Examining the First Uses of Pottery by Northern Great Plains Peoples During the Time of Besant and Sonota

by

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Abstract

Highly successful pedestrian era communal bison hunters of the Besant and Sonota archaeological phases were the first to use pottery on the northern Great Plains. While the Besant phase is widely distributed across this region, the Sonota phase is confined to North and South Dakota. The Sonota phase shares notable similarities with the Besant phase but is marked by the first burial mounds on the northern Great Plains, with clear Hopewell connections. Pottery is one of the defining features of the Sonota phase. It is abundant at the Stelzer site, located along the Missouri River in South Dakota. Occupied between 1810 and 1556 cal BP, Stelzer is a massive campsite situated among a number of burial mound sites (including Arpan, Grover Hand, and Swift Bird), several of which also contained pottery (Neuman 1975).

The Stelzer site provided an opportunity to examine over 15 vessels from a single Besant-Sonota era site, and compare this dataset to a scattering of vessels from 24 additional northern Great Plains sites in an arc extending across the northern Great Plains. Pottery was examined through multiple approaches: 1) visual analyses of decorations to connect these vessels with nearby contemporaneous cultures; 2) use-alteration analyses to identify how communities used these vessels; and 3) plant microfossil analyses of carbonized food residues, followed by isotopic analyses, to identify what foods were prepared in these vessels.

The arrival of pottery coincided with widespread interregional interaction as the Hopewell Interaction Sphere spanned large parts of North America, in addition to a notable rise in community-driven bison kills and visible increases in tipi ring sizes. Of the 20 vessels examined at the Stelzer site, 11 had distinct shapes, surface expressions, and decorations. Influences for these variants ranged from as far east as Havana Hopewell of Ohio, to the Laurel complex and Malmo phase of Minnesota, but are most reminiscent of Valley phase variants of

Nebraska and Iowa. This diversity appears to reflect gatherings of northern Great Plains and Hopewell affiliated groups at a time when items and ideas were moving across great distances.

Pottery vessels are infrequent within the Besant-Sonata era, but were well maintained and repaired. Multiple pottery vessels exhibited signs of modification in the form of drilled holes. Wear observed around these holes was likely the by-product of a carrying strap being attached to these vessels and rubbing against the vessel during transportation. V-shaped carbonized stains noted on the exterior and interior of reconstructed vessels from the Arpan Mound, 39JK63, Greyrocks, and Butler-Rissler sites reveal that vessels were placed beside fires to bring foods to a boil slowly.

Northern Great Plains peoples played an active role in the movement of items and ideas throughout North America. Carbonized food residues from the Stelzer and Arpan Mound sites yielded evidence for maize (*Zea mays* ssp. *mays*). The presence of maize adds further depth to the diversity of exotic materials acquired by the peoples responsible for the Stelzer site and the nearby mounds, joining Great Lakes copper, obsidian, and oceanic shells as remnants of cross-continental trade. In contrast to the Stelzer and Arpan Mound sites, early northern Great Plains pottery residues from all other sites contained plant microfossils from locally available plants. These included saskatoon berry (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), white pond lily (*Nymphaea odorata*), prairie turnip (*Psoralea esculenta*), and goosefoot (*Chenopodium*).

Pottery was in limited use during the Besant-Sonota time frame. Therefore, its presence at sites of unusual significance (such as the Sonota burial mounds), presents a different perspective: that these items were important symbols. Vessels may have had ritual significance, given their placement in ceremonial contexts, modifications to increase their lifespan, and their resemblance to ritual paraphernalia such as pipes. Likely, this was not limited to the northern Great Plains during this time, and large conoidal vessels remained symbolic items throughout the Avonlea period until these were replaced by globular forms.

Preface

This dissertation is ultimately based on the analyses of northern Great Plains pottery specimens curated at archaeological repositories in Canada and the United States. None of the text of the dissertation is taken directly from previously published or collaborative articles. All of the analyses conducted in this dissertation are original, unpublished, independent work by the author.

Dedication

To Megan

Acknowledgements

Completion of this dissertation is the culmination of a lifelong journey. I am very blessed to have met so many helpful, caring people along the way and I cannot write in words what their support has meant to me.

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As this journey comes to an end, I cannot wait for the next one to begin!

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Chapter 1: The Roles and Uses of Early Northern Great Plains Pottery

Archaeologists strive to identify how technologies changed over time, investigate how new technologies arrived in places they had not previously existed, and determine any repercussions caused by these changes. Information gathered from the remains of ancient materials is used to create phases, sub-phases, and complexes that represent spatially and temporally related archaeological units (e.g., Willey and Phillips 1958). Examples of such phases include the Besant and Sonota phases, which occupied the northern Great Plains for approximately 2,000 to 1,150 years BP (Epp and Dyck 1983; Reeves 1983). Situated in the heart of North America, the northern Great Plains were, and still remain, an ecologically diverse region with a mixture of grassland and aspen parkland environments that were home to a wide range of animals and edible plants. In recognition of this diversity, the term northern Great Plains is used to refer to this entire study area (encompassing North and South Dakota, Montana, Wyoming and southern Manitoba, Saskatchewan, and Alberta) rather than identifying each particular environment separately. Not all archaeologists agree on which phases are recognized as independent phases and which are viewed as all-inclusive (e.g., Peck 2011). Moreover, such archaeological units can be misinterpreted as representing individual instances of past languages and cultures, when this is difficult to substantiate for past societies that shared some aspects of material culture, but were, likely, polyethnic in their geographic extent. Therefore, terms such as the "Besant-Sonota era" or the "Besant-Sonota time frame" will be utilized within this document in place of the Besant or Sonota phase terminology, to shift the emphasis of the analyses discussed away from taxonomic issues. This term will refer to a specific time frame in which northern Great Plains people were influenced by Middle Missouri peoples, who were, in turn, being influenced by Hopewell societies to the east (Scribe 1997).

What we now label Besant and Sonota assemblages come from a time and places where activities and technologies made their appearance in northern Plains settings. Changes to material culture, subsistence practices, habitation structures, and burial practices all occurred during the Besant-Sonota era (Frison 1971; Neuman 1975; Reilly 2015; Walde 2006a). Some of these changes had the potential to diverge considerably from previous activities conducted on the northern Great Plains. Within this incredibly fascinating period, pottery is used for the first time on the northern Great Plains, the number and frequency of large-scale communal bison (*Bison bison*) hunts appears to increase, habitation structures see a marked increase in the overall size of dwellings, and funerary rites appear to reflect those more akin to Hopewell centres further east.

Although these changes touched many aspects of the human experience, including daily life and sacred rites of passage, these changes have often been viewed in comparative isolation from each other. Finding a thread that connects these changes can provide some subtle, yet profound, insights into how past societies responded to social and technological change. Pottery was a 'new' technology on the northern Great Plains and is found infrequently amongst sites of this period. Although a minor component of the Besant-Sonota era material culture, pottery was found within sites ranging from everyday life (e.g., habitation sites) to those of heightened ceremonial activity (e.g., burial mounds).

Why did pottery appear during this time and place in northern Great Plains prehistory and at these sites in particular? To answer this question, a re-examination of the study of pottery is necessary. For decades, the origin, spread, and use of pottery have been viewed by archaeologists predominantly through the lens of taxonomy. Indeed, taxonomic approaches help identify trends in decoration and establish cultural-historical frameworks. Yet, pottery was not simply made to be decorated, but to fill functional roles within past hunter-gatherer societies (e.g., Skibo 1992). These roles span the gamut of the human experience, from daily culinary activities to rites of passage such as death and burial. Understanding how ancient pottery vessels were used in these different roles can provide insights into many aspects of past society that remain unseen when viewed solely through the lens of taxonomy.

The inclusion of pottery in burial customs is a fascinating aspect of this northern Great Plains timeframe. How people in the past treated their dead provides archaeologists with an incredible source of anthropological insight, including cultural belief systems, cultural interactions, social statuses, and political relationships of these past societies (Insoll 2011). Burial of human remains within large earthen mounds first appeared on the northern Great Plains during the Besant-Sonota era (Neuman 1975; Wood 1960). Identified, named, and excavated by Neuman in the early 1960s, the Sonota mounds consist of Arpan (39DW252), Grover Hand (39DW240), Alkire (32SI200), Swift Bird (39DW233) and Boundary (32SI1). All of these mounds were located on bluffs overlooking the Missouri River and were tightly clustered in northern South Dakota, with the exception of the Boundary Mound site, that was located 60 km to the north in North Dakota (Neuman 1975). This was a significant departure from conventional practices that had occurred on the northern Great Plains, where completion of scaffold burials or single burials was more common (Bushnell 1927; Kidd 1986; Wissler 1911). When completed, sub-surface burials were believed to be shallow to allow the deceased individual's spirit to move freely between spiritual realms above and below the ground (Kidd 1986).

Although rare, there are a few examples of sub-surface burials predating the Besant-Sonota era. In Alberta, the Highwood River burial (EePk-272) provides a look into sub-surface burial practices of the Pelican Lake phase occurring roughly 2725 ± 95 ^{14}C yrs BP (S-1962) (Brink and Baldwin 1988). Further east, in Manitoba, the Eriksdale site burials (EfLl-1) (Hoppa et al. 2005) provide a window into the Late Archaic Period (3,470 ± 40 ^{14}C yrs BP and 3,700 ± 60 ^{14}C yrs BP). Another significant burial site created prior to the Besant-Sonota era is the Gray site (EcNx-1a) of Saskatchewan (Millar 1981; Wade 1981). With radiocarbon ages ranging from 3015 ± 85 ^{14}C yrs BP to 5720 ± 320 ^{14}C yrs BP, this Oxbow phase cemetery site was the location for the burial of an estimated 300 individuals interred over approximately 2,500 years (Millar 1981; Wade 1981).

Birth, marriage, and death were, and remain, essential rites of passage that are intimately tied to culture and identity (Fowler 2004; Lucy 2005). Funerals provided an opportunity to symbolize transformations from one world to another, a universal theme within past and present cultures (Stutz 2003). Interestingly, the Sonota mounds contain traits of both northern Great Plains and Hopewell cultures. At the Sonota mounds and associated Stelzer site [39DW242], exotic items such as oceanic shells, copper from the Great Lakes, and obsidian from the west were left behind. Whereas the overall design of the mound and selection of items for interment are reminiscent of Hopewell burials (Van Nest 2006), the synchronic nature of the Sonota mound burials, the dominance of bundle burials, and the inclusion of bison remains alongside human remains speak strongly of pre-existing northern Great Plains precepts. This fusion of practices suggests that these burial events presented an opportunity for interaction, alliance building, or trade among northern Great Plains cultures and peoples from the east or south who had strong ties to Hopewell centres.

Recent archaeological research by Graham (2014) concerning the Sonota sites in North and South Dakota reveals the significant scale of activity at these burial sites. Radiocarbon dates collected from the Stelzer campsite and nearby Arpan, Alkire, Swift Bird, Grover Hand, and Boundary mound sites indicate that these sites were broadly contemporaneous. In the case of the Stelzer site in South Dakota, situated near several burial mounds, the skeletal remains from an estimated 8,300 bison, 400 deer and elk, and 1,000 canids were identified through Minimum Number of Individuals (MNI) extrapolations scaled to site size (Graham 2014:205). This is particularly impressive considering that radiocarbon evidence suggests that the Stelzer site was occupied over just 80 radiocarbon years (from 1696 to 1615 ^{14}C yrs BP) (Graham 2014:263).

Yet, burial mounds are only part of the story as changes to subsistence strategies also occurred. Communal hunting activities such as bison drives and jumps appear to have increased in frequency during this time (Frison 1978; Walde 2006a). This led George Frison (1978) to label the Besant-Sonota era as the apex of large-scale bison hunting on the northern Great Plains; while in retrospect it is clear that Avonlea and Old Women's phase communal bison hunting was even more impressively effective, there can be no doubt that Besant-Sonota era communal bison hunting was remarkably successful. Concurrently, diameters for Besant-Sonota tipi rings were noticeably larger than preceding or later pre-equestrian tipi rings (Brumley and Dau 1988; Quigg 1986; Reilly 2015; Vickers 1994).

Using tipi ring dimensions from the Elma Thompson (EiOj-1), 32OL270, Boyd (EdPn-8), Muddy Creek (48FR34), and Ross Glen (DlOp-2) sites, Reilly (2015:163) calculated that the average number of hides required for each tipi ring ranged from 22 to 53. This number is potentially two to five times greater during the Besant-Sonota era than is seen in later northern Great Plains cultures until horses were used to transport materials between sites. This is a staggering number when one considers the costs of labour and time required to create, mend, and transport these hides by foot, or with the assistance of dogs, during a seasonal round (Reilly 2015). From an archaeological standpoint, not only was there an increased number of communal bison hunts, but habitation structures regularly housed larger numbers of people, potentially impacting social organization. The increase in community-driven hunting activities and growing dimensions of dwellings both imply that these societal changes were not limited to ritual or ceremonial components of life but extended to everyday activities.

Pottery is one of many threads connecting these changes. At Arpan Mound, a Sonota mound in South Dakota, pottery was placed in the centre of the mound structure and in direct association with the buried individuals (Figure 1.1; Neuman 1975). Pottery has also been recovered from large-scale communal bison hunting sites such as the Walter Felt site (EcNm-8) in Saskatchewan (Watson 1966), as well as being present at archaeological sites where tipi rings have been noted to be larger than previous traditions, such as the Muddy Creek site in Wyoming (Reher 1989). And finally, at sites containing evidence of large-scale feasting, such as the Butler-Rissler site (41NA1000) in Wyoming, we find pottery at the centre of these culinary activities (Miller and Waitkus 1989). Before we can make sense of these past cultural events and the role of pottery, we must direct our attention to understanding how these vessels were used.

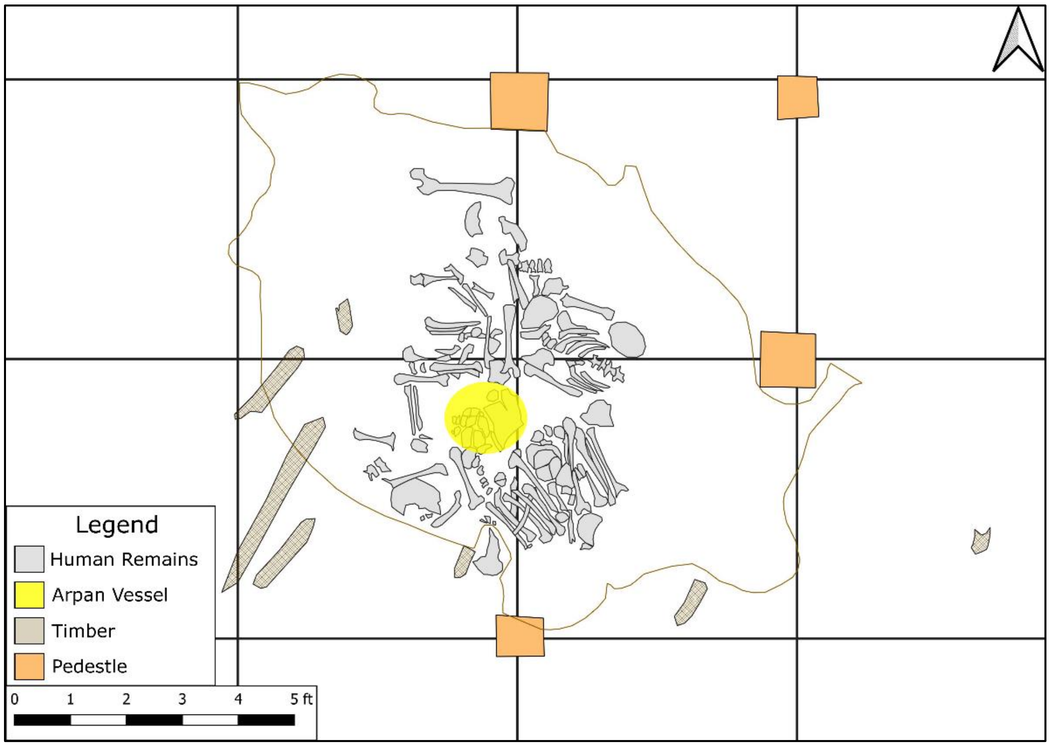


Figure 1.1 Illustration of the Arpan Mound site (39DW252) based on Neuman's (1975) site maps. Shapefile data courtesy of Graham (2023). Pottery (highlighted with yellow) was recovered within a circle of secondary burials.

Adding to the mystery of the first northern Great Plains pottery is the need for more information concerning what foods were cooked within these vessels. Although Besant-Sonota pottery was discovered over 50 years ago, not a single paleodietary research study has been completed on these wares despite the dramatic rise in paleodietary studies over the past ten years (e.g., Boyd et al. 2019; Horiuchi et al. 2015; Li et al. 2010). Currently, there are multiple approaches to paleodietary analyses including plant microfossils, stable isotopes, proteins and lipids, and trace elements. This dissertation used plant microfossil data, supported by stable isotope data, to identify what foods were prepared within these first northern Great Plains vessels.

