired in the spring, and nuts, maize, and wild rice are all easily stored for spring consumption and crops would require planting.

Methodological Considerations

The results of the chemical and microbotanical analyses of adhered and absorbed residues from Cloudman site pottery were highly complementary. Each of the three methods provides unique dietary data that are critical to the study, but inconsistencies between results highlight potential shortcomings of each method. The greatest disparities in outcome originate from lipid and isotopic signatures for fish, and microbotanical and isotopic signatures for maize.

Aquatic Resources, Acorns, Lipid Residue Analysis, and Stable Isotope Analysis

The greatest discrepancy between the results of the lipid residue analysis and the stable isotope analysis lies in the detection of signatures for fish. As previously observed, the high nitrogen enrichment of the Cloudman pottery residues correlates well with signatures for high-trophic-level fish. Malainey and Figol (2018) identify the presence of medium fat content foods by a C18:0 level less than or equal to 25% and a C18:1 isomer level between 15% and 27.5% (see Appendix C). Both maize and fish are medium fat content foods, although fish usually display higher levels of C14:0 and lower levels of C12:0 and C:15. Only 17% (5 of 30) of vessel residues tested positive for medium fat foods (maize or fish), while 96% (48 of 50) of residue samples tested positive for aquatic resources through stable isotope analysis. Seventeen (17) vessels contained lipid biomarkers (specifically, cholesterol) for general animal product, which could be indicative of fish but cannot be positively associated with aquatic (or any animal) species. A total of 19 vessels with elevated δ^{15}N values tested negative for medium fat lipids. However, fish are often smoked and/or dried and later reconstituted in soups (Densmore 1979), a process that may affect the lipid content of the fish upon cooking. High δ^{15}N values could also be associated with aquatic plants (Chappuis et al. 2017; Cloern et al. 2002), which may correspond to low fat content plants detected in the lipid residues.

An alternative method for identifying fish lipids was employed by Taché and Craig (2015), who use a suite of biomarkers, including isoprenoid alkanoic acids and *ω*-(o-alkylphenyl)alkanoic acids containing a minimum of 20 carbon atoms, as indicators for aquatic resources in absorbed lipid residue. They found these markers in approximately half of their samples of Early Woodland Vinette I pottery from northeastern North America. They note, however, that these biomarkers are vulnerable to degradation through exposure to the burial environment and underrepresent the presence of aquatic resources in lipid residues. Fish may be difficult to capture in lipid signatures and may therefore be underrepresented by current methods of lipid residue analysis employed in North America.

An additional discrepancy between the stable isotope and lipid residue analyses lies in the detection of acorns. Acorns produce very low $\delta^{15}N$ values (Eerkens et al 2013), and high $\delta^{15}N$ in human bone collagen and archaeological residues have been interpreted as diets dominated by fish and lacking beans, another low-^{15}N foodstuff (Katzenberg et al. 1995; Morton and Schwarcz 2004; Schwarcz et al. 1985). The lipid residue analysis of the Cloudman pottery residues indicated the presence of nut/acorn lipids in 67% of the pottery vessels, the presence of which did not appear to affect the overall $\delta^{15}N$ values of the adhered residues. The presence of nuts/acorns in the lipids adds another layer of complication to the analysis. Acorns produce very low which may be expected to lower the overall nitrogen enrichment of the Cloudman residues. This, however, did not appear to manifest in the stable isotopes. However, $\delta^{15}N$ values are more heavily influenced by foods with higher proportions of dietary protein (Philips and Koch 2002; Schwarcz et al. 1985), and therefore $\delta^{15}N$ values from high-protein sources, such as fish, would likely be more strongly expressed than those of lower protein foods, such as acorns (Boyd et al. 2008; Craig et al. 2007).

In consideration of these factors, the effectiveness of stable isotope analysis for evaluating pottery residues and cooked food warrants further exploration. Only a small number of studies have investigated the stable isotope values of carbonized food mixes. Morton and Schwarcz (2004) conducted the primary study used for evaluating stable isotopes values of mixes containing maize, beans, and fish. Royer et al (2017) evaluated raw versus cooked fish and meat for the effects of various cooking techniques on the stable isotope levels, although these were not evaluated in the context of food mixes. Hart et al. 2007 found that a variety of factors, including food mixes and preparations, can effect $\delta^{13}C$ yields in food residues. Similar studies focusing on the effects of these variations on nitrogen stable isotopes have not been conducted, nor have residue experiments containing acorns and aquatic plants. Future experimental work investigating isotope values of cooked residues containing acorns, aquatic plants, and fish of varying preparations and food mixes is required to fully evaluate the expected stable isotope values of residues representing these foodstuffs.

Until further investigation of these issues can be conducted, tandem application of the lipid residue analysis and stable isotope analysis may be the best method for identifying a broad range of resources in food residues. The effectiveness of using lipid residue analysis alongside stable isotope analysis for investigating aquatic resource processing in pottery has been demonstrated by Taché and Craig (2015) and Anderson et al. (2017). If, ultimately, lipid residue analysis underrepresents fish and stable isotope analysis underrepresents nut/acorns, as the results of this study suggest, then their corroborative employment will be necessary for future investigations of ancient diet.

Maize, Stable Isotope Analysis, and Microbotanical Analysis

The presence of maize in pottery residues is also obscured in the stable isotope analysis results. The mean $\delta^{13}C$ of the Cloudman pottery residues is -26.65‰, and the highest delta value of any samples was -22.65‰ (see Appendix B). Hastorf and DeNiro (1985) interpreted $\delta^{13}C$ values above -22‰ as indicative of the presence of maize in carbonized food remains, and all but one (V35 at -21.78‰) of the Cloudman samples fell below that threshold. More recent studies correlate maize with $\delta^{13}C$ values closer to -17.4‰ in human bone collagen (Katzenberg and

Pfeiffer 1995; Muhammad 2010). Considering fractionation, expectations for maize in carbonized residues should be around -20‰, higher than the Cloudman residue values.

Hart et al. (2003) also encountered adhered residues producing both low $\delta^{13}C$ enrichment and maize phytoliths in pottery from the Finger Lakes region of New York. Hart et al. (2007) demonstrated that while the ratio of C4 to C3 foods affects delta values, the amount of carbon released by different foods during the cooking process is highly variable. They also found that dried maize and green maize release different amounts of carbon. This variability makes it difficult to accurately quantify a delta value threshold for residues containing maize, and Hart et al. (2007) therefore recommend against using stable isotope analysis as an independent measure for the presence of maize in archaeological residues.

The results of the Cloudman residue analysis support this conclusion. A total of 48 pottery residues were tested for both stable isotopes and microbotanical remains. The average $\delta^{13}C$ value of residues lacking maize microbotanicals (n=35) is -25.59‰; the average $\delta^{13}C$ value of residues containing maize microbotanicals (n=13) is -25.60‰, a nearly identical value. In the case of the Cloudman pottery assemblage, the amount of maize in food mixes was not sufficient to elevate carbon stable isotope values which are therefore not predictive of maize presence or absence.

Discussion

The application of three different analytic methods for evaluating foods cooked in ancient pottery provides a robust depiction of precontact indigenous cuisine while highlighting the shortcomings of each method. Important foodstuffs for occupants of the Cloudman site include acorns/nuts, high-trophic-level fish, maize, wild rice, and squash, in addition to various wild plants and terrestrial animals. Exploitation of acorns and aquatic resources appears intensive and consistent throughout the occupational history of the site, while the intensity of maize, wild rice, and squash consumption varied over time.

The most unexpected finding was the timing and intensity of maize consumption at the site. Maize was most frequent in residues from Middle Woodland cooking vessels and continued to be common through the early Late Woodland period, but it is absent from all food signatures yielded by late Late Woodland vessels. The intensification of maize at coastal sites during the northern Great Lakes late Late Woodland period has been posited by O'Shea (2003), but evidence from the Cloudman site does not support this hypothesis at the local level. The lack of maize at the Cloudman site during the late Late Woodland is not representative of overall regional trends—several studies have found evidence of moderate maize consumption in late Late Woodland diets in the Upper Great Lakes (Brandt 1996; Muhammad 2010). Instead, it signals a possible change in the use of the Cloudman site rather than a macroregional dietary shift.

Conversely, the presence of wild rice microbotanicals in pottery residues increases in frequency over time. Although present in the Middle Woodland samples, it is not as abundant as maize within the same subset. Wild rice microbotanicals all but disappear in the early Late Woodland period, occurring in only 5% of samples. Among pottery constructed after AD 1200, the frequency of wild rice in residues dramatically increases, present in nearly half of the late Late Woodland samples and 80% of the Iroquoian samples. The Cloudman site is located at the mouth of the Potagannissing River and down river from contemporary wild rice patches, and although the antiquity of these patches is unknown, the microbotanical remains indicate that wild rice has grown in the area for some time.

The early Late Woodland period occupation of the Cloudman site occurred during the Medieval Climatic Optimum (AD 900-1000), a warm period during which lake levels dropped, causing riverine fluctuation and flooding (Lovis et al. 2012; Monaghan and Lovis 2005). Wild rice is very sensitive to climate and water levels (Boyd et al. 2013; Vennum 1988), so water-level fluctuations may have disrupted local rice beds while the warmer climate would have been conducive to maize horticulture. The end of the Optimum brought cooler weather and caused higher lake levels and streams grading to higher elevations, thereby reducing riverine fluctuations and allowing stable aquatic environments required for the re-establishment of productive wild rice beds (Lovis et al. 2012; Monaghan and Lovis 2005). During the late Late Woodland period, the Cloudman site, located downriver from productive modern wild rice paddies, would have been a prime base locale for logistical forays exploiting the renewed abundance of this resource. At the same time, the site may not have remained a viable locale for continued maize cultivation, or the expense of energy invested in growing maize or acquiring it through social relationships was too great. Instead, late Late Woodland occupants of Cloudman site supplemented their diet with nuts/acorns, which appear in nearly 90% of lipid signatures of the late Late Woodland vessels sampled.

The focus on wild rice exploitation may also signal a shift in food-related identities at a time of increased group localization and identity, as manifested by the proliferation of distinct pottery styles during the late Late Woodland period (McHale Milner 1991, 1998; O'Shea and McHale Milner 2002). While maize may have grown poorly at the Cloudman site at this time, its availability and/or appeal may have also changed in the altering social landscape. Wild rice is closely related to the identity of modern Ojibwe identity (Densmore 1979, 2005; Scott 1996;

Vennum 1988), so as a locally abundant resource, late Late Woodland groups may have begun to root both their subsistence and identity to this sacred food.

Maize microbotanicals appear again in Iroquoian vessel residues, as expected given the centrality of maize in Iroquoian diets. Whether the vessels present at Cloudman were used by Ontario Iroquois groups or by Late Woodland/proto-Odawa groups engaging in intensive trade relationships with the Ontario Iroquois, maize would have been a component of their diet. However, even among the Iroquoian vessels, wild rice was more common than maize. Wild rice is not mentioned in ethnohistoric accounts of Iroquoian/Huron groups (Tooker 1991; Waugh 1973), nor is it generally associated with the Odawa (Scott 1996; Smith 1996). Wild rice must have been abundant enough at the site for it to become an important resource for all local groups using the site post-AD 1200. In aggregate, the microbotanical and lipid evidence ultimately supports Dunham's (2014) hypothesis that wild rice and acorns grew in importance in the late Late Woodland period, and that maize was not as significant a resource during the same period for groups occupying the Eastern Upper Peninsula.

Synchronic culinary trends associated with identity were not evident from the results of the dietary analyses. Cluster analyses of food types inferred from lipid and microbotanical data did not reveal groupings of foods or food combinations within analytic subsets. However, the only vessels in which maize, wild rice, and squash were found together were in Ontario Iroquois vessels. This could be a local variety of the Three Sisters food tradition that later formed the foundation of Iroquoian cuisine, which, although is important to modern Anishinaabe/Algonquian groups, has been historically more closely associated with the Iroquois, and is the strongest evidence for cuisine-related identity at the Cloudman site.

The results of the dietary analyses also have important methodological implications. Lipid analysis of Cloudman pottery residues detected medium fat foods (indicated by C1:0 isomer ratios) in 17% of samples, while stable isotope analysis detected aquatic resources in 96% of sampled vessels. These high delta nitrogen values may represent aquatic plants but fall closer to values expected from high-trophic-level fish. Smoking or drying fish prior to cooking in pottery vessels may affect its lipid content, so this method of lipid analysis may therefore underrepresent fish, as do other methods using lipid biomarkers (Taché and Craig 2015). If fish are anticipated in food signatures from archaeological pottery residues, lipid residue analysis may best be employed in cohort with stable isotope analysis.

Stable isotope analysis of charred food residue, however, has also been found problematic when independently employed for evaluating maize processing. The use of maize in varying amounts was predicted at the Cloudman site, where maize macrobotanicals were identified from Late Woodland features (Egan-Bruhy 2007). Microbotanical analysis identified maize starches and phytoliths in pottery residues from the Middle Woodland, early Late Woodland, and Iroquoian pottery subsets, while stable isotope analysis yielded δ^{13}C values well below those expected for residues containing maize. As Hart et al. (2007) demonstrated, stable isotope analysis is not a reliable indicator of maize in archaeological food residues, yielding false negatives unless large amounts of maize are present in food resource mixes. Acorns may similarly become masked in stable isotopes results; nuts, which are low in nitrogen, were not represented in the high δ^{15}N values of the Cloudman pottery residues, possibly because protein-rich foods contribute more to nitrogen values than resources with less protein (Philips and Koch 2002; Schwarcz et al. 1985). Additional experimental replications are required to further clarify isotopic values of cooked fish, aquatic plants, and acorns in carbonized food residue. The results of this study demonstrate that tandem employment of lipid residue, stable isotope, and microbotanical analyses of pottery residues is not only recommended but necessary for accurate depictions of ancient diet.

Conclusion

Results of microbotanical and chemical (stable isotope and lipid residue) analyses of adhered and absorbed food residues from ancient pottery contribute rich insight into dietary and culinary habits of groups occupying the Cloudman site. Nuts (mostly acorns) and aquatic resources (likely high-trophic-level fish) were important dietary staples of people living at the site from its earliest occupation (ca. AD 100) until the contact period. Maize, wild rice, and squash were also consumed throughout the occupational history of the site, although in varying intensity. Maize was more frequently present in food residues associated with the earlier occupations of the site (AD 100-AD 1000), all but disappearing from residues in the late Late Woodland, in a near-inverse relationship with wild rice, which increases in frequency through time. Whether external social relationships, environmental change, or culinary preferences changed (or some combination of these reasons) is unknown, although the environmental effects of the Medieval Climatic Optimum post AD-900 may have affected resource abundance and selection. A local variant of the "Three Sisters" cuisine may have developed at the Cloudman site post-AD 1200, when maize, wild rice, and squash are found together in residues from Ontario Iroquoian vessels.

These results support Dunham's (2014) finding that exploitation of starchy foods, particularly wild rice and acorns, was intensified in the Eastern Upper Peninsula of Michigan in the late Late Woodland period. However, if Cloudman is considered representative of the larger region, there is little evidence to support intensive maize agriculture at northern Great Lakes coastal sites during the late Late Woodland period (O'Shea 2003). There is also no clear evidence in support of an increased reliance on deep-water spawning (high-trophic-level) fish during the Late Woodland period per Cleland (1982); although the exploitation of aquatic resources, likely including high-trophic-level fish, appears consistent at the Cloudman site throughout its occupational history, the data is not fine-grained enough for evaluation of the relative dietary proportion of these resources at any given time.

The novel combination of lipid residue, stable isotope, and microbotanical analyses for assessing foods cooked in ancient pottery has provided greater inferential resolution than could any one method alone. Each method has proven important for providing unique and vital information about ancient diet. There are also inherent and acknowledged limitations in the types of foods each method can identify, but their use together has highlighted additional shortcomings in their applications to evaluating residue content. This study should be used as the basis for developing guidelines and best practices for inferring ancient diet from pottery residues.

The archaeological data summarized in this chapter has substantially increased our understanding of culinary habits of people who lived at the Cloudman site have been. However, it can be further enhanced through examination of ethnographic and ethnohistoric accounts of food selection and cooking. The next chapter will review observed culinary traditions of historic Native American groups living in the Upper Great Lakes region and discuss them in context with the outcomes of the archaeological data, discursive comparisons that will augment the inferential strength of interpretations of past cuisine.

CHAPTER 8

ETHNOGRAPHIC AND ETHNOHISTORIC ACCOUNTS OF DIET AND COOKING

Introduction

Interpretations of archaeological data can be supported and enhanced by comparisons with traditions and practices of historic or modern peoples by forming analogical connections between culinary behavior and its physical (i.e., archaeological) manifestations. This chapter reviews ethnographic and ethnohistoric accounts of Ojibwe and Iroquoian culinary practices and discusses dietary and cooking data from the Cloudman site within the context of observed indigenous traditions. Together, the ethnographic and archaeological information will be used to reconstruct precontact cuisine and highlight potential ethnic culinary differences in food preparation methods and recipes.

Ethnographic analogy as a middle-ranging method for interpreting archaeological data has limitations and is here approached with recognition of its limits and biases (Johnson 2010). As the archaeological evidence demonstrates, diet and cooking are not static behaviors and are instead subject to change over time, although subsistence behaviors are also often conservative, with certain culinary traditions remaining constant through long stretches of time (Twiss 2012). Historic-period lifeways of indigenous communities may therefore resemble those of precontact groups inhabiting similar environments with comparable resources. These accounts also capture Native American life only after contact with Europeans and subsequently cannot fully reflect precontact lifeways, whether explicitly acknowledged by the ethnographer (e.g., Rogers 1962) or not (e.g., Densmore 1979; Hilger 1959). For example, most of the groups observed no longer manufactured or used pottery, which prevents analogous observation of cooking habits, as metal cooking pots have different performance characteristics and ranges of functions than their ceramic predecessors. Access to local, traditional foods may have been limited to communities inhabiting reserve lands, while the introduction of Western (Euro-American) foods after and during contact with Europeans would have also impacted local foodways. Historical and ethnographic accounts are likewise biased, both in the information recorded by the observers, and the ways in which the information is conveyed.

Despite these concerns, ethnographic data is informative when carefully examined in context with archaeological data. Ethnographic and ethnohistoric accounts of the historic-period Algonquian and Iroquoian groups provide additional details and support the archaeological data. Accounts of Ojibwe (Baraga 1976; Densmore 1979, 2005; Hilger 1959; Rogers 1962; Vennum 1988) and Huron/Iroquoian (Tooker 1991, Waugh 1973) lifeways were used for assessment of culinary habits and behaviors. Culinary habits as inferred from the archaeological data are compared to and re-assessed in context with behaviors observed in the ethnographic and ethnohistoric sources.

Fish

The evidence for possible habitual fish processing in pottery vessels from the Cloudman site was unexpected given the results of prior ethnographic and lipid residue analyses (and modern distaste for boiled fish). Previous ethnographic surveys of Ojibwe, Cree, Innu, and Iroquoian ethnographic and ethnohistoric literature concluded that boiling was among the least common methods of fish preparation (Kooiman 2012, 2016; Lovis and Hart 2015), supporting the lack of fish lipids in previous sampling of pottery from the south shore of Lake Superior (Malainey and Figol 2015; Skibo et al. 2009). The results of the stable isotope analysis of

Cloudman site pottery residues necessitated a more in-depth and broadly framed review of ethnographic and ethnohistoric accounts of Ojibwe and Iroquoian groups to better capture the range of traditional methods for fish preparation.

One of the earliest accounts of Ojibwe life, from Rev. Frederick Baraga in 1847, claims that the L'Anse Chippewa of the Upper Peninsula "have no particular skill in boiling fish" (1976:64). In *Chippewa Customs,* Densmore (1979:42) notes that fish were either eaten fresh or stored by drying or freezing. When eaten fresh, the fish were commonly spit roasted, fried, or flaked and packed with sugar. However, "the head of fresh fish, especially suckers, were boiled and greatly liked," and "fresh fish were boiled and the broth used;" when dried or smoked fish were needed for food, they were also boiled (Densmore 1979:42).

Hilger notes in *Chippewa Child Life* that both fresh and smoked fish were important in early Chippewa diets, but that meat, fish and fowl "were boiled with cultivated vegetables, such as beans, corn, squash, and pumpkin, and with native ones, such as wild rice, wild potatoes, and tips of certain plants" (Hilger 1959:144). The Round Lake Ojibwe in northern Ontario mostly dried or smoked fish, but "fish head and intestine provide oil; boiled in water, oil rises to surface and skimmed off with a wood spoon" (Rogers 1962:C49). Species of fish other than whitefish were infrequently used as food (Rogers 1962:C47-48), indicating the taste preference for the high-trophic-level species reflected in the stable isotope values of pottery residues at the Cloudman site.

Iroquoian groups also relied heavily on fish and processed them with a variety of cooking techniques. F. W. Waugh recounts how early explorers encountered "great kettles of Indian corn soup…with dried eels and other fish boiled in it" (1973:136). Among the preparations for fish observed directly by Waugh include boiled fish, fish soup, and fish and potato soup, although fish were also fried, roasted, and dried (1973:137). Among the Huron of Ontario, fish was commonly dried in the sun or smoked but was also used "as a relish for their soup, especially in the winter," and the "biggest and fattest fish" were boiled to extract the fat (Tooker 1991:64). According to these sources, boiling fish was practiced among the Ojibwe and Ontario Iroquois and is not in opposition to an interpretation of the stable isotope analysis results indicating habitual fish processing in pottery at the Cloudman site.

Acorns

The lipid analysis of absorbed pottery residue suggests that nut processing was a regular if not important function of pottery vessels at the Cloudman site. Among some Ojibwe groups, acorns of white oak (red oak was considered too bitter) were "boiled in hulls, cooled, hulled, and dried in the sun, [and] when needed they were crushed or pounded to meal, boiled with meat, and served as thick soup" (Hilger 1959:145). Densmore (2005) reported that other Ojibwe groups had an affinity for *Quercus macrocarpa*, or burr oak, which produce large acorns. These were gathered in the late fall and buried for use in winter or spring, but they were also cooked for immediate consumption, when they were roasted in ashes, boiled and mashed, or boiled, split open and "eaten like a vegetable" (Densmore 2005: 320).

According to Waugh (1973:123), hickory nuts were the most esteemed nuts among historic-period Iroquoian groups, but they also routinely consumed walnut, butternut, hazelnut, beechnut, chestnut. Acorns were also popular, prepared by "first boiling them in lye made from ashes, in order to take from them their excessive bitterness (pp. 122-123). Nut meats were "pounded, boiled slowly in water, and the oil skimmed off into a bowl," the oil then mixed with a variety of foods, used in ceremonial foods of the False Face society, or used as mosquito repellent (Waugh 1973:124). Nut meats were also ground, sifted, and added to corn soup to "make it rich" (Waugh 1973:90, 124). Tooker (1991:62) mentions that among the Huron, acorns were boiled several times to "take away the bitter taste" and then consumed.

Although acorns are never referred to as primary staples of either the Ojibwe or Iroquois/Huron, their ubiquity in lipid signatures and macrobotanical remains demonstrate their importance to the occupants of the Cloudman site. Acorns were cooked and eaten independently but also added to soups and stews as a thickener. As Hilger (1959) noted, acorns were boiled to leech the tannins before they were stored or consumed, so Cloudman may have served as a seasonal residential locale to which logistical parties of gatherers brought acorns for large-scale processing and/or consumption.

Maize

According to the microbotanical evidence, there is a long history of maize consumption at the Cloudman site. The Ojibwe considered maize a primary food staple, which they roasted in the husks, parched in hot kettles, dried and boiled, or incorporated into soup (Densmore 1979:39; Densmore 2005:319). Maize was also boiled in its shucks prior to ripening, then braided, and hung to dry; the dried maize was then ground into meal and used primarily for thickening soups, although it was occasionally made into breads (Hilger 1959:145). The Ojibwe also made hominy by boiling maize in hardwood ashes (nixtamalization), rinsing, and boiling again (Densmore 2005:319).