Use-alteration analyses provide valuable contributions toward our understanding of how ancient pottery vessels were used; over time, pottery vessels exhibit signs of use through discoloration, scratching, repair, or other cultural modifications (Duddleson 2008; Skibo 1992). Understanding such alterations can inform archaeologists about how these ancient vessels were made, how they were used to prepare food, and what role these vessels served within past societies (Duddleson 2008; Skibo and Deal 1995). For these reasons, use-alteration studies were also completed on pottery from the Besant-Sonota era.

At first glance, the above research project might appear to promise answers relating only to the Besant-Sonota era. However, the outcomes of this research delve deeper into anthropological questions revolving around the human experience of hunter-gatherers inhabiting the northern Great Plains. Using the Besant-Sonota era as a case study can provide insights into how past northern Great Plains cultures responded and adapted to change, especially given that sites from this interval are situated between what are commonly considered to be the Middle Pre-Contact (or Archaic) and Late Pre-Contact periods. This research project evaluated the following anthropological questions:

1. What were the uses of these first pottery wares to appear on the northern Great Plains? Were these vessels designed to serve ritual or everyday roles within the Besant-Sonota era, or did they fulfill both roles?
2. By understanding how these vessels were used, can more be inferred about how technologies were shared among northern Great Plains societies during the time of Besant and Sonota?
3. What role did pottery play during large-scale events such as burials and communal bison hunting activities?

4. What does the adoption of pottery tell archaeologists about how past cultures accommodated new technologies or social practices?

While pottery from Besant-Sonota era sites is rare, it does accompany other material that remains indicative of the societal changes that occurred during this time on the northern Great Plains. The role of pottery in these changes can only be fully understood with a clear determination of how these vessels were used. To accomplish this task, carbonized food residues were analyzed to identify foodstuffs prepared within these vessels and use-alteration analyses were completed to determine how these vessels were used to prepare the identified foods. This study aimed to understand why pottery was adopted by the peoples we now distinguish as Besant and Sonota, how these peoples interacted with outside communities, and how larger processes of cultural change took place on the northern Great Plains.

1.1. Chapter Summary

Chapter 2 provides a detailed description of ethnographic accounts of pottery making within the northern Great Plains. The second half of Chapter 2 is dedicated to the archaeological evidence from the Besant-Sonota era and contemporaneous pottery-producing cultures surrounding the study area. Theoretical frameworks used for the interpretation of pottery adoption by hunter-gatherer societies and how this relates to the Besant-Sonota era are reviewed in Chapter 3. In Chapter 4, the methods used for this research specific to pottery analysis and paleodietary analyses will be discussed. Terms used to describe pottery in this study, use-alteration, and carbonized food residue analyses for plant microfossils and isotopes will be described in detail. The results of this study are split into two chapters, with a visual survey of pottery presented in Chapter 5 and paleodietary results in Chapter 6. Interpretations of these results are also divided into two chapters with the results of the visual survey of Besant-Sonota pottery presented in Chapter 7, followed by paleodietary interpretations in Chapter 8. Finally, Chapter 9 synthesizes these interpretations and presents the findings of this study and how pottery was introduced onto the northern Great Plains. It is important to note that this dissertation includes descriptions and diagrams made during the 1960s of Besant-Sonota era burials and items. Out of respect for Indigenous communities today, no photographs of human remains have been included in this study.

Chapter 2: People and Pottery of the Northern Great Plains

Cooking foods within pottery vessels was a hunter-gatherer invention that first occurred in areas of Hunan Province in China dating, between 18,000 to 15,000 BP (Chi and Hung 2012), in areas of Japan dating to 16,500 BP (Habu and Hall 1999), and in the Russian Far East from 16,200 to 10,200 BP (Shoda et al. 2019). Since then, pottery has been adopted by societies across the globe and remains part of the material culture today. Within the northern Great Plains of North America, pottery first occurs during the Besant-Sonota era. Cultures using this early form of pottery were highly adapted to a mobile lifestyle. To fully understand the extent to which pottery was a contributor to these peoples, we must establish how hunter-gatherer societies fashioned pottery vessels and how the Besant-Sonota era peoples of the northern Great Plains adopted this technology in a North American setting that had become increasingly rich in pottery producing cultures.

2.1. Accounts of Pottery Making

From an archaeological standpoint, Besant-Sonota pottery is believed to have been made exclusively by hand-forming; clay was worked into the desired shape before applying cord-wrapped textures and decorations (Arthurs 1986:90; Neuman 1975; Scribe 1997; Wood and Johnson 1973). Before fully accepting these viewpoints, it is useful to seek inspiration from the memories of Indigenous potters. To re-imagine how pottery vessels within the Besant-Sonota period were created, ethnographic reports of practices used by Indigenous potters were surveyed. Observations made by Indigenous peoples that lived within and on the periphery of the study area are outlined in this chapter (Figure 2.1). It is essential to acknowledge that all archaeological sites examined in this dissertation were left behind by Indigenous peoples whose descendants currently reside within the northern Great Plains and adjacent lands. While the information in these reports cannot be traced directly to the Besant-Sonota era, it provided a valuable source of ideas for interpreting how these vessels may have been made.

Figure 2.1 Nineteenth-century locations of Indigenous cultures whose pottery manufacturing techniques were recorded within ethnographic surveys.

Early forays into pottery analysis often strived to infer pottery manufacture from the examination of archaeological specimens and comparisons to ethnographic reports (Newman 1955). Many observations of pottery-making relied heavily on second-hand information, and in many cases, these observations lacked the detail necessary to offer insight into archaeological records (Newman 1955). The abrupt decline in the quality and amount of pottery made after the late 1700s on the northern Great Plains also contributed to difficulties retrieving observations of pottery-making techniques (Wilson 1917). The number of Indigenous potters declined in the 1700s as many succumbed to illnesses such as smallpox between 1780 and 1782 (Wilson 1917). Smallpox was responsible for the deaths of three-quarters of the Mandan and Hidatsa populations; many elderly individuals who would have been masters in the art of pottery making would not have been able to pass along their knowledge to younger individuals (Wilson 1910). The onset of the fur trade placed additional demands, such as preparing hides for trade, on the surviving women responsible for making pottery. Wilson (1910) believed individuals would have neglected making pottery in favor of other time-demanding activities related to the fur trade industry, particularly as metal kettles became available.

Despite the limited number of detailed accounts, the information collected is useful in contemplating how northern Great Plains Indigenous peoples viewed pottery. The following sections will discuss some of the information gathered from first- and second-hand observations by Pawnee, Arikara, Mandan, Hidatsa, Cheyenne, Blackfoot, Dakota, Plains Cree, Ojibwe as well as other Algonkian community members whose ancestors would have been responsible for many of the sites examined or mentioned in this research.

2.1.A. Pawnee

Beginning with the Pawnee, Newman (1955) presented accounts made by John B. Dunbar in 1880; his father spent time with Pawnee individuals from 1831 to 1849. During his time with the Pawnee, Dunbar's father recorded that pottery making was entirely within the domain of women and noted that while pottery vessels were not glazed like most European ware, it was quite serviceable. In conversations with a 50-year-old man whose grandmother had made clay vessels, he reported that a smoothed section of the end of a tree was used as a mold for the clays during construction (Newman 1955). Before the clay was shaped into a vessel, fire-cracked-rock (FCR) was prepared and combined with sand and greased buffalo tallow and smeared over the wooden mold. This was done to allow the clay vessel to disengage from the housing. Once the vessel was made, it was dried and then fired, during which a maize (*Zea mays* spp. *mays*) paste was stirred inside to make the vessel as hard as iron, potentially serving as a glaze for the interior (Newman 1955). This individual also noted that a framework of willow twigs was sometimes used as a mold and was burnt alongside the clay vessel during firing.

Another observation of Pawnee pottery making was reported by Weltfish (1937), in which individuals regularly returned to a known location where clays were noted to be sticky. Vessels made from this sticky clay were called mud vessels by Weltfish (1937). Firing these vessels involved placement either within ashes or close to the bank of a firepit until the desired hardness was achieved. These mud vessels were not used for cooking food, but for the transportation of water to campsites.

2.1.B. Arikara

Turning his attention to the Arikara, Newman (1955) also provided reports of pottery making observed by John Bradbury in 1811 (reported in Thwaites 1904), who visited the Arikara at Leavenworth Village, South Dakota. Bradbury noted that clay vessels were formed within baskets that were then placed within fires to transform clays into durable earthenware. Almost surprised, Bradbury pointed out that these clay vessels were quite strong and could serve many uses such as cooking and as containers for crushing plant foods with a pestle.

Newman (1955) also recorded accounts of individuals taking fine clays from the upper Missouri river regions and combining this with crushed granite (or grit) temper gathered from spent sweat lodge rocks. The Arikara took the amount of clay needed and prepared a vessel on a flat boulder using the paddle and anvil technique, where a round cobblestone was placed on the inside of the pot and a wooden tool of eight or nine inches was used to beat the clay on the surface directly opposite the cobblestone. Once decorated and dried, it was left in a place protected from air currents and accidental breakage for 24 hours. To fire the vessel, elmwood was used to construct a wooden housing for the vessel. This housing would be covered by additional elmwood that was ignited and left to completely burn and cool.

2.1.C. Mandan and Hidatsa

While detailed information was collected from interactions with the Pawnee and Arikara, direct observations made by Catlin in 1832 (Catlin 1857) and Maximilian from 1833 to 1834 (Maximilian 1843) of the Mandan and Hidatsa respectively contained less detailed information. During his travels on the Upper Missouri, Catlin noted the creation of numerous pottery vessels. Such vessels were made from tough black clay, were quite durable, and were molded into a variety of forms. After witnessing their durability, Catlin compared these clay vessels to the iron pots that Europeans used.

In conversation with members of the Hidatsa, Maximilian (1833 to 1834) reported that fashioning pottery was done like the Arikara and Mandan. Entirely the domain of women, vessels were formed from the inside by hand and smoothed on the exterior using poplar (*Populus alba*) bark. After the vessel sufficiently dried, the pot was filled and surrounded with dry wood shavings and then fired for an extended period.

Gilbert Wilson collected stories in 1910 from Mahidiwiás, a Hidatsa woman, and another by Hides-and-Eats, a Dakota woman who was adopted by the Mandan at a young age. The stories from these two individuals provide concrete first-hand information regarding how clays were transformed into pottery vessels by some Indigenous peoples of South Dakota. At the time of meeting Wilson, Hides-and-Eats was 85 years old, which would make her knowledge of pottery making traditions especially vital as the stories told to her by elders in her adoptive community would reach even further back in time.

Mahidiwiás, a Hidatsa woman who was born around 1839, explained to Wilson (1910) that the best clay for pottery was found near the old Fort Stevenson Road, North Dakota. This woman explained that the clay was called *awatsata-tawiihi,* which translates to "earth-sticks-small," meaning that when the clay was collected it would stick to anything while wet, and when dry, it would break into tiny fragments (Wilson 1910). Mahidiwiás' knowledge of pottery revolved around teachings from another individual known as Sage. According to Sage, clay from the hills was preferred to those from the river since it was of higher quality (Wilson 1910:272-282). Below is an observation by Mahidiwiás regarding how grit temper was prepared and mixed into clay:

> "She [Sage] would put enough clay into a skin sack to make up a pack or a little less. With this clay, she mixed a double handful of powdered stone. This stone was gotten from the sweat lodge fire pit. There were always stones there that had been burned many times and had gotten soft; these were usually thrown away. My aunt [Sage] gathered these to pound up fine. For this purpose, she would put a skin on the floor and lay a flat stone on it. On this flat stone, she would pound the burned stone with a stone hammer (Mahidiwiás as recorded by Wilson 1910:272-282)."

The Pawnee and Arikara also prepared grit in a similar manner. After the temper was prepared, the clay was mixed and kneaded until a proper consistency was found; not too stiff and not too soft, like that of modelling clay (Wilson 1910:272-282). Mahidiwiás provided insight regarding the creation of pottery vessels:

> "This lump [referring to clays] she rolled into the form of a cylinder about the size of the pot to be made. With the right thumb, she made a hollow in the top of the cylinder big enough to put one's fist in, always working the thumb against the other hand. The top of the pot she shaped with the thumb and finger of the right hand working and moulding it around. Four little knobs were left on the edge at equal distances. These knobs were like little calf's horns. To some these little knobs looked pretty, but they used to tie a rawhide thong around the neck of the pot, and when we went down to the river for water, the knobs kept the rawhide from slipping. The rest of the pot was moulded into shape (Mahidiwiás as recorded by Wilson 1910:272-282)."

Once again, similarities with the reports gathered by second-hand accounts and observations made with the Pawnee, Arikara, and earlier observations of the Mandan and Hidatsa are obvious. Mahidiwiás also recalled using a combination of a wooden paddle (referred to as a bark beater) and a smoothed stone to shape the clay vessel (Wilson 1910:272-282). She told Wilson more details about the design and use of this wooden paddle:

> "This beater was made of cottonwood bark brought in from the woods. Cottonwood bark is thick and was formerly used by us for many purposes. The beater was cut (on the side of the bark that is nearest the wood of the tree) in grooves so that the rough surface might further knead the moist clay when beating it. The patterns I remember were like these. They were cut in with a knife. One season she might use a beater with one pattern and the next season another kind. The little grooves were always diagonal with the surface of the beater. Beating the sides of the pot was important because by it the pot was beaten to the desired thickness and the clay was made firmer. This beating and drying continued for about three days. While the edge of the pot's mouth was still soft it was ornamented by pressing a twisted sinew into the soft clay. This was done before the beating. Only one twisted sinew was used at a time (Mahidiwiás as recorded by Wilson 1910:272-282)."

The paddle and anvil technique was ubiquitous during the late Historic period, as observed with the Pawnee, Arikara, Mandan, and Hidatsa. Coiling or patching of clays together, along with the use of molds are techniques absent from these descriptions.

The memories of Mahidiwiás are essential to this dissertation for three reasons: 1) they provide support for the use of paddle and anvil technique in the creation of pottery vessels; 2) they provide evidence of how twisted cord impressions were applied to vessels; and 3) they provide a subtle clue that may explain variations in surface treatments found on pottery vessels. Mahidiwiás also provided details of the amount of pottery that was produced by Hidatsa potters. She mentions that while one pot was worked on per day, preparation of other vessels commenced while others dried to the extent that up to five pots would be made during one period of pottery making. These vessels would also vary in size as some were noted to be as big as a cast iron cooking pot, some of smaller size, and other larger pots used to pulverize maize into a paste (Wilson 1910). It is important to note that this community was largely sedentary and pottery vessels were created for trade purposes. Therefore, these numbers may not reflect the amount produced purely for domestic use, or what would be created by groups that frequently conducted residential mobility.

When two to five vessels were ready, these were fired in a bed of coals and fresh bark was added but not in contact with the clay vessels (Wilson 1910). Rather than use animal grease, as seen with other accounts, liquid gathered from heavily boiled maize was mixed on the inside and the outside to make the pot "look better and last longer" (referenced by Sage in Wilson 1910:272-282). Imperfect pottery vessels were not thrown away but were reportedly kept and used for other tasks (Wilson 1917).

When forming the vessel, Hides-and-Eats reportedly used a cloth band wrapped around the neck of the vessel to provide support. There is no information about whether this cloth left any textile or cordage impressions on the wet clay. Hides-and-Eats similarly used a wooden paddle and stone to shape and harden the vessel after it had sufficiently dried. While these techniques are quite like the previous report by Mahidiwiás, further detail is provided by Hides-and-Eats concerning the repair and maintenance of pottery vessels. Hides-and-Eats always held a small amount of clay paste to repair any imperfections during the creation of pottery vessels. Wilson (1917:103) reported that "Hides-and-Eats finds a slight imperfection in the interior, digs it out with her nail, and mends it with a bit of repair clay, spitting on it first to make it stick."

The firing of vessels by Mandan peoples also followed a similar trend seen with the Hidatsa as coals were placed within the pot in separate intervals and oiling was completed on the interior and the exterior of the vessel. As Hides-and-Eats fired the clay vessel, if several sparks were seen on the pot, this indicated that the clays were not suitable for firing, and it was discarded. Wolf Chief, Hides-and-Eats' nephew, provided Wilson (1910:272-282) with stories on the significance of this malfunction in firing. Pottery vessels held a symbolic and spiritual meaning to Mandan peoples as described here:

> "Always we kept pots put away in a safe place. This was in the rear, near the place the family medicines or shrines were kept, usually. We made ringlets of willow bound about with bark; and into these, we set out pots, one in each ringlet. We never set the pots on the bare ground. Our clay pots were considered sacred. When a pot set in a safe place cracked, we knew that someone was going to die. We believed that, if while pots were being made, a thunderstorm came up, the pots would be cracked. For this reason, we discontinued work at pot making during a storm. At Knife River, a sacred pot was kept by the Hidatsa. It was very large and was always kept in the *Awahawi*, or Peaked Hill village [the Awahawi site, 32ME8]. When drought came, men came and beat on the pot as a drum and sang songs for rain. Incense was placed before every post in the lodge. The pot was taken to one post before the incense was beaten and sacred songs were sung. Then it was taken before another post, and so forth until all four posts had been visited. There was no water in the pot. The keeper of this pot, during the smallpox year, buried the pot in a cache and then died. So, the pot has remained lost to us because the keeper of the pot did not tell where the pot was buried (Wolf Chief as recorded by Wilson 1910:272-282)."

The above passages provide a powerful example of how these pottery vessels were not only tools for cooking and preparing foods, but in some cases, treated with great respect. As seen in many of the observations of pottery making above, it is interesting that the grit used for temper came from sweat lodge stones. This would be a practice in which raw materials were secured from the detritus of what was in many cases a ceremonial activity. This is another vital consideration important when reimagining how pottery vessels were used.

2.1.D. Cheyenne

From 1900 to 1923, Grinnell (1923) collected accounts of pottery making from the Cheyenne. As seen in the description below, one can be drawn to the similarities reported with the cultures already mentioned in this chapter. Grinnell (1923) observed that when making pottery vessels, the Cheyenne would add grit temper and then shape the item using a combination of hand forming and paddle and anvil techniques. After the vessel was shaped and dried, it was covered with animal grease on the interior and exterior. In some cases, Grinnell (1923) reported that a hole would be prepared and the hide from a bison skull would be cut into pieces and stone boiled within the hole to produce a glue-like substance. The glue, skimmed from the water of the boiling pit, would be mixed with the clays to keep it from cracking during construction.

After being left to dry, vessels were placed inside a hole excavated into the side of a hill where a fire was allowed to burn down to produce a thick layer of coals. Clay vessels would be placed inside on the coals, while the hole was covered with a large stone to retain heat. It is unknown how often this process was completed or how long the vessels were kept within the hole.

2.1.E. Blackfoot

Observations of pottery making within Blackfoot communities at the onset of European colonization are few and far between. In her analysis of a single sun-dried vessel found in Montana, Kehoe (1959) reported that Ewers (1945), Sapir (1923), and Schaeffer (1952) gathered information from Indigenous peoples about the creation of thick, round bucket-shaped vessels that were sun-dried and not fired. Kehoe (1959) initially thought that these vessels were likely rare to non-existent. Yet, upon analysis of materials from Montana, Kehoe (1959) observed a sun-dried clay vessel found by William Big Spring Sr. of the Blackfoot Indian Reservation. This short, thick-walled sun-dried vessel smelled of kinnikinic, which is a traditional combination of plants, such as bearberry (*Arctostaphylos uva-ursi*), made by Indigenous cultures of the northern Great Plains. Analysis of other archaeological collections found three additional sun-dried vessels. Elders of these communities interpreted these as containers for burning sweet pine before use in medicine bundles.

2.1.F. Assiniboine and Gros Ventre

Similar to the Blackfoot, not much is known about Assiniboine and Gros Ventre pottery making. Although pottery is found in the archaeological histories of these cultural areas, detailed observations of pottery making are brief and often recorded through second-hand accounts. When discussing the Gros Ventre, Kroeber (1908:150) noted that "…pottery is declared to have been made formerly of clay mixed with crushed rock." Although this passage does provide additional support for the use of temper within pottery vessels of the northern Great Plains, this is hardly informative as no detail is given concerning manufacturing, decorating, or firing vessels. Kroeber (1908) also provides very little information on cooking techniques as only two passing statements were used to describe the use of stone boiling through bags and pits.

2.1.G. Eastern Dakotas

In 1914, Alanson Skinner met with several individuals from the Sisseton, Isanti, and Wahpeton groups that are also labelled the Eastern Dakota (Skinner 1919). Such discussions on

Eastern Dakota culture were collected in Portage La Prairie, Manitoba, and Sisseton, South Dakota. Unfortunately, although this was a survey of Eastern Dakota culture, limited detail was reported for pottery use.

Concerning pottery, Skinner (1919:165) learned that "…pottery was made of pounded clay tempered with burnt flint that was also pounded. The coil process was unknown, the vessel was built up by pinching from a flat bottom. It was stamped on the sides with a paddle. Ears or lugs were placed on it, and it was smeared with glue and burned by use." The burnt flint that Skinner (1919) was referring to was likely grit temper, as noted in previous accounts. An interesting component of this observation was that the coiling method was unknown to the Eastern Dakotas and that the pinching and shaping of a solid piece of clay was the main technique reported. This coincides again with many observations about pottery making within the northern Great Plains. When referring to 'ears or lugs' Skinner (1919) was referencing the placement of additional pieces of clay to serve as handles.

Skinner (1919) also provided an interpretation of how cultural differences may have held some connections with geography. As the Isanti and Wahpeton were identified by Skinner (1919) as typical intermediate tribes for the Great Plains culture area, he believed that the Sisseton were more closely aligned with groups such as the Ponca, Omaha, and Plains Cree—groups that had adopted a Great Plains way of life. Although the Isanti, Wahpeton, and Sisseton share similarities in material culture, they identify themselves as distinct cultures. Within the archaeological record, this is important to keep in mind considering archaeological traditions often span large geographical areas and include similarities when near others. Even though material cultures were similar, we cannot assume social customs and identity were also shared.

2.1.H. Plains Cree

In addition to collecting ethnographic evidence from community members within the Dakotas, Skinner (1914) also collected information from the Plains Cree residing on the Keewistaihau Reserve (later named Kahkewistahaw First Nation) and adjacent reservations, located near Broadview, Saskatchewan. In this instance, Skinner (in June of 1913) wanted to learn more about the military organization of Plains Cree for the American Museum of Natural History. Information concerning other aspects of Plains Cree life was recorded only in brief detail given Skinner's emphasis on military organization.

Skinner (1914) found that many individuals did not recall much about pottery making but did emphasize that it was practised by their ancestors. When asked for information on cooking techniques, community members spoke mostly of stone boiling that was completed by both men and women. To complete this process, their direct ancestors would prepare a hole approximately two feet in depth and one foot in circumference. This hole would then be lined with fresh rawhide or a bison's stomach that was pegged down with wooden pins around the edge of the hole (Skinner 1914:82). A mixture of animal blood, meat, and water was placed in the pit and immediately followed by hot stones that were heated in a nearby fire. This technique of cooking reportedly prepared meat in a relatively quick fashion. If stone boiling was not used, meat was otherwise prepared by roasting over a fire or covered in animal fat and placed directly on hot coals.

2.1.I. Ojibway and Algonquin

Ethnographic accounts from the boreal forest of Ontario and further east provide some clarity about pottery production within areas that were located on the outer periphery of the northern Great Plains. This research by Skinner in 1912 was in response to claims by others that Indigenous groups did not retain any knowledge about ancient technologies. When speaking with Ojibway individuals from Cat Lake, Skinner (1912) heard that individuals recently made pottery vessels via coiling. In this fashion, rows of long clay coils were prepared and then placed on one another to create a general shape of a vessel.

When discussing pottery traditions with a member of the Menomini of Wisconsin, that person recalled in detail how their people constructed pottery vessels:

> "Pottery vessels are said not to have been made or used for over one hundred years, yet the memory of the process still lingers. They were made from selected clay which was pounded and mixed with pulverized shells for tempering. When the clay was properly compounded, more water was added, and it was kneaded into a stiff paste which was plastered by the hands over a large ball of basswood bark twine leaving one end uncovered. The clay was next smoothed off with a stick and the incipient vessel was set in the sun to dry. In fact, sunshine was considered such a necessary factor in the drying process that no one ever made pottery on a dull day. When the clay coating was dry, the potter took hold of the end of the ball of twine which protruded from the opening left for that purpose, and, pulling it unwound the ball within and left the earthen shell. Fresh clay was then daubed over the rough inside and the vessel was scraped smooth with a stick, outside and in. The kettle was next sized with a coating of finer clay and ornamented with incised designs made by a sharpened stick. Holes were then bored near the rim to receive a bail of basswood bark. The vessel was dried again, and it was then ready for use without further treatment. It was not fired but became baked by the flames when in use. It is said that bowls and spoons were made of clay before wood came into use. The first iron and brass kettles of commerce are thought to have been thrown upon earth to sacred dreamers by the Underneath Powers; probably this is a survival of a tradition in vogue when pots were made of earth, the property of the Gods Below (As told by Ojibwa to Skinner 1912:130)."

The above statement by the Menomini informant named Ojibwa provides a valuable description of both the technological and spiritual dimensions employed when constructing pottery vessels within their culture. This account outlines the use of shell tempering, a frame or mould to aid in the shaping of the vessel, the use of modelling rather than coiling, and the overall process of drying. Beyond the technical component of pottery making, a glimpse into the spiritual belief shared by this culture was provided, illustrating that pottery vessels were the property of the *Underneath Powers*. This account provides another example of spirituality that was tied to pottery vessels as seen earlier in this chapter with the Mandan. Nieves Zedeño (2008:264-265) noted that in Ojibway taxonomy, round objects like kettles (along with grandfather rocks) are accorded animacy (they are "other-than-human-persons" as Hallowell [1976] styled the meaning), a distinction very likely to have applied to pottery in the past.

Skinner (1912) also recalled that until recently, pottery was still being manufactured and was not lost or replaced by metal items. When making pottery, clay was tempered by adding fine gravel or coarse sand and formed into rolls and vessels were constructed with the coiling process. These coils were noted to "…begin at the middle of the bottom [of the vessel] and winding the coils around outward and upward to make the sides, which were then smoothed over until the appearance of the coil was effaced. When complete, the vessel was dried before the fire (Skinner 1912:130)." This informant also provided some insight concerning how these vessels would have been used. When cooking food and materials, "the kettle [clay pot] was set upright in the sand or propped up with stones and the fire built around it (Skinner 1912:130)."

To the west, the Bunji or Plains Ojibway (also known as Saulteaux at Long Plains, Manitoba and elsewhere) also recalled traditional pottery making. Skinner described how information collected from the Saulteaux of Lac Seul, Ontario, surpassed accounts from other Algonkian or Siouan groups that he had visited in terms of detail. Skinner (1923:429) found compelling evidence within the language of Algonkian groups as the names for 'kettle' in Ojibway (Saulteaux) is '*akik*,' in Cree '*askik*,' and in Menomini '*akax,*' which all roughly translates to 'earthen vessel,' although the word is primarily applied to metal instruments today.

The etymology for this word provides additional support for Skinner's arguments that pottery was an important component of material culture for these groups in the past. With the years of subsequent archaeological data recovered from these areas, Skinner's (1923) observations were supported through evidence of pottery use spanning multiple millennia.

2.1.J. Summary of Ethnographic Accounts of Pottery Making

This brief review of ethnographic accounts reveals two general practices concerning the production of pottery vessels: 1) the use of grit from FCR for temper; and 2) the paddle and anvil technique for the shaping of clays into vessels (Table 2.1). Other techniques, such as shell or sand tempering, and the coiling process, were restricted to the boreal forest environments of Ontario and Wisconsin.

Table 2.1 Pottery techniques reported by Indigenous peoples of the northern Great Plains.

	Temper	**Construction**	**Additives**	**Drying/Firing**
Pawnee	grit, sand, grease	wooden molds	animal grease	placed on coals
Arikara	grit collected from FCR	basket mold paddle anvil	n/a	elmwood fuel and low heating
Mandan and Hidatsa	grit collected from FCR	hand-formed paddle anvil	maize liquids	coals placed within
Cheyenne	grit	hand-formed paddle anvil	glue from bison skull	fired within a hole on the side of a hill
Blackfoot	n/a	bucket mold	medicinal plants	sun-dried
Gros Ventre	grit	n/a	n/a	n/a
Eastern Dakotas	grit	hand-formed	n/a	n/a
Plains Cree	n/a	n/a	n/a	n/a
Ojibway and Algonkian	shell, sand	coiling hand-formed wooden mold	n/a	dried multiple times basswood fuel

The use of grit collected from fire pits appears to have been a common practice for northern Great Plains potters. A fascinating detail is the use of stones that were collected from broken rocks used within sweat lodges. On the surface, these stones served a practical purpose in sweat lodges and within pottery as temper, but the prospect for deeper spiritual importance must be noted. Some Ojibway peoples believe that rocks have the potential for social interaction and relational personhood (Posthumus 2018).

When interviewed by Walker (1917), a Dakota individual stated that "…there is a different kind of *wakanla* rock; they are the sweat lodge stones (*tonkan yatapika*), as they say. These act differently (Walker 1991:154)." In addition, Samuel Pond (1908:420) claimed that "…the same kind of stones were used [in the sweat lodge] as they were accustomed to worship." When heated and placed within a sweat lodge, the steam emitting from the stones was, and still is, viewed as more than just water in a gaseous state. This steam that arose when the hot stones were sprinkled with water provided, "…physical and spiritual purification and healing for the ritual gathering, the audience or spectators not directly engaged with the production of the rite but nonetheless participant and vital in it and its dynamics (Kapferer 2010:239; Posthumus 2018:78; Rappaport 2000)." This power that was on display from rocks within sweat lodges is emphasized by terminology for these objects. To the Dakotas, sweat lodge rocks are called *t'ųká* (*yatápika*) and are referred to as grandfather in ceremonies (Posthumus 2018:78). The use of the title grandfather within Sioux communities is applied, "when they describe experiences in which Wakan Tanka, the Great Mystery, has become personified (Deloria 2009:14)."

During research on the spirituality of rocks, David Posthumus (2018) outlined the use of rocks in sweat lodge ceremonies and their importance. Heated stones would be placed within the centre of a sacred lodge and were viewed as nonhuman spirits brought to life through heating (Posthumus 2018:17). During the use of these rocks in sweat lodge ceremonies of the Dakotas, the steam that emanated from the rocks is the physical manifestation of spirits (Posthumus 2018:79).

Regarding the ethnographic evidence of temper collected from sweat lodge rocks, one cannot escape the spiritual connotations of breaking down these sacred stones to the size required for pottery making. As stated earlier, pottery making was not always successful—clay vessels were exposed to extreme temperatures and susceptible to breakage. The placement of spent sweat lodge stones to serve as temper may have fulfilled a practical need in the firing process, but also provided an additional layer of spiritual protection for the survival of these vessels.

The second recurring theme of the ethnographic accounts was making vessels through hand formation followed by paddle and anvil preparation. These two techniques appear more frequently in ethnographic accounts from the northern Great Plains region, particularly when compared to the practice of using coils. Although we cannot disregard the possibility of the lesser-known techniques to have occurred on the northern Great Plains in the past, the many examples of hand formation and paddle and anvil construction cannot be overlooked.

The opportunity to examine pottery from Besant and Sonota contexts may allow us to trace the origins of pottery making on the northern Great Plains. The extent of this form of pottery making in archaeological contexts has not been fully investigated. If indeed hand forming or paddle and anvil construction are noted amongst these first pottery vessels of the northern Great Plains, ethnographic accounts may prove vital in understanding what decisions would have been made by the peoples we label Besant and Sonota today.

2.2. Contemporaneous and Adjacent Pottery Cultures

This dissertation is focused on archaeological phases that would variously be referred to as the latest Middle Pre-Contact Period or the earliest Late Pre-Contact Period on the northern Great Plains in the Canadian prairie provinces and the Middle and Early-Late Woodland Periods (Figure 2.2) in the United States. The Middle Woodland Period (ca. 2150 to 1450 BP) was a time of immense change in pre-contact North America, one aspect of which involved the arrival of pottery on the northern Great Plains. Over the past 50 years, the emergence of the Hopewell Interaction Sphere has been seen by many as a primary contributing factor to these changes.

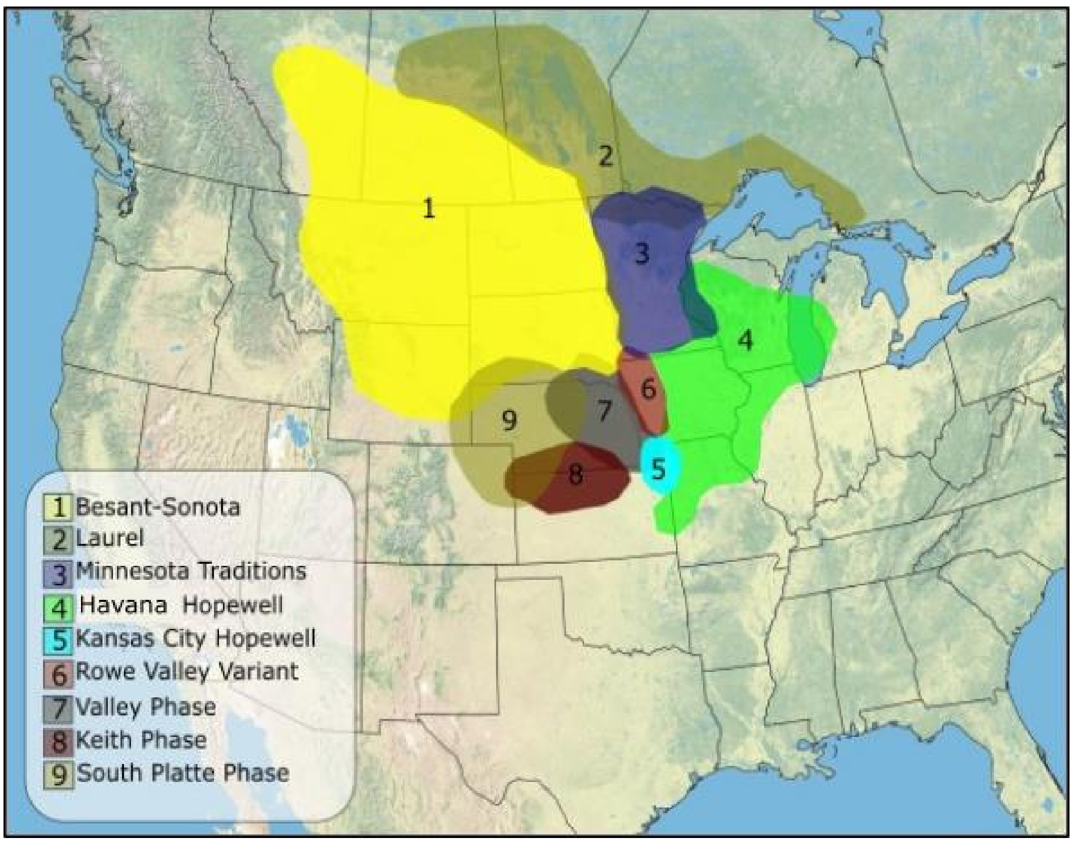


Figure 2.2 Middle Woodland archaeological phases discussed in this chapter.