Iroquoian groups developed a maize-centric cuisine over the course of several centuries, resulting in over 40 methods of corn preparation (Waugh 1973). The Huron (Wendat) preferred boiling maize to roasting it, and commonly used it as the primary ingredient in soups, which constituted many of their meals (Tooker 1991:68). Waugh (1973) lists pages upon pages of Iroquoian maize preparations. Maize was routinely nixtamalized, rinsed, hulled, and pounded into a flour. Corn bread was common and was boiled rather than baked; the resulting broth was then used to make corn soup (Waugh 1973:84).

Both maize nixtamalization and cooking processes are enhanced by extensive boiling, the preferred cooking method for the grain. During nixtamalization, maize would have been the sole content of a pottery vessel, but in all other preparations, corn was cooked with other ingredients, most commonly in soups and stews. Of the thirteen vessels from the Cloudman site associated with residues containing maize microbotanical remains, maize always co-occurs with another food or food group. This tradition of cooking maize primarily with other foods may have extended back to its earliest incorporation into the northern Great Lakes subsistence regime.

Wild Rice

Wild rice, or *manoomin*, has long been a primary dietary staple of Ojibwe groups of the northern Great Lakes. An ideologically and ceremonially important food, it has transformed into a marker of Ojibwe identity (Vennum 1988) and has even been used to distinguish their cuisine from those of neighboring Odawa groups in archaeological studies (Scott 1996). Densmore (1979, 2005), Hilger (1959), and Vennum (1988) all identify wild rice as the primary staple of Ojibwe diet.

Following harvest, wild rice was dried. Both Hilger and Densmore discuss the two primary methods of drying: air/fire drying, or parching. Hilger (1959:14) claims the divide in practices can be attributed to technology—that prior to European contact, wild rice was routinely spread on sheets of birchbark to dry in the sun, while after contact it was instead parched in metal kettles. Densmore does not link parching to metal kettles, but does comment that drying has greater antiquity than parching:

> "The second [method] is undoubtedly the oldest process, and produced what was known as "hard rice". This was greenish black in color, much darker than parched rice and requiring longer to cook. This rice could be kept indefinitely, and could be used for seed. In preparing "hard rice," a frame was made similar to that on which berries were dried. It was covered by a layer of hay on which the rice, either on stalks or in the husk, was spread to a depth of about 3 inches. A slow fire was kept burning beneath the frame. In this manner the rice was dried as vegetables or berries are dried (Densmore 2005:315).

After drying or parching, which loosened the husks, the rice was pounded and stored in birchbark *makuks* (Densmore 1979:148). To prepare it for consumption, wild rice was boiled in water or broth (Densmore 1979:39) or boiled in soups (Hilger 1959:148). It was also boiled in water and eaten "with or without maple sugar" or boiled with meat (Densmore 2005:319). Sometimes meat or fish broth was poured over fresh parched rice and allowed to "steam" until softened, while so-called "hard rice" was stored with dried blueberries in the winter and cooked together in the spring (Densmore 2005:319).

Some historical accounts record contact period groups preparing wild rice in the form of a gruel, which required a greater liquid-to-rice ratio than nonglutinous (fluffy) rice (Vennum 1988:47). Rice was also "used thicken broths including venison, bear, fish, and wildfowl," cooked into a bread-like paste, or pounded into flour (Vennum 1988:48). Wild rice is cited by

Vennum (1988) as being incorporated into a variety of stews with venison, small game, duck, or *tassimanonny*, a dish of boiled wild rice, corn, and fish.

Wild rice is not mentioned in ethnohistoric accounts of the Iroquoian groups, suggesting it was not a primary resource for these groups post-European contact, but it is also not generally perceived of as an Iroquoian food staple, despite the fact that it grows regularly throughout traditional Iroquois territory (Boyd et al. 2013; Terrell et al. 1997). The high proportion of Iroquoian vessels containing traces of wild rice implicates opportunistic foraging habits of the users of these vessels (be they Odawa or Iroquoian, neither of whom are associated with wild rice consumption). Considering the proximity of the Cloudman site to wild rice stands, occupants of the site, despite cultural identity, wisely exploited the seasonal abundance of this resource.

Like maize, wild rice phytoliths were only identified in vessels containing signatures for other foods. Although not entirely clear, ethnographic accounts seem to indicate that wild rice was sometimes cooked independently, as we cook rice today, but was more often cooked with a variety of other foods. Pottery vessels, then, were not constructed specifically for rice cooking, as is seen in other societies (i.e., Kobayashi 1994; Skibo 1994), but instead were all-purpose cooking pots. Regardless, wild rice requires long-term boiling to become palatable, necessitating cooking vessels with sufficient heating effectiveness and thermal shock resistance to withstand these processing demands. Late Late Woodland and Ontario Iroquois pottery from the Cloudman site with small temper particles would be technologically ideal for rice processing.

Squash

The persistent and consistent presence of squash was the most unexpected result of the food residue analyses at the Cloudman site. This is not because squash was unimportant for indigenous groups historically, but because the antiquity of its use in the northern Great Lakes is relatively unknown and rarely discussed. Squash and pumpkins were in common use by 1847, when Frederick Baraga recorded them as one of the few crops grown by the L'Anse Ojibwe. The Ojibwe ate pumpkins and squash fresh, or they dried them for use later in the winter (Densmore 1979, 2005; Hilger 1959). When consumed fresh, they were generally baked in coals (Hilger 1959:144). Neither Hilger nor Densmore mentions boiling fresh squash. Squash was cut into strips to dry, and dried squash and pumpkin were boiled with meat or maple sugar (Densmore 2005: 319; Hilger 159:144). If dried squash were boiled, it might gradually break down and act as a thickening agent, potentially resulting in the dual boiling/stewing interior carbonization patterns associated with squash phytoliths in Cloudman cooking vessels.

The Iroquois incorporated squash into a more complex cuisine. They, too, dried, boiled, or baked squash and pumpkins in coals (Tooker 1991:71; Waugh 1973:114). Squash/pumpkin and corn were "frequently combined in the preparation of food" (Waugh 1973:87), including corn and squash or pumpkin bread (into which berries were also mixed), dried pumpkin hominy porridge, and a sort of boiled pudding made of pumpkin/squash and hominy.

Like maize and wild rice, squash was never the sole foodstuff cooked in the sampled vessels from the Cloudman site. Although squash has long been associated with maize as two of the "Three Sisters," it is not found in context with maize except in two Iroquoian vessels, suggesting a relatively late adoption of the Three Sisters culinary tradition in the region, or signaling a switch in the cultural (and culinary) identity of the occupants of the Cloudman site alongside the new, distinct pottery tradition post-AD 1400.

Other Foods

Also integral to the Ojibwe and Iroquoian diets were meat, berries, some vegetables, and maple sugar, although the degree to which these foods could be distinguished in the food residues is variable. Lipid signatures for large herbivores and medium-sized mammals were present in a few vessels. Most vegetables/greens (including aquatic plants) and berries would be considered low fat content plants but cannot be identified to a more specific level. Maple sugar is not detectable by any of the methods employed in this study. Nonetheless, these foods were all important components of Ojibwe and Iroquoian diets and may have been incorporated into the cuisine of precontact Cloudman site occupants.

The Ojibwe prepared meat much in the same way as fish: it was boiled; cut in pieces and spit-roasted on the fire; or cut in thin slices, dried in the sun or smoked over a low fire, and stored for later use, when it was typically boiled (Densmore 1979:43; Hilger 1959:148). Fresh meat was often cooked with green vegetables, dried berries, and/or wild rice (Hilger 1959:148). Moose meat and rabbit bones were boiled to render fat and grease (Densmore 1979:44). The Iroquois employed similar yet slightly different methods of cooking meat. Large game was boiled twice, then removed from the pot and fried in grease (Waugh 1973:134). Meat and bones of bear, raccoon and porcupine were rendered for their grease, which was retained for medicinal purposes. Meat was also spit roasted or dried and rehydrated by boiling (Waugh 1973:134). Non-mammal species consumed by Iroquoian groups include frogs, snakes, and turtles (Waugh 1973:138).

Berries were integral to Ojibwe and Iroquoian diets. They were regionally abundant (Baraga 1976:10) and added flavor to many dishes. Berries were eaten fresh but also extensively collected and dried, then boiled with other foods (Densmore 1979:40; Hilger 1959:144; Waugh

1973:126). Fresh berries were also boiled down and spread into little patches on birch barks sheets, leaving storable and transportable concentrated berry cakes that could be eaten raw or easily added into a pot of food (Densmore 1979:127; Rogers 1962:C52; Waugh 1973:127). Among the Iroquois, dried berries were often incorporated into cornbread (Waugh 1973:80). Blackberries and thimbleberries were combined with maple sugar and used in longhouse ceremonies (Waugh 1973:145).

Vegetables are not emphasized in the ethnographic literature, but still played an important role in ancient diet nonetheless (Yarnell 1964). Roots, bark, and lichen are referred to as Ojibwe starvation foods by Baraga (1976:65), and Rogers (1962:C47) claims the collection of vegetal foods is of “limited importance” among the Round Lake Ojibwe. However, a wide array of vegetables is mentioned in other sources. Milkweed flower, woodbine bark, and white pine moss are “unusual vegetable foods” of the Ojibwe (Densmore 1979:40). Milkweed shoots and tips of ferns were boiled and flavored with grease by the Lac Courte Oreilles Ojibwe (Hilger 1959:146). Wild potatoes were eaten by both the Ojibwe and Iroquois, and were typically boiled (Densmore 2005:319; Waugh 1973:119). The Iroquois extensively used the vegetative parts of various trees and shrubs, which were “cooked like spinach” (Waugh 1973:117). They also used roots such as pepper root, burdock, and artichoke, which were boiled or fried, and bark was pounded and made into bread (Waugh 1973:118-120). A number of other vegetable foods present in archaeological and ethnographic record are detailed by Yarnell (1964).

Aquatic plants may have contributed to the high $\delta^{15}N$ values detected in the stable isotope analysis of the Cloudman pottery residues. Those consumed by the Ojibwe include arrowhead root, bulrush (cattail), and hog peanut (Densmore 1979, 2005; Yarnell 1964). The Iroquois were known to consume marsh marigold, watercress, yellow pond-lilly roots, and skunk cabbage

(Waugh 1973). Aquatic plants were exploited and consumed but do not appear to have been a significant component of indigenous diet in the Great Lakes region. While they may have been available on Drummond Island prior to contact, none of these species were present in the macrobotanical remains from the Cloudman site (Egan-Bruhy 2007).

Maple sugar was an important component of historic Ojibwe diet. It served as one of the primary food seasonings, used with fruits, vegetables, cereals (including wild rice) and fish (Densmore 1979:123). It was also considered a snack, as “all forms of the sugars were extensively eaten as a delicacy” (Densmore 1979:39). Even various Iroquoian groups enjoyed maple sugar, adding it to hominy to make “parched corn meal” or sometimes even fermenting the sap for use as an intoxicant (Waugh 1973:141, 147).

Unfortunately, standard lipid residue, stable isotope, or microbotanical analyses cannot distinguish maple sugar in pottery residues. The antiquity of maple sugaring has been hotly debated (Holman 1984; Holman and Egan 1985; Mason 1986; Mason and Holman 2000), so the timing of its incorporation into regional cuisine is unclear. Many of the foodstuffs present in the residues are late summer/early fall foods, suggesting the Cloudman site was used extensively in the fall, while maple sap is collected in the spring. Still, faunal and macrobotanical remains indicate some spring occupation of the site (Cooper 1996; Egan-Bruhy 2007), so some occupations may have taken place during sugaring season. Maple sugar is also easily storable, and, as an important flavoring agent and source of carbohydrates, it may have been brought to the site for consumption during the fall. Even if pottery vessels at Cloudman were not involved in maple sap processing, maple sugar may have been incorporated into recipes and meals cooked in the pots, leaving chemical signatures in the residues. Biomolecular analysis of organic residues may be a line of future study for detecting maple sugar in archaeological pottery (see McGovern and Hall 2016).

Cooking and Cuisine

The historical focus of archaeological investigations into foodways has been the individual components of diet. Cuisine, or food culture, encompasses not only food choice but also food combinations and cooking styles (Twiss 2012). Patterning of carbonized food residues on Cloudman pottery vessels (and pottery from other sites in the northern Great Lakes) show some degree of diachronic variation, suggesting a change in cooking styles over time (see Chapter 6). Microbotanical analysis revealed a diachronic shift in maize and wild rice processing, yet connections between transformations of diet and cooking styles remain speculative. The archaeological food residues also prove that different types of foods were routinely cooked in the same vessels, but the dietary analyses cannot distinguish whether processing of distinct foods occurred together or in separate, sequential cooking events. Ethnographic observations of cooking behaviors, coupled with actualistic experiments, can inform and enhance inferential connections between diet and cuisine.

Among both the Ojibwe and Iroquois, the following are specified as foods that are habitually boiled: corn, squash/pumpkin, fish, berries, meat, acorns, wild potatoes, roots, greens, and maple sap. Wild rice was also boiled by the Ojibwe. Among the Round Lake Ojibwe, “all food is prepared basically in one of two ways, either boiling or roasted on a spit beside a fire; boiling is more common and practically all species of mammal, bird, and fish are cooked in this way” (Rogers 1962:C53). The ubiquity of boiling as a cooking practice among post-contact

Ojibwe and Iroquois/Huron appears rooted in cooking traditions extending back to the Middle Woodland period (and probably earlier—see Speth 2015).

"Stewing" was only mentioned as a cooking technique by Vennum (1988) in his discussion of wild rice preparations, although several other sources mention adding ingredients such as acorn flour, pumpkin blossoms, and corn silk to soups as "thickening agents" (Densmore 1979; Hilger 1959; Waugh 1973). Stewing, a cooking process involving water-content reduction, was practiced at the Cloudman site throughout its occupational history, but it was most commonly employed during the Middle Woodland occupation.

Groups with distinct cultural identities and traditions may consume the same foods as other groups but maintain unique methods of food preparation. For the Ojibwe, "a typical meal comprised meat or fish, broth, rice with maple sugar, and dried berries prepared in some way" (Densmore 1979:40). Meat and fish were "boiled with cultivated vegetables, such as beans, corn, squash, and pumpkin, and with native ones, such as wild rice, wild potatoes, and tips of certain plants" (Hilger 1959:144). Foods were boiled, often multiple types together, but it is not clear if food was extracted from the cooking water and served, or if components of each dish were served together as soups. Stews incorporating wild rice were common (Vennum 1988).

Among the Iroquois, "a very large proportion of… foods were evidently of liquid nature – numerous references to soups and broths made from ripe and unripe corn, beans, squashes, meats, and other materials" (Waugh 1973:79). Corn soup was particularly common, and modern iterations tend to be rather aqueous. There are reports of "great kettles of Indian corn soup, or thin hominy, with… fish boiled in it" (Waugh 1973:136). It is then of little surprise that evidence of boiling was commonly observed in Ontario Iroquois vessels.

However, another Iroquoian dish, *sagamité*, could be characterized as a stew or thick soup made by "pounding two or three handfuls of raw pounded [corn] meal which had not had the hull removed; put in an earthen pot full of water, boiled very clear and stirred to prevent meal from sticking to pot and burning; if available a small quantity of fish… or meat was added, sometimes pumpkin, too. If fish had been added, it was taken out and pounded very fine, without removing the bones, scales or entrails, and put back into the pot" (Tooker 1991:68). In this process, maize was first boiled, then other foods, such as squash/pumpkin and pounded fish, were added, which would thicken the soup. *Sagamité* preparation could result in the combined interior carbonization pattern (Pattern #3) indicative of both boiling and stewing, which was slightly more prevalent among the Iroquoian pottery than among late Late Woodland vessels (see Table 6.14).

Both Ojibwe and Iroquoian cuisines included varieties of boiled foods and dishes. Although foods can be boiled in organic containers by either adding hot stones to the contents or by filling containers full and putting them directly over the fire (Densmore 1979; Holman and Egan 1985; Speth 2015; Wallis and Wallis 1955; Waugh 1973), the advent of pottery at the outset of the of the Woodland period would have facilitated greater incorporation of boiling into everyday culinary routines. The eventual adoption of metal cooking pots by Native American groups following the establishment of trade with Europeans may have led to an increase in boiling practices in the historic period, resulting in overrepresentation of the cooking method in the ethnographic record. Nevertheless, interior carbonization patterns present in the Cloudman pottery assemblage demonstrates that boiling practices were employed as early as the Middle Woodland period and became increasingly common through time.

Stewing, or long-term, low-heat cooking, was employed by the Ojibwe for certain preparations of wild rice and squash, which could result in interior carbonization patterns corresponding to stewing or boiling/stewing. In Middle, early Late, and late Late Woodland vessels, wild rice phytoliths are associated only with stewing interior carbonization patterns (see Table 7.10). Among Ontario Iroquois pottery vessels, wild rice is associated with the dual boiling/stewing pattern.

Ojibwe and Iroquoian cuisines share many similarities while remaining distinct. Soup was a common dish among the Iroquois; Ojibwe cooks boiled food and consumed their meals with broth, ethnographers only occasionally refer to their dishes as "soups," and wild rice stews were popular. Overall, cooking styles appear similar, as are cooking styles inferred from interior carbonization patterns of late Late Woodland and Ontario Iroquois pottery vessels. The Iroquois diet centered on maize, while wild rice was more important to the Ojibwe. However, both maize and wild rice were more frequent in residues from Ontario Iroquois vessels than in late Late Woodland vessels (see Table 7.7). The Three Sisters culinary tradition, including maize, beans, and squash, may be represented at the Cloudman site with wild rice serving as a substitute for beans. Maize, wild rice, and squash co-occur in residues only from Ontario Iroquois vessels, possibly representing a local expression of Three Sisters cuisine. However, because the identity of the group using the Iroquoian vessels at the Cloudman site is unclear, such an interpretation is merely speculative, as the Ojibwe and other Algonquian groups also routinely consumed these foods.

Conclusion

The ethnographic and ethnohistoric records largely support the archaeological data for the food types selected and modes of cooking employed at the Cloudman site. Most of the primary food staples consumed by post-European contact Ojibwe and Iroquoian groups were represented in the pottery food residues, with the exception of maple sugar, which is not detectable through conventional residue analyses. Common cooking methods, particularly boiling, reflect interior carbonization patterns encountered in the ceramic cooking vessels, particularly those from later occupations of the site. Stewing as a cooking technique may have gradually fallen out of favor with northern Great Lakes cooks over time and was likewise a less common cooking method observed by ethnographers. Culinary distinctions are apparent between historic Ojibwe and Iroquois, although these differences cannot definitively distinguish ethnic identities of the groups that occupied the Cloudman site.

Overall, the ethnographic and ethnohistoric evidence supports and enhances interpretations of the archaeological data presented in this study. Historic Ojibwe and Iroquoian resource selection closely parallel the archaeological food remains and chemical signatures discovered at the Cloudman site. Actualistic observations of indigenous preparations of the same suite of resources has proved a useful tool for connecting cooking styles with specific foodstuffs and food mixes. Reinforced by these data, interpretations of the results of this study can be reviewed and final conclusions summarized.

CHAPTER 9

CONCLUSIONS

Introduction

Application of a novel combination of analytic methods to the pottery assemblage from the Cloudman site has produced a robust body of data about precontact northern Great Lakes indigenous pottery technology, pottery use, and cuisine. This study employed taxonomic categorization and functional analysis of the Cloudman pottery assemblage in tandem with vessel-specific AMS dating, stable isotope analysis, lipid residue analysis, and microbotanical analysis of food residues associated with pottery. This is the largest sample subjected to this range of analytic approaches in the Great Lakes region, and the results, enhanced by ethnographic analogy, inform local site history, long-standing regional questions in the northern Great Lakes region, and methodological considerations for evaluating ancient diet through food residues associated with pottery.

Context and Chronology of the Cloudman Site

The occupational history of the Cloudman site was established through the taxonomic classification of pottery vessels and AMS dating of adhered pottery residues. Diachronic comparisons of the ceramic technical and use-alteration properties and outcomes of dietary analyses could not have been achieved without an established chronological framework. Initial taxonomic classifications of the Cloudman assemblage by Branstner (1995) were revisited and refined with accumulated new data. Middle Woodland, early Late Woodland, late Late Woodland, and Ontario Iroquois pottery types represented the most substantial occupations of the site. Small subassemblages from the Middle Woodland/Late Woodland transition and the middle Late Woodland period were identified but were not large enough for inclusion in most analytic comparisons.

Reassessment of the assemblage supported a majority of Branstner's identifications and temporal assignations, and AMS dating allowed further refinement of the occupational history of the site. A Middle Woodland period occupation is represented by several varieties of Laurel ware. Two Laurel vessels yielded statistically different median AMS ages—cal AD 87 and cal AD 127—representing at least two distinct occupations at the site during this period. Several late Laurel and Middle/Late Woodland transitional vessels (ca. AD 500-700) signify brief uses of the site after the primary Middle Woodland occupations. The early Late Woodland occupation is represented by AMS dates from individual Mackinac Banded and Blackduck Banded vessels, which produced a mean pooled median age of cal AD 957. Five Bois Blanc vessels represent a small middle Late Woodland occupation. The late Late Woodland occupation is represented primarily by Juntunen wares typically manufactured between AD 1200-1400 (Lovis 2014) and Traverse wares associated with the period between AD 1100-1550 (Hambacher 1992).

Reassessment revealed that the most recent occupation, originally considered a "Protohistoric" Odawa occupation of the site ca. AD 1630, may instead represent a more complex habitation history. Much of the Ontario Iroquoian pottery assumed to have been brought to Drummond Island by the Odawa likely pre-dates 1630, supported by an AMS date of cal AD 1433 for one Ontario Iroquois vessel. Trade beads associated with this early Protohistoric occupation were likely made in the latter half of the 17^{th} century (Heather Walder, personal communication), meaning that trade items initially associated with Iroquoian pottery may instead date later than AD 1630. Most of the Ontario Iroquoian pottery present at the Cloudman site was manufactured between AD 1400-1650 and represents a distinct occupation subsequent to that of late Late Woodland peoples, although some overlap may have occurred. European-manufactured trade items at the site are likely indicative of distinct occupations dating to post-AD 1650.

Research Questions and Results

The questions used as a framework for this research (detailed in Chapter 3) were explored using a unique suite of analytic methods. Interpretations of the data for each question are summarized below. A synthesis of the findings is provided in response to the overarching research question posed in Chapter 1, which includes a diachronic summative account of the social and subsistence sequences observed through pottery and food remains at the Cloudman site.

<u>Question 1</u>: Are there differences in technical properties (i.e., thickness, temper size, rim diameter) among Middle Woodland, early Late Woodland, late Late Woodland, and Ontario Iroquoian pottery from the Cloudman site?

If regional reliance on starchy foods increased during the Late Woodland period, as proposed by Dunham (2014), it was predicted that there would be changes in pottery vessel thickness and temper size to accommodate new food processing needs, specifically, intensive boiling to make foods like acorn, wild rice, and maize palatable. Tethered dietary and technological changes have been observed elsewhere in the Eastern Woodlands (Braun 1983; Hart 2012). Observed technical changes include thinner pottery walls to increase heating effectiveness, and/or temper size reduction to improve thermal shock resistance.

Contrary to expectations, average vessel wall thickness increased through time at the Cloudman site. Middle Woodland vessels were, on average, the thinnest subassemblage, although once thickness was corrected for vessel size, Middle Woodland vessels were no longer significantly thinner than pots from later time periods. Vessel necks and shoulders were thickest among late Late Woodland vessels, a technical choice more likely associated with the need to support the heavy collared rims characteristic of the time rather than heating effectiveness, a structural or engineering decision rather than one associated with food preparation. Body thickness would be the most sensitive indicator of technical decisions to increase heating effectiveness, but this property did not significantly alter over time. Sample sizes for body thickness were small because of the low incidence of body sherds that could be confidently associated with identified vessels, affecting statistical outcomes.

Temper size proved the most significant and informative technical property of the Cloudman pottery vessels. Particle size remained relatively constant among Middle Woodland and early Late Woodland pottery but underwent significantly reduction among late Late Woodland and Ontario Iroquoian vessels. Decreased temper size can improve the overall strength of a vessel, a property appealing to potters constructing the collared wares characteristic of both late Late Woodland and Iroquoian societies, but it also increases thermal shock resistance, a durability required for vessels employed in intensive and/or long-term cooking episodes required for processing starchy foods, such as wild rice, acorns, and maize.