Emanating from central Ohio, the Hopewell Interaction Sphere was the product of technological and social shifts from previous lifeways that had remained largely unchanged for over 5,000 years (Seeman 1979; Struever and Houart 1972). Examples of such changes included the use of large-scale trade networks, experimentation with horticulture, increased use and exchange of pottery, and changes to the internal structure of burial mounds and associated mortuary patterns (Adair 1988; Charles 1995; Fie 2008; Sarich 2010). Struever and Houart (1972) suggested that archaeological trends reflected a social transformation, promoted by hierarchically ordered patterns of interaction and trade. More recently, Byers and Wymer's (2010) research on Hopewell society appears to confirm the early hypotheses of Struever and Houart (1972), although Byers and Wymer maintain that increasingly more complex symbolizations of past landscapes and cultural identities also provided fuel for this transformation. This multifaceted nature of the Hopewell Interaction Sphere led Carr (2005:576) to define Hopewell as a cultural phenomenon that contained the following traits:

- Extensive trade of raw materials and ideas (Struever 1964; Struever and Houart 1972; see Griffin 1965 and Seeman 1979 for rebuttals)
- Mortuary conditions reminiscent of a cult (Prufer 1964; see Caldwell 1964 and Struever 1964 for rebuttals)
- Shared religion and worldview (Caldwell 1964; Carr 1998, 1999, 2000, Romain 2000)
- Artistic style spanning many regions (Prufer 1968; Willey 1971)
- Interaction and innovation to facilitate long-distance trade (Caldwell 1964)
- Social organization based on marking and claiming leadership and prestige (Seeman 1995)
- A network of peer polities involved in competitive display (Braun 1986; Dancey and Pacheco 1997)

The Hopewell Interaction Sphere can also be described as a continental phenomenon, as traces of this influence have been identified as far south as Florida, spanning from the Atlantic coast of the Eastern Woodlands to the Missouri River in the west (Seeman 1979). How far this phenomenon reached into the northern Great Plains during the Besant-Sonota era remains unclear.

Items originally from the Great Lakes and Atlantic Ocean found at the Sonota mound sites have shown that items travelled great distances during the time of Hopewell (Neuman 1975). The presence of Knife River Flint (KRF) reported by Clark (1984), obsidian from the Yellowstone area of Wyoming (Griffin et al. 1969; Hughes 2006), and big-horn sheep remains and representations (DeBoer 2004) are direct evidence of materials being exchanged eastward through the northern Great Plains and into Hopewell contexts. It is worth exploring further connections between the Besant-Sonota phases and broadly contemporaneous cultures adjacent to the northern Great Plains including the Kansas City Hopewell phase, Valley phase, South Platte, Keith phase, and Laurel phase (Figure 2.3).

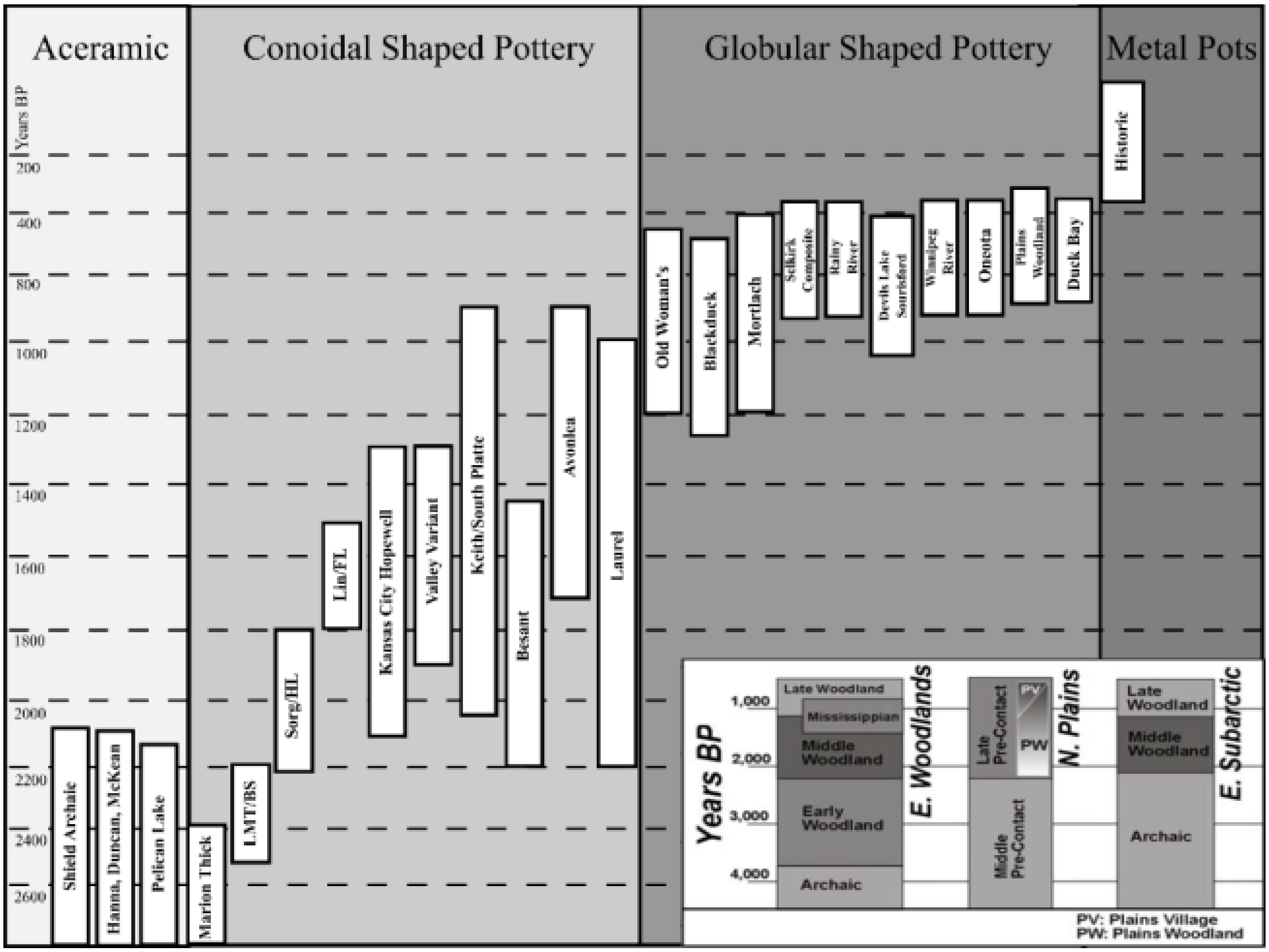


Figure 2.3 Northern Great Plains and Canadian boreal forest archaeological taxa separated by chronology (adapted from Hamilton et al. 2011:109). (LMT = La Moille Thick, BS = Black Sand, FL = Fox Lake, HL = Howard Lake).

2.2.A. Kansas City Hopewell

Despite only appearing within a small area and from ca. 2050 to 1250 BP, Kansas City Hopewell (KCH) is thought to exhibit the strongest ties to Hopewell of all archaeological phases west of Ohio during the Middle Woodland Period (Bozell and Winfrey 1994). Pottery from this period was heavily influenced by an expansion of ideas from Hopewell centres (Figure 2.4).

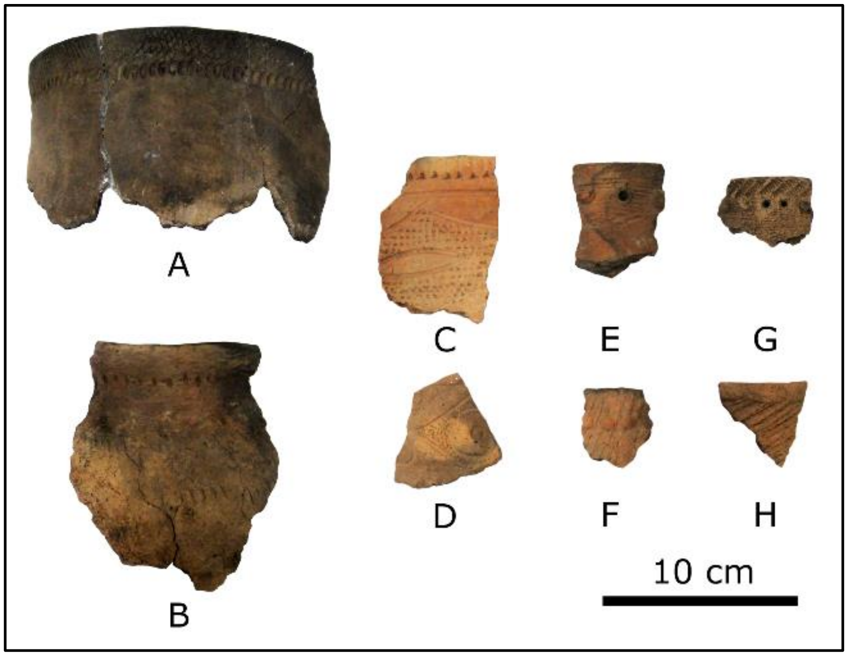


Figure 2.4 Examples of Kansas City Hopewell timeframe rim sections from the eastern Central Plains. Photo courtesy of Adair (2021).

One explanation for the cause of KCH revolves around a migrant population of Hopewell peoples originating from Illinois or Ohio that settled within Kansas and southeast Nebraska (Ludwickson and Bozell 1994). This migrant population has been thought to have greatly influenced surrounding populations that they encountered during their exodus westwards (Ludwickson and Bozell 1994). Although it has yet to be determined if this potential 'transplant' population represented migrants or converts to Hopewellian ideas, archaeological evidence about site organization, trade items, pottery, and subsistence strategies like those within the Hopewell Interaction Sphere offer support to this theory (Ludwickson and Bozell 1994).

O'Brien and Wood (1998:198-199) offered three contributing factors for the development of KCH: 1) intra-regional trade; 2) diffusion of knowledge and ideas; and 3) independent invention. These scenarios offered by O'Brien and Wood (1998) allow for the movement of ideas in addition to that of people. Logan (2006:340) believed that the third scenario put forward by O'Brien and Wood (1998) was not feasible because of the direct similarities of pottery and other artifacts identified at KCH and other Hopewell sites discovered in Illinois.

Continuing with the notion of trade as a catalyst for KCH, some believe this phase represented a Hopewell outpost where participants served as middlemen for the exchange of goods to Hopewell centres (Bozell and Winfrey 1994; Ludwickson and Bozell 1994). This scenario would appear to have merit, as KCH is situated within the transitional region between the Great Plains and the Eastern Woodlands. This location could have served as a suitable 'gateway' between the Great Plains and Eastern Woodlands where goods from both regions may have been exchanged.

Domesticated plant use is another aspect of KCH and the broader Besant-Sonota phenomenon. Zeder (2015:3191) defined domestication as a sustained, multigenerational, mutualistic relationship in which one organism assumes a significant degree of influence over the reproduction and care of another organism, thereby securing a more predictable supply of a particular resource. Domestication processes may enhance the fitness of both the domesticator and the domesticate. Today, domestication is widely recognized as taking place along a continuum of behaviors (e.g., Harris 1989). With respect to the plants that will be considered here, the threshold of domestication had already been passed elsewhere in the Eastern Woodlands and American Southwest where plants had become increasingly important components of horticultural activities. Little evidence of domesticated plant use has been reported at KCH sites (Bozell and Winfrey 1994; Ludwickson and Bozell 1994). This may in part be due to the methods archaeologists have employed to identify horticulture and domesticated plant use. Adair (1988), Bozell and Winfrey (1994), and Smith (1992) have suggested that macrobotanical evidence alone cannot provide adequate identification of small-scale domesticated plant use because macrobotanical materials simply do not preserve well within the archaeological record. Adair (1988) hypothesized that KCH peoples collected a wide variety of plants that have been associated with horticultural economies, ranging from ‘camp followers’ such as marsh elder (*Iva annua*) and sunflower (*Helianthus* sp.) to squash (*Cucurbita* sp.) and small amounts of maize (likely acquired through trade). Marsh elder, sunflower, and squash were part of food economies well before the emergence of maize horticulture in North America (Smith and Cowan 2003). Yet other food plants, such as berries, may have been managed through use of fire and sustained harvesting to stimulate productivity.

After ca. 1350 BP, evidence of KCH in the archaeological record diminishes. The exact cause of this disappearance has been hypothesized as either a complete replacement by Late Woodland peoples moving into this area or the adoption of new forms of material culture influenced by outside cultures. Bozell and Winfrey (1994) suggest affiliation of KCH descendants with the subsequent Keith Focus, or movement westward onto the Central Plains as alternative scenarios, although either explanation may be the case.

2.2.B. The Valley Phase

Coinciding with the arrival of KCH, the Valley phase (ca. 2050 to 1250 BP) represented another Hopewellian-influenced Middle Woodland phase that appeared on the Great Plains. This archaeological tradition was first defined by Hill and Kivett (1941) based on their research at the Schultz site (25VY1) in Valley County Nebraska. Valley has often been connected to Besant and Sonota as Reeves (1983:166) suggested that Sonota pottery was an extension of the Valley phase (Scribe 1997:145).

Bozell and Winfrey (1994:138) postulated that the peoples residing in these areas were faced with two choices as a result of pressure from swelling Hopewell populations: either relocation westwards or adoption of Hopewell customs. These authors recited evidence of both scenarios occurring within Nebraska at this time (Bozell and Winfrey 1994). Identification of similar pottery motifs and burial customs to Hopewell centres may echo adaptation to outside influences, while a decrease in settlement sizes and trade items within the Valley area appears to indicate a diminished role within the Hopewell Interaction Sphere.

Conversely, Tiffany (1978:179) believed that Valley and other related Middle Woodland groups represented outside cultures ancillary to emerging and ongoing changes that occurred in the Hopewell Interaction Sphere. The location of the Valley phase on the outer edge of the Hopewell Interaction Sphere allowed these peoples to have been more selective about which social practices (e.g., mortuary customs) or technologies to adopt (e.g., pottery). This uneven adoption of material culture by Valley society would lead to a hybrid material culture. Evidence of such activities is best displayed at the Schultz site in Nebraska where archaeological data suggests a blending of Central Plains activities and Hopewell material culture.

More recently, Adair (2016) hypothesized that Valley ware first appeared as a Middle Woodland expression in eastern Nebraska sometime around 1950 BP and was influenced by Havana Hopewell. Emerging from this initial spread of ideas, or people, several sub-types occur as pottery continues to be adopted by peoples with no previous experience with this cooking technology. This connection is further supported by the identification of maize consumption through the examination of Valley phase carbonized residues and from dental calculus taken directly from human remains from the Schultz burials (Adair 2019; Adair et al. 2022).

Carbonized food residues adhering to pottery from the Schultz site, at which maize was identified, have been directly dated to 1695 ± 15 ^{14}C yrs BP (Adair et al. 2022:338).

Regarding material culture, pottery represents the most noticeable hallmark of this Middle Woodland phase (Figure 2.5). Valley phase pottery is defined as large, thick-walled, cord-roughened conical pottery, pottery with slightly out-curving rims with closely spaced cord impressions, and punctates (Griffin 1952; Ludwickson and Bozell 1994; Tiffany 1978). Cord roughened, or marked, exteriors show either vertical, oblique, or horizontal impressions. Such attributes were common throughout the Middle Woodland Period as Valley wares bear a striking resemblance to both utilitarian Havana Hopewell wares (Griffin 1952) and those produced by KCH (Ludwickson and Bozell 1994). Surface treatment of these vessels typically included the use of twisted cord impressions in a vertical, angled, and horizontal orientation. Although decoration was limited, the use of a single row of punctates or bosses near the rim of the vessels can be viewed on many samples from this phase (Bozell and Winfrey 1994; Tiffany 1978).

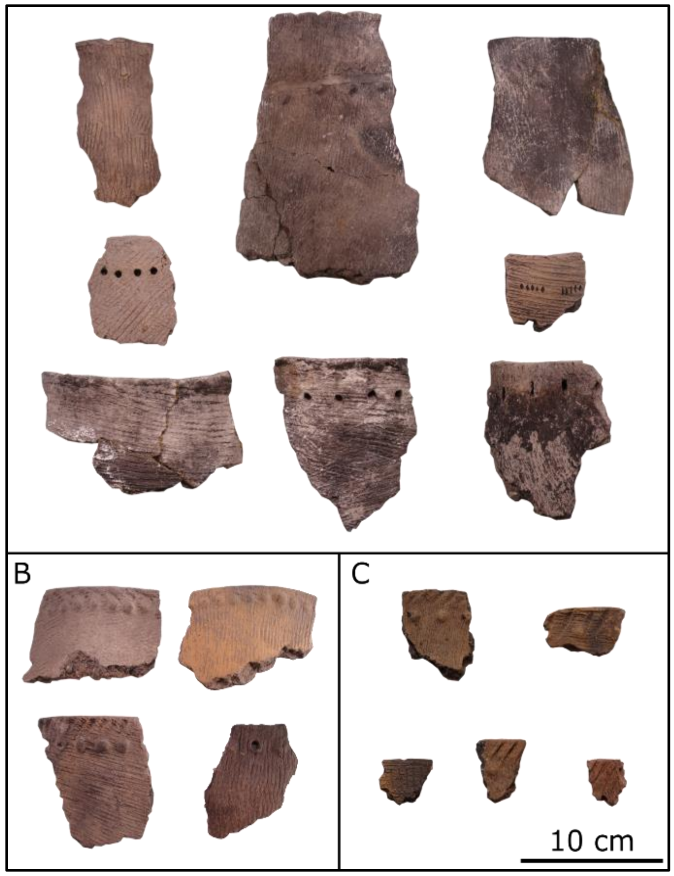


Figure 2.5 Eastern Central Plains early pottery rim fragments. A) Nebraska Valley phase rims; B) Havana influenced specimens from Platte County, NE; C) Taylor Mound (14DP3) rims with both Havana and Valley (also labelled Rowe) traits. Photographs courtesy of Adair (2021).

While archaeologists agree on the traits that define Valley ware, how variations in decorative styles should be interpreted has led to disagreements. Whereas Nebraska archaeologists have defined Valley as an all-encompassing phase that included a wide variety of pottery decoration styles, archaeologists in Iowa have relied more on systematic approaches. While researching Rowe ware, a Valley sub-phase located in Iowa, Tiffany (1978) separated pottery styles into several taxonomic groups based upon variations in decoration. In doing so, Tiffany (1978) believed tracing these variations would aid in deciphering kin networks within social groups of the Valley phase. While attempting this line of research, Tiffany (1978) was restricted to Iowa as archaeologists within surrounding states identified Valley wares based on differing classification strategies. Before Tiffany's (1978) research, Griffin (1952) labelled wares sharing attributes of Valley in Illinois as Havana Cord-marked and Crawford Cord Roughened in Iowa (Adair 2016).

Pottery varieties are not synchronous as Havana-influenced wares predate Valley types by approximately 100 years (Adair 2016). During analyses of accelerated mass spectrometer (AMS) dates from carbonized residues, Adair (2016) found these Havana-influenced types to appear from 1970 to 1813 ^{14}C yrs BP. At the Taylor Mound site (14DP3), Adair (2016) found that pottery contained a mixture of Havana and Valley characteristics, which is further complicated typologically as wares have been called Valley, Rowe, and Crawford. According to the results of Adair (2016), later Valley wares contain fewer decorations and potentially represent a sub-type of Valley ware.

Materials from the Valley phase first appear in the archaeological record in Western Iowa and Nebraska at around 1850 BP and widely expanded through much of Nebraska and into southeast South Dakota until around 1550 BP. The degree of this expansion may also have been much more extensive than the previous KCH as pottery reminiscent of the Valley phase has been reported in Colorado, South Dakota, North Dakota, and perhaps central Wyoming (Kivett 1949:67-69; Miller et al. 1986; Neuman 1975; Wood 1956).

After the initial Valley phase expansion, archaeologists in Nebraska identified several sub-phases appearing from 1650 to 1250 BP. These later phases were marked by a decrease in pottery decoration (Adair 2016), replacement of the atlatl with bow and arrow technology, and increases in storage pit dimensions. These changes are potential signs that a transition away from hunter-gathering towards a more sedentary village lifestyle was occurring (Bozell and Winfrey 1994).

2.2.C. Keith Phase and South Platte

The last two Central Plains phases discussed in this literature review occurred within parts of Nebraska, Kansas, and Colorado and are perhaps the least known. Compared to Valley and KCH, scarce archaeological data from early Keith and South Platte sites have limited the identification of an ancestral region for this new Middle Woodland phase. Some believe mortuary customs, subsistence practices, and pottery characteristics of the Keith phases resemble those found in Valley and other Middle Woodland phases (Bozell and Winfrey 1994).

Temporal ranges for these two Middle Woodland phases have also proved troublesome due to the limited number of radiocarbon dates. The Keith phase is believed to appear as early as 1800 BP and extended to 1150 BP, followed by the arrival of the South Platte phase at around 1450 to 950 BP (Bozell and Winfrey 1994). The overlapping temporal ranges and cultural practices of Keith and South Platte suggest a close connection (Bozell and Winfrey 1994).

Like the Valley phase and KCH, traces of Hopewellian influence have been used by archaeologists to interpret the formation of the Keith and South Platte phases. Bozell and Winfrey (1994) used the limited adoption of pottery as a subtle indication that these two phases were the result of local nomadic Late Archaic groups that practiced only a partial adoption of Hopewell technology (Figure 2.6). Additional evidence for outside influence has been observed in both hunting technology and burial practices. The first appearance of bow and arrow technology in Nebraska occurs within the Keith phase. Further, burial practices noted at the Keith phase Woodruff Ossuary (14PH4) suggest increased social complexity, and status, marked by arrow projectile points and differential mortuary goods alongside the interred individuals (Bozell and Winfrey 1994). The movement of exotic goods and increasingly complex burial patterns were both trademarks of Hopewellian influence; the limited use of pottery complicates this connection. Perhaps, adoptions of Hopewell traits were more selective, suiting the needs of the individuals composing the South Platte and Keith phase populations.

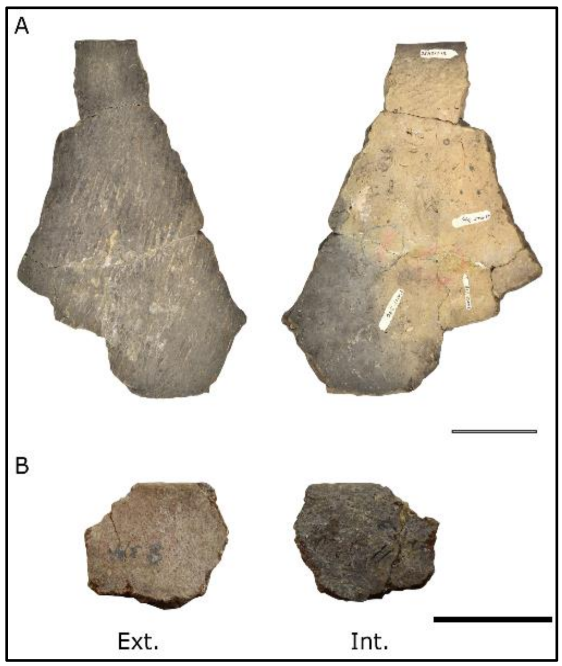


Figure 2.6 Examples of Keith (A) and South Platte (B) phase pottery rim fragments. Photo courtesy of the History of Nebraska Archaeological Collections and photographed by Fogerty (2021). Scale bar represents 5 cm.

The Keith and South Platte phases had a lasting foothold in Nebraska and Colorado, persisting in the region from 1800 to 800 BP. Archaeological evidence of South Platte pottery in association with Late Woodland wares at the Chadron State Park site (25DW1), Nebraska, provides some indication of incorporation into later village-forming societies, yet a paucity of Late Keith and South Platte phase sites limits the interpretations that can be formed.

2.2.D. Minnesota and the Canadian Boreal Forest

Most of the pottery specimens examined in this study were found within North and South Dakota, but Middle Woodland trends within neighboring Minnesota and Ontario should not be overlooked. Pottery arrived in Minnesota much earlier than is seen on the northern Great Plains and Central Plains. Beginning with the Early Woodland Period, sometime between 2750 to 2350 BP, pottery is first documented through the identification of La Moille Thick and Black Sand pottery types (Gibbon 2012:98). La Moille Thick pottery is thought to resemble Marion Thick varieties found within the Midwestern United States (Gibbon 2012:98) but has only been recovered from five archaeological sites. Attributes of La Moille include thick walls with coarse grit temper, conical shape, oblique cord-roughened exterior, and little to no decoration (Gibbon 2012).

Black Sand pottery also appears to have origins within the American Midwest and is defined by narrow incised lines with occasional use of fingernail impressions. While radiocarbon evidence concerning the timing of Black Sand pottery is lacking, it is speculated to have been contemporaneous with La Moille Thick and followed a similar trajectory into the Great Lakes region (Gibbon 2012). Evidence of Black Sand pottery has been identified at the Naze site (32SN246) in North Dakota; the small sample sizes and lack of diagnostic features limit confidence in this identification.

Following the Early Woodland Period, later pottery forms found within Minnesota are regarded as northern variants of Havana Hopewell pottery (Gibbon 2012). Dating between 2150 and 1750 BP, Sorg and Howard Lake morphotypes mark the arrival of Hopewellian influence within Minnesota as such wares recovered from the Sorg site (21DK1) near St. Paul directly resemble Havana wares of Illinois. Whereas pottery types are similar to Hopewell wares, Guy Gibbon (2012) found that lithics from the Sorg site share more in common with the Pelican Lake and Samantha phases of the northern Great Plains. If true, this provides evidence of the selective introduction of Hopewellian influence into Minnesota, rather than an overall adoption. A similar trend is found within Valley and Keith-South Platte phase assemblages of Nebraska where pottery is reminiscent of Hopewell, yet lithic assemblages do not share any resemblance.

After the Sorg and Howard Lake phases, there is an increase of pottery found within Minnesota. This is represented by Linn and Fox Lake varieties (ca. 1750 to 1450 BP), both of which include minor alterations to known Havana Hopewell pottery styles. Coinciding with this increased pottery use are burial activities that resemble those found within Havana Hopewell centres, although not as elaborate (Gibbon 2012). Changes to pottery manufacturing also occurred during this transition, as vessels are noted to have become more globular in shape, thinner, and featured more intricate decorations (Gibbon 2012). Concerning the origins of these new pottery types, the location of Fox Lake pottery along the Prairie Lake region of Minnesota and identification of materials from Iowa and South Dakota has led Gibbon (2012) to suggest a Central Plains connection to Linn and Fox Lake phases in Minnesota.

Later pottery wares occurring within the Middle to Late Woodland Periods (ca. 1450 to 850 BP) such as Malmo, Laurel (Figure 2.7), and Brainerd (Elk Lake) ushered in a time of increased participation in wild rice harvesting, and other domesticated plant consumption (Boyd and Surette 2010; Boyd et al. 2014; Staller and Thompson 2002). Increased numbers of burial mounds, and increased sedentism were also documented (Gibbon 2012). During this period, the use of pottery expanded northwards into the Canadian boreal forest, as seen with the appearance of numerous Laurel pottery-bearing sites. Some have viewed this northern expression to represent an offshoot of the Hopewell Interaction Sphere, expanding into northern Ontario, Manitoba, and eventually into Saskatchewan (Wright 1967).

Figure 2.7 Laurel pottery fragments from the Beeber site, North Dakota. Image courtesy of the North Dakota State Historical Society.

Of these Minnesota traditions, Malmo ware of central Minnesota has been linked to Besant-Sonota (Neuman 1975:87; Reeves 1983:154). Plain wares from Malmo were similar to those found at the Stelzer and Arpan Mound sites of South Dakota. While these pottery types shared a likeness, Reeves (1983:155) did not believe this was enough to imply a cultural connection or affiliation between Malmo and Sonota. In other regions, Malmo ware has also been linked to Havana Hopewell (Anfinson 1979:137), which has also been linked to Besant-Sonota by Neuman (1975). Indeed, this is a common theme in the literature reviewed for this study: many adjacent pottery-bearing cultures existing during the time of Besant-Sonota have been listed as possible sources of influence.

The arrival of pottery and Hopewell characteristics appears to have occurred much earlier in the Canadian boreal forest and Minnesota than seen further west on the northern Great Plains. The simplest explanation for this 500-year difference would be the proximity of Minnesota phases to Hopewell centres in Ohio and Illinois. While their proximity to Hopewell areas holds merit as an explanation, the movement of materials and ideas over large distances would have required some degree of cross-cultural interaction. Identifying how these interactions occurred appears to have been dismissed in favour of determining when and where Hopewell traits arrived in new regions. Although identification of how past cross-cultural interactions occurred is a difficult task, understanding the key trends of this period can provide useful information on this dynamic time in North America.

2.2.E. Trends of the Contemporaneous Middle Woodland Traditions

The emergence of the Hopewell Interaction Sphere had a considerable impact on societies that occupied much of North America during the Middle Woodland Period. As a direct consequence of this influence, several key trends are noted within the Middle Woodland Period:

- Emergence of the Hopewell Interaction Sphere in Illinois and Ohio is viewed as a driving force behind technological and social change. The introduction of maize-based horticulture, storage, decreased mobility, and increased social stratification all appear to have coincided with this wave of influence. The introduction of pottery and trade goods represented the first markers of this change.
- Pottery vessels within the Middle Woodland Period shared similar characteristics: they were conical or bag-shaped, with twisted-cord markings, thick walls, and had decoration limited to near the rim, often involving punctates. Large vessel sizes, occasional use of incised lines or cord-wrapped-tool decorations, and rare preparation of smooth exterior vessels were other common traits.

- Bow and arrow adoption within areas on the outer edge of the Hopewell Interaction Sphere appears to occur after the adoption of pottery as dart, spear, and atlatl technology is not replaced until the Late Middle Woodland Period.
- Contemporaneous sites directly east of the northern Great Plains all appear to have eventually transitioned to a village horticultural lifestyle after the arrival of Hopewell technology and practices.

Although Middle Woodland groups within Nebraska, Iowa, and Minnesota were involved with the Hopewell Interaction Sphere, any such ties to peoples occupying the northern Great Plains are challenging to interpret. Despite the use of pottery, increased complexity in burial practices, and appearance of trade items, the peoples of the Besant-Sonota era remain seen by some as ‘outsiders' located on the periphery of the Hopewell Interaction Sphere. Another rising trend within this time was the consumption of maize by groups to the south and east of the northern Great Plains. As many exotic items and ideas were being spread throughout North America during the time of Besant and Sonota, we must also question if northern Great Plains peoples participated in the acquisition of this important domesticated plant. Identifying how these northern Great Plains societies may have acquired maize requires the reviewing of previous archaeological research on the dispersal of this domesticated plant throughout North America.

2.2.F. Tracing the Origins of Maize Consumption in North America

Although maize has often been considered one of the most crucial domesticated food products consumed in pre-contact North America, the earliest uses of this plant have been the subject of much debate (Adair and Drass 2011; Adair et al. 2022; Fritz 2011; Pearsall et al. 2003; Schneider 2002; Staller and Thompson 2002). Based on plant microfossils and molecular clock estimates, it is believed that maize was domesticated from a wild grass, known as teosinte (*Zea mays* spp. *parviglumus*), in the Balsas River Valley of southwestern Mexico, approximately 8,000 to 9,000 years ago (Doebley 2004; Piperno et al. 2009). Early domesticated cobs have been directly dated to around 5300 to 4950 cal BP and are composed of a mix of modern maize-type alleles with ancestral teosinte alleles (Vallebueno-Estrada et al. 2016; Ramos-Madrigal et al. 2016).

Recent isotopic analyses by Kennett et al. (2020), have provided further clarity on the use of maize within this region. Through examination of two well-preserved rock shelters in Belize spanning the past 10,000 years, Kennett et al. (2020) determined that human skeletal remains dating to 7000 BP show signs of limited maize consumption. Substantial maize consumption, representing approximately 30 percent of the total diet, appears within individuals living between 4700 and 4000 BP. After 4000 BP, isotopic evidence from human remains suggests that this food product became a staple, representing over 70 percent of the total diet (Kennett et al. 2020).

The earliest macrobotanical evidence for maize has been dated to occur sometime between 6250 and 4950 cal BP (Vallebueno-Estrada et al. 2016; Ramos-Madrigal et al. 2016). This implies a later use of maize within this region. The discrepancy between microfossil, macrofossil, and isotopic evidence within this region is worth revisiting. Microfossil evidence suggests that early maize was widely dispersed through the lowland neotropics by at least 7000 BP (Piperno et al. 2009). Yet, isotopic evidence from direct human skeletal remains suggests it was not consumed regularly. Kennett et al. (2020) hypothesized that around 7000 BP maize played a minor role in diet, and this would explain its absence from skeletal isotopes. Despite the limited contribution to diet, Kennett et al. (2020) believed hunter-gatherers used maize for specific events as a marker of increased social status. Over time, this led to further experimentation and eventual domestication (Kennett et al. 2020). Over time, a similar sequence of increased maize use may have transpired in North America.

Many theories outline how maize was brought into North America. One theory considers a southwestern arrival through the planting of maize by mobile-hunter gatherers and/or horticulturalists moving upwards from what is now Mexico (Figure 2.8). Under these circumstances, maize was spread through sporadic planting and cultivation (Hill 2001; Matson 1999; Minnis 1992). Matson (1999) proposed that maize consumption preceded horticulture in adjacent areas as family groups travelling northwards acted as middlemen, trading maize to groups living in the Central Plains and Great Basin. Such a process of interaction would be attractive to parties on both sides and further aid in the dispersal of maize.