Prior diachronic studies of ceramic technology have not included vessel size as a factor, and its use in the study was largely exploratory. Using rim diameter as a proxy for size, Middle Woodland vessels were found to be significantly smaller than those constructed after AD 700. Since people in the Middle Woodland were more mobile and may have traveled in smaller groups (Brose and Hambacher 1999), the diminutive vessel size may be connected to group size or the need for more transportable vessels. If later occupations included larger aggregates of people and their durations of stay were more prolonged, construction of larger vessels would have been warranted. The increase in vessel size also co-occurs with the proliferation of boiling signatures, so vessel capacity may also be associated with some aspect of cooking effectiveness, although the connection is unclear at present and requires experimental work for clarification.

<u>Question 2</u>: Are there diachronic changes in ceramic vessel use and cooking habits evident through use-alteration traces?

Pottery use at the Cloudman site is characterized by both consistency and change. Pottery vessels from all occupations were primarily involved in cooking over fire, evidenced by high frequencies of vessels with interior carbonization across all subassemblages. Distribution of interior carbonization patterns also demonstrated that pots from all time periods were routinely filled to the top during the cooking process, a culinary habit seen at Woodland sites across the Upper Peninsula of Michigan (Kooiman 2012, 2015b, 2016).

Interior carbonization patterning, however, varied over time, representing alterations in cooking behaviors. Patterns indicative of stewing were most frequent among the Middle Woodland pottery assemblage, while boiling patterns increased in frequency among early Late Woodland, late Late Woodland, and Ontario Iroquoian subassamblages. This corroborates previously observed trends among Woodland pottery assemblages in the northern Great Lakes (Albert et al. 2018; Kooiman 2012, 2016). Differences in interior carbonization pattern frequencies between the Cloudman subassemblages were not statistically significant, but the small sample size may have affected the outcome.

An interior carbonization pattern not previously observed in the northern Great Lakes is present within the early Late Woodland, late Late Woodland, and Ontario Iroquoian subassemblages (see Figures 6.2 and 6.5). This pattern represents distinct signatures for both boiling and stewing in the same vessel. It was not observed in any Middle Woodland vessels and is therefore a cooking habit apparently adopted by northern Great Lakes peoples after AD 600. The boiling/stewing pattern could indicate boiling of starchy foods followed by water-reduction cooking (as with cooking rice) or later incorporation of other foods to create a thick soup or stew. The overall increase in the frequency in boiling and boiling/stewing patterns, when contextualized in data from other sites in the northern Great Lakes, signals a shift in cooking styles following the end of the Middle Woodland period. Boiling became a more common cooking technique, and while stewing was still employed, it diminished in importance.

***Question 3*: Are there diachronic changes in subsistence strategies (and possible attendant changes in cooking habits) detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery?**

Results of lipid residue and stable isotope analyses revealed that some aspects of diet remained consistent throughout the occupational history of the Cloudman site. Lipid residue analysis revealed that a majority (67%) of ceramic cooking vessels sampled from all subassemblages were involved in nut processing. Based on the proximity of the Cloudman site to precontact oak stands (Comer et al. 1995, 1997), the prevalence of acorns in microbotanical remains at the site (Egan-Bruhy 2007), and a preference for acorns among historic Ojibwe groups (Densmore 1979; Hilger 1959; Yarnell 1964), the nut lipids most likely represent acorns (although hazlenut and butternut were also probably consumed at the site). Nut lipids were increasingly present in pottery residues throughout the Late Woodland period, appearing in almost 90% of late Late Woodland samples, but decreased in frequency among Ontario Iroquois pottery.

Stable isotope analysis of Cloudman pottery residues yielded high $\delta^{15}N$ values, representing aquatic resources, either fish or plants. While consumption of fish at the Cloudman site was expected, the processing of fish in pottery vessels was not predicted based on the absence of fish lipids in absorbed pottery residues from other sites in the northern Great Lakes (Kooiman 2016; Malainey and Figol 2015; Skibo et al. 2009). Enriched $\delta^{15}N$ values were encountered in 96% of sampled vessels from the Cloudman assemblage, including vessels from all occupations. These values most closely resemble those of high-trophic-level fish, which would include species like whitefish and lake trout. The practice of boiling fish is chronicled in several ethnographic and ethnohistoric sources, corroborating this interpretation of the stable isotope results. Aquatic plants may have also contributed to the nitrogen enrichment of the pottery residues, although these were less important components of historic-period indigenous diet and are absent from the microbotanical remains recovered from the site. Whether floral or faunal, aquatic resources were consistently processed in pottery vessels at the Cloudman site throughout all occupations.

Microbotanical analysis revealed diachronic disparities in foods processed in ceramic vessels. Maize was present in adhered food residues in Middle and early Late Woodland vessels with relatively greater frequency than in late Late Woodland and Ontario Iroquoian vessels. Conversely, wild rice increased in frequency over time. All but absent in the early Late Woodland, wild rice is present in over half of all late Late Woodland and 80% of Iroquoian pottery residues sampled. Differences in microbotanical frequencies between the early Late

Woodland and late Late Woodland samples were statistically significant, signaling a drastic shift in subsistence habits between AD 1000 and AD 1200.

These shifts in resource selection could be associated with the Medieval Climatic Optimum (AD 900-1000), which caused both an overall warmer climate and lower lake levels, contributing to increased riverine fluctuations and flooding episodes that could destabilize established wild rice beds (Lovis et al. 2001; Lovis et al. 2012; Monaghan and Lovis 2005). Higher temperatures would have increased productivity of horticultural efforts while water level fluctuations adversely affected the availability of wild rice during the early Late Woodland occupation of the Cloudman site. Climatological cooling concurrent with the late Late Woodland period may have inhibited productivity of maize horticulture, and re-stabilization of riverine environments would have facilitated regrowth of wild rice beds, causing a reversal in resource availability and selection (Lovis et al. 2012). Maize starches and phytoliths, completely absent from late Late Woodland pottery residues, reappear among Ontario Iroquoian vessels, although only in context with squash and wild rice. Squash was processed and consumed throughout the occupational history of the site, but is most abundant in pottery residues associated with later occupations.

Previous studies argued that exploitation of high-trophic-level, deep-water-spawning aquatic resources (Cleland 1982), maize (O'Shea 2003), and wild rice and acorns (Dunham 2014) intensified in the Late Woodland period, particularly post-AD 1200. Results of this study support the increased importance of wild rice but do not support the increased importance of maize at the Cloudman site during the late Late Woodland period. The results presented here also indicate consistent exploitation of aquatic resources and nuts/acorns from AD 100 to AD 1600. Increased intensification of aquatic resources, including high-trophic-level fish, during the Late

Woodland is neither supported nor disputed by data from the Cloudman site. Nut/acorn lipids are most frequent in late Late Woodland vessels, in accordance with Dunham's (2014) findings, but nut lipids are present in over half of all samples during all time periods and were therefore important at the Cloudman site throughout all occupations.

<u>Question 4</u>: Is there synchronic variation in ceramic vessel use, subsistence strategies, and cooking habits evident through use-alteration studies or detectable through lipids, stable isotopes, and microbotanical remains extracted from pottery of differing typological categories?

Synchronic variation of technology and diet was difficult to assess given the limited size of the Cloudman assemblage. As hypothesized, the number of distinct taxonomic pottery types increased over the span of the Woodland occupations. The Middle Woodland subassemblage was dominated by Laurel wares, for which typological variation appears related to diachronic disparities rather than expression of group identity, according to the statistically distinct AMS dates between the Laurel Dentate Stamped and Laurel Pseudo-scallop Stamped vessels. Two North Bay vessels were the only non-Laurel ceramics in the subassemblage. The early Late Woodland subassemblage was only slightly more varied, comprised primarily of Mackinac wares, but also including Blackduck ware common to the north and Bowerman ware, which is local to the northern lower peninsula of Michigan. The late Late Woodland assemblage was the most varied, with Juntunen wares, a substantial number of Traverse wares, and numerous vessels that did not fit into existing taxonomic typologies. This supports the narrative that the social fluidity of Middle Woodland groups was gradually replaced with increased social localization of Late Woodland groups, with socially-distinct groups (using distinct pottery types) interacting at seasonal aggregation sites during the Late Woodland period (Brose and Hambacher 1999; Carroll 2013; Cleland 1982; Dorothy 1978; McHale Milner 1998; McPherron 1967).

Variation in technical and use-alteration properties and food residue content between contemporary pottery types was explored to identify unique dietary and cooking habits associated with social identity. However, given the relatively small sample sizes for each taxonomic type, clear patterns of pottery use, cooking, and diet were not apparent. A broader, regional survey of taxonomic types is required to accurately assess the relationship between cuisine and identity among precontact groups in the northern Great Lakes region.

***Question 5*: How do ethnographic and ethnohistoric accounts of indigenous diet and cooking in the Great Lakes inform interpretations of ancient cuisine generated from the archaeological data?**

Culinary habits of historic Ojibwe and Iroquoian groups reflect many of the food traditions inferred from the archaeological record, particularly those of later occupations. Boiling foods was a common cooking mode among both the Ojibwe and Iroquoians, a practice that emerged as the predominant cooking technique during the Late Woodland period, as evidenced by interior carbonization patterns on pottery from Cloudman and other sites in the northern Great Lakes. Foods were generally cooked and/or served together as soups or multi-component dishes. The twenty Cloudman pottery vessels subjected to all three dietary analyses (lipid residue, stable isotope, microbotanical) all produced signatures for more than one food category, reflecting the multi-use nature of pottery and culinary traditions of groups occupying the site.

Both the Ojibwe and Iroquois commonly consumed fish and nut/acorns, much as Cloudman residents did throughout history. Despite prior oversight of the prevalence of boiling fish, review of the ethnographic and ethnohistoric sources revealed that fish were regularly boiled, reflecting the patterns of possible fish processing in pottery vessels used at the Cloudman site throughout precontact history. Nuts, and particularly acorns, were boiled for leaching purposes but also ground into flour and added to soups as a thickening agent.

Maize was commonly consumed by both historic Ojibwe and Iroquois, although it was much more central to Iroquoian cuisine. Based on the observed frequencies of starches and phytoliths, maize may have been more common during the earlier occupations of the Cloudman site (AD 100-1000) than in post-AD 1200 occupations. By the Historic period, however, maize is ethnographically listed as one of the primary foods for both societies. Squash, which was grown and consumed by both the Ojibwe and Iroquois, was consistently present at the Cloudman site during all occupations.

Wild rice was considered a staple food among the Ojibwe, although it does not seem to have been a staple among groups at the Cloudman site until the late Late Woodland period, although it was processed and consumed in small amounts during the earlier occupations. Wild rice was not reported as a component of historic-period Iroquoian cuisine. The presence of wild rice in food residues adhered to Ontario Iroquois pottery poses an intriguing question about the identity of the users of these vessels. Wild rice is not a foodstuff generally associated with the Odawa, either (Scott 1996; Smith 1996), so if occupants of the site post-AD 1400 were Iroquoian or proto-Odawa, they were opportunistically exploiting a locally abundant resource that may not have been part of their traditional cuisine. Residues from these same vessels also yielded a unique combination of maize, wild rice, and squash microbotanicals not observed in residues associated with earlier occupations, possibly reflecting a local variant of the Three Sisters, with locally abundant wild rice replacing the nutritional contribution of beans in the culinary triad.

<u>Overarching Research Question</u>: Do pottery technology, pottery use, diet, and cooking habits change over time, and if so, how do these changes relate to hypothesized transitions in settlement, subsistence, and social patterns among pottery-making groups in the northern Great Lakes region?

Data derived from ceramic taxonomic classifications, pottery function analysis, dietary analyses, and ethnographic analogy successfully informed the discrete archaeological queries posed in this study, but when evaluated together they create a dynamic narrative of life at the Cloudman site. Middle Woodland Laurel peoples occupied the Cloudman site on at least two separate occasions, around AD 87 and AD 127. The highly mobile, socially fluid Middle Woodland groups made small pottery vessels which served the primary function of stewing foods. Pottery vessel size may have been restricted to facilitate mobility/transportability, to feed smaller groups of people, or to fulfill other cooking-related requirements. Diet consisted of aquatic resources, nuts/acorns, various wild animal and plant foods, including wild rice, and cultivated food such as maize and squash. While boiling was employed as a cooking method at this time, it was not as prevalent as stewing, a habit observed at other Middle Woodland sites in the eastern Upper Peninsula of Michigan (Albert et al. 2018; Kooiman 2012, 2016). Maize macrobotanicals are associated with stewing patterns of adhered food residues; maize at this time may have been incorporated into the diet primarily as a ground meal incorporated into soups as a thickening agent. Peoples inhabited the site after the primary Middle Woodland occupations, as represented by a few Late Laurel vessels (ca. AD 500-700), although use-alteration traces and food residues reflect general continuity with prior food-related behaviors.

At the outset of the early Late Woodland period, pottery vessels grew larger and were employed more frequently for boiling food than stewing. The larger vessels may reflect larger groups gathering at "persistent places," locales repeatedly visited for extended occupations to exploit abundant nearby resources (Schlanger 1992; Thompson 2010), a trend observed among Late Woodland sites in the eastern Upper Peninsula of Michigan (Dunham 2014). The new social and settlement pattern accommodated manufacture and use of less-transportable materials that could be stored at a site for future use, aka "locale provisioning" (Lovis et al. 2005). The increase in vessel size is also concurrent with the proliferation of boiling practices, so expanded volume may have provided a functional advantage for this method of cooking.

The variety of foods cooked during this period did not significantly differ from those processed and consumed during the Middle Woodland, so the impetus for transforming cooking habits lies elsewhere. Among early Late Woodland vessels, maize microbotanicals are associated with interior carbonization patterns for boiling, potentially representing the emergence of nixtamalization (boiling whole kernels in alkaline solutions) as a maize processing method in this region. Although early Late Woodland vessels increased in capacity, temper particle size did not decrease, as seen in New York, where thermal shock resistance became a premium physical characteristic because of increased dependence on maize (Hart 2012). However, early Late Woodland vessels are distinguished from all other subassamblages by a one morphological characteristic: constricted necks (and everted rims). Vessel neck constriction would increase the heating effectiveness of a vessel, allowing the larger vessels to heat up more quickly, remain hot by limiting the flow of air and steam in and out of the vessel, and, as a consequence, more effectively boil contents for prolonged periods of time.

People occupying the Cloudman site during the late Late Woodland period continued to manufacture large vessels (relative to Middle Woodland pottery). Distinct social groups, represented by greater ceramic stylistic diversity, aggregated at the site for intensive seasonal resource extraction. Potters selected temper particles that were significantly smaller than observed in earlier pottery. Smaller temper size, which improves increased thermal shock resistance, may have been a technical choice related to requirements for vessel durability during prolonged high-temperature cooking events. Manufacturers of Juntunen wares had abandoned the constricted necks characteristic of earlier Mackinac pottery for straight rim profiles and distinctive collars, a stylistic change that may have required a technological trade-off—the loss of temperature regulation provided by neck constriction required greater external heat application and the ability of pottery vessels to maintain integrity in these conditions. Frequency of wild rice phytoliths in carbonized residues increases during this same period. Wild rice requires long-term cooking to be made palatable and would require vessel built to withstand prolonged use over fire.

Maize is unexpectedly absent from late Late Woodland pottery residues. The amelioration of the Medieval Climatic Maximum at this time would have led to a cooler climate with riverine stabilization, a reversal that would have decreased maize productivity while creating an advantageous growing environment for wild rice on Drummond Island (Lovis et al. 2012; Monaghan and Lovis 2005). A new abundance of wild rice, which grows downriver from the Cloudman site, may have undercut the value of maize output given the energy required to cultivate the crop. The late Late Woodland period also signals a time of greater social localization (McHale Milner 1991, 1998; O'Shea and Milner 2002). Distinct group identities manifested through pottery style may have also been expressed through food selection, representing a conscious choice by late Late Woodland Cloudman occupants to exploit and associate themselves with locally-abundant wild rice. Microbotanical remains and lipid residues provide evidence for selection of wild rice and acorns in lieu of maize by late Late Woodland occupants of the Cloudman site. Wild rice is also found in context with stewing and boiling/stewing interior carbonization patterns on cooking pots. As boiling became a popular cooking method, the continuation of stewing practices may be connected to various modes of wild rice processing.

The manufacturers of the Ontario Iroquoian (or Iroquoian-like) vessels also followed the straight-rimmed, small-tempered pottery formula of late Late Woodland vessels, while employing distinct methods of decoration application. Again, these were vessels built to hold a reasonable amount of food that could withstand long periods over the fire without breaking. The users of these vessels (which may or may not have been the same people who manufactured them) employed cooking techniques and cooked foods similar to those of the late Late Woodland occupants of the site. However, maize reappears in association with Iroquoian pottery. The onset of the Little Ice Age after AD 1300 may have affected wild food availability, driving groups to increased reliance on cultivated maize and squash. The choice may also be connected to identity-related culinary choice. This is the first reported subassemblage in which wild rice, maize, and squash microbotanical remains co-occur in pottery residues. The Three Sisters cuisine (maize, squash, and beans) that became synonymous with Iroquoian cuisine emerged after AD 1300 (Bamann et al. 1992; Hart 2008; Kuhn and Funk 2000). Wild rice has similar nutritional value to beans (Boyd et al. 2014), and the combination observed at the Cloudman site may represent a local variation of Three Sisters cuisine, with occupants taking advantage of abundant wild rice stands. Ultimately, neither functional nor dietary analysis could clarify the identity of groups occupying the site post-AD 1400, a line of inquiry requiring further investigation.

Methodological Importance

Aside from contributions to the scholarship on regional food processing technology, diet, and cooking in the northern Great Lakes, this study yielded critical insights concerning methods for exploring ancient diet using food residues associated with pottery. At the outset of the study, it was clear that each method had defined limits for the types of data it could provide. Carbon/nitrogen stable isotope analysis of adhered carbonized food residues can detect terrestrial vs. aquatic food contents and distinguish C4 plants (i.e., maize) present in food mixes, but cannot identify other food categories or species. Lipid analysis of absorbed residues can identify general food groups, both plant and animal, but rarely allows for identification at the level of species. Microbotanical analysis of adhered residues can identify only a limited number of plant species known to preserve well in archaeological remains. This suite of analytic methods was complementary from the outset, but their application to the Cloudman pottery assemblage suggests that not only is it beneficial to use these methods in cohort, it may also be necessary.

The lipid residue analysis results came back mostly negative for medium-fat foods, a category inclusive of both maize and fish. The presence of medium-fat signatures in only 17% of samples is low, particularly compared to the 27% frequency of maize in microbotanical samples and the presence of enriched $\delta^{15}N$ values, possibly representing high-trophic-level fish, in 96% of residues sampled for stable isotope analysis. The lipid residue analysis used by Malainey and Figol (2018) and Taché and Craig 2015 may both underrepresent fish. Lipid residue analysis is otherwise a rich resource for dietary and cooking data, but if aquatic resources are expected, it should be employed in tandem with stable isotope analysis, a relatively inexpensive method that can enhance explorations of diet at a variety of sites.

Stable isotope analysis, however, should also be applied to ceramic assemblages with caution. Only a single sample (out of 50 total) yielded $\delta^{13}C$ values high enough to be interpreted as containing maize by some standards (Hastorf and DeNiro 1985), although even this sample is not considered enriched enough to indicate maize by more current standards (Katzenberg and Pfeiffer 1995; Muhammad 2010). This is well below the frequency of samples containing maize microbotanicals (27%). Hart et al. (2007) have already noted that carbon yield of cooked foods is highly variable and that maize can be underrepresented in the isotope values of food mixes, yielding false negatives. The results presented here support their conclusion that stable isotope analysis should not be used as the sole measure for maize in carbonized residues. Additionally, acorns evident in the lipid residue analysis did not appear to affect the stable isotope results. Acorns are low ^{15}N plants and the $\delta^{15}N$ values of the Cloudman residues were consistently very high, so the interplay of carbon and nitrogen contributions to the stable isotope compositions of food residues requires further exploration, as does the effect of cooking on isotope values. This method is therefore most gainfully employed in tandem with microbotanical and lipid analyses.

Finally, soil samples from the Cloudman site were subjected to both lipid residue analysis and stable isotope analysis to test for potential contamination of the pottery residue samples. Stable isotope signatures of the soil samples yielded low $\delta^{15}N$ values relative to the level of nitrogen enrichment characterizing the Cloudman pottery residue samples, proving the site matrix did not contaminate the archaeological remains. Lipid residue analysis provided similar results; the sole sample with high “cultural” lipid saturation contained different ratios of fatty acids than those yielded by absorbed pottery residues (Malainey and Figol 2018, Appendix C).

Soil samples have also been collected for examination using microbotanical analysis, the results of which are forthcoming. The completed tests established that contamination of adhered and absorbed archaeological food residues from the burial environment and taphonomic processes is negligible.

Future Research

This study has laid the groundwork for future research by revealing aspects of the archaeological record requiring additional clarification. The most obvious issue affecting analysis of the Cloudman pottery assemblage was the ambiguity of the timing and nature of the site's later, more recent, occupations. The Cloudman site occupies a unique geographical crossroads between the Upper Peninsula of Michigan, traditionally occupied by Woodland Algonquian groups, and southwestern Ontario, the territory of Iroquoian groups such as the Wendat, Petun, and Neutral (Trigger 1976). The presence of Ontario Iroquois pottery in areas outside of their traditional territory is commonly interpreted as the result of trade between local Algonquian groups and the Iroquoians, rather than the result of Iroquoian occupation of these sites (Fox and Garrad 2004; Guindon 2009). Such is the case at the Cloudman site, where the use of Ontario Iroquois pottery was attributed to Odawa traders occupying the site ca. AD 1630 (Branstner 1995). However, two Early Ontario Iroquoian vessels, likely dating to AD 1200-1300, and an AMS date of AD 1433 from another Iroquoian vessel, demonstrate an earlier presence of Iroquoian wares at the site than previously believed (although most of the Iroquoian pottery was probably manufactured and used after the late Late Woodland occupation of the site). Functional and dietary analyses revealed very few differences between the late Late Woodland and the Ontario Iroquoian assemblages, except for an absence of maize in late Late Woodland carbonized food remains and its presence in combination with wild rice and squash in Iroquoian pottery residues. Whether this disparity is a function of time or identity-related cuisine cannot be distinguished.

The exact timing of the late Late Woodland occupations requires further investigation by obtaining AMS dates from late Late Woodland Juntunen and Traverse wares and additional Iroquoian vessels to examine the time-depth and span of occupation(s) associated with both subassamblages. Compositional studies of the pottery itself could reveal clay and temper sources and determine whether all or some of the Ontario Iroquois vessels were manufactured locally or elsewhere. A mixture of foreign and locally manufactured vessels could support Branstner's (1995) hypothesis that the Late Precontact occupants were Odawa (or proto-Odawa) who used traded Huron/Wendat pottery alongside their own imitation Iroquoian vessels. Revisiting original excavation notes could provide additional contextual clues about the Iroquoian pottery in relation to Woodland pottery and various protohistoric trade goods.

The Cloudman assemblage was not large enough to provide useful insights about the relationship between cuisine and identity. Distinct culinary identities have been identified between archaeologically distinct groups and historic period tribes through archaeological and ethnographic data (Egan-Bruhy 2014; Scott 1996; Smith 1996). A regional survey of pottery and food residue contents of common local ceramic taxonomic types, particularly from the late Late Woodland and protohistoric periods, would facilitate more accurate examination of food choice and cuisine in relation to group identity. Expansion of the ethnographic and ethnohistoric survey, and the inclusion of sources chronicling the culinary habits of the Odawa, would be useful for refining the details of group-specific cuisine. The resulting data could be used to create standard dietary patterns/signatures for use in exploring possible multi-ethnic protohistoric and historic period sites in the northern Great Lakes and surrounding regions.

Actualistic experiments could answer lingering questions related to cooking techniques, pottery function, and interpretations of dietary analyses. Most interpretations of vessel size variation relate it primarily to the processing of different types of foods (Kobayashi 194; Rice 1987), social/ideological functions (Blitz 1993; Kooiman 2016; Potter 2000) or group/household size (Nelson 1981; Tani 1994; Turner and Lofgren 1966). Experiments testing the heating efficacy and other cooking-related capabilities of vessels of varying capacity could allow further insight into the function of vessel size in food processing.