Figure 2.8 Estimated timing of maize macrobotanicals within the American Southwest (A) and the Lockport site [EaLf-1] and directly dated macrobotanical evidence of maize from the Shultz (Adair et al. 2022), the Icehouse Bottom [40MR23] (Chapman and Crites 1987), and the Edwin Harness [22RO33] sites. Directly dated carbonized food residues containing plant microfossil evidence of maize from the Vinette (Hart et al. 2003), the Arpan Mound (This Study), the Miniota (Lints 2012), and The Pas (Boyd et al. 2019) sites.

To provide a more refined perspective on the spread of maize into the American Southwest, da Fonseca et al. (2015) used comparisons of nuclear DNA from 32 maize specimens including samples of teosinte and Mexican maize (*Zea mays* ssp. *mexicana*). In this study, the authors found that an initial diffusion of maize into the American Southwest occurred around 4,000 years ago along a highland route (da Fonseca et al. 2015). Two thousand years later, a second gene flow occurred along the lowland coast (da Fonseca et al. 2015). During this time, the spread of maize was largely impacted by its ability to evolve to climate conditions (such as drought) and sugar content. The extreme aridity of this region, combined with the food preferences of hunter-gatherers unfamiliar with this food item, likely played a considerable role in the spread of maize.

According to Smith and Cowan (2003), the Eastern Woodlands is a hearth of domestication, for squash, sunflower, marsh elder, and goosefoot but not maize. Sites such as the Icehouse Bottom (40MR23) of Tennessee, Tuskegee Pond (31JK12) of Alabama, Edwin Harness (33RO22) of Ohio, and the Holding site (11MS118) of Illinois have long been used to infer that maize consumption began sometime between 2200 to 1600 BP. Still, it was not integral to diets in this region until later (Emerson et al. 2020). While this would suggest an arrival that coincided with the rise of Hopewell, isotopic analyses by Simon (2017) and Emerson et al. (2020) suggested otherwise. When re-examining directly dated maize cobs from the Holding site, Simon (2017) revealed that these were not maize and further, that maize was not integral to diet until around 1050 BP. This timing was further revised by Emerson et al. (2020) through isotopic analyses of human and canid skeletal remains in the greater Cahokia area. According to the authors, maize appeared abruptly in the diets of Cahokians and quickly increased in importance afterwards.

Discrepancies concerning the timing of maize consumption in North America are not limited to the Eastern Woodlands as plant microfossil evidence points to an earlier arrival than macrobotanical evidence. For instance, pollen analysis of sediments from the Lake Shelby (1MT209) site (Alabama) by Fern and Lui (1995) showed evidence of maize dating to 3,500 cal BP. This suggests that maize was brought into this region over 1,000 years earlier than reported elsewhere in the Eastern Woodlands. Simon (2017) took a more cautious approach and focused on the timing of maize horticulture as the dispersal and first consumption of maize was interpreted by many without the use of more recent, and more accurate, AMS dated and DNA identified macrobotanicals. Following this approach, this plant became a staple food and the economic base for Mississippian polities such as Cahokia sometime after 1200 to 1150 cal BP (Lopinot 1994; Simon and Parker 2006).

Maize was brought to the American Southwest by around 4100 BP (Merrill et al. 2009; Wills 1988) and spread to groups of the Great Basin. Maize kernels and cobs from Archaic occupations in central Colorado at the Recon John Shelter (5PE648), LoDaiska (5JF142), Medina Rock Shelter (5LA22), and site 5HF1109 suggest an early arrival, followed by an extensive period of transitional maize consumption. For this scenario, the adoption of maize would have been to supplement traditional foods or for use in ceremonial activities (Scarry 1993; Smith and Cowan 2003).

Adair and Drass (2011) suggested that maize was not only a vital crop introduced to the Central Plains economy but also contributed to the creation of ritual ceremonies and in the building of trade relations between groups. Further analyses by Adair and colleagues (2022:337-338) have revealed that maize was first consumed by the hunter-gatherers of Nebraska and Kansas roughly 2311 cal BP. Adair and colleagues (2022) hypothesized that during times of nutritional stress, people consumed maize to supplement their diet. Maize was also identified within Valley phase carbonized food residues of Nebraska dating to 1695 ± 15 ^{14}C yrs BP (Adair 2016, 2019; Adair et al. 2022). While present in both Middle Woodland cultures, Adair and colleagues (2022) have interpreted that maize was used at this time for ritual consumption and was of minor dietary importance.

The earliest and northernmost evidence of maize is found in Laurel pottery (1450 to 850 cal BP) from northern Ontario (Boyd et al. 2019). The earliest evidence of maize consumption on the northern Great Plains comes with Avonlea pottery (Lints 2012). At the Miniota site specifically, three separate AMS dates of carbonized residues suggest that people were consuming maize during the winter months in southwestern Manitoba between 1230 ± 30 ^{14}C yrs BP (Lints 2012). Owing to the results of Adair et al. (2022) and Boyd et al. (2019), maize was present in areas adjacent to the northern Great Plains during the time of Besant and Sonota. Analysis of carbonized residues from pottery wares used by Besant-Sonota era peoples will provide an answer to whether northern Great Plains peoples were involved in the acquisition and dispersal of maize.

2.3. The Besant and Sonota Phases

Through many years of archaeological research, the Besant and Sonota phases have presented different windows into the daily life of peoples that inhabited the northern Great Plains during the Middle Woodland Period. While the Besant phase has become synonymous with bison-focused hunter-gatherers, Sonota, on the other hand, provides a window into ritual and ceremonial aspects of life during this time.

The Besant phase was originally named by Wettlaufer (1955) during investigations at the Mortlach site (EcNl-1) in Saskatchewan. Identification of this phase is based upon atlatl projectile points, and cord roughened pottery recovered from sites within South Dakota, North Dakota, Wyoming, Montana, Manitoba, Saskatchewan, and Alberta. While the term Besant is widely used, Sonota has also been applied to similar materials found within North and South Dakota. Although some argue that Besant and Sonota represent two separate phases (see Neuman 1975; Peck 2011; Syms 1977), recent comparisons of the Stelzer site in South Dakota and the Muhlbach site (FbPf-1) in Alberta found that material assemblages were indistinguishable (Graham 2014). It should be acknowledged that the peoples responsible for these vessels went by different names that are now lost. In search of a more appropriate name, Scribe (1997:165) called Besant potters *nistam ka-ke askikokechik Puskwaw-askihk*, which in Cree translates to “the first potters of the Plains.”

The placement of the Besant and Sonota phases in archaeological classification systems has also been an issue. The Besant phase has been classified as both in the Middle Woodland (also called Late Pre-contact) and the Late Plains Archaic (also called Middle Pre-contact) (Beckes and Keyser 1983; Deaver and Deaver 1988; Frison 1978; Gregg 1985; Reeves 1983). Taxonomic ambiguity may be primarily due to the transitional nature of the Besant and Sonota phases. As new materials and practices are appearing for the first time in some northern Great Plains areas and not others, some archaeologists may place these phases in later periods.

Regardless of these variations in taxonomy, Foreman (2010) has suggested that the earliest sites occur in North and South Dakota, followed by a spread northward through the Missouri and Saskatchewan River Basins. Foreman (2010) also noted that commonly accepted date ranges included 2000 to 1150 BP (Epp and Dyck 1983; Reeves 1983) and 2400 to 1000 BP (Duke 1991; Peck 2011). Additional variations in material culture and chronology have led some to associate Kenny, Sandy Creek, Outlook, and Sonota as subphases within an overarching Besant phase (Duke 1991; Frison 1978; Joyce 1984; Neuman 1975; Varsakis 2006; Vickers 1986), whereas others insist that each represent separate cultural phases (Peck 2011). Occurring between 2000 to 1150 BP, the Besant and Sonota phases were preceded by the Middle Pre-contact Pelican Lake phase and subsequently followed by the Late Pre-contact Avonlea phase (see Figure 2.3).

Through examination of Besant and Sonota sites on the northern Great Plains, archaeologists posited that the peoples were connected to traditions in the Middle Missouri region. Based on the appearance of KRF, an exotic lithic material originating in the Knife River region of North Dakota, some authors believed the peoples responsible for the Besant phase held connections to these areas (Peck 2011). Evidence of this connection was observed at archaeological sites across the northern Great Plains such as Fitzgerald (ElNp-8), Melhagen (EgNn-1), Muhlbach, Fincastle (DlOx-5), and Smith-Swainson (FeOw-1). These sites contained a high proportion of KRF and were viewed as anomalies compared to other known Besant lithic assemblages (Figure 2.9). The earliest of these examples, the Fincastle site, is located at a great distance (over 1,000 km) from North Dakota and contained a lithic assemblage composed of 83 percent KRF (Varsakis 2006:142). Although KRF frequency is high at a handful of sites, these represent a small portion of the total Besant sites across the study area. Peck (2011) summarized that in most cases, lithic assemblages are dominated by local materials and not KRF, making the high frequencies of KRF at considerable distances from the source area of genuine interest.

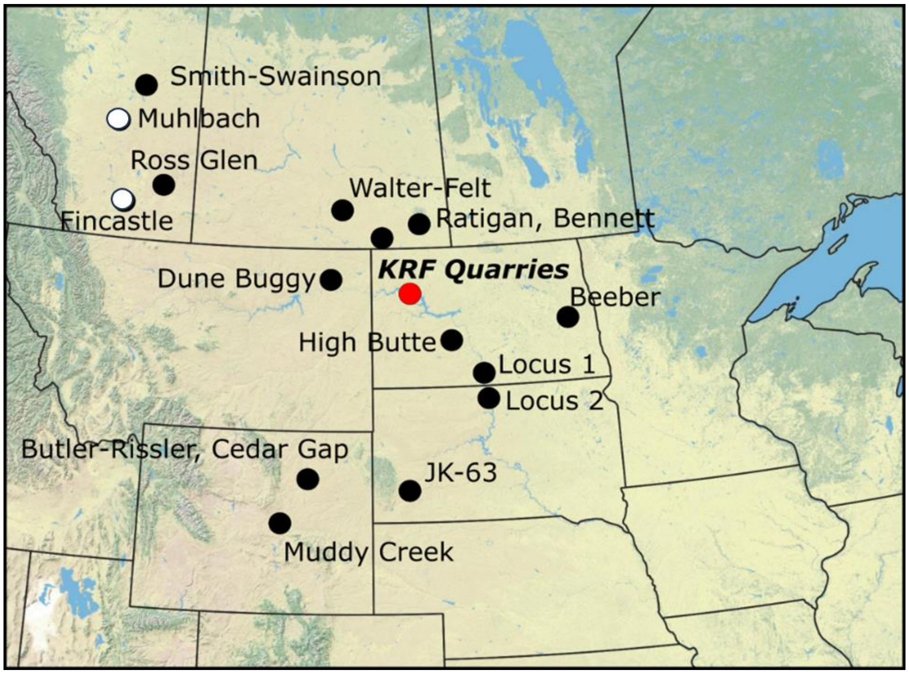


Figure 2.9 Selected Besant-Sonota sites bearing pottery in relation to KRF quarries (red) and the non-pottery bearing Fincastle and Muhlbach sites (white). Locus 1 includes Boundary Mound, Naze Mound, and Schmidt Mounds; Locus 2 includes Stelzer, Arpan Mound, Grover Hand, Alkire, DW255, and DW256.

The observance of these few sites rich in KRF has led some to believe that these sites were created by peoples from the Middle Missouri region (Peck 2011:247). With several radiocarbon dates averaging around cal. 2500 radiocarbon years (Bubel 2014:213; Foreman 2010), the Fincastle site is remarkably early for a Besant site, by almost 600 to 700 radiocarbon years. Despite this, the Fincastle site can be construed as the earliest evidence for sites revealing a pattern with a high proportion of Knife River indicative of some kind of Middle Missouri connection.

The Sonota Mounds, and their contents, provided additional support for long-distance connections while also presenting a taxonomical conundrum for archaeologists. Although bearing projectile points that were typologically similar to Besant, the Sonota sites yielded a diversity of exotic materials (Table 2.2). This is particularly true at the Boundary, Swift Bird, Grover Hand, and Arpan burial mound sites and the Stelzer campsite. Objects such as marine shells from the Pacific and Atlantic Oceans, native copper, shell "Thunderbird" effigies, obsidian, and modified animal and human mandibles and palette bones strongly suggest that the peoples responsible for Sonota were very much connected to trade networks spanning much of North America (Clark 1984; Caldwell 1964; DeBoer 2004; Neuman 1975; Reeves 1983; Syms 1977).

Table 2.2. An overview of Sonota Mound site materials highly suggestive of a Hopewell or Middle Missouri Connection.

Sonota Site	Source	Materials of Note
Boundary Mound (32SI1), North Dakota	Neuman (1975:77) Wood (1960:74)	*Modified human and animal bones* *Snyders point* *Dentalium* *Obsidian* *Grooved pendants* *Antler pins*
Alkire Mound (32SI200), North Dakota	Neuman (1975:79)	*Hematite coated human remains*
Swift Bird Mound (39DW233), South Dakota	Neuman (1975:42)	*Conch shell* *Shell "Thunderbird" pendant* *Bacculite fossil segment* *Olivella sp. shell pendant*
Grover Hand (39DW240), South Dakota	Newman (1975:49)	*Conical pipe bowl* *Dentalium shell* *Olivella sp. shell* *Perforated large conch shell*
Arpan Mound (39DW252), South Dakota	Neuman (1975:59)	*Mosasaur caudal vertebra* *Bacculite fossil segment* *Single, large pottery vessel* *Dentalium shell* *Olivella sp. shell*
Stelzer (39DW242), South Dakota	Neuman (1975)	*Native copper* *Knife River Flint* *Obsidian*

Indeed, the presence of exotic materials and the arrangement of bundle burials within a burial mound structure is anomalous when compared to sites outside of the Sonota Mounds. Neuman (1975) used the similarities of these sites to place Sonota closer to Middle Missouri traditions than Besant. Nevertheless, the arrangement of bundle burials and the placement of whole, articulated and partially articulated bison skeletons speak strongly to northern Great Plains customs.

Unlike taxonomy, one aspect of this archaeological phase that most archaeologists can agree on is the role of bison within subsistence practices. George Frison (1978:223) once described the Besant-Sonota era as, "…a cultural incursion onto the northern Great Plains that brought with it or developed there, the most sophisticated bison procurement method the area had ever seen and it was a cultural climax that was never to be achieved again." Such large-scale bison procurement sites include Muhlbach (Gruhn 1969), Fitzgerald (Hjermstad 1996), Ruby (48CA302) (Frison 1971), and Muddy Creek (Reher 1989). Although Frison (1978) identified the Besant-Sonota era as the apex of communal bison hunting on the northern Great Plains, it is important to note that large-scale bison procurement not only continued but increased in intensity during the subsequent Avonlea and Old Women's phases (Brink and Dawe 1989; Ives 2003; Kehoe 1973; Walde 2006a).

Research into tipi ring sizes at the Ross Glen site in Alberta revealed that the average interior diameter for Besant-Sonota tipi rings was 6.8 m (Quigg 1986). In contrast, rings belonging to subsequent (pre-equestrian) phases throughout southern Alberta averaged 4.6 m (Brumley and Dau 1988). Tipi ring average sizes from many Besant-Era sites including the Boyd (AB), Ross Glen, Muddy Creek (WY), Elma Thompson (SK), and 32OL270 (ND) were consistently found to be larger than those observed by Brumley and Dau (1988:119) during their analysis of 686 tipi rings from later archaeological phases. Other estimates by Kehoe (1960:462) found that pre-equestrian tipi ring sizes averaged around 3.04 m, which is also lower than what has been observed within the Besant-Sonota era.

This anomaly in tipi ring sizes has led some to explore the amount of materials necessary to create these larger structures. Comparisons of tipi ring dimensions from the Elma Thompson, 32OL270, Boyd, Muddy Creek, and Ross Glen sites led Reilly (2015:163) to conclude that the average number of hides required for each tipi ring ranged from 22 to 53. Using Kehoe's estimate of pre-equestrian tipi ring sizes more generally, Reilly (2015:163) calculated that 10.43 hides were used to produce a tipi in other time frames. The Besant figures are two to five times greater for the materials needed to produce Besant-Sonota tipis compared to the later pre-equestrian phases. When we consider the costs of labour and time required to create, mend, and transport these hides during a seasonal round in the pedestrian era (even with the assistance of dogs and travois), the Besant numbers are all the more impressive (Reilly 2015). Not only was there an increased number of communal bison hunts, but habitation structures were being designed to support larger numbers of people, potentially impacting social organization. The increase in community-driven hunting activities and growing dimensions of dwellings both imply that these societal changes were not limited to ritual or ceremonial components of life but extended to everyday activities. The social ramifications associated with the increased dwelling sizes warrant our attention regarding the impetus for this change. Was the increase in large-scale bison procurement facilitated to satisfy the need for larger housing structures due to growing population sizes, or were there unseen social implications, such as changes in status, that required the creation of larger housing structures?

While the exact cause of this increase may be difficult to decipher, examination of the time and resources required to create these lodges can provide a window into an essential aspect of daily life during the Besant-Sonota era that is largely forgotten by archaeologists: hide-tanning (Reilly 2015). Although hides do not preserve well in most contexts, the tools designed to facilitate hide-working do. During the excavation of the Stelzer site (1800 and 1550 cal BP), which is situated near the Sonota Mound cluster in South Dakota, 587 hide-working stone tools were recovered from this single occupation site (Neuman 1975). Any manner of 'scaling-up' predictions for this large, rich site would suggest that huge numbers of these implements were present. Excavation units at Stelzer were 5m by 5m and despite their size, only a small portion of this site was excavated (approximately 0.5 percent of the 220,000 m^2 site). Graham (2014:165) projected the number of hide-working tools uncovered through the excavation to their proportion for the entire site and estimated that approximately 117,400 of these tools could have been present.

Analysis of these hide-working tools by Graham (2014) revealed that many had been well-used, which may imply that intensive hide-working was being completed at this important location. The Stelzer site is anomalous, however, owing to the rich nature of the archaeological deposits. At most Besant-Sonota sites, the number of scrapers is considerably lower with numbers ranging from 48 recovered at the Muddy Creek site (Reher 1989) to 16 as seen at the Ross Glen site (Quigg 1988).

During her analysis of the Besant-Sonota era and hide-working, Reilly (2015:175) outlined several possibilities as to why this change in tipi ring sizes occurred. One possibility was the creation of larger tipi structures to house ceremonial activities as seen in Blackfoot ceremonies, where as many as 400 people could participate in a ceremony within a single tipi

(Kehoe 1960:461). An alternative explanation is a change that occurred in family size structures and dynamics such as co-residence of multiple family units and polygyny (Finnigan and Johnson 1984:32; Kehoe 1960:435; Oetelaar 2003:114).

Another alternative worth exploring is that a change in social stratification occurred during the Besant-Sonota era requiring the need to create larger housing structures for specific individuals with greater achieved status (Oetelaar 2003, 2021). Perhaps more successful hunters could provide their families with a more significant number of hides, therefore allowing the creation of larger housing structures (Oetelaar 2003, 2021).

The introduction of pottery may also have led to changes in status and food practices. Pottery can sterilize foods via boiling, retain nutrients that are otherwise lost in stone boiling pits, and enable the preparation of otherwise inedible foods, increasing the general diet breadth of a community (Rice 1999). Although infrequently found at Besant-Sonota sites, Scribe (1997) has suggested that clay vessels may have held a sentimental value and served as an indicator of status. If accurate, examining what foods were prepared in pottery vessels may provide insight as to why tipi ring sizes were larger during the Besant-Sonota era. That is, identification of what foods were cooked or stored within vessels may provide answers regarding community food practices during the Besant-Sonota era.

It is difficult to determine the scale and timing of changes in tipi diameter. While tipi rings are easily distinguishable at archaeological sites, few have been directly dated. Likewise, some locations were visited on multiple occasions throughout the Besant-Sonota era (e.g., Muddy Creek and Ross Glen) and therefore may be misleading when trying to reconstruct social unit size per housing structure. Consequently, it is difficult to estimate when and how frequently these larger rings were made. It is unclear whether the increased sizes of tipi rings were connected to other societal changes that were occurring, such as increased large-scale communal bison hunting, or the use of new technology (e.g., pottery).

A second form of dwelling, more typical of the Eastern Woodlands, has also been found in limited numbers at Besant sites such as the Mortlach (Wettlaufer 1955) and La Roche (39ST9) sites (Neuman 1975). These structures were labelled as post-in-ground dwellings and consisted of a double row of post-hole stains in a semi-circular shape ranging from seven to eight metres in diameter. While investigating structures at the La Roche site, SD, Neuman (1975:82) believed that a ridge pole ran the length of the structure and was supported by posts at opposite ends of the dwelling. Outside of this structure was a small midden full of waste materials such as freshwater mussel shells, pottery, and FCR (Scribe 1997). These circular dwellings were considered by Epp and Dyck (1983:113) to be reminiscent of mat-covered dwellings of Woodland culture found to the southeast of the northern Great Plains.

2.3.A. Northern Great Plains Burial Practices During the Besant-Sonota Timeframe

The most notable change that occurred within the Besant-Sonota era was the placement of deceased individuals within burial mounds. Before the Besant-Sonota era, most deceased individuals were treated as single or isolated interments (e.g., Milsom 2012). Some articulated individuals were buried, but more commonly they were for a time placed above ground on scaffolding or within trees, during which defleshing took place. These individuals often became 'bundled' arrangements of bones subsequently interred in places such as river bank crevices (Bushnell 1927; Dodge 1959:292; Kidd 1986). As these practices exposed human remains to the natural environment, limited mortuary records exist for cultures occurring before and after the Besant-Sonota era (with the remarkable exception of the Gray site noted below).

Although sub-surface burials were completed on the northern Great Plains, these did not include the creation of burial structures and earthen mounds directly above the burial (Kidd 1986; Millar 1981). These subsurface burials were commonly shallow and are believed to have been designed in this manner to allow the spirit of the individual to travel between the above and below ground worlds (Kidd 1986). The Greenwater Lake site (FcMv-1, 4390 ± 105 ^{14}C yrs BP) and the St. Denis burial (not dated) reflect single Oxbow phase interments. The Eriksdale Site (EfLl-1) from Manitoba's Interlakes region featured two flexed individuals of 3,470 ± 40 and 3,700 ± 60 ^{14}C years BP respectively. One individual, who had survived a femoral wound from a Pelican Lake projectile point, also had a rich assortment of grave goods including more than 300 shell beads, worked bone tubes from trumpeter swans, verdigris staining implying the presence of copper, mussel shells, 55 long bone fragments from a large mammal (bison), a wolf canine and a small amount of lithic debris. There were no grave goods associated with the second individual. The Highwood burial (2,725 ± 95 ^{14}C yr BP) from southern Alberta involved a 10 year old whose body had been defleshed and then interred in a small, sub-surface pit excavated into the bank of a high river terrace. The bones had probably been covered with red ochre and placed in a bundle along with grave goods consisting of a Pelican Lake projectile point, several other lithic tools, eleven perforated grizzly bear claws, several dozen perforated bison teeth, freshwater calm shell beads, a piece of native copper, and several exotic marine shells.

There is one extraordinary exception to this pattern of isolated mid-Holocene interments that preceded the Besant-Sonata interval. That is the Gray site located eight km northwest of Swift Current, Saskatchewan. The Gray site represents the largest known precontact burial site on the northern Great Plains (Millar 1978). With 99 burial units and 304 individuals recovered from an excavation estimated to have covered just 60 percent of the site, the Gray site must have been an incredibly significant place to the past societies living in this area approximately 5,000 to 2,500 years ago (Millar 1981:104). Primary burials (n=18) were predominantly extended while the majority of individuals were found in bundle arrangements. A single case of cremation was also noted at this site (Millar 1981). Differential weathering on the secondary interments was hypothesized by Millar (1981:105) to be the result of exposure to the elements as remains were left on scaffolding for differing periods of time.

Whether or not this site was made by one or more communities has been the subject of debate. Based on skeletal features, Vyvyan (1977) interpreted the skeletal remains as the result of multiple communities, or populations, over a period of two thousand years. Contradicting this was Pardoe (1980), who used cluster analyses of 26 skeletal variables to interpret the burial assemblage as a single population that likely practiced exogamous marriages. Although tracing the source population, or populations, is difficult, we can view this site as either a long continuum of use or perhaps as the culmination of four separate periods of burial activities (Millar 1978:386-389). Regardless of the differing explanations Pardoe (1980) and Vyvyan (1977) presented, the numerous bundles at the Gray site reinforce that this was the common burial practice dating millennia before the Besant-Sonota era. They were very much a part of northern Great Plains customs that would later be blended with Hopewell mound building at the Sonota mound sites.

The presence of exotic trade items within some of the Gray site burials provides direct evidence that individuals responsible for this site were actively involved in long-distance trade (Millar 1978:256, 265, 336, 1981:111). Shell from the Atlantic Ocean and copper from the Great

Lakes point to trade relations to the east while obsidian and KRF allow us to infer that similar relationships were established to the west and south (Millar 1978:346). Although the Gray site was distant from these source areas, the communities responsible for these burials had the social connections necessary to acquire these items. For the most part, however, there is little differentiation of material culture across such a long period of time and grave goods were sparse. They were found in only 32 percent of dispersed secondary interments, 33 percent of compact secondary interments (i.e., bundles) and 53 percent of the primary (supine, extended) burial units (Millar 1978:347). Furthermore, the items that were placed within burials provided little indication that some individuals had significantly heightened rank compared to others. This may be partially explained by one or multiple closely related and largely egalitarian communities using this location as a burial site for an extensive period of time.

2.3.A.i. Early Northern Great Plains Mound Building

The Sonota mounds represent the first burial mound structures on the northern Great Plains, and mark a significant departure in burial practices. Mound building began in conjunction with Sonota sites including Swift Bird, Grover Hand, and Arpan Mound near Stelzer and Boundary Mound at the North Dakota border (Figure 2.10). During the Besant-Sonota era, these burial practices were confined to the upper terraces of the Missouri River in north-central South Dakota and south-central North Dakota. Placement of the individual(s) within a subterranean pit under a wooden structure with further burial by a mound structure clearly represents a different spiritual belief system that merged pre-existing northern Plains precepts with ideas from the Hopewell world. Unlike the Hopewell mounds, the Sonota mounds were short term events with varied archaeological assemblages marked by the presence of pottery along with somewhat more elaborate grave offerings. The placement of multiple individuals within earthen mounds coincided with a growing number of burial mound sites in the Eastern Woodlands, Minnesota, and within isolated areas of the Canadian boreal forest (Gibbon 2012; Hill and Kivett 1941:182; Neuman 1975).

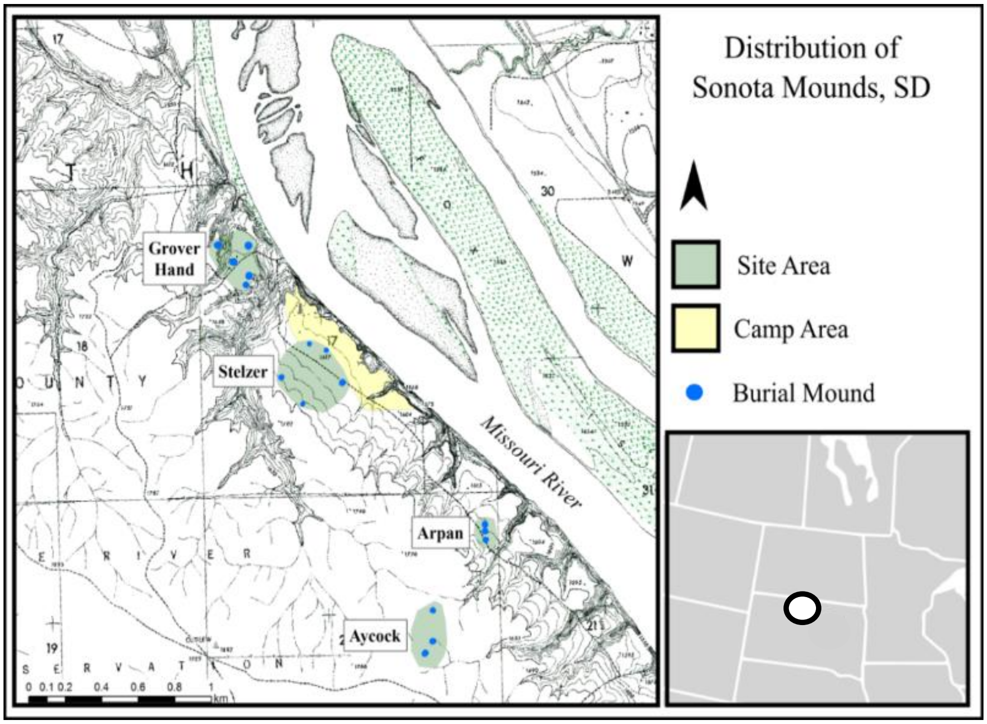


Figure 2.10 Distribution of the Sonota mounds in relation to the Stelzer site, South Dakota (Neuman 1975). Map adapted from Graham (2014:163).

The brief occupation span of the Sonota sites has only recently been brought to the attention of archaeologists. Before the renewed AMS dating summarized by Graham (2014), radiocarbon dates from the Sonota mound sites were limited to those collected by Haberman and Travis (1995:75) and Neuman (1975:37). Graham (2014) has provided a ground-breaking perspective on these sites, especially the immense Stelzer site. Bayesian modelling of the 12 dates on faunal remains reported by Graham (2014:263) and those collected by Haberman and Travis (1995) now shows that the Stelzer site was created during a narrow window of time, with outer limits of approximately 1810 and 1556 cal BP (Figure 2.11). This would imply that the large camp area adjacent to the burial mounds resulted from one or a few events, during which many people occupied this site.

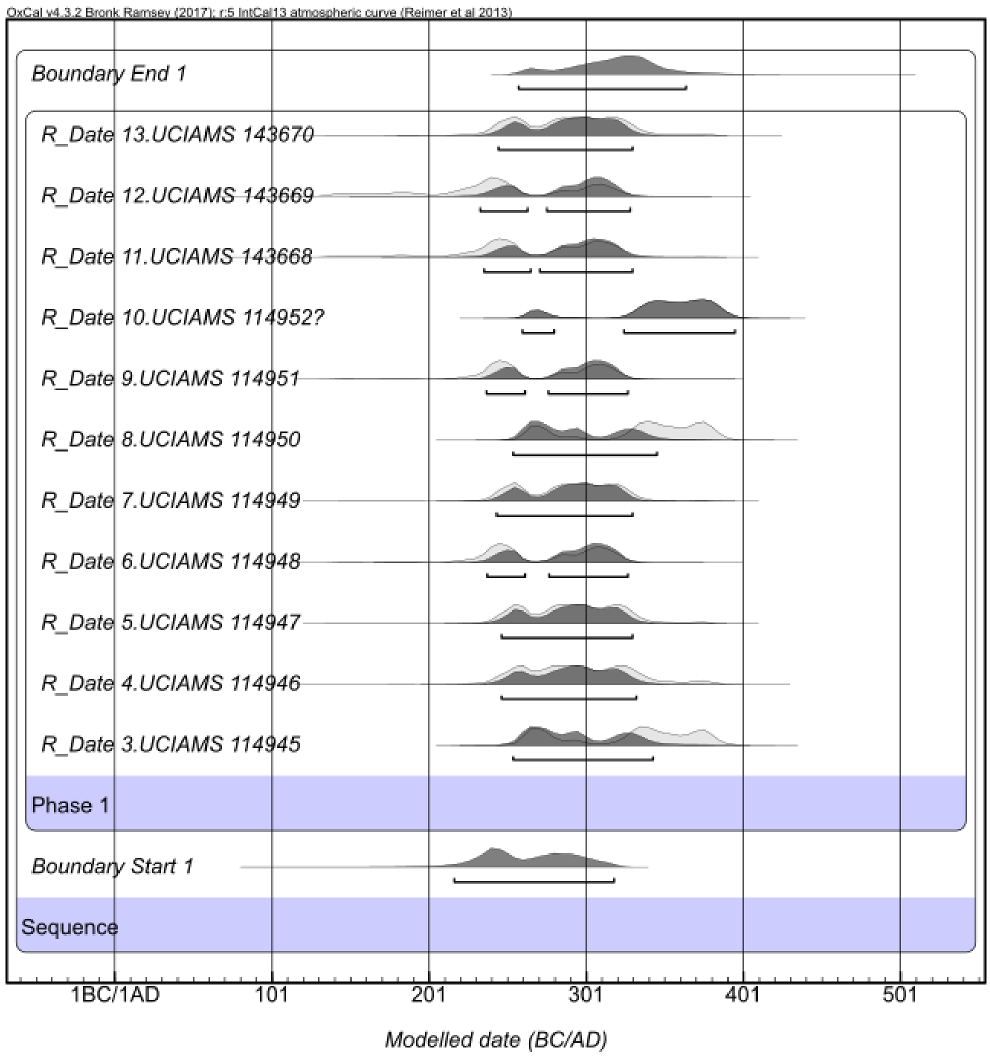


Figure 2.11 Bayesian analyses of Stelzer site faunal AMS radiocarbon dates collected by Graham (2014:243).

Looking at the construction of these mounds in greater detail reveals that each site contained two to five mounds ranging from 16.76 to 25.91 meters in diameter and 0.43 to 1.74

meters in height (Neuman 1975). In some instances, a timber superstructure was placed above the burials, forming a covering that in some cases was burned (Figure 2.13) (Neuman 1975). Within some Sonota mounds, grass matting or additional timbers were used as a sub-floor lining. Both adults and adolescents were interred in the mounds, with their demographic proportions varying between individual mounds. Only limited osteological analyses were completed by Bass and Phenice (1975).