The effects of cooking on the stable isotope yields of different foods and food mixes has also been minimally explored and requires further investigation to improve interpretive accuracy. Cooking wild rice, maize, squash, fish, aquatic plants, and acorns in different forms and combinations and recording the resulting interior carbonization patterns and carbon and nitrogen stable isotope values could yield important information about the interpretation of cooking, diet, and ceramic use-alterations traces in the northern Great Lakes and beyond. Although re-analysis of the Cloudman ceramic assemblage has informed several questions about northern Great Lakes lifeways and methodological efficacy, it has ultimately created a greater number of avenues of future inquiry.

Conclusion

A multi-decade debate about the nature of Woodland settlement and subsistence has persisted in northern Great Lakes archaeological research, and this study has contributed new information to this topic. Archaeological remains from the Cloudman site revealed the deep historical importance of fish, acorns, maize, wild rice, and squash to groups occupying the northern Great Lakes. Fluctuations in the intensity of wild rice and maize exploitation and variations in cooking methods and pottery technology reflect adaptive reactions to changes in the natural and/or social environments, reinforcing both the maintenance of food traditions and the adaptability and dynamism of human response to social and environmental change.

This study has also demonstrated the efficacy of a multiproxy approach to pottery and culinary research. Taxonomic and functional pottery analyses intertwine time, identity, and pottery use patterns, resulting in a deeper understanding of ancient social and human-environment relationships The novel collaborative application of lipid residue, stable isotope, and microbotanical analysis, further informed by macrobotanical information and ethnographic research, to a large pottery sample culminated in a comprehensive picture of ancient diet and cooking and serves as a model for future research initiatives exploring past foodways in contexts across the world.

APPENDICES

APPENDIX A:

Cloudman Pottery Data

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
1	MW	Laurel Pseudo-scallop Shell	**cal AD 80-214 (AMS)**	Laurel Pseudo-scallop Shell
2	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
3	MW	Laurel Plain	AD 100-300	Laurel Plain
4	MW	Laurel Dentate Stamped	**cal AD 60-125 (AMS)**	Laurel Dentate-stamped
5	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
6	MW	Laurel Dentate Rocker Stamped	AD 100-300	Dentate Rocker Stamped
7	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
8	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
9	MW	Laurel Pseudo-scallop Shell (oblique)	AD 100-300	Laurel Oblique/Pseudo-scallop Shell variety
10	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
11	MW	Laurel Pseudo-scallop Shell (oblique)	AD 100-300	Laurel Oblique/Pseudo-scallop Shell variety
12	MW	Laurel Dentate Stamped (oblique)	AD 100-300	Laurel Oblique/Dentate Stamped
13	MW	Laurel Dentate Stamped	AD 60-125	Laurel Dentate-stamped
14	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
15	MW	Laurel Pseudo-scallop Shell (oblique)	AD 100-300	Laurel Oblique/Pseudo-scallop Shell variety
16	MW	Laurel Trailed	AD 100-300	Laurel Trailed
17	MW	Laurel Dentate Stamped (oblique)	AD 60-125	Laurel Oblique/Dentate Stamped
18	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
19	MW	Laurel Dentate Stamped (oblique)	AD 60-125	Laurel Oblique/Dentate Stamped
20	MW	Laurel Dentate Stamped (oblique)	AD 60-125	Laurel Oblique/Dentate Stamped
21	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
22	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laural Pseudo-scallop Shell
23	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped
24	LLW	"proto-Juntunen" Ware (plain)	AD 1200	untyped
25	LLW	Juntunen Ware	AD 1200-1600	untyped
26	LLW	Juntunen Ware	AD 1200-1600	untyped

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
27	LLW	untyped (late)	AD 1200-1600	untyped
28	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
29	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
30	MW/LW	Late Laurel (cf. Laurel Incised)	AD 500-700	Laurel Incised
31	MLW	cf. Bois Blanc Ware (expedient?)	AD 1000-1200	untyped
32	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
33	MW/LW	Untyped (incipient Blackduck? MN type)	AD 500-700?	untyped
34	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
35	MW/LW	Late Laurel (cross-hatched, cf. Laurel Incised)	AD 500-700	Cross-hatched/Impressed lip
36	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
37	LLW	untyped	NA	untyped
38	IRO	untyped	NA	untyped
39	MW	Laurel Ware (mini)	AD 100-300	Untyped
40/153	IRO	cf. Lawson Opposed or Methodist Point Group 7	AD 1600-1700	untyped/chevron; cf. Lalonde High Collar
41	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
42	MLW	Bois Blanc Ware	AD 1000-1200	untyped
43	LLW	Traverse Decorated v. Punctate	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
44	LLW	Juntunen Drag-and-Jab	AD 1300-1400	untyped
45	LLW	Juntunen Drag-and-Jab	AD 1300-1400	untyped
46	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
47	LLW	Juntunen Ware	AD 1400-1500	untyped
48	IRO	untyped	NA	untyped
49	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
50	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
52	ELW	Mackinac Undecorated (mini)	AD 800-1000	Untyped
53	ELW	Mackinac Punctate (mini)	AD 700-900	Mackinac Punctate
54	LLW	untyped (cf. O'Neill site cup)	AD 1300-1650	Untyped

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
55	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped?
56	LLW	Traverse Decorated v. Punctate	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
57	LLW	untyped (cf. Juntunen Ware)	AD 1200-1400	untyped
58	LLW	untyped	NA	untyped
59	MW	Laurel Dentate Stamped (oblique)	AD 100-300	Laurel Oblique/Dentate Stamped
60	LLW	Juntunen Ware	AD 1200-1600	untyped
61	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
62	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
63	ELW	untyped (mini)	AD 800-1000	Untyped
64	IRO	cf. Ripley Plain	AD 1000-1700	untyped
65	LW	untyped (brushed)	NA	untyped
67	LLW	Traverse Decorated v. Punctate	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
68	IRO	untyped	NA	untyped
69	LLW	Traverse Plain v. Scalloped	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
70	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
71	LLW	untyped	NA	untyped
72	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
73	MLW	Bois Blanc Ware	AD 1000-1200?	untyped
74	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
75	LLW	Traverse Plain v. Scalloped (mini)	AD 1100-1550/1600	cf. Algoma ware
76	ELW	Mackinac Undecorated	AD 800-1000	Mackinac Undecorated
77	IRO	untyped	AD 1000-1700	untyped
78	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
79	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
80	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
81	ELW	Blackduck Banded	895-988 AD	Blackduck Banded
82	IRO	cf. Huron Incised	AD 1450-1700	untyped
83	ELW	Mackinac Ware (mini)	AD 800-1000	Mackinac Phase

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
85	LW	untyped	NA	untyped
86	LLW	Juntunen Ware (cf. Plain)	AD 1200-1600	untyped
87	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
88	ELW	Blackduck Banded	895-988 AD	Blackduck Banded
89	LLW	Jununen Drag-and-Jab	AD 1300-1400	untyped
90	LLW	untyped	NA	untyped
91	MW	Laurel Plain	AD 100-300	Laurel Plain
100	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
101	LLW	Juntunen Ware	AD 1200-1600	jab-drag/cw object; untyped
102	LLW	Juntunen Drag-and-Jab	AD 1300-1400	jab-drag; untyped
103	ELW	Mackinac Banded	**cal AD 897-995 (AMS)**	Mackinac Banded
104	LLW	Traverse Plain v. Scalloped	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
105	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
106	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/untyped/punctate
108	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
109	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped
110	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped
112	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped
113	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped/Incised?
114	MW	Laurel Banked Linear Stamped	AD 100-300	Laurel Banked Linear Stamped?
115	LLW	Juntunen Ware	AD 1200-1600	Cross-hatched/Impressed lip
116	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated
117	ELW	Blackduck Banded	895-988 AD	similar to Laurel and Blackduck banded
118	MW/LW	untyped (cordmarked/undecorated)	AD 500-700?	Cordmarked/undecorated
120	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
121	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
122	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/punctate?
123	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate?

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
124	ELW	Mackinac Banded	AD 897-995	Mackinac Banded?
125	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated?
126	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
127	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
128	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated
129	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/prob. Undecorated
130	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
131	MW	North Bay Linear Stamp	AD 100-300	untyped
132	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/punctate?
133	LLW	Juntunen Ware	AD 1200-1600	untyped
134	LLW	untyped	NA	untyped
135	IRO	cf. Ripley Plain (notched lip)	AD 1000-1700	untyped
136	IRO	cf. Lawson Incised or Huron Incised	AD 1450-1700	untyped
137	ELW	Mackinac Ware (cf. Banded)	AD 800-1000	Mackina Phase/banded
138	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/punctate
139	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
140	LLW	untyped	NA	untyped
141	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/M. Punctate?
142	MW	North Bay Cordmarked	AD 100-200	untyped
143	LLW	Juntunen Drag-and-Jab	AD 1300-1400	Juntunen Phase/jab-drag
144	MW	Laurel Ware	AD 100-300	untyped
145	IRO	Early Ontario Iroquoian (incised)	AD 1200-1300	Juntunen Phase/late?
146	IRO	Early Ontario Iroquoian (incised)	AD 1200-1300	Juntunen Phase/late?/chevron
147	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated
148	NA	untyped (late, peaked, smoothed, punctates)	NA	untyped
149	LLW	Traverse Ware (lost)	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
150	LLW	Traverse Plain v. Scalloped	AD 1100-1550/1600	untyped
151	IRO	cf. Ripley Plain (trailed)	AD 1000-1700	untyped

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
152	LLW	Juntunen Ware (cf. O'Neil Curvilinear)	AD 1400-1700	untyped
154	IRO	cf. Lawson Opposed	AD 1400-1700	untyped
155	IRO	cf. Huron Incised	AD 1450-1700	"imitation" Huron incised
156	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
157	IRO	cf. Lawson Opposed or Methodist Point Group 7	AD 1600-1700	untyped/chevron; cf. Lalonde High Collar
158	MLW	Bois Blanc Ware (cf. Braced Rim)	AD 1000-1200	untyped
159	IRO	cf. Huron Incised	AD 1450-1700	"imitation" Huron incised
160	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
161	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
162	IRO	cf. Sidey Notched or Lawson Incised	**cal AD 1420-1446 (AMS)**	Huron Incised
163	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
164	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
165	LLW	Traverse Ware	AD 1100-1550/1600	cf. Algoma ware/scalloped lip
166	IRO	cf. Huron Incised	AD 1450-1700	similar to Huron incised
167	IRO	cf. Huron Incised (mini)	AD 1450-1700	Huron Incised
168	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated
169	MW	Laurel Pseudo-scallop Shell	AD 100-300	Laurel Pseudo-scallop Shell
170	MW/LW	Late Laurel (cf. Laurel Incised)	AD 500-700	cross-hatched/linear stamped/incised
171	MW/LW	untyped (vertical punctate)	AD 500-700?	vertical punctate
172	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
173	ELW	Mackinac Banded	AD 897-995	Mackinac Banded
174	ELW	Mackinac Ware (cf. Punctate)	AD 700-900	Mackinac Phase/punctate
175	ELW	Mackinac Punctate	AD 700-900	Mackinac Punctate
176	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	Mackinac Phase/undecorated?
177	LLW	untyped	AD 1200-1600	cf. Algoma ware/scalloped lip
178	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
179	IRO	cf. Huron Incised	AD 1450-1700	similar to Huron incised

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
180	LW	untyped	NA	untyped
181	ELW	Mackinac Ware	AD 700-1000	Mackinac Phase/untyped
182	IRO	cf. Huron Incised (mini)	AD 1450-1700	Huron Incised
183	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
184	LW	untyped	NA	untyped
185	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
186	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
187	IRO	cf. Huron Incised	AD 1450-1700	Huron Incised
188	IRO	untyped	AD 1000-1700	untyped
189	ELW	Late Mackinac Ware	AD 1000	pseudo-collared/exterior beveled lip
190	LLW	Traverse Plain v. Scalloped	AD 1100-1550/1600	cf. Algoma ware/poss. shell tempered
191	ELW	Mackinac Punctate	AD 700-900	Mackinac????
192	ELW	Mackinac Banded	AD 897-995	Mackinac Banded?
193	ELW	Blackduck Banded	**cal AD 895-988 (AMS)**	NA
194	ELW	Late Mackinac ware	AD 900-1000	Mackinac Banded?
195	NA	untyped, unknown time period	NA	NA
196/203	ELW	Mackinac Punctate	AD 700-900	NA
197	MW/LW	untyped	AD 500?	NA
198	ELW	Mackinac Ware (cf. Undecorated)	AD 800-1000	NA
199	ELW	cf Bowerman Plain v. Cordmarked	AD 900	NA
200	LW	untyped (Generic Woodland, ELW/MLW)	NA	NA
201	MW	untyped (mini) (Hopewellian)	NA	LLW Mini Vessel?
202	ELW	Mackinac Ware (mini)	AD 700-1000	? Mini Vessel?
204	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
205	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
206	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
207	LLW	untyped	AD 1200-1700	NA
208	LLW	untyped	AD 1200-1700	NA

Vessel	Period	Final Type	Dates	Original Type (Branstner 1995)
209	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
210	LLW	Juntunen Ware	AD 1200-1700	NA
211	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
212	LLW	Juntunen Linear Punctate	AD 1200-1300	NA
213	LLW	Juntunen Ware (cf. Jab-and-Drag)	AD 1300-1400	NA
214	LLW	Juntunen Ware (cf. Linear Punctate)	AD 1200-1300	NA
215	MLW	Bois Blanc Ware	AD 1000-1200	NA
216	LLW	untyped	post-AD 1200	NA
217	LLW	untyped	NA	NA
218	LLW	Juntunen Ware (cf. Linear Punctate)	AD 1200-1300	NA

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
1	5	13	6	3.9	5.57	na	9.74	0.58	1.38	1.37
2	2	na	na	3.69	7.17	na	na	1.1	1.15	0.98
3	5	13	8	2.96	5.07	na	na	1.23	2.46	1.27
4	8	20	6	4.28	6.69	6.69	na	2.45	1.08	1.99
5	1	na	na	4.71	7.62	9.11	9.02	1.18	1.12	1.28
6	103	24	22	4.81	8.09	9.52	10.12	3.03	1.34	1.83
7	1	na	na	5.85	7.14	na	na	1.32	1.38	1.14
8	1	na	na	6.01	6.43	6.58	na	1.7	1.39	0.98
9	3	na	na	3.36	5.84	na	na	1.05	1.69	0.9
10	3	na	na	3.12	5.93	6.1	na	1.37	2.21	1.61
11	8	14	10	2.74	5.34	na	na	2.39	1.94	1.16
12	3	18	8	5.42	7.78	na	na	1.46	1.43	1.16
13	1	na	na	2.53	6.35	na	na	1.44	1.08	1.21
14	3	na	na	3.07	4.59	5.81	na	1.8	2.49	0.99
15	1	15	5	3.13	5.12	5.78	na	1.09	1.45	1.15
16	2	na	na	5.64	6.99	na	na	1.74	1.69	1.12
17	9	na	na	2.63	4.91	na	4.62	0.88	1.36	0.93
18	1	na	na	4.49	5.88	na	na	1.56	0.7	1.26
19	1	na	na	3.89	4.44	na	na	na	na	na
20	12	16	23	3.72	6.43	6.5	5.56	1.48	1.96	1.14
21	5	17	21	10.4	6.24	5.65	5.79	1.47	0.78	2.27
22	1	na	na	2.92	6.55	na	na	2.21	1.9	1.2
23	1	na	na	5.02	4.93	na	na	1.51	1.21	1.64
24	7	19	17	9.1	9.01	10.16	8.41	1.58	1.03	1.61
25	10	na	na	8.94	10.28	10.89	8.62	1.32	1.78	1.14
26	1	22	7	8.25	6.63	10.02	na	1.14	1.12	0.84

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
27	4	18	7	9.63	11.14	12.84	na	0.9	3.11	1.39
28	1	19	7	4.4	8.37	na	na	2.08	3.76	1.41
29	1	na	na	4.42	3.11	na	na	2.02	0.59	0.92
30	1	na	na	8.43	8.04	na	na	2.36	1.35	0.98
31	1	na	na	7.01	6.85	na	na	1.66	1.08	1.81
32	1	na	na	10.94	6.98	na	na	1.16	1.52	0.76
33	4	24	8	10.69	8.62	8.09	na	1.33	1.53	1.91
34	6	27	25	7.45	5.25	7.89	8.06	1.2	0.96	2.25
35	56	22	50	9.17	5.5	6.36	6.59	2.52	1.11	1.61
36	1	17	9	3.8	6.96	na	na	0.71	0.73	0.52
37	1	na	na	8.41	9.61	na	na	1.16	na	na
38	1	na	na	na	na	na	na	1.06	1.75	1.42
39	1	na	na	5.58	6.2	6.75	na	3.07	1.22	1.4
40/153	1	na	na	na	na	9.15	8.41	1.32	2.11	1.34
41	12	32	20	14.4	6.62	na	na	0.89	2.64	1.65
42	1	20	6	7.15	4.31	na	na	1.26	1.1	1.42
43	4	22	7	7.65	7.09	na	na	1.03	1.22	1.15
44	3	30	7	8.08	12.03	na	na	1.58	2.32	1.11
45	19	26	7	8.74	14.62	7.75	na	1.07	1.56	1.6
46	1	na	na	10.45	5.66	na	na	1.06	1.12	0.82
47	3	na	na	6.89	14.5	9.41	na	1.19	2.4	1.15
48	1	15	9	6.52	7.64	na	na	1.27	0.95	1.02
49	1	14	8	8.17	3.83	4.3	na	1.29	0.62	1.08
50	3	25	21	11.29	6.06	5.44	na	1.4	1.77	0.82
52	1	5	25	3.91	3.89	4.93	4.14	na	na	na
53	2	9	25	5.84	6.39	3.21	na	2.17	1.4	1.49
54	9	8	50	5.92	5.22	7.13	5.32	0.64	1.22	0.63

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
55	105	30	21	10.27	7.67	na	2.8	1.01	1.24	1.95
56	1	na	na	na	na	na	na	0.97	1.35	1.13
57	2	na	na	na	6.85	6.49	9.9	1.11	1.36	1.74
58	1	na	na	7.14	8.97	na	na	1.43	1.07	1.02
59	2	na	na	3.39	4.55	na	na	0.91	0.62	na
60	2	na	na	5.15	4.22	na	na	0.75	0.91	1.53
61	1	na	na	5.84	5.67	na	na	2.06	1.62	na
62	3	na	na	na	na	na	na	1.64	1.51	1.35
63	1	8	10	9.38	6.76	na	na	na	na	na
64	2	28	8	6.33	6	5.03	0	1.86	0.99	1.35
65	14	15		9.36	11.46	11.29	na	2.02	0.94	1.35
67	1	na	na	8.05	6.09	na	na	0.96	1.83	0.82
68	1	na	na	7.04	7.62	na	na	2.16	1.39	na
69	1	na	na	7.76	7.77	na	na	1.2	3.37	1.5
70	7	na	na	8.34	7.77	6.16	na	1.58	1.26	0.76
71	1	na	na	7.41	5.56	na	na	1.23	1.3	1.16
72	1	16	5	9.35	5.46	na	na	1.38	0.99	1.15
73	1	na	na	4.88	8.92	na	na	1.15	1.87	2.07
74	5	25	7	8.43	8.86	na	na	1.21	1.83	1.18
75	7	8	20	5.29	5.48	3.54	na	0.86	1.35	1.02
76	31	24	25	8.8	8.06	6.02	7.72	1.99	0.83	2.62
77	8	na	na	9.8	8.93	na	11.37	1.91	1.22	1.01
78	34	24	6	8.4	7.04	6.98	8.46	3.06	1.46	2.15
79	1	12	5	3.45	5.02	na	na	0.88	0.76	na
80	22	25	24	14.03	6.01	5.93	na	3.7	1.8	1.3
81	1	28	8	11.15	7.87	na	na	0.96	0.85	0.79
82	1	28	5	5.33	7.03	0	0	0.85	1.45	1.26
83	12	9	20	5.03	4.38	3.49	na	na	na	na

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
85	1	na	na	5.75	8.98	7.89	na	0.74	1.06	1.02
86	2	20	16	8	9.67	na	na	1.46	1	1.48
87	1	na	na	7.63	9.04	na	na	3.18	0.89	2.15
88	1	30	6	11.17	6.77	na	4.36	2.62	1.42	1.84
89	1	na	na	7.07	7.63	na	na	1.13	0.82	1.01
90	1	na	na	6.53	5.84	na	na	1.37	0.89	0.84
91	1	na	na	3.48	5.1	na	na	1.17	1.54	1.74
100	88	19	9	8.41	9.14	10.89	na	3.02	0.66	1.53
101	2	na	na	na	9.86	na	na	1.09	2.72	1.42
102	5	na	na	8.81	7.2	na	na	1.9	1.46	1.93
103	6	14	10	9.95	8.06	na	na	1.85	1.22	0.78
104	1	13	10	5.88	5.18	7.1	na	1.04	0.9	1.58
105	4	19	20	6.47	3.83	3.57	na	1.58	1.33	1.12
106	1	na	na	8.16	6.86	8.63	na	1.25	2.02	1.21
108	6	na	na	na	6.3	6.05	na	2.42	1.75	0.96
109	6	25	10	4.55	4.5	4.85	5.33	2.18	1.75	1.82
110	1	>18	na	5.49	6.36	na	na	1.5	1.4	1.19
112	2	na	na	5.06	4.45	na	na	0.77	1.15	1.82
113	1	na	na	4.42	5.84	na	na	2.06	1.42	1.5
114	1	na	na	4.82	6.21	na	na	1.96	0.95	1.16
115	1	na	na	7.22	9.79	na	na	2.48	1.63	1.41
116	4	14	9	6.3	4.29	na	na	2.32	1.03	2.01
117	2	12	7	9.03	5.01	5.02	na	1.37	1.35	1.24
118	3	na	na	4.51	4.23	na	na	1.09	1.68	1.02
120	3	20	19	8.02	7.79	5.53	na	2.32	1.05	1.45
121	19	18	20	7.14	6.84	5.49	na	5.58	2.92	1.97
122	5	25	7	9.58	7.14	na	na	1.18	0.82	0.88
123	1	25	5	9.53	5.68	na	na	1.9	1.14	1.18

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
124	1	na	na	10.64	6.44	na	na	5.86	1.41	0.98
125	4	13	6	5.28	5.38	na	na	1.28	1.02	1.9
126	3	25	6	10.42	7.62	7.48	na	1.52	1.72	1.68
127	2	na	na	8.58	6.24	na	na	2.63	2.14	1.18
128	11	24	7	9.25	4.29	na	na	1.87	1.1	1.4
129	3	na	na	8.82	4.08	na	na	0.95	1.39	1.31
130	1	26	5	10.19	6.08	na	na	2.45	3	1.04
131	19	25	5	7.6	7.79	na	na	1.33	0.87	1.64
132	2	16	10	8.71	6.31	na	na	1.33	1.05	1.31
133	23	na	na	9.11	8.31	na	na	1.81	2.25	1.94
134	1	na	na	9.89	6.67	na	na	1.1	1.17	na
135	2	na	na	5.35	7.39	na	na	1.22	1.13	0.74
136	1	na	na	7.3	6.68	na	na	1.08	1.1	1.71
137	2	na	na	6.62	7.49	na	na	1.47	1.5	1.28
138	1	20	9	10.63	9.18	na	na	1.69	3.66	1.35
139	6	na	na	9.24	7.45	na	na	1.16	1.01	1.2
140	1	na	na	5.81	6.07	na	na	1.34	3.43	1.48
141	1	19	6	9.65	7.52	6.56	na	2.55	3.15	1.36
142	5	20	9	9.16	7.36	6.75	na	1.36	3.4	1.41
143	1	na	na	na	na	na	na	1.37	1.81	1.24
144	1	na	na	5.96	7.28	na	na	1.51	1.08	1.26
145	3	17	6	8.13	7.76	na	na	0.86	1.77	1.37
146	4	18	16	8.52	7.21	5.92	na	1.76	0.94	1.8
147	3	17	17	5.75	4.02	na	na	1.37	1.45	1.23
148	1	17	16	8.06	6.46	na	na	1.38	1.23	1.22
149	1	na	na	7.92	5.83	na	na	1.32	1.41	1
150	21	21	15	6.56	6.7	5.69	3.89	1.28	0.87	1.34
151	1	na	na	8.15	7.57	na	na	2.3	1.19	1.05

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
152	2	na	na	7.35	7.95	na	na	1.32	1.25	1.58
154	2	na	na	na	na	na	na	0.89	0.75	0.78
155	3	18	10	13.06	8.63	0.19	na	1.59	1.07	0.71
156	3	na	na	6.51	8.48	na	na	2.34	1.54	1.27
157	1	na	na	na	na	na	na	1.15	0.97	0.82
158	1	na	na	5.95	8.17	0	0	0.79	1.28	1.1
159	1	na	na	6.62	8.57	na	na	1.3	2.02	0.66
160	3	na	na	7.1	8.36	na	na	1.88	0.79	1.42
161	2	na	na	5.26	6.92	na	na	1.23	1.11	0.8
162	5	27	20	6.8	7.63	7.63	6.66	1.45	1.72	1.52
163	1	na	na	7.39	10.01	na	na	1.56	1.3	1.1
164	14	21	10	7.62	8.9	na	na	2.17	1.8	1
165	1	na	na	4.52	5.86	7.73	na	1.61	1.91	1.12
166	48	28	20	6.22	6.6	7.51	10.03	1.65	1.53	1.11
167	1	na	na	5.74	6.61	na	na	na	na	na
168	1	na	na	5.45	5.12	na	na	4.11	1.56	1.04
169	1	14	5	3.68	5.15	na	na	1.19	1.27	1.17
170	8	15	5	3.49	4.12	5.55	na	1.37	0.99	1.73
171	1	na	na	4.34	5.58	na	na	1.23	0.93	1.42
172	2	26	7	10.31	7.97	6.72	na	1.43	1.36	1.26
173	12	17	23	10.49	8.01	8.45	na	1.43	2.15	1.16
174	6	na	na	3.92	4.06	7.47	na	1.18	1.46	0.68
175	19	na	na	9.52	3.44	3.08	6.38	1.45	1.25	1.73
176	1	na	na	8.43	4.26	na	na	1.94	1.16	1.74
177	2	na	na	7.82	6.56	na	na	1.16	0.74	1.28
178	1	na	na	5.83	5.29	na	na	1.06	0.89	1.03
179	1	25	7	8.06	9.2	na	na	1.13	0.9	1.64

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
180	1	12	5	5.57	3.93	na	na	1.45	0.79	0.69
181	2	na	na	10.34	10.13	na	na	0.77	1.6	2.22
182	1	7	14	4.19	6.69	5.7	na	0.74	na	na
183	2	na	na	6.6	12.56	na	na	1.04	0.64	1.13
184	1	na	na	8.89	5.71	na	na	1.27	1.01	1.24
185	1	na	na	9.23	7.97	na	na	1.35	1.58	0.69
186	1	na	na	na	na	na	na	1.29	0.76	0.87
187	1	na	na	6.59	na	na	na	1.57	1.47	1.1
188	1	na	na	na	na	na	na	0.8	0.65	1.03
189	1	na	na	3.38	5.25	na	na	2.77	1.31	1.26
190	1	na	na	5.31	4.07	na	na	1.2	na	na
191	9	26	23	12.44	7.91	7.48	na	1.89	1.75	1.85
192	114	16	21	10.49	7.7	6.35	5.27	1.32	1.81	0.77
193	82	20	22	9.4	6.81	6.03	6.14	0.84	1.21	1.93
194	1	19	7	5.01	4.74	na	na	1.02	1.05	0.81
195	1	na	na	na	na	na	na	1.98	0.68	1.45
196/203	2	na	na	10.75	8.75	na	na	2.21	0.87	1.1
197	3	na	na	8.89	6.98	na	na	0.98	2	1.48
198	9	26	6	7.63	6.83	7.23	na	2.18	1.12	1.73
199	13	na	na	6.91	4.94	na	na	1.51	1.3	1.03
200	36	10	18	6.03	6.64	9.43	7.79	3.47	3.13	2.64
201	3	5	20	5.76	5.57	6.74	5.15	0.95	na	na
202	4	6	27	4.15	4.52	2.78	3.71	na	na	na
204	19	26	19	8.91	5.98	4.15	4.2	1.38	1.9	1.07
205	2	16	20	7.64	8.55	5.19	na	1.05	1.58	1.17
206	4	30	6	7.77	8.35	na	na	1.67	0.78	1.37
207	1	na	na	7.01	6.88	na	na	1.2	0.87	1.27
208	1	na	na	3.98	6.89	5.43	na	1.52	0.82	1.29

Vessel	Ct.	Rim Radius (cm)	% rim	Lip Thickness	Neck Thickness	Shoulder Thickness	Body Thickness	Temper 1	Temper 2	Temper 3
209	1	13	8	6.21	9.12	11.23	na	1.29	1.39	1.44
210	1	na	na	4.4	6.49	9.15	na	1.45	0.7	0.86
211	1	na	na	6.9	8.35	5.65	na	3.18	0.81	1.16
212	1	na	na	8.47	8.44	na	na	1.18	1.31	1.28
213	1	na	na	5.47	6.56	7.67	na	1.22	0.67	0.88
214	7	8	10	7.86	8.73	7.46	na	1.21	0.83	0.9
215	3	na	na	6.45	8.65	11.26	na	1.19	1.51	1.13
216	2	30	5	7.3	8.61	8.37	6.59	1.47	1.31	1.33
217	1	na	na	9.72	6.04	na	na	0.82	1.24	0.85
218	1	na	na	8.03	6.58	na	na	2	1	1.64

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
1	0	0	1	2	0
2	0	0	0	na	0
3	0	0	0	na	0
4	0	0	1	2	0
5	0	0	1	2	0
6	0	0	1	5	0
7	0	0	0	na	0
8	0	0	1	2	0
9	0	0	0	na	0
10	0	0	1	4	0
11	0	0	0	na	0
12	0	0	1	4	0
13	0	0	0	na	0
14	0	0	0	na	0
15	0	0	0	na	0
16	0	0	0	na	0
17	0	0	0	na	0
18	0	0	0	na	0
19	0	0	0	na	0
20	0	0	1	5	0
21	1	0	1	4	0
22	0	0	1	4	0
23	0	0	1	1	0
24	0	0	1	4	0
25	0	1	1	2	0
26	0	1	1	3	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
27	0	0	1	4	0
28	0	0	1	4	0
29	0	0	1	4	0
30	0	0	1	4	0
31	0	0	0	na	0
32	0	0	0	na	0
33	0	0	0	na	0
34	0	0	1	2	0
35	0	0	1	5	0
36	0	1	1	1	0
37	0	0	0	na	0
38	0	0	na	na	0
39	0	0	0	na	0
40/153	1	0	1	2	0
41	0	1	1	4	0
42	1	0	1	4	0
43	0	1	1	2	0
44	0	1	1	2	0
45	0	0	1	1	0
46	0	1	1	4	0
47	0	0	0	na	0
48	0	0	0	na	0
49	0	0	0	na	0
50	1	0	1	2	0
52	0	0	0	na	0
53	0	0	1	1	0
54	0	0	0	na	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
55	1	0	0	na	0
56	0	0	na	na	na
57	0	0	1	5	0
58	0	0	0	na	0
59	0	0	1	5	0
60	0	0	0	na	0
61	0	0	0	na	0
62	0	0	0	na	0
63	0	0	0	na	0
64	0	0	1	1	0
65	0	0	0	na	0
67	0	0	0	na	0
68	0	0	0	na	0
69	0	0	0	na	0
70	1	0	1	3	0
71	0	0	0	na	0
72	0	0	0	na	0
73	0	0	1	4	0
74	0	0	1	3	
75	0	1	1	3	0
76	1	1	1	3	0
77	1	0	1	1	0
78	0	0	0	na	0
79	0	0	0	na	0
80	1	0	1	5	0
81	0	1	1	4	0
82	0	0	1	4	0
83	0	0	1	1	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
85	0	0	1	1	0
86	1	0	1	4	0
87	1	0	0	na	0
88	1	1	1	5	
89	0	0	1	4	0
90	0	0	1	4	0
91	0	0	0	na	0
100	1	0	0	na	0
101	0	0	1	2	0
102	0	1	1	4	0
103	0	0	1	4	0
104	0	0	1	1	0
105	1	1	1	3	0
106	0	0	0	na	0
108	0	0	0	na	0
109	0	0	1	2	0
110	0	0	0	na	0
112	0	1	1	1	0
113	0	0	0	na	0
114	0	1	1	5	0
115	0	0	0	na	0
116	1	0	1	5	0
117	0	0	0	na	0
118	0	1	1	4	0
120	0	0	1	1	0
121	0	0	0	na	0
122	0	1	1	1	0
123	1	0	1	5	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
124	0	1	1	4	0
125	0	0	0	na	0
126	0	0	0	na	0
127	0	0	0	na	0
128	0	0	1	4	0
129	0	0	0	na	0
130	0	0	0	na	0
131	0	0	1	5	0
132	0	0	1	4	0
133	0	0	1	4	0
134	0	0	1	5	0
135	0	0	0	na	0
136	0	0	1	4	0
137	0	0	0	na	0
138	0	0	0	na	0
139	0	0	1	4	0
140	0	0	0	na	0
141	0	0	0	na	0
142	0	0	0	na	0
143	0	0	na	na	na
144	0	0	0	na	0
145	0	0	1	4	0
146	0	1	1	3	0
147	0	1	1	1	0
148	0	0	0	na	0
149	0	1	1	4	0
150	1	1	1	3	0
151	0	0	0	na	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
152	0	0	1	1	0
154	0	0	1	2	0
155	0	0	0	na	0
156	0	0	0	na	0
157	0	0	na	na	0
158	0	0	0	na	0
159	0	0	1	4	0
160	0	0	1	4	0
161	0	1	1	4	0
162	0	1	1	3	0
163	0	0	1	4	0
164	0	0	1	4	0
165	0	0	0	na	0
166	0	0	1	5	0
167	0	1	1	1	0
168	0	0	0	na	0
169	0	0	0	na	0
170	0	0	0	na	0
171	0	0	0	na	0
172	0	0	1	4	0
173	1	0	1	1	0
174	1	1	1	1	0
175	0	0	1	1	0
176	0	0	1	4	0
177	0	0	1	4	0
178	0	1	1	4	0
179	0	1	1	5	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
180	0	0	0	na	0
181	0	0	0	na	0
182	0	0	0	na	0
183	0	0	0	na	0
184	0	0	0	na	0
185	0	0	0	na	0
186	0	0	0	na	0
187	0	0	0	na	0
188	1	0	0	na	0
189	0	0	0	na	0
190	0	0	0	na	0
191	0	1	1	2	0
192	1	0	1	3	0
193	1	0	1	3	0
194	0	0	1	4	0
195	0	0	na	na	0
196/203	0	0	1	4	0
197	0	0	1	5	0
198	0	0	0	na	0
199	0	0	0	na	0
200	0	0	0	na	0
201	0	0	1	2	0
202	0	0	0	na	0
204	0	0	1	2	0
205	0	1	1	3	0
206	0	0	0	na	0
207	0	0	0	na	0
208	0	0	1	1	0

Vessel	Exterior Sooting	Exterior Carbonization	Interior Carbonization	IC Type	Attrition
209	0	0	0	na	0
210	0	0	0	na	0
211	0	0	0	na	0
212	0	0	1	5	0
213	0	1	1	1	0
214	0	0	0	na	0
215	0	0	1	4	0
216	0	1	1	1	0
217	0	0	0	na	0
218	0	1	1	4	0

APPENDIX B:

Cloudman Site Pottery Residue Samples for Microbotanical, Lipid Residue, and Stable Isotope Analyses

Table B1. Pottery Residue Samples Collected for Microbotanical Analysis (by Vessel)

Vessel No.	Period	Type	Wt (g)
1	MW	Laurel Pseudo-scallop Shell	0.0110
4	MW	Laurel Dentate Stamped	0.0074
5	MW	Laurel Pseudo-scallop Shell	0.0061
6	MW	Laurel Dentate Rocker Stamped	0.0110
10	MW	Laurel Pseudo-scallop Shell	0.0026
12	MW	Laurel Dentate Stamped (oblique)	0.0030
22	MW	Laural Pseudo-scallop Shell	0.0027
23	MW	Laurel Banked Linear Stamped	0.0024
28	MW	Laurel Pseudo-scallop Shell	0.0064
109	MW	Laurel Banked Linear Stamped	0.0053
112	MW	Laurel Banked Linear Stamped	0.0026
35	MW/LW	Late Laurel Ware	0.0054
8	ELW	Mackinac Ware	0.0106
34	ELW	Mackinac Ware	0.0031
41	ELW	Mackinac Ware	0.0047
50	ELW	Mackinac Banded	0.0061
76	ELW	Mackinac Undecorated	0.0052
80	ELW	Mackinac Punctate	0.0023
81	ELW	Blackduck Banded	0.0103
88	ELW	Blackduck Banded	0.0034
103	ELW	Mackinac Banded	0.0043
105	ELW	Mackinac Punctate	0.0073
120	ELW	Mackinac Banded	0.0049
122	ELW	Mackinac Ware (cf. Punctate)	0.0032
124	ELW	Mackinac Banded	0.0064
132	ELW	Mackinac Ware (cf. Punctate)	0.0030
173	ELW	Mackinac Banded	0.0077
174	ELW	Mackinac Ware (cf. Punctate)	0.0058
175	ELW	Mackinac Punctate	0.0055
193	ELW	Blackduck Banded	0.0278
42	MLW	Bois Blanc Ware	0.0066
215	MLW	Bois Blanc Ware	0.0061
25	LLW	Juntunen Ware	0.0053
26	LLW	Juntunen ware	0.0058
43	LLW	cf. Traverse Ware	0.0041
75	LLW	cf. Traverse Ware (mini)	0.0056

Table B1 (cont'd)

101	LLW	Juntunen Ware	0.0165
102	LLW	Juntunen Drag-and-Jab	0.0077
150	LLW	Traverse Undecorated v. Scalloped	0.0232
152	LLW	Juntunen Ware (late, corded)	0.0062
204	LLW	Juntunen Linear Punctate	0.0041
205	LLW	Juntunen Linear Punctate	0.0079
36	IRO	cf. Huron Incised	0.0051
40	IRO	cf. Lawson Opposed or Methodist Point	0.0101
70	IRO	Huron Incised	0.0072
146	IRO	Early Ontario Iroquoian (incised)	0.0111
162	IRO	cf. Lawson Incised or Sidey Notched	0.0133
179	IRO	cf. Huron Incised	0.0056

Table B2: Pottery Residue Samples Collected for Stable Isotope Analysis (by Vessel)

Vessel No.	Period	Type	Wt. (g)
1	MW	Laurel Pseudo-scallop Shell	0.0132
4	MW	Laurel Dentate-stamped	0.0065
5	MW	Laurel Pseudo-scallop Shell	0.0099
6	MW	Laurel Dentate Rocker Stamped	0.0271
10	MW	Laurel Pseudo-scallop Shell	0.0045
12	MW	Laurel Dentate Stamped (oblique)	0.0027
22	MW	Laural Pseudo-scallop Shell	0.0028
23	MW	Laurel Banked Linear Stamped	0.0033
28	MW	Laurel Pseudo-scallop Shell	0.0099
109	MW	Laurel Banked Linear Stamped	0.0103
112	MW	Laurel Banked Linear Stamped	0.0026
35	MW/LW	Late Laurel Ware	0.0074
8	ELW	Mackinac Ware	0.0034
34	ELW	Mackinac Ware	0.0026
41	ELW	Mackinac Ware	0.0026
50	ELW	Mackinac Banded	0.0051
76	ELW	Mackinac Undecorated	0.0043
80	ELW	Mackinac Punctate	0.0022
81	ELW	Blackduck Banded	0.0045
88	ELW	Blackduck Banded	0.0031
100	ELW	Mackinac Punctate	0.0070
103	ELW	Mackinac Banded	0.0028
105	ELW	Mackinac Punctate	0.0034
120	ELW	Mackinac Banded	0.0056
122	ELW	Mackinac Ware (cf. Punctate)	0.0023
124	ELW	Mackinac Banded	0.0062
132	ELW	Mackinac Ware (cf. Punctate)	0.0030
173	ELW	Mackinac Banded	0.0037
174	ELW	Mackinac Ware (cf. Punctate)	0.0051
175	ELW	Mackinac Punctate	0.0048
191	ELW	Mackinac Punctate	0.0108
193	ELW	Blackduck Banded	0.0148
42	MLW	Bois Blanc Ware	0.0048
215	MLW	Bois Blanc Ware	0.0108
25	LLW	Juntunen Ware	0.0028
26	LLW	Juntunen ware	0.0068

Table B2 (cont'd)

43	LLW	cf. Traverse Ware	0.0036
75	LLW	cf. Traverse Ware (mini)	0.0051
101	LLW	Juntunen Ware	0.0137
102	LLW	Juntunen Drag-and-Jab	0.0058
150	LLW	Traverse Undecorated v. Scalloped	0.0067
152	LLW	Juntunen Ware (late, corded)	0.0800
204	LLW	Juntunen Linear Punctate	0.0056
205	LLW	Juntunen Linear Punctate	0.0104
36	IRO	cf. Huron Incised	0.0045
40	IRO	cf. Lawson Opposed or Methodist Point	0.0054
70	IRO	Huron Incised	0.0098
146	IRO	Early Ontario Iroquoian (incised)	0.0104
162	IRO	cf. Lawson Incised or Sidey Notched	0.0069
179	IRO	cf. Huron Incised	0.0047

Table B3: Pottery Residue Samples Collected for Lipid Residue Analysis (by Vessel)

Vessel No.	Period	Type	Wt. (g)
1	MW	Laurel Pseudo-scallop	6.56
6	MW	Laurel Dentate Rocker Stamped	43.38
20	MW	Laurel Dentate Stamped (oblique)	9.64
109	MW	Laurel Banked Linear Stamped	14.95
131	MW	North Bay Linear Stamp	6.20
35	MW/LW	Late Laurel Ware	7.14
34	ELW	Mackinac Ware	23.45
55	ELW	Mackinac Ware	16.84
76	ELW	Mackinac Undecorated	16.48
80	ELW	Mackinac Punctate	12.44
100	ELW	Mackinac Punctate	23.68
173	ELW	Mackinac Banded	13.86
175	ELW	Mackinac Punctate	10.16
191	ELW	Mackinac Punctate	36.72
193	ELW	Blackduck Banded	15.94
215	MLW	Bois Blanc Ware	7.21
24	LLW	"Proto-Juntunen" Ware (plain)	16.77
25	LLW	Juntunen Ware	24.27
43	LLW	cf. Traverse Ware	11.86
75	LLW	cf. Traverse Ware (mini)	5.71
101	LLW	Juntunen Ware	13.62
150	LLW	Traverse Undecorated v. Scalloped	10.35
204	LLW	Juntunen Linear Punctate	21.24
216	LLW	Untyped	31.23
70	IRO	Huron Incised	39.94
77	IRO	Untyped	13.21
146	IRO	Early Ontario Iroquoian (incised)	9.02
162	IRO	cf. Lawson Incised or Sidey Notched	11.04
164	IRO	Huron Incised	7.73
166	IRO	cf. Huron Incised	21.73

APPENDIX C:

Carbon and Nitrogen Stable Isotope Analysis:
Summary of Illinois State Geological Survey (ISGS) Reports

Pottery Residue Analysis Results

Vessel	Job #	ISGS #	Mass (mg)	$\delta^{15}N_{Air}$	% N	$\delta^{13}C_{VPDB}$	% C
1	1261	EA008538	1.294	9.63	4.70	-26.12	47.05
4	1261	EA008539	1.295	12.83	5.24	-26.36	51.17
5	1292	EA008887	1.296	12.81	6.56	-26.1	57.76
6	1261	EA008540	1.291	10.24	5.87	-23.21	46.80
8	1292	EA008888	1.298	11.93	7.47	-23.77	61.40
10	1292	EA008889	1.314	12.98	5.61	-26.53	52.72
12	1261	EA008541	1.304	11.49	5.47	-24.45	45.68
22	1261	EA008542	1.282	11.98	5.07	-26.66	48.24
23	1292	EA008890	1.288	10.93	3.35	-25.9	51.29
25	1261	EA008543	1.291	11.50	2.84	-26.65	36.43
26	1292	EA008891	1.320	11.65	3.22	-26.3	49.39
28	1292	EA008892	1.315	13.44	5.61	-26.8	54.97
34	1261	EA008544	1.323	11.26	2.94	-24.74	33.08
35	1261	EA008545	1.288	13.28	6.67	-21.78	44.24
36	1292	EA008893	1.287	10.29	3.83	-23	47.22
40	1292	EA008894	1.299	11.43	3.63	-26.46	43.80
41	1261	EA008546	1.302	11.85	4.38	-25.68	36.95
42	1292	EA008895	1.315	10.20	3.93	-26.3	55.05
43	1292	EA008896	1.284	11.53	5.76	-23.66	45.53
50	1292	EA008900	1.282	12.81	7.58	-25.01	54.24
70	1261	EA008547	1.318	12.51	3.57	-26.41	40.59
75	1261	EA008551	1.307	10.33	4.36	-24.49	46.70
76	1261	EA008552	1.292	11.67	5.71	-22.65	51.75
80	1261	EA008553	1.308	10.58	3.04	-22.99	22.25
81	1261	EA008554	1.296	12.66	6.50	-27.02	55.70
88	1292	EA008901	1.288	5.17	3.60	-28.36	39.10
100	1292	EA008909	1.308	13.76	8.28	-25.18	53.18
101	1261	EA008555	1.299	13.77	6.20	-27.04	54.75
102	1261	EA008556	1.300	13.37	3.97	-27.33	45.19
103	1261	EA008557	1.316	12.35	7.63	-24.65	51.03
105	1261	EA008558	1.282	13.33	5.40	-27.2	49.32
109	1261	EA008559	1.304	11.90	3.17	-24.03	25.80
112	1261	EA008560	1.298	12.31	2.39	-27.43	39.34
120	1292	EA008902	1.280	10.22	3.85	-26.84	52.22
122	1261	EA008564	1.282	11.96	3.41	-26.63	40.42
124	1292	EA008903	1.294	12.88	5.86	-26.56	61.81
132	1292	EA008904	1.299	10.28	6.17	-24.43	49.37
146	1261	EA008565	1.280	10.32	2.72	-29.13	54.03
150	1261	EA008566	1.302	10.57	5.13	-24.8	56.66

Vessel	Job #	ISGS #	Mass (mg)	$\delta^{15}N_{Air}$	% N	$\delta^{13}C_{VPDB}$	% C
152	1261	EA008567	1.283	11.84	4.53	-25.03	43.56
162	1261	EA008568	1.302	11.01	3.69	-25.31	46.78
173	1261	EA008569	1.308	12.93	5.19	-27.25	50.53
174	1292	EA008905	1.300	12.78	6.57	-27.34	60.69
175	1292	EA008906	1.317	13.27	8.04	-22.88	57.86
179	1261	EA008570	1.314	8.74	4.73	-25.29	47.84
191	1292	EA008908	1.307	10.58	6.63	-27.29	60.24
193	1261	EA008571	1.294	12.52	5.66	-25.61	52.92
204	1261	EA008572	1.303	13.57	4.58	-25.94	34.89
205	1292	EA008907	1.319	11.69	1.93	-28.89	51.07
215	1261	EA008573	1.309	11.71	8.45	-22.78	48.97

Soil Sample Analysis Results

Sample ID	Job #	ISGS #	Mass (mg)	$\delta^{15}N_{Air}$	% N	$\delta^{13}C_{VPDB}$	% C
T2-S1-2	1278	EA008610	29.997	8.89	0.27	-22.91	5.02
T2-S2-2	1278	EA008611	44.994	7.25	0.06	-4.66	3.20
T3-S1-1	1278	EA008605	29.992	8.26	0.30	-18.08	5.07
T3-S2-1	1278	EA008606	30.009	9.16	0.16	-11.47	4.00
T1-S2-3	1292	EA008932	15.005	7.47	0.86	-23.46	13.78
T1-S2-2	1292	EA008933	15.002	8.86	1.10	-25.42	15.36
T3-S2-3	1292	EA008915	29.997	12.27	0.74	-25.08	9.42
T2-S2-3	1292	EA008916	29.991	7.32	0.41	-21.78	6.51
T1-S1-2	1292	EA008934	10.002	8.70	1.50	-25.67	21.02
T1-S2-1	1292	EA008918	30.001	8.79	0.76	-24.37	11.19
T3-S2-2	1292	EA008935	60.002	5.80	0.06	-5.72	2.90
T2-S2-1	1292	EA008936	60.000	8.12	0.07	-5.93	3.92

APPENDIX D:

Lipid Residue Analysis Report

Analysis of Lipid Residues Extracted from

Archaeological Material from the Cloudman site, 20CH6.

Prepared for

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Introduction

Thirty pottery sherds and three soil samples from the Cloudman site were submitted for analysis. Exterior surfaces were ground off the pottery to remove any contaminants then crushed. Absorbed lipid residues were extracted from the powdered sherds and loose soil with organic solvents. Lipid extracts were analyzed using gas chromatography (GC), high temperature GC (HT-GC) and high temperature gas chromatography with mass spectrometry (HT-GC/MS). Residue identifications were based on fatty acid decomposition patterns of experimental residues, lipid distribution patterns and the presence of biomarkers. Procedures for the identification of archaeological residues are outlined below; analytical procedures and results are then presented.

The Identification of Archaeological Residues

Identification of Fatty Acids

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, consisting of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The "Cx" refers to a fatty acid with a carbon chain length of x number of atoms. The "y" represents the number of double bonds or points of unsaturation, and the "ωz" indicates the location of the most distal double bond on the carbon chain, i.e. closest to the methyl end. Thus, the fatty acid expressed as C18:1ω9, refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin et al. (1976), gas chromatography has been used extensively to analyze the fatty acid component of absorbed archaeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archaeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and non-volatile products which continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Attempts have been made to identify archaeological residues using criteria that discriminate uncooked foods (Marchbanks 1989; Skibo 1992; Loy 1994). The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992) and Loy (1994) is they have never been empirically tested. The proposed ratios are based on criteria that discriminate food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decompositional changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archaeological samples.

In order to identify a fatty acid ratio unaffected by degradation processes, Patrick et al. (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded in order to identify a stable fatty acid ratio. Patrick et al. (1985) found that the ratio of two C18:1 isomers, oleic and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archaeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick et al. (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

Development of the Identification Criteria

As the first stage in developing the identification criteria used herein, the fatty acid compositions of more than 130 uncooked Native food plants and animals from Western Canada were determined using gas chromatography (Malainey 1997; Malainey et al. 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature (Table 1). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens and berries/seeds/nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries/seeds/nuts.

Samples in cluster A, the large mammal and fish cluster had elevated levels of C16:0 and C18:1 (Table 1). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat and high levels of very long chain unsaturated fatty acids (VLCU) in fish. Differences in the fatty acid composition of plant roots, greens and berries/seeds/nuts reflect the amounts of C18:2 and C18:3ω3 present. The berry, seed, nut and small mammal meat samples appearing in cluster B have very high levels of C18:2, ranging from 35% to 64% (Table 1). Samples in subclusters V, VI and VII have levels of C18:1 isomers from 29% to 51%, as well. Plant roots, plant greens and some berries appear in cluster C. All cluster C samples have moderately high levels of C18:2; except for the berries in subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3ω3 and/or very long chain saturated fatty acids (VLCS) are also common except in the roots which form subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland and forests of Western Canada were prepared by cooking samples of meats, fish and plants, alone or combined, in replica vessels over an open fire (Malainey 1997; Malainey et al. 1999b). After four days at room temperature, the vessels were broken and a set of sherds analysed to determine changes after a short term of decomposition. A second set of sherds remained at room temperature for 80 days, then placed in an oven at 75°C for a period of 30 days in order to simulate the processes of long term decomposition. The relative percentages were calculated on the basis of the ten fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11, C18:2) that regularly appeared in Precontact Period vessel residues from Western Canada. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archaeological residues (Table 2).

It was determined that levels of medium chain fatty acids (C12:0, C14:0 and C15:0), C18:0 and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey et al. 1999b). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0, were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally; the seventh type, plant with large herbivore, was inferred (Table 2). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey et al. 1999c; 2001b). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Work has continued to understand the decomposition patterns of various foods and food combinations (Malainey et al. 2000a, 2000b, 2000c, 2001a; Quigg et al. 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano Berlandier*), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasylirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*) and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg et al. 2000) or as a griddle. In order to accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75°C. After either 30 or 68 days, residues were extracted and analysed using gas chromatography. The results of these decomposition studies enabled refinement of the identification criteria (Malainey 2007).

Using Lipid Distribution and Biomarkers to Identify Archaeological Residues

Archaeological scientists working in the United Kingdom have had tremendous success using high temperature-gas chromatography (HT-GC) and gas chromatography with mass spectrometry (HT-GC/MS) to identify biomarkers. High temperature gas chromatography is used to separate and assess a wide range of lipid components, including fatty acids, long chain alcohols and hydrocarbons, sterols, waxes, terpenoids and triacylglycerols (Evershed et al. 1990, Evershed et al. 2001). The molecular structure of separated components is elucidated by mass spectrometry (Evershed 2000).

Triacylglycerols, diacylglycerols and sterols can be used to distinguish animal-derived residues, which contain cholesterol and significant levels of both triacylglycerols, from plant-derived residues, indicated by plant sterols, such as β-sitosterol, stigmasterol and campesterol, and only traces of triacylglycerols (Evershed 1993; Evershed et al. 1997a; Dudd and Evershed 1998). Barnard et al. (2007), however, have recently suggested that microorganisms living off residues can introduce β-sitosterol into residues resulting from the preparation of animal products. Waxes, which are long-chain fatty acids and long-chain alcohols that form protective coatings on skin, fur, feathers, leaves and fruit, also resist decay. Evershed et al. (1991) found epicuticular leaf waxes from plants of the genus *Brassica* in vessel residues from a Late Saxon/Medieval settlement. Cooking experiments later confirmed the utility of nonacosane, nonacosan-15-one and nonacosan-15-ol to indicate the preparation of leafy vegetables, such as turnip or cabbage (Charters et al. 1997). Reber et al. (2004) recently suggested *n*-dotriacontanol could serve as an effective biomarker for maize in vessel residues from sites located in Midwestern and Eastern North America. Beeswax can be identified by the presence and distribution of n-alkanes with carbon chains 23 to 33 atoms in length and palmitic acid wax esters with chains between 40 and 52 carbons in length (Heron et al. 1994; Evershed et al. 1997b).

Terpenoid compounds, or terpenes, are long chain alkenes that occur in the tars and pitches of higher plants. The use of GC and GC/MS to detect the diterpenoid, dehydroabietic acid, from conifer products in archaeological residues extends over a span of 25 years (Shackley 1982; Heron and Pollard 1988). Lupeol, α- and β-amyrin and their derivatives indicate the presence of plant materials (Regert 2007). Eerkens (2002) used the predominance of the diterpenoid, Δ–8(9)-isopimaric acid, in a vessel residue from the western Great Basin to argue it contained piñon resins. Other analytical techniques have also been used to identify terpenoid compounds. Sauter et al.

(1987) identified the triterpenoid, betulin in Iron Age tar to confirm the tar was produced from birch. Azelaic acid is a short chain dicarboxylic acid is associated with the oxidation of unsaturated fatty acids (Regert et al. 1998). Unsaturated fatty acids are most abundant in seed oils; its presence may indicate the residue reflects the processing of plant seeds.

The data obtained by HT-GC and HT-GC/MS analysis is useful for distinguishing plant residues, animal residues and plant/animal combinations. As noted above, the sterol cholesterol is associated with animal products; β-sitosterol, stigmasterol and campesterol are associated with plant products. The presence and abundance of triacylglycerols (TAGs) also varies with the material of origin. When present, amounts of TAGs tend to decrease with increasing numbers of carbon atoms in plant residues (Malainey et al. 2010, 2014, in press). The peak arising from C48 TAGs is largest and peak size (and area) progressively decreases with the C54 TAG peak being the smallest. A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks slopes down to the right. This pattern is due to the preponderance of triacylglycerols with fatty acids having carbon chains ranging between 12 and 16 in length; C46 TAG peaks may also be detected. In animal residues, amounts of TAGs tend to increase with carbon numbers, with the C52 or C54 TAG peaks being the largest (Malainey et al. 2010, 2014, in press). A line drawn to connect the tops of the C48, C50, C52 and C54 TAG peaks either resembles a hill or the line slopes up to the right. A parabola-like pattern, such as the shape of a "normal distribution," can also occur in the residues of oil seeds that contain high levels of C18:1 isomers (Malainey et al. 2010, 2014, in press). This pattern is due to the abundance of triacylglycerols composed of fatty acids with mostly chain lengths of 16 or 18 carbons.

Methodology

Descriptions of the various samples are provided in Tables 4, 5 and 6. Possible contaminants were removed from pottery by grinding off exterior surfaces with a Dremel® tool fitted with a silicon carbide bit. Immediately thereafter, the sample was crushed with a hammer mortar and pestle and the powder transferred to an Erlenmeyer flask. The loose soil did not require any additional preparation. Lipids were extracted using a variation of the method developed by Folch et al. (1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2×25 mL) using ultrasonication (2×10 min). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 13.3 mL of ultrapure water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform removed by rotary evaporation. Any remaining water was removed by evaporation with 2-propanol (1.5 mL); 1.5 mL of chloroform-methanol (2:1, v/v) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon®-lined cap. The sample was flushed with nitrogen and stored in a -20°C freezer.

Preparation of FAMES

A 100-400 μL aliquot of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 3 mL of 0.5 N anhydrous hydrochloric acid in methanol (68°C; 60 min). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 2.0 mL of ultrapure water was added; FAMES were recovered with petroleum ether (2×1.5 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen; the FAMES were dissolved in 75 μL of *iso*-octane then transferred to a GC vial with a conical glass insert.

Preparation of TMS derivatives

A 100-200 μL aliquot of the total lipid extract solution was placed in a screw-top vial and dried under nitrogen. Trimethylsilyl (TMS) derivatives were prepared by treating the lipid with 70 μL of *N,O*-bis(trimethylsilyl)trifluoroacetamide (BSTFA) containing 1% trimethylchlorosilane, by volume (70ºC; 30 min). The sample was then dried under nitrogen and the TMS derivatives were redissolved in 100 μL of hexane.

Solvents and chemicals were checked for purity by running a sample blank. Traces of fatty acid contamination were subtracted from sample chromatograms. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample. In order to identify the residue on the basis of fatty acid composition, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very long chain fatty acids) and second with respect to the ten fatty acids utilized in the development of the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1ω9, C18:1ω11 and C18:2) (not shown). The second step is necessary for the application of the identification criteria presented in Table 2. It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues (see Table 3). It is possible only to say that the material of origin for the residue was similar in composition to the food(s) indicated. High temperature gas chromatography and high temperature gas chromatography with mass spectrometry is used to further clarify the identifications.

Gas Chromatography Analysis Parameters

The GC analysis was performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a VF-23 fused silica capillary column (30 m × 0.25 mm I.D.; Varian; Palo Alto, CA). An autosampler injected the sample using a split/splitless injection system. Hydrogen was used as the carrier gas with a column flow of 1.0 mL/min. Column temperature was increased from 80°C to 140°C at a rate of 20°C per minute then increased to 185°C at a rate of 4°C per minute. After a 4.0 minute hold, the temperature was further increased to 250°C at 10°C per minute and held for 2 minutes. Chromatogram peaks were integrated using Varian MS Workstation® software and identified through comparisons with external qualitative standards (NuCheck Prep; Elysian, MN).

High Temperature Gas Chromatography and Gas Chromatography with Mass Spectrometry

Both HT-GC and HT GC-MS analyses were performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector and a Varian 4000 mass spectrometer connected to a personal computer. For HT-GC analysis, the sample was injected onto a DB-1HT fused silica capillary column (15 m × 0.32 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the flame ionization detector, using hydrogen as the carrier gas. The column temperature was held at 50°C for 1 minute then increased to 350°C at a rate of 15°C per minute and held for 26 minutes. For HT-GC/MS analysis, samples were injected onto a DB-5HT fused silica capillary column (30 m × 0.25 mm I.D.; Agilent J&W; Santa Clara, CA) connected to the ion trap mass spectrometer in an external ionization configuration using helium as the carrier gas. After a 1 minute hold at 50°C, the column temperature was increased to 180°C at a rate of 40°C per minute then ramped up to 230°C at a rate of 5°C per minute and finally increased to 350°C at a rate of 15°C per minute and held for 27.75 minutes. The Varian 4000 mass spectrometer was operated in electron-impact ionization mode scanning from m/z 50-700. Chromatogram peaks and MS spectra were processed using Varian MS Workstation® software and identified through comparisons with external qualitative standards (Sigma Aldrich; St. Louis, MO and NuCheck Prep; Elysian, MN), reference samples and the National Institute of Standards and Technology (NIST) database.

Results of Archaeological Data Analysis

Fatty acid compositions of the residues were determined by using the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. Lipid compositions of all extracted pottery residues, except residue 17KMS 25, are presented in Table 4. Insufficient fatty acids were present in residue 17KMS 25 to attempt identification but lipid biomarkers were detected (Table 5). Compositions of the lipid residues extracted from the soil samples are given in Table 6. The term "Area" represents the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. Hydroxide or peroxide degradation products can interfere with the integration of the C22:0 and C22:1 peaks; these fatty acids were excluded from the analysis.

Decomposed Nut Oil

Residue 17KMS 5 is characterized by extremely high levels of the fatty acid C16:0, 71.07%, and relatively low levels of other fatty acids. No biomarkers were detected; analysis using HT-GC/MS indicates that the C48 and C50 TAGs may be present. This residue does not conform to the criteria outlined in Table 2, but its identity can be established with confidence. High and very high fat content foods produce residues dominated by greatly elevated levels of C18:1 isomers, moderate levels of C16:0 and low levels of other fatty acids. When these residues are highly degraded, the level of monounsaturated C18:1 isomers drops and relative levels of the stable saturated fatty acids increase. The result is a residue with very high levels of C16:0 and low to moderate levels of other fatty acids.

The experimental cooking residue resulting from the preparation of crushed acorns, residue MQ 19D, can be used to illustrate how this occurs (Table 7; see also Malainey 2007). This crushed acorn cooking residue was prepared by J. Michael Quigg in Texas and sent to the Brandon University lab where it was stored in an oven at 75°C for 30 days. Lipids were extracted with organic solvents; FAMEs were derived and analyzed using gas chromatography. The first column of Table 7 shows the relative fatty acid composition of the partially degraded residue MQ 19D after 30 days of oven storage. The next two columns show how the relative amounts of stable fatty acids would change if the level of C18:1 isomers dropped to 3.73%, which is the amount in 17KMS 5. The relative percentage composition of 17KMS 5 is given in the fourth column. The changes in relative fatty acid composition extrapolated for highly degraded residue of cooked crushed acorns compares very favourably with the archaeological residue 17KM 5. For this reason, residue 17KMS 5 can be identified as a decomposed nut oil. The level of C18:0 is above 14%; this is slightly higher than expected and may indicate traces of animal products are also present.

<u>Decomposed Nut Oil Dominates</u>

Residues 17KMS 19 and 17KMS 27 are characterized by extremely high levels of the fatty acid C16:0, 68.65% and 69.95%, respectively. As outlined above, the very high levels of C16:0 can be attributed to the decomposition of high and very high fat content foods, such as nut oil, that originally had high levels of C18:1 isomers, moderate levels of C16:0 and low levels of other fatty acids. Levels of the fatty acid C16:0 in residues 17KMS 19 and 17KMS 27 are just slightly lower than those observed in residue 17KMS 5 and there is evidence that other foods were prepared in the vessels, as well. The level of medium chain saturated fatty acids (sum of the fatty acids C12:0, C14:0 and C15:0) is 15.14% in residue 17KMS 19. In North America, similarly high levels of medium chain saturated fatty acids indicate the preparation of low fat content plants, such as roots, greens and certain berries. The level of the fatty acid C18:0 in residue 17KMS 27 is 16.32%, which suggests the possible presence of animal products. The occurrence of animal products in residue 17KMS 27 is further substantiated by the probable presence of the animal sterol cholesterol. The distribution of triacylglycerols in the residues attests to the presence of both plant and animal products. The area of the C48 TAG in residue 17KMS 27 was larger than C50 TAG peak; the C52 and C54 TAGs were also present. There is only weak evidence for the presence of cholesterol in residue 17KMS 19 and only traces of TAGs were detected.

<u>Decomposed Nut Oil and Other Foods</u>

Nineteen residues, 17KMS 1, 17KMS 2, 17KMS 3, 17KMS 7, 17KMS 8, 17KMS 9, 17KMS 11-15, 17KMS 17, 17KMS 18, 17KMS 20, 17KMS 22, 17KMS 23, 17KMS 26, 17KMS 29 and 17KMS 30, are identified as combinations of decomposed nut oil and other foods. The fatty acid C16:0 appears in all foods and archaeological food residues. The mean and standard deviation of C16:0 levels in 600 archaeological residues previously identified as food was determined and found to be 31 ± 9%. Levels of the fatty acid 16:0 in the residues discussed in this section are outside of the expected range of 22% and 40%. Levels of the fatty acid 16:0 in all but one of the residues discussed in this section range exceed 49% but are less than 67%, i.e., they are more than two standard deviations from the mean, but within the four standard deviations of the mean value. At 48.91%, the C16:0 level in 17KMS 7 is just outside of the two standard deviation range of 49%. Elevated levels of C16:0 in these residues are likely due to presence of decomposed nut oil but various other foods, such as animal products, low fat content plants and/or medium fat content foods, were also prepared in these vessels.

Decomposed Nut Oil and Low Fat Content Plant Products, Animal Products Present or Probably Present: Residues 17KMS 9, 17KMS 13, 17KMS 14, 17KMS 15, 17KMS 18, 17KMS 20, 17KMS 22, 17KMS 23, 17KMS 26 and 17KMS 29 are similar in that the level of the fatty acid 16:0 is high, ranging between 49.30% and 64.19%, which indicates the presence of decomposed nut oil. Levels of medium chain saturated fatty acids (the sum of C12:0, C14:0 and C15:0) exceed 10% in all of these residues. As noted above, similarly high levels of medium chain saturated fatty acids in North American archaeological lipid residues indicate the preparation of low fat content plants, such as roots, greens and certain berries. The residues are likely a combination of decomposed nut oil and low fat content plants. Elevated levels of the fatty acid C18:0 indicate the presence of animal products in all of these residues as well. In most residues, the level of this fatty acid ranges between 13% and 16%. The level of the fatty acid C18:0 is close to or exceeds 20% in residues 17KMS 9, 17KMS 13, 17KMS 14 and 17KMS 22, which suggests the animal component of some of these complex residues may be due in part to the presence of large herbivore products, such as deer, moose or bison flesh. The animal sterol cholesterol was detected in residues 17KMS 9, 17KMS 15, 17KMS 26 and 17KMS 29. Dehydroabietic acid may occur in residue 17KMS 15 and 17KMS 26; this biomarker indicates the presence of conifer products, which may have been introduced from pine nuts, firewood, resins or other conifer products. The C48 TAG peak appears in residue 17KMS 14, 17KMS 15 and 17KMS 18, which suggests that plant products dominate these residues. Both the C48 and C50 TAGs may appear in residues 17KMS 9 and 17KMS 13. Only traces of TAGs appear in the other samples.

Decomposed Nut Oil with Low Fat Content Plants and Medium Fat Content Foods: Residue 17KMS 17 has a high level of C16:0, 55.49%, which suggests the presence of decomposed nut oil. As with the residues described above, the sum of the levels of medium chain saturated fatty acids C12:0, C14:0 and C15:0 is 11.32%, which indicates the presence of low fat content plant foods, such as greens, roots or certain berries. The level of C18:1 isomers is 20.34%, which indicates the presence of medium fat content foods. As indicated in Table 3, both plant and animal foods can produce these types of residues. Examples of medium fat content plant foods include corn, mesquite and cholla. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. The biomarker for conifer products dehydroabietic acid may occur in this residue. Only traces of TAGS appear in this residue.

Decomposed Nut Oil, Animal Products present or possibly present: Residues 17KMS 2, 17KMS 3, 17KMS 7, 17KMS 11, 17KMS 12 and 17KMS 30 are similar in that 1) the levels of C16:0 are high, 2) levels of medium chain saturated fatty acids are elevated but do not exceed 10% and 3) there is evidence of animal products. Levels of C16:0 in most of these residues range between 54.69% and 62.24%; the level in 17KMS 7 is 48.91%. High levels of C16:0 suggest the presence of decomposed nut oil in all residues; the somewhat elevated levels of medium chain saturated acids may be due to the nuts themselves. Evidence of animal products is stronger in some residues than in others. The animal sterol cholesterol occurs in residue 17KMS 11 and probably occurs in residue 17KMS 7 and possibly in 17KMS 30. Levels of the fatty acid C18:0 are close to, or exceed, 20% in residues 17KMS 3, 17KMS 7, 17KMS 12 and 17KMS 30, which suggests the presence of animal products. The C18:0 level is somewhat elevated in residue 17KMS 2, 17.19%, which indicates animal products may occur. Dehydroabietic acid may occur in residues 17KMS 7 and 17KMS 30, which indicates the possible presence of conifer products. Analysis by HT-GC/MS shows that both the C48 and C50 TAGs occur in residue 17KMS 12. These TAGs may be present in residues 17KMS 2, 17KMS 3 and 17KMS 11; the C48 TAG may appear in residue 17KMS 7. Traces of TAGs were detected in residue 17KMS 30.

Decomposed Nut Oil with Animal and High C18:0 (Large Herbivore): Residue 17KMS 8 has a high level of C16:0, 59.03%, which indicates the presence of decomposed nut oil. It also has a high level of C18:0, 28.44%; similar levels of C18:0 result from the preparation of large herbivores, such as bison, deer, moose, fat elk meat or other bovines or cervids; but javelina meat and tropical oil seeds also produce residues high in C18:0 and must be considered as potential sources where available. No biomarkers occur; the C48 and C50 TAGs may be present.

Decomposed Nut Oil with Medium Fat Content Foods: As with the other residues described in this section, residue 17KMS 1 has a high level of C16:0, 51.32%, which suggests the presence of decomposed nut oil. It differs, however, in that the level of C18:1 isomers is 15.07%, which indicates the presence of medium fat content foods. As noted above, both plant and animal foods can produce these types of residues. Examples of medium fat content plant foods include corn, mesquite and cholla. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. The biomarker for conifer products dehydroabietic acid occurs; the C48 and C50 TAGs may be present.

High C18:0 level "Large Herbivore"

Both residue 17KMS 24 and 17KMS 28 are characterized by high levels of the fatty acid C18:0, 46.19% and 38.45% respectively. Similarly high levels of C18:0 result from the preparation of large herbivores, such as bison, deer, moose, fat elk meat or other bovines or cervids; but javelina meat and tropical oil seeds also produce residues high in C18:0 and must be considered as potential sources where available. The level of medium chain saturated fatty acids in residue 17KMS 28 is just below 10%, which suggests low fat content plant products are probably present and the level of the fatty acid C17:0 is 5.53%. Elevated levels of this particular fatty acids are associated with plant roots. No lipid biomarkers were detected in either residue. The C48: C50:C52:C54 TAG ratio in residue 17KMS 24 is 1.0: 3.1: 4.3: 2.2, which is consistent with the identification of animal products. Only traces of TAGs were detected in 17KMS 28.

Low Fat Content Plants Dominate

Residues 17KMS 4 and 17KMS 10 are similar in that the levels of medium chain saturated fatty acids (sum of C12:0, C14:0 and C15:0) are very high, 33.72% and 40.15%, respectively. As these vessels were recovered from a site in North America, they were probably used in the preparation of low fat content plant foods. The level of C18:0 is elevated in residue 17KMS 4 and the animal sterol cholesterol may occur, which strongly suggests the presence of animal products. The biomarker for conifers, dehydroabietic acid, may occur in residue 17KMS 4. The level of C18:1 isomers is 18.15% in residue 17KMS 10, which indicates the presence of medium fat content foods. Both plant and animal foods can produce medium fat content residues; but in this case, the absence of the fatty acid C18:0 indicates medium fat content plant foods are the most likely source. Examples of medium fat content plant foods include corn, mesquite and cholla. No biomarkers were detected in residue 17KMS 10; the C48 and C50 TAGs may occur in both residues.

Low Fat Content and Medium Fat Content

Residue 17KMS 6 is characterized by high levels of medium chain saturated fatty acids, 18.67%, which probably indicates the presence of low fat content plant foods, such as greens, roots and certain berries. The level of C18:1 isomers in this residue is 24.85%, which indicates the presence of medium fat content foods. While both plant and animal foods can produce medium fat content residues, the presence of the animal sterol cholesterol suggests that an animal source is more likely. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. The biomarker for conifers, dehydroabietic acid, may occur in this residue; the C48 and C50 TAGs may also occur.

<u>Medium Fat Content with Animal Products and Low Fat Content Plants</u>

The level of C18:1 isomers in residue 17KMS 21 is 15.20%, which indicates the presence of medium fat content foods. While both plant and animal foods can produce medium fat content residues, the possible presence of the animal sterol cholesterol and elevated levels of the fatty acid C18:0, 18.88%, suggests that an animal source is more likely. Freshwater fish, terrapin, Rabdotus snail and late winter, fat-depleted elk are examples of medium fat content animal foods. The level of medium chain saturated fatty acids is just under 10%, which suggests that low fat content plant foods, such as greens, roots and certain berries, are probably present. The biomarker for conifers, dehydroabietic acid, may occur in this residue. Traces of the C48, C50, C52 and C54 TAGs appear.

<u>Moderate-High Fat Content</u>

The level of C18:1 isomers in residue 17KMS 16 is 28.61%, which is a moderate-high level. Foods known to produce moderate-high fat content residues include Texas ebony seeds and the fatty meat of medium-sized mammals, such as beaver. The origin of the residue is somewhat ambiguous. The level of the fatty acid C18:0 in this residue is 13.30%; which suggests the possible presence of animal products. The presence of cholesterol derivatives further indicates that the processing of an animal gave rise to this medium-high fat content residue. The presence of plants is indicated by the probable occurrence of the plant sterol β-sitosterol. It is possible that the residue was due to a combination of moderate-high fat animal and moderate-high fat content plants. Only traces of TAGs were detected in this residue.

Biomarkers Detected: Insufficient Fatty Acids

Insufficient fatty acids were recovered to attempt a characterization of residue 17KMS 25 but two biomarkers may occur (Table 5). The animal sterol cholesterol may occur; the biomarker for conifers, dehydroabietic acid may occur. This suggests the possible presence of animal products and conifer products. No triacylglycerols were detected in the residue.

Soil Samples

Please note that only fatty acids that elute (i.e., emerge from the GC column) in the typical range of fatty acids found in foods are discussed. The fatty acid compositions of the residues extracted from the soil samples are very different from those extracted from the pottery. Levels of polyunsaturated fatty acids (those with multiple double bonds) in the soil residues are much higher than those observed in archaeological pottery residues. The composition of soil residue 17KMS 33 is most different from the archaeological pottery residues and may reflect only natural soil lipids. If this is correct, the other two soil residues may be combinations of natural and cultural lipids. The animal sterol cholesterol and the plant sterols stigmasterol and β-sitosterol occur in all soil residues. Triacylglycerols appear in all residues but we do not have information on the typical distribution of TAGs in soils. If the distribution is similar to that in foods, it suggests they were primarily derived from plant products.

The fatty acid composition of soil residue 17KMS 33 is characterized by high levels of very long chain polyunsaturated fatty acid C22:4 (19.04%) and high levels of two polyunsaturated fatty acids that elute simultaneously, a C20:3 isomer and C20:5 (14.06%). The level of the long chain polyunsaturated fatty acid C18:2 is 5.05%. The level of the fatty acid

C16:0 is 16.85% and the level of the fatty acid C18:1 is 12:84%. A wide variety of other polyunsaturated, monounsaturated and saturated fatty acids were also detected. Soil residue 17KMS 33 may have been derived primarily from natural soil lipids.

Soil residue 17KMS 31 is quite similar to 17KMS 33 but levels of the fatty acid C22:4 and the C20:3/C20:5 combination are somewhat lower, 16.86% and 8.59%, respectively. The level of the fatty acid C18:2 in soil residue 17KMS 31 is slightly higher, 5.83%. The major difference is the significantly higher level of C18:1 isomers in residue 17KMS 31. At 28.03%, the level of C18:1 isomers in soil residue 17KMS 31 is more than twice that in soil residue 17KMS 33. If the fatty acid composition of residue 17KMS 33 reflects only natural soil lipids, the elevated level of C18:1 isomers may signify the presence of some cultural lipids in this residue.

Levels of the polyunsaturated fatty acid C22:4 (5.08%) and the C20:3/C20:5 combination (2.79%) are much lower in soil residue 17KMS 32 compared to the other soil residues. The level of the polyunsaturated fatty C18:2 is somewhat higher, 8.57%; the level of C18:1 isomers is much higher, 53.67%. The context of the soil sample should be carefully evaluated; it may indicate the location of an activity area where high fat foods were processed.

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List of Tables

Table 1. Summary of average fatty acid compositions of modern food groups generated by hierarchical cluster analysis.

Cluster	**A**				**B**						**C**				
Subcluster	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
Type	Mammal Fat and Marrow	Large Herbivore Meat	Fish	Fish	Berries and Nuts	Mixed	Seeds and Berries	Roots	Seeds	Mixed	Greens	Berries	Roots	Greens	Roots
C16:0	19.90	19.39	16.07	14.10	3.75	12.06	7.48	19.98	7.52	10.33	18.71	3.47	22.68	24.19	18.71
C18:0	7.06	20.35	3.87	2.78	1.47	2.36	2.58	2.59	3.55	2.43	2.48	1.34	3.15	3.66	5.94
C18:1	56.77	35.79	18.28	31.96	51.14	35.29	29.12	6.55	10.02	15.62	5.03	14.95	12.12	4.05	3.34
C18:2	7.01	8.93	2.91	4.04	41.44	35.83	54.69	48.74	64.14	39.24	18.82	29.08	26.24	16.15	15.61
C18:3	0.68	2.61	4.39	3.83	1.05	3.66	1.51	7.24	5.49	19.77	35.08	39.75	9.64	17.88	3.42
VLCS	0.16	0.32	0.23	0.15	0.76	4.46	2.98	8.50	5.19	3.73	6.77	9.10	15.32	18.68	43.36
VLCU	0.77	4.29	39.92	24.11	0.25	2.70	1.00	2.23	0.99	2.65	1.13	0.95	2.06	0.72	1.10

VLCS- Very Long Chain (C20, C22 and C24) Saturated Fatty Acids
VLCU - Very Long Chain (C20, C22 and C24) Unsaturated Fatty Acids

Table 2. Criteria for the identification of archaeological residues based on the decomposition patterns of experimental cooking residues prepared in pottery vessels.

Identification	**Medium Chain**	**C18:0**	**C18:1 isomers**
Large herbivore	≤ 15%	≥ 27.5%	≤ 15%
Large herbivore with plant OR Bone marrow	low	≥ 25%	15% ≤ X ≤ 25%
Plant with large herbivore	≥ 15%	≥ 25%	no data
Beaver	low	Low	≥ 25%
Fish or Corn	low	≤ 25%	15% ≤ X ≤ 27.5%
Fish or Corn with Plant	≥ 15%	≤ 25%	15% ≤ X ≤ 27.5%
Plant (except corn)	≥ 10%	≤ 27.5%	≤ 15%

Table 3. Known food sources for different types of decomposed residues.

Decomposed Residue Identification	**Plant Foods Known to Produce Similar Residues**	**Animal Foods Known To Produce Similar Residues**
Large herbivore	Tropical seed oils, including sotol seeds	Bison, deer, moose, fall-early winter fatty elk meat, Javelina meat
Large herbivore with plant OR Bone marrow		
Low Fat Content Plant (Plant greens, roots, berries)	Jicama tuber, buffalo gourd, yopan leaves, biscuit root, millet	Cooked Camel's milk
Medium-Low Fat Content Plant	Prickly pear, Spanish dagger	None
Medium Fat Content (Fish or Corn)	Corn, mesquite beans, cholla	Freshwater fish, *Rabdotus* snail, terrapin, late winter fat-depleted elk
Moderate-High Fat Content (Beaver)	Texas ebony	Beaver and probably raccoon or any other fat medium-sized mammals
High Fat Content	High fat nuts and seeds, including acorn and pecan	Rendered animal fat (other than large herbivore), including bear fat
Very High Fat Content	Very high fat nuts and seeds, including pine nuts	Freshly rendered animal fat (other than large herbivore)

Table 4. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 1		17KMS 2		17KMS 3	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	25739	1.47	17827	0.23	76814	1.17
C14:0	89947	5.14	323400	4.09	377191	5.76
C14:1	1280	0.07	0	0.00	53031	0.81
C15:0	46171	2.64	245908	3.11	169748	2.59
C16:0	897233	51.32	4884437	61.71	3578739	54.69
C16:1	68704	3.93	135756	1.72	68330	1.04
C17:0	29529	1.69	220596	2.79	178638	2.73
C17:1	2334	0.13	30616	0.39	32025	0.49
C18:0	282682	16.17	1360199	17.19	1561883	23.87
C18:1s	263520	15.07	564478	7.13	244748	3.74
C18:2	3772	0.22	17691	0.22	1714	0.03
C18:3s	3751	0.21	3998	0.05	67818	1.04
C20:0	23130	1.32	71520	0.90	110197	1.68
C20:1	4920	0.28	4812	0.06	1409	0.02
C24:0	4456	0.25	33303	0.42	17247	0.26
C24:1	1137	0.07	0	0.00	3818	0.06
Total	1748305	100.00	7914541	100.00	6543350	100.00
Biomarkers	Dehydroabietic acid		None detected		None detected	
Triacylglycerols	Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS	
Identification	Medium fat content; Decomposed nut oil; Plant products present; Animal product may be present; Conifer products present		Decomposed nut oil; Animal products may be present		Decomposed nut oil; Animal products probably present	
Vessel No.	1		6		109	
Catalogue No.	7282.169.2.01.01		7282.195.06.02		7282.770.05.02	
Sample Mass	6.563 g		11.788 g		10.271 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 4		17KMS 5 (dil)		17KMS 6	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	84787	10.57	27690	0.30	27435	4.98
C14:0	92001	11.47	351963	3.81	56122	10.19
C14:1	15319	1.91	56244	0.61	0	0.00
C15:0	93688	11.68	154868	1.68	19246	3.50
C16:0	199973	24.93	6565301	71.07	229683	41.71
C16:1	6601	0.82	11101	0.12	15846	2.88
C17:0	15656	1.95	222725	2.41	0	0.00
C17:1	6058	0.76	9901	0.11	2247	0.41
C18:0	145136	18.10	1320023	14.29	24316	4.42
C18:1s	93107	11.61	344797	3.73	136856	24.85
C18:2	21809	2.72	6121	0.07	17301	3.14
C18:3s	7544	0.94	24060	0.26	0	0.00
C20:0	14808	1.85	80343	0.87	10398	1.89
C20:1	0	0.00	7328	0.08	6188	1.12
C24:0	1628	0.20	53867	0.58	3502	0.64
C24:1	3939	0.49	1193	0.01	1525	0.28
Total	802054	100.00	9237525	100.00	550667	100.00
Biomarkers	Possibly Cholesterol; possibly Dehydroabietic acid		None detected		Cholesterol; possibly Dehydroabietic acid	
Triacylglycerols	Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS	
Identification	Low fat content plant dominates; Animal products; Conifer products may occur		Decomposed nut oil; possible traces of animal products		Low fat content plant and Medium fat content food; Animal products; Conifer products may occur	
Vessel No.	131		35		34	
Catalogue No.	7282.770.03.02		7282.479.04.03		7282.479.03.01	
Sample Mass	6.187 g		7.138 g		8.184 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 7		17KMS 8 (dil)		17KMS 9	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	116245	1.06	19626	0.14	34181	0.59
C14:0	648828	5.92	246229	1.69	390212	6.76
C14:1	110588	1.01	53083	0.37	45668	0.79
C15:0	261115	2.38	163802	1.13	154672	2.68
C16:0	5358484	48.91	8576741	59.03	3164006	54.85
C16:1	25621	0.23	8663	0.06	57011	0.99
C17:0	232927	2.13	407807	2.81	169064	2.93
C17:1	39212	0.36	13228	0.09	27459	0.48
C18:0	2294192	20.94	4131903	28.44	1179750	20.45
C18:1s	1079260	9.85	423166	2.91	447253	7.75
C18:2	142203	1.30	9231	0.06	11625	0.20
C18:3s	83604	0.76	25571	0.18	2063	0.04
C20:0	472498	4.31	276696	1.90	55331	0.96
C20:1	10949	0.10	0	0.00	4915	0.09
C24:0	80326	0.73	41460	0.29	23679	0.41
C24:1	0	0.00	131800	0.91	1368	0.02
Total	10956052	100.00	14529006	100.00	5768257	100.00
Biomarkers	Probably Cholesterol; possibly Dehydroabietic acid		None detected		Cholesterol	
Triacylglycerols	Possibly C48 TAG		Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS	
Identification	Decomposed nut oil; Animal products probably present; Conifer products may occur		Large Herbivore; Decomposed nut oil		Animal; Low fat content plant; Decomposed nut oil	
Vessel No.	76		80		193	
Catalogue No.	7282.880.02.04		7282.932.04.02		7282.619.03.01	
Sample Mass	11.223 g		12.438 g		7.998 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 10		17KMS 11 (dil)		17KMS 12 (dil)	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	134205	15.39	31613	0.30	23454	0.17
C14:0	171467	19.66	692023	6.67	1008727	7.49
C14:1	15986	1.83	85011	0.82	71555	0.53
C15:0	44399	5.09	188585	1.82	156103	1.16
C16:0	236428	27.11	6454880	62.24	7705492	57.21
C16:1	35137	4.03	7668	0.07	7713	0.06
C17:0	24575	2.82	186144	1.79	173689	1.29
C17:1	15496	1.78	42796	0.41	7391	0.05
C18:0	0	0.00	1722293	16.61	2799966	20.79
C18:1s	158310	18.15	730294	7.04	1076937	8.00
C18:2	14091	1.62	6898	0.07	13716	0.10
C18:3s	0	0.00	0	0.00	23893	0.18
C20:0	8940	1.03	82981	0.80	154636	1.15
C20:1	9970	1.14	16715	0.16	55356	0.41
C24:0	3011	0.35	117573	1.13	36972	0.27
C24:1	0	0.00	5117	0.05	152403	1.13
Total	872015	100.00	10370591	100.00	13468003	100.00
Biomarkers	None detected		Cholesterol		None detected	
Triacylglycerols	Possibly C48 and C50 TAGS		Possibly C48 and C50 TAGS		C48 and C50 TAGS	
Identification	Low fat content plant dominate; Medium fat content plants		Decomposed nut oil; Animal products present		Decomposed nut oil; Animal products probably present	
Vessel No.	101		150		204	
Catalogue No.	7282.787.03.03		7282.939.03.02		7282.619.04.03	
Sample Mass	14.098 g		10.813 g		10.461 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 13		17KMS 14		17KMS 15	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	103892	0.58	511414	0.51	158478	0.76
C14:0	1576100	8.78	12123650	11.98	2455800	11.73
C14:1	184746	1.03	931544	0.92	230086	1.10
C15:0	419886	2.34	2442276	2.41	541595	2.59
C16:0	10334127	57.58	55042282	54.37	12042466	57.53
C16:1	9648	0.05	355035	0.35	137713	0.66
C17:0	379951	2.12	1039082	1.03	128874	0.62
C17:1	55212	0.31	2084691	2.06	58471	0.28
C18:0	3615596	20.14	20122359	19.88	3018355	14.42
C18:1s	583078	3.25	5206328	5.14	1548211	7.40
C18:2	115855	0.65	124905	0.12	91499	0.44
C18:3s	109920	0.61	68268	0.07	156049	0.75
C20:0	331836	1.85	475534	0.47	182079	0.87
C20:1	5776	0.03	692948	0.68	13075	0.06
C24:0	117573	0.66	7776	0.01	165064	0.79
C24:1	5117	0.03	0	0.00	5333	0.03
Total	17948313	100.00	101228092	100.00	20933148	100.00
Biomarkers	None detected		None detected		Cholesterol; possibly Dehydroabietic acid	
Triacylglycerols	Possibly C48 and C50 TAGS		C48 TAG		C48 TAG	
Identification	Decomposed nut oil; Low fat content plant; Animal products present		Decomposed nut oil; Low fat content plant; Animal products present		Decomposed nut oil; Low fat content plant; Animal products present; Conifer products may occur	
Vessel No.	25		70		162	
Catalogue No.	7282.479.03.02		7282.2.07.02 L3		7282.787.01.03	
Sample Mass	9.935 g		9.892 g		11.487 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 16		17KMS 17		17KMS 18	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	8957	0.98	20688	2.75	13698	1.45
C14:0	32622	3.55	48199	6.40	53277	5.63
C14:1	0	0.00	0	0.00	0	0.00
C15:0	13242	1.44	16351	2.17	38513	4.07
C16:0	410092	44.68	417884	55.49	522847	55.30
C16:1	1596	0.17	13213	1.75	0	0.00
C17:0	12509	1.36	9152	1.22	34625	3.66
C17:1	1643	0.18	1385	0.18	3953	0.42
C18:0	122064	13.30	37519	4.98	152667	16.15
C18:1s	262576	28.61	153170	20.34	83981	8.88
C18:2	17937	1.95	17947	2.38	9278	0.98
C18:3s	3664	0.40	3361	0.45	0	0.00
C20:0	9998	1.09	2631	0.35	24000	2.54
C20:1	15313	1.67	8343	1.11	4678	0.49
C24:0	5641	0.61	3188	0.42	4013	0.42
C24:1	0	0.00	0	0.00	0	0.00
Total	917854	100.00	753031	100.00	945530	100.00
Biomarkers	Cholesterol derivative present; β-sitosterol probably present		Possibly dehydroabietic acid		None detected	
Triacylglycerols	Traces of TAGs		Traces of TAGs		C48 TAG	
Identification	Moderate-high fat content; Animal and plant products present		Decomposed nut oil, medium fat content; low fat content plants; conifer products may be present		Decomposed nut oil; Low fat content plant, Animal products present	
Sample No.	20		24		43	
Catalogue No.	7282.481.06.03.01		7282.479.03.01		7282.567.02.03	
Sample Mass	9.569 g		7.972 g		9.564 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 19 (dil)		17KMS 20		17KMS 21	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	22254	0.29	35613	0.74	11346	1.87
C14:0	995328	12.95	334540	6.98	39238	6.45
C14:1	0	0.00	0	0.00	0	0.00
C15:0	145750	1.90	155045	3.24	9470	1.56
C16:0	5275432	68.65	3074762	64.19	285917	47.00
C16:1	121792	1.58	22446	0.47	20470	3.37
C17:0	94402	1.23	135898	2.84	9391	1.54
C17:1	28387	0.37	21452	0.45	1880	0.31
C18:0	636099	8.28	711362	14.85	114865	18.88
C18:1s	318151	4.14	249618	5.21	92464	15.20
C18:2	2055	0.03	5761	0.12	4547	0.75
C18:3s	0	0.00	0	0.00	0	0.00
C20:0	24660	0.32	29180	0.61	6797	1.12
C20:1	6262	0.08	3409	0.07	9383	1.54
C24:0	14016	0.18	11134	0.23	2518	0.41
C24:1	0	0.00	0	0.00	0	0.00
Total	7684588	100.00	4790220	100.00	608286	100.00
Biomarkers	Possibly Cholesterol		None detected		Possibly Cholesterol; possibly Dehydroabietic acid	
Triacylglycerols	Traces of TAGs		Traces of TAGs		Traces of TAGs	
Identification	Decomposed nut oil; Low fat content plants		Decomposed nut oil; Low fat content plants; Animal products may be present		Medium fat content; Animal products, Low Fat Content plants probably present; conifer products may occur	
Sample No.	55 (exfoliated)		75		77	
Catalogue No.	7282.567.02.003		7282.880.03.04		7282.889.03.01	
Sample Mass	7.504 g		5.706 g		13.212 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 22		17KMS 23		17KMS 24 (dil)	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	62823	4.50	43238	5.11	26934	0.20
C14:0	85303	6.11	84902	10.04	329217	2.50
C14:1	0	0.00	0	0.00	0	0.00
C15:0	24135	1.73	23950	2.83	179630	1.36
C16:0	688206	49.30	457996	54.17	4596852	34.85
C16:1	1340	0.10	5748	0.68	92851	0.70
C17:0	39024	2.80	14832	1.75	496245	3.76
C17:1	4643	0.33	2827	0.33	25924	0.20
C18:0	332632	23.83	111618	13.20	6093217	46.19
C18:1s	123275	8.83	84015	9.94	1025651	7.77
C18:2	10467	0.75	5990	0.71	76158	0.58
C18:3s	1553	0.11	0	0.00	3818	0.03
C20:0	12084	0.87	6241	0.74	229863	1.74
C20:1	5656	0.41	2317	0.27	4780	0.04
C24:0	4679	0.34	1736	0.21	10718	0.08
C24:1	0	0.00	0	0.00	0	0.00
Total	1395820	100.00	845410	100.00	13191858	100.00
Biomarkers	Possibly Dehydroabietic acid		None detected		None detected	
Triacylglycerols	Traces of TAGs		Traces of TAGs		C48:C50:C52:C54 ratio 1.0: 3.1: 4.3: 2.2	
Identification	Decomposed nut oil; Animal products; Low fat content plants; Conifer products may be present		Decomposed nut oil; Low fat content plants; Animal products may be present		High C18:0 Large Herbivore	
Sample No.	100		146		164	
Catalogue No.	7282.918.05		7282.823.03.03		7282.770.02.1	
Sample Mass	9.084 g		9.001 g		7.727 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 26		17KMS 27		17KMS 28	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	38880	2.73	12450	0.34	54391	1.70
C14:0	91696	6.44	155177	4.27	130565	4.09
C14:1	0	0.00	0	0.00	0	0.00
C15:0	32639	2.29	59107	1.63	127847	4.00
C16:0	877764	61.65	2540048	69.95	1145591	35.88
C16:1	2991	0.21	50849	1.40	75290	2.36
C17:0	36044	2.53	72316	1.99	176717	5.53
C17:1	6314	0.44	26068	0.72	10525	0.33
C18:0	216346	15.20	592690	16.32	1227835	38.45
C18:1s	91211	6.41	83905	2.31	140712	4.41
C18:2	10908	0.77	1218	0.03	11362	0.36
C18:3s	0	0.00	0	0.00	0	0.00
C20:0	10926	0.77	20587	0.57	74439	2.33
C20:1	0	0.00	2300	0.06	3938	0.12
C24:0	8054	0.57	14661	0.40	12868	0.40
C24:1	0	0.00	0	0.00	1117	0.03
Total	1423773	100.00	3631376	100.00	3193197	100.00
Biomarkers	Cholesterol; possibly Stigmasterol; Dehydroabietic acid		Probably Cholesterol		None detected	
Triacylglycerols	Traces of TAGs		C48 TAG larger than C50 TAG; traces of C52 and C54 TAG occur		Traces of TAGs	
Identification	Decomposed nut oil; Low fat content plants; Animal product; Conifer products present		Decomposed nut oil; Animal products present		Large herbivore; low fat content plant roots may be present	
Sample No.	175		173		191	
Catalogue No.	7282.989.031.04		7282.880.04.03		7282.000.033	
Sample Mass	10.158 g		13.843 g		10.314 g	

Table 4 cont'd. Sample descriptions and lipid compositions of Cloudman site pottery residues.

Fatty acid	17KMS 29		17KMS 30	
	Area	Rel%	Area	Rel%
C12:0	36211	1.91	75215	1.09
C14:0	154294	8.13	424413	6.13
C14:1	0	0.00	0	0.00
C15:0	86053	4.53	109879	1.59
C16:0	1060792	55.89	4235558	61.22
C16:1	15778	0.83	79234	1.15
C17:0	60611	3.19	139478	2.02
C17:1	12836	0.68	24653	0.36
C18:0	285590	15.05	1312648	18.97
C18:1s	131465	6.93	356759	5.16
C18:2	13667	0.72	20890	0.30
C18:3s	1454	0.08	2164	0.03
C20:0	19437	1.02	89568	1.29
C20:1	7120	0.38	12443	0.18
C24:0	12621	0.66	35651	0.52
C24:1	0	0.00	0	0.00
Total	1897929	100.00	6918553	100.00
Biomarkers	Cholesterol		Possibly Cholesterol; probably Dehydroabietic acid	
Triacylglycerols	Traces of TAGs		Traces of TAGs	
Identification	Decomposed nut oil; Animal products; Low fat content plants		Decomposed nut oil; Animal products; Low fat content plants may be present; Conifer products probably present	
Sample No.	215		216	
Catalogue No.	7282.619.041.04		7282.219.04.02	
Sample Mass	7.179 g		10.913 g	

Table 5. Sample description and lipid biomarkers in residue 17KMS 25.

Biomarkers	Possibly Cholesterol; possibly Dehydroabietic acid
Triacylglycerols	None detected
Identification	Animal products may be present; Conifer products may be present
Sample No.	166
Catalogue No.	7282.029.06.2
Sample Mass	11.791 g

Table 6. Sample descriptions and lipid compositions of Cloudman site soil lipids.

Fatty acid	17KMS 31		17KMS 32		17KMS 33	
	Area	Rel%	Area	Rel%	Area	Rel%
C12:0	9326	0.24	4224	0.11	6736	0.20
C14:0	39594	1.02	21475	0.56	48301	1.47
C14:1	1558	0.04	1758	0.05	4513	0.14
C15:0	19153	0.49	17110	0.44	28181	0.86
C16:0	467886	12.00	553842	14.35	555104	16.85
C16:1	289759	7.43	80474	2.09	160486	4.87
C17:0	9897	0.25	7022	0.18	17520	0.53
C17:1	30491	0.78	21917	0.57	21828	0.66
C18:0	121865	3.13	104298	2.70	257871	7.83
C18:1s	1092745	28.03	2071376	53.67	422748	12.84
C18:2	227452	5.83	330916	8.57	166269	5.05
C18:3s	10533	0.27	22096	0.57	50039	1.52
C20:0	126476	3.24	54270	1.41	215590	6.55
C20:1	12194	0.31	16304	0.42	14231	0.43
C20:2	24418	0.63	37708	0.98	899	0.03
C20:3	126042	3.23	17696	0.46	4275	0.13
C20:4	21697	0.56	13344	0.35	31798	0.97
C20:3/C20:5	335021	8.59	107544	2.79	463143	14.06
C22:0	3022	0.08	16848	0.44	22009	0.67
C22:1	8049	0.21	2875	0.07	26070	0.79
C22:2	85410	2.19	57832	1.50	3660	0.11
C22:4	657241	16.86	196051	5.08	627153	19.04
C22:5	42601	1.09	3578	0.09	26850	0.82
C24:0	3767	0.10	5103	0.13	13192	0.40
C22:6	95820	2.46	73928	1.92	105109	3.19
C24:1	36465	0.94	19990	0.52	0	0.00
Total	3898482	100.00	3859579	100.00	3293575	100.00
Biomarkers	Cholesterol; Stigmasterol; β-sitosterol; possibly Dehydroabietic acid		Cholesterol; Stigmasterol; β-sitosterol; possibly Dehydroabietic acid		Cholesterol; Stigmasterol; β-sitosterol	
Triacylglycerols	Plant products		Plant products		Plant products	
Identification	Possible Combination of Cultural and Natural Soil Lipids; Conifer products may occur		Combination of High Fat Content Cultural Lipids and Natural Soil Lipids; Conifer products occur		Natural Soil Lipids Dominant	
Sample No.	T2-S1-2		T2-S2-2		T3-S1-1	
Sample Mass	9.211 g		10.070 g		10.105 g	

Table 7. Experimental cooking residue of crushed acorn with extrapolation of further degradation compared to the relative fatty acid composition of residue 17KM 5.

Fatty acid	MQ 19D	Recalculated MQ 19D (C18:1s = 3.73%)		17KMS 5
	Rel%	Area	Rel%	Rel%
C12:0	0.30	0.30	0.72	0.30
C14:0	3.66	3.66	8.90	3.81
C14:1	0.03	0.03	0.07	0.61
C15:0	0.18	0.18	0.43	1.68
C16:0	28.27	28.27	68.71	71.07
C16:1	0.17	0.17	0.41	0.12
C17:0	0.71	0.71	1.73	2.41
C17:1	0.00	0.00	0.00	0.11
C18:0	4.64	4.64	11.27	14.29
C18:1s	56.04	1.54	3.73	3.73
C18:2	3.78	0.00	0.00	0.07
C18:3s	0.14	0.00	0.00	0.26
C20:0	1.01	1.01	2.45	0.87
C20:1	0.43	0.00	0.00	0.08
C24:0	0.65	0.65	1.57	0.58
C24:1	0.00	0.00	0.00	0.01
Total	100.00	41.14	100.00	100.00
Identification	Cooked crushed acorns after 30 days decomposition in 75°C oven	Extrapolation of Decomposition: Crushed acorns when C18:1 isomers drop to 3.73%		Decomposed nut oil; possible traces of animal products

APPENDIX E:

Microbotanical Analysis Data

Vessel No.	Phytoliths			Starch	
	Maize	Wild Rice	Squash	Maize	Squash
1	0	0	0	0	0
4	0	0	0	2	0
5	0	1	0	1	0
6	0	2	0	4	0
8	0	1	0	1	0
10	0	0	0	0	0
12	0	0	3	0	0
22	0	0	0	2	0
23	0	0	1	0	0
25	0	0	0	0	0
26	0	0	0	0	0
28	0	0	0	0	0
34	0	0	0	0	0
35	0	1	0	1	0
40/153	1	1	1	0	0
41	0	0	0	0	0
43	0	0	0	0	0
46	0	0	0	0	0
50	0	0	0	0	0
70	1	1	1	0	0
75	0	0	1	0	0
76	0	0	1	0	1
80	0	0	0	0	0
81	0	0	1	0	0
88	0	0	0	0	0
101	0	1	0	0	0
102	0	1	1	0	0
103	0	0	0	0	0
105	0	0	1	0	0
109	1	0	0	0	0
112	0	0	0	0	0
114	0	0	0	0	0
118	0	0	0	0	0
120	0	0	0	1	0
122	0	0	0	1	0
124	0	0	0	0	0
132	0	0	0	0	0
146	0	1	0	0	0
150	0	1	1	0	0
152	0	0	0	0	0
162	0	9	0	0	0

Vessel No.	Phytoliths			Starch	
	Maize	Wild Rice	Squash	Maize	Squash
173	1	0	0	2	0
174	0	0	0	2	0
175	0	0	0	0	0
179	0	0	0	0	0
193	0	0	0	0	0
204	0	1	0	0	0
215	0	0	0	0	0

APPENDIX F:

Stable Isotope, Microbotanical, and Lipid Residue Analysis Results by Vessel

VESSEL	STABLE ISOTOPES		MICROBOTANICALS			LIPIDS								
	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{Air}$	Maize	Wild Rice	Squash	Nut Oil	Large Herbivore	Mod-High Fat	Medium Fat (maize, fish)	Low Fat Plants	Animal Product	Possible Animal	Possible Plant	Conifer Product
1	-26.12	9.63	0	0	0	1	0	0	1	0	0	0	0	0
4	-26.36	12.83	1	0	0	na	na	na	na	na	na	na	na	0
5	-26.1	12.81	1	1	0	na	na	na	na	na	na	na	na	0
6	-23.21	10.24	1	1	0	1	0	0	0	0	0	1	0	0
8	-23.77	11.93	1	1	0	na	na	na	na	na	na	na	na	0
10	-26.53	12.98	0	0	0	na	na	na	na	na	na	na	na	0
12	-24.45	11.49	0	0	1	na	na	na	na	na	na	na	na	0
20	na	na	na	na	na	0	0	1	0	1	1	0	0	0
22	-26.66	11.98	1	0	0	na	na	na	na	na	na	na	na	0
23	-25.9	10.93	0	0	1	na	na	na	na	na	na	na	na	0
24	na	na	na	na	na	1	0	0	1	0	0	0	0	0
25	-26.65	11.50	0	0	0	1	0	0	0	1	1	0	0	0
26	-26.3	11.65	0	0	0	na	na	na	na	na	na	na	na	0
28	-26.8	13.44	0	0	0	na	na	na	na	na	na	na	na	0
34	-24.74	11.26	0	0	0	0	0	0	1	1	0	0	0	0
35	-21.78	13.28	1	1	0	1	0	0	0	0	0	0	0	0
36	-23	10.29	na	na	na	na	na	na	na	na	na	na	na	0
40/153	-26.46	11.43	1	1	1	na	na	na	na	na	na	na	na	0
41	-25.68	11.85	0	0	0	na	na	na	na	na	na	na	na	0
42	-26.3	10.20	na	na	na	na	na	na	na	na	na	na	na	0
43	-23.66	11.53	0	0	0	1	0	0	0	1	1	0	0	0
46	na	na	0	0	0	na	na	na	na	na	na	na	na	0
50	-25.01	12.81	0	0	0	na	na	na	na	na	na	na	na	0
55	na	na	na	na	na	1	0	0	0	1	0	0	0	0
70	-26.41	12.51	1	1	1	1	0	0	0	1	1	0	0	0
75	-24.49	10.33	0	0	1	1	0	0	0	1	0	1	0	0
76	-22.65	11.67	0	0	1	1	0	0	0	0	1	0	0	0

VESSEL	STABLE ISOTOPES		MICROBOTANICALS			LIPIDS								
	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{Air}$	Maize	Wild Rice	Squash	Nut Oil	Large Herbivore	Mod-High Fat	Medium Fat (maize, fish)	Low Fat Plants	Animal Product	Possible Animal	Possible Plant	Conifer Product
77	na	na	na	na	na	0	0	0	1	1	1	0	0	0
80	-22.99	10.58	0	0	0	1	1	0	0	0	0	0	0	0
81	-27.02	12.66	0	0	1	na	na	na	na	na	na	na	na	0
88	-28.36	5.17	0	0	0	na	na	na	na	na	na	na	na	0
100	-25.18	13.76	na	na	na	1	0	0	0	1	1	0	0	0
101	-27.04	13.77	0	1	0	0	0	0	1	1	0	0	0	0
102	-27.33	13.37	0	1	1	na	na	na	na	na	na	na	na	0
103	-24.65	12.35	0	0	0	na	na	na	na	na	na	na	na	0
105	-27.2	13.33	0	0	1	na	na	na	na	na	na	na	na	0
109	-24.03	11.90	1	0	0	1	0	0	0	0	1	0	0	0
112	-27.43	12.31	0	0	0	na	na	na	na	na	na	na	na	0
114	na	na	0	0	0	na	na	na	na	na	na	na	na	0
118	na	na	0	0	0	na	na	na	na	na	na	na	na	0
120	-26.84	10.22	1	0	0	na	na	na	na	na	na	na	na	0
122	-26.63	11.96	1	0	0	na	na	na	na	na	na	na	na	0
124	-26.56	12.88	0	0	0	na	na	na	na	na	na	na	na	0
131	na	na	na	na	na	0	0	0	0	1	1	0	0	0
132	-24.43	10.28	0	0	0	na	na	na	na	na	na	na	na	0
146	-29.13	10.32	0	1	0	1	0	0	0	1	0	1	0	0
150	-24.8	10.57	0	1	1	1	0	0	0	0	1	0	0	0
152	-25.03	11.84	0	0	0	na	na	na	na	na	na	na	na	0
162	-25.31	11.01	0	1	0	1	0	0	0	1	1	0	0	1
164	na	na	na	na	na	0	1	0	0	0	0	0	0	0
166	na	na	na	na	na	0	0	0	0	0	0	1	0	0
173	-27.25	12.93	1	0	0	1	0	0	0	0	1	0	0	0
174	-27.34	12.78	1	0	0	na	na	na	na	na	na	na	na	0
175	-22.88	13.27	0	0	0	1	0	0	0	1	1	0	0	1
179	-25.29	8.74	0	0	0	na	na	na	na	na	na	na	na	0

VESSEL	STABLE ISOTOPES		MICROBOTANICALS			LIPIDS									
	$\delta^{13}C_{VPDB}$	$\delta^{15}N_{Air}$	Maize	Wild Rice	Squash	Nut Oil	Large Herbivore	Mod-High Fat	Medium Fat (maize, fish)	Low Fat Plants	Animal Product	Possible Animal	Possible Plant	Conifer Product
191	-27.29	10.58	na	na	na	0	1	0	0	0	0	0	1	0
193	-25.61	12.52	0	0	0	1	0	0	0	1	1	0	0	0
204	-25.94	13.57	0	1	0	1	0	0	0	0	1	0	0	0
205	-28.89	11.69	na	na	na	na	na	na	na	na	na	na	na	0
215	-22.78	11.71	0	0	0	1	0	0	0	1	1	0	0	0
216	na	na	na	na	na	1	0	0	0	0	1	0	1	1

APPENDIX G:

Select Vessels from the Cloudman Pottery Assemblage

Figure G1. Laurel Pseudo-scallop Shell

Figure G2. Vessel 5, Laurel Pseudo-scallop Shell

Figure G3. Vessel 10, Laurel Pseudo-scallop Shell

Figure G4. Vessel 22, Laurel Pseudo-scallop Shell

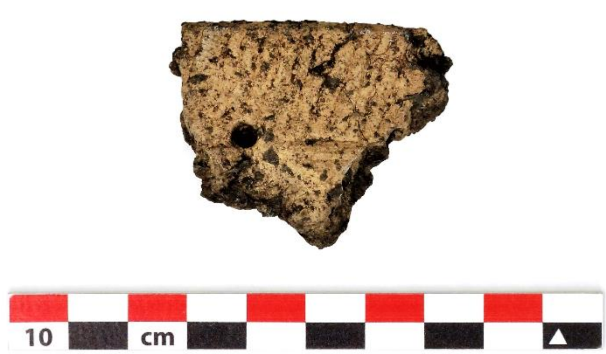

Figure G5: Vessel 28, Laurel Pseudo-scallop Shell

Figure G6. Vessel 4, Laurel Dentate Stamped

Figure G7: Vessel 12, Laurel Dentate Stamped (oblique)

Figure G8. Vessel 20, Laurel Dentate Stamped (oblique)

Figure G9. Vessel 23, Laurel Banked Linear Stamped

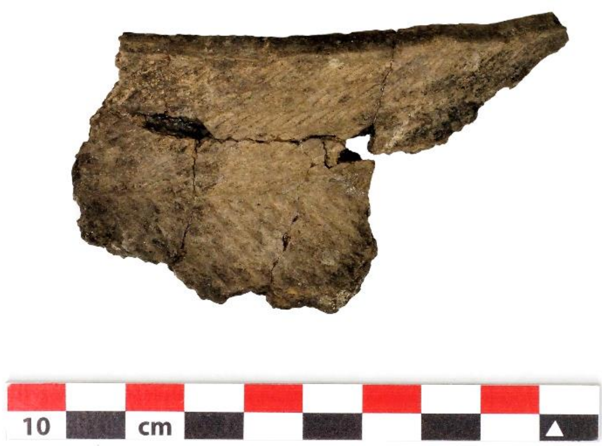

Figure G10. Vessel 109, Laurel Banked Linear Stamped

Figure G11. Vessel 112, Laurel Banked Linear Stamped

Figure G12. Vessel 114, Laurel Banked Linear Stamped

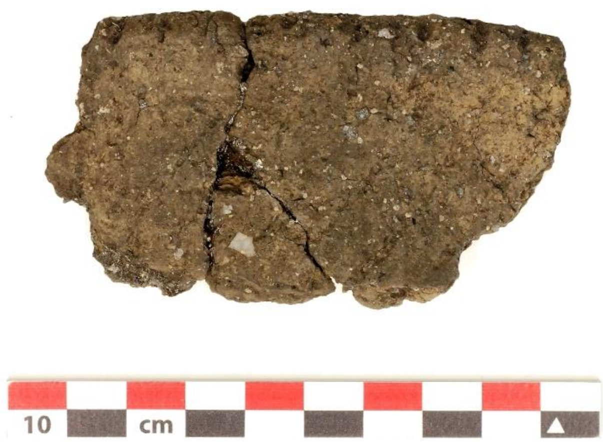

Figure G13. Vessel 6, Laurel Dentate Rocker Stamped

Figure G14: Vessel 131, North Bay Linear Stamped

MIDDLE WOODLAND/LATE WOODLAND TRANSITION VESSELS

Figure G15. Vessel 35, Late Laurel (*cf*. Laurel Incised or Mackinac Banded)

Figure G16. Vessel 118, Untyped (Middle/Late Woodland Transition)

Figure G17. Vessel 33, Untyped (incipient Blackduck?)

Figure G18. Vessel 80, Mackinac Punctate

Figure G19. Vessel 191, Mackinac Punctate

Figure G20. Vessel 100, Mackinac Punctate

Figure G21. Vessel 105, Mackinac Punctate

Figure G22. Vessel 175, Mackinac Punctate

Figure G23. Vessel 50, Mackinac Banded

Figure G24. Vessel 103, Mackinac Banded

Figure G25. Vessel 124, Mackinac Banded

Figure G26. Vessel 120, Mackinac Banded

Figure G27. Vessel 173, Mackinac Banded

Figure G28. Vessel 76, Mackinac Undecorated

Figure G29. Vessel 55, Mackinac Ware

Figure G30. Vessel 8, Mackinac Ware

Figure G31. Vessel 34, Mackinac Ware

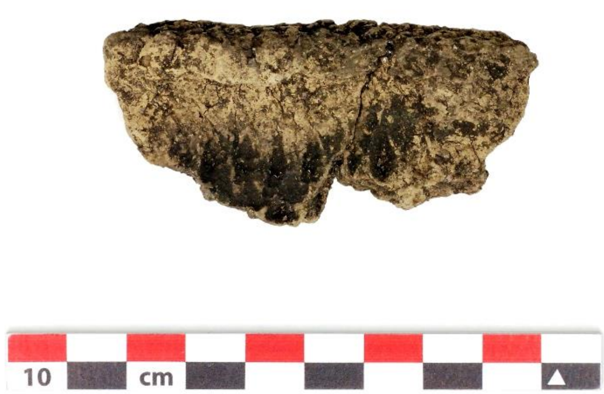

Figure G32. Vessel 41, Mackinac Ware

Figure G33. Vessel 46, Mackinac Ware

Figure G34. Vessel 122, Mackinac Ware (*cf*. Punctate)

Figure G35. Vessel 132, Mackinac Ware (*cf*. Punctate)

Figure G36. Vessel 174, Mackinac Ware (*cf*. Punctate)

Figure G37. Vessel 81, Blackduck Banded

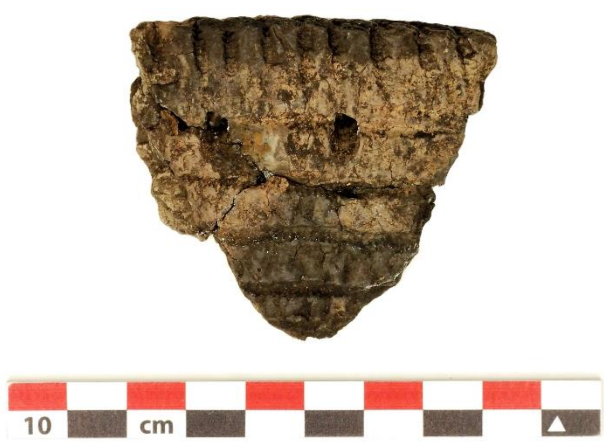

Figure G38. Vessel 88, Blackduck Banded

Figure G39. Vessel 193, Blackduck Banded

Figure G40. Vessel 199, *cf.* Bowerman Plain v. Cordmarked

Figure G41. Vessel 200, Untyped (ELW/MLW Transition)

Figure G42. Vessel 42, Bois Blanc Ware

Figure G43. Vessel 215, Bois Blanc Ware

Figure G44. Vessel 24, "Proto-Juntunen" Ware (plain)

Figure G45. Vessel 102, Juntunen Drag-and-Jab

Figure G46. Vessel 205, Juntunen Linear Puncate

Figure G47. Vessel 204, Juntunen Linear Punctate

Figure G48. Vessel 213, Juntunen Ware (*cf*. Drag-and-Jab)

Figure G49. Vessel 25, Juntunen Ware

Figure G50. Vessel 26, Juntunen Ware

Figure G51. Vessel 101, Juntunen Ware

Figure G52. Vessel 152, Late Juntunen Ware (*cf.* O'Neil Curvilinear)

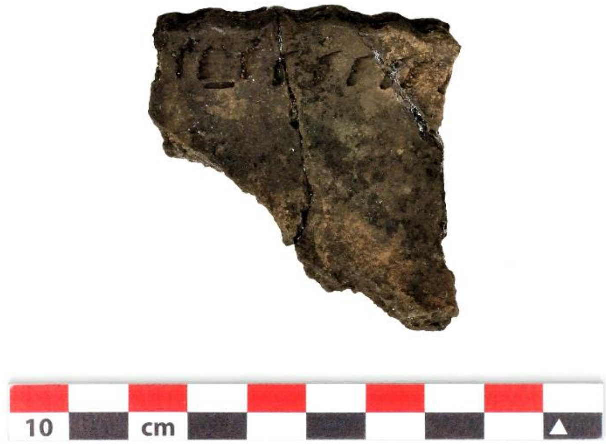

Figure G53. Vessel 43, Traverse Decorated v. Punctate

Figure G54. Vessel 150, Traverse Plain v. Scalloped

Figure G55. Vessel 216, Untyped

Figure G56. Vessel 146, Early Ontario Iroquoian

Figure G57. Vessel 40/153, *cf*. Lawson Opposed or Methodist Point Group 7

Figure G58. Vessel 162, *cf*. Sidey Notched or Lawson Incised

Figure G59. Vessel 64, *cf*. Ripley Plain

Figure G60. Vessel 70, *cf.* Huron Incised

Figure G61. Vessel 74, *cf.* Huron Incised

Figure G62. Vessel 36, *cf*. Huron Incised

Figure G63. Vessel 155, *cf*. Huron Incised

Figure G64. Vessel 156, *cf*. Huron Incised

Figure G65. Vessel 164, *cf*. Huron Incised

Figure G66. Vessel 166, *cf*. Huron Incised

Figure G67. Vessel 179, *cf*. Huron Incised

Figure G68. Vessel 77, Untyped

Figure G69. Vessel 39, Laurel Ware (Middle Woodland)

Figure G70. Vessel 201, Untyped (*cf*. Hopewellian, Middle Woodland)

Figure G71. Vessel 52, Mackinac Undecorated (Early Late Woodland)

Figure G72. Vessel 53, Mackinac Punctate (Early Late Woodland)

Figure G73. Vessel 83, Mackinac Ware (Early Late Woodland)

Figure G74. Vessel 202, Mackinac Ware (Early Late Woodland)

Figure G75. Vessel 63, Untyped (Early Late Woodland)

Figure G76. Vessel 75, Traverse Plain v. Scalloped (Late Late Woodland)

Figure G77. Vessel 54, Untyped (*cf*. O'Neill site cup; Late Late Woodland)

Figure G78. Vessel 167, *cf*. Huron Incised (Ontario Iroquois)

Figure G79. Vessel 182, *cf*. Huron Incised (Ontario Iroquois)

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