The mounds reflect a significant investment of communal labour, but an investment well within the capacity of groups likely to have been present at such a large residential encampment as Stelzer. By employing the formula for a truncated sphere to determine volume calculations, Yanicki and Ives (2012) estimated that the Sonota mounds would have required roughly 25 people over five days to complete the mound construction. The construction of the mounds would require considerable effort, but so too would the collection of bison remains to be placed within the mounds (Figure 2.12) (Hallson et al. 2015).

Figure 2.12 Photograph of Grover Hand Mound 3 taken by Robert Neuman on August 8th, of 1962 just before the excavation of the burial pit (circled in yellow). Note the exposed articulated skeletons of what appear to be two adult bison just outside of the burial pit.

Although the scale of these structures was smaller than those observed in Hopewell areas, their significance cannot be overlooked. The secondary burials within these mounds were arranged within a rectangular or ovoid burial pit, ranging from seven to 48 individuals (Bass and Phenice 1975). Evidence of defleshing and dismemberment was identified by Bass and Phenice (1975:111-113) suggesting that individuals were scaffolded or otherwise left exposed for some time before being bundled and carried to these mounds for final burial. Based upon ethnographic observations of proto-historic Indigenous groups and analyses of burial remains, northern Great Plains archaeologists commonly assume that bundles were treated in this fashion (Key and Janz 1990). After statistical analyses of cranial features of individuals buried in Woodland mounds, Key and Janz (1990) believed that the Sonota mounds represented a longer sequence of interments by endogamous macro-bands over a considerable period rather than a single event (Snortland-Coles 1983). Following this line of thought, each burial mound would represent a gradual accumulation of deceased individuals from an endogamous group over an extensive interval of time. In other words, the 48 individuals found at the Arpan Mound site, were not likely from a single event, but rather from a longer period of accumulation prior to burial. Further, Key and Janz (1990) believed that the Sonota groups did not have the population size to maintain band endogamy to support this number of individuals to be buried immediately after death.

Although there was likely a longer prior period for the accumulation of skeletal bundles, the burial mounds themselves are better viewed as the result of events as opposed to lengthy processes. The patterning of burial arrangements and articulated bison remains, the lack of stratigraphic disturbances indicative of repeated visitations and burials, and the overall uniformity of the burials do not fit with the concept of these mounds being the consequence of generations of repeated visits. Moreover, the nearby massive Stelzer campsite (which suggests many individuals present during a very short interval of time) strongly suggests that the Sonota mounds are better viewed as specific events rather than processes. This is especially true if the Stelzer site served as a staging area for the nearby Sonota mounds, as the evidence strongly suggests. Additionally, Key and Janz did not consider the possibility that there may have been multiple non-kin related visitors to the Stelzer site who may have participated in the burial activities directly or as witnesses to these, the first burial mounds constructed on the northern Great Plains. For Hopewell mounds further east, Buikstra et al. (1998) interpreted features on the periphery of burial mounds as ‘ritual camps’ where individuals gathered to witness or participate in ceremonies. It is plausible that the Stelzer site served as one of these 'ritual camps' and that multiple groups used it, leading to its immense size and richness.

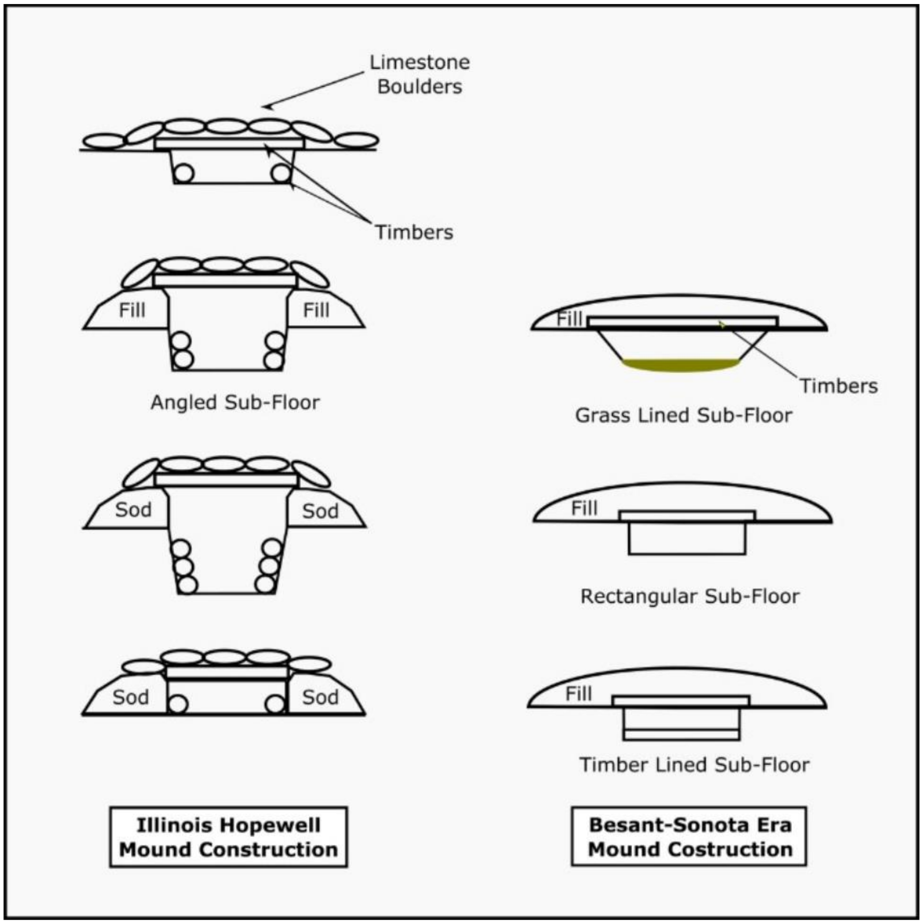


Figure 2.13 Mound profiles of the Illinois Hopewell and northern Great Plains during the Besant-Sonota era (Adapted from Van Nest 2006:410).

Not only were the mounds created in a similar style to those found in the east, but so too were the items placed alongside the individuals connected with regions to the east. Buried within these mounds were items that resembled those found in the Eastern Woodlands such as pottery, exotic lithics, and articles of personal adornment (Charles and Buikstra 2006; Ludwickson and Bozell 1994; Neuman 1975). In addition to large conoidal pottery vessels, decorated shells from the Gulf of Mexico, ground human and animal tooth rows (Hewes 1949:327), and a clay pipe bowl highlight the exotic grave goods placed alongside the deceased (Figure 2.14). The pipe bowl represents an early example of this form of material culture to appear on the northern Great Plains. Perhaps more intriguing with this item is the decoration and shape, which is analogous to Besant-Sonota pottery. The pipe bowl is conoidal and exhibits a series of punctates along the rim of the item, identical to known pottery styles of the period.

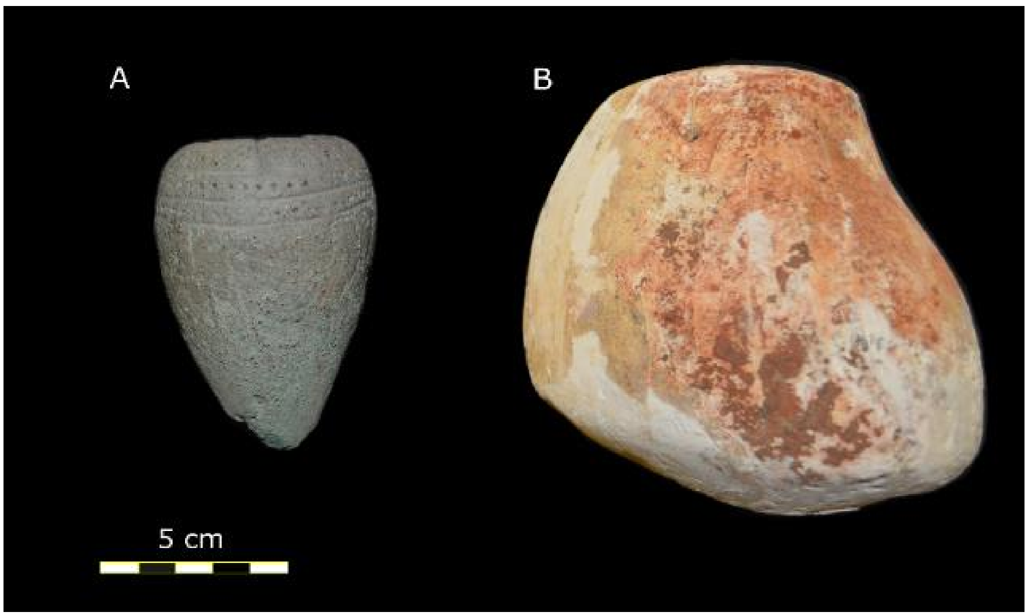


Figure 2.14 Items recovered from the Sonota mounds (SD) similar to those found in Valley and Hopewell related contexts: A) pipe bowl and B) modified shell from the Gulf of Mexico. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

While these mounds contain artifacts with Hopewell traits, definitive northern Great Plains traits were also present. In addition to stone tools and pottery reminiscent of those identified at other Besant sites, the inclusion of bison remains, and in some cases articulated bison skeletons (Neuman 1975), near bundle burials is highly suggestive of northern Great Plains influences. The Sonota human remains themselves were bundled, often arrayed around the mound subfloor. At the Boundary Mound site in North Dakota, 33 intact bison skulls were found alongside the burial mound (Neuman 1975). Within the belief system of current and past Indigenous peoples of the northern Great Plains, the skull of a bison represented immense spiritual importance and often was present during ritual activities (Brink 2008; Kehoe 1973).

2.3.B. Besant-Sonota Pottery

The appearance of pottery within the Besant-Sonota era marks the first use of this technology by pre-contact peoples inhabiting the northern Great Plains. Upon first discovery, some doubted the legitimacy that Besant-Sonota era peoples used pottery (Scribe 1997:57). Early findings of pottery within Besant components of the Mortlach site, were labelled by Wettlaufer (1955) as intrusive. Similarly, Thomas Kehoe's discovery of pottery from Besant components of the Walter Felt site was initially rejected by most northern Great Plains archaeologists (Scribe 1997:59) and was only accepted after more pottery from Besant sites was uncovered (Reeves 1983:9).

Besant-Sonota pottery vessels are conoidal in shape and are marked with cord-roughened or cord-marked exteriors and scarce decoration, with occasional use of a single row of punctates near the rim (Johnson 1977; Walde et al. 1995:18). A second, albeit rarer form of pottery, was identified by Neuman (1975:93) and Scribe (1997). It exhibited smooth exteriors with placements of punctates or fingernail impressions. This led Walde et al. (1995) to regard Besant-Sonota pottery as a northern Great Plains expression of contemporaneous Eastern Woodland phases, analogous to the Valley phase of Nebraska and Iowa. Although Valley has often been cited as an area of influence for Besant-Sonota pottery, some have opted to view Illinois travellers from Hopewell centres (Johnson 1977:38; Neuman 1975:93) or intermarriage of northern Great Plains cultures and midwestern Woodland groups (Scribe 1997:57) as other sources of influence. Scribe (1997) listed several pottery-producing cultures that were contemporaneous such as Malmo, Loseke, Keith, Ash Hollow, Laurel, and even Avonlea as other possibilities. Despite the rare occurrence of pottery within archaeological sites of this time, and the difficulties identifying a source influence, a few well-preserved specimens have been recovered from South Dakota, North Dakota, Montana, Wyoming, and Saskatchewan (Figure 2.15).

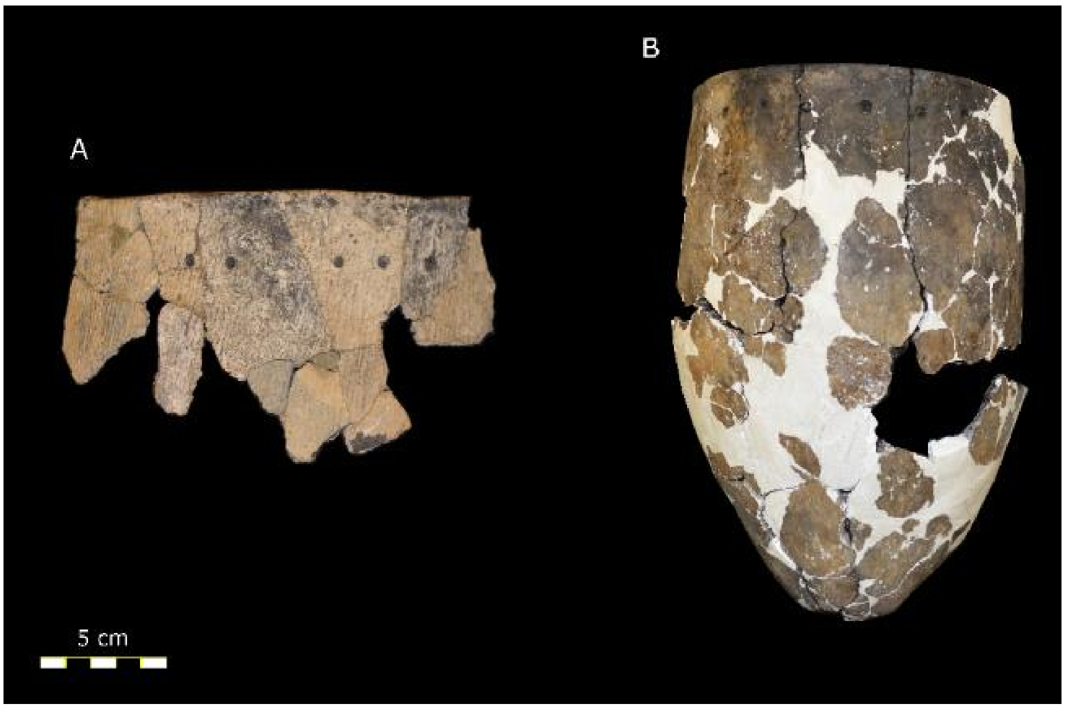


Figure 2.15 Reconstructed Besant-Sonota vessels: A) cord-marked vessel from the Butler-Rissler site, Wyoming, and B) smooth conical vessel from the Arpan Mound site, South Dakota. Photographed by the author courtesy of the Smithsonian National Museum of Natural History and the University of Wyoming Archaeological Repository (UWAR).

Besant-Sonota pottery is not limited to cord-roughened or marked exteriors. An excellent example of non-cord marked pottery came from the Arpan Mound site in South Dakota where a complete vessel was recovered in association with human remains (Neuman 1975). Classified as ‘Arpan Punctate' by Neuman (1975:62), this vessel has a single row of punctates and a smooth exterior (see Figure 2.15b). Further variations in decorative style have been observed from samples obtained at the Stelzer site in South Dakota with the use of cord-wrapped tools, bosses, incised lines, and fabric impressions. As seen within the Valley phase, Tiffany (1978) interpreted the variations in decoration styles as evidence of kin-related groups.

Before the use of pottery, stone boiling and open-pit roasting were the two main methods of cooking. Pottery represented a new form of cooking, for which knowledge of the manufacturing and use of this culinary instrument was also necessary. Likewise, the creation of burial mounds would require the acquisition of new knowledge ranging from construction methods to cosmological viewpoints. The consequences of these required changes have gone largely unexplored in over 50 years of archaeological research within the northern Great Plains.

The Besant and Sonota phases represent the start of trends that would eventually become woven into the fabric of northern Great Plains identity. Each archaeological phase that followed Besant and Sonota included pottery in its toolkit. The Avonlea phase overlaps with and eventually succeeds Besant and Sonota, with evidence of multiple forms of pottery in consistently greater frequencies (Meyer and Walde 2009; Walde 2006b).

Owing to the lengthy time frame for Besant, Sonota, and Avonlea research, the relative scarcity of radiocarbon dates for earlier episodes of research, and more recent advances in AMS dating over conventional methods, it is difficult to assess the timing of these two traditions. As a recent example, acquisition of new AMS radiocarbon dates from the Mulbach site by Graham (2014:33) resulted in a refinement of the timing of this site by almost 400 years. A series of AMS dates (UCIAMS 89684 to 89687) produced ages ranging between 1688 and 1410 cal BP, which is much earlier than Gruhn's (1969) original date of 1522 to 918 cal BP, suggestive of a greater degree of overlap with Avonlea and early Old Women's Phase time frames. With greater attention to chronological "hygiene" as well as the collection of additional AMS radiocarbon dates for late Besant-Sonota and Avonlea phase sites, our understanding of the temporal relationships among these two phases will become clearer.

There is, however, a distinct separation between Besant-Sonota and Avonlea material culture. Avonlea pottery is represented in this tradition by net-impressed (also called Rock Lake), parallel grooved (also called Truman), Ethridge cord-roughened, and rarer plain, undecorated designs (Meyer and Walde 2009). David Meyer and Dale Walde, in 2009, proposed that archaeologists recognize the geographic distribution of Avonlea wares as Lebret, Sjovold, Upper Kill, and Morkin (Figure 2.16). Other technologies that may have Eastern Woodland origins, such as the bow and arrow, also entered regular use during the Avonlea phase. After the Avonlea phase, pottery, placement of the deceased in mound structures, and bow and arrow technology continued until the arrival of European cultures. Late Woodland phases such as Mortlach, Black Duck and Vickers Focus, Devils Lake Sourisford, and Old Women's all continue to show evidence of pottery use and/or burial mound construction on the northern Great Plains (Hanna 1976; Nicholson 1994; Peck 2011; Syms 1979).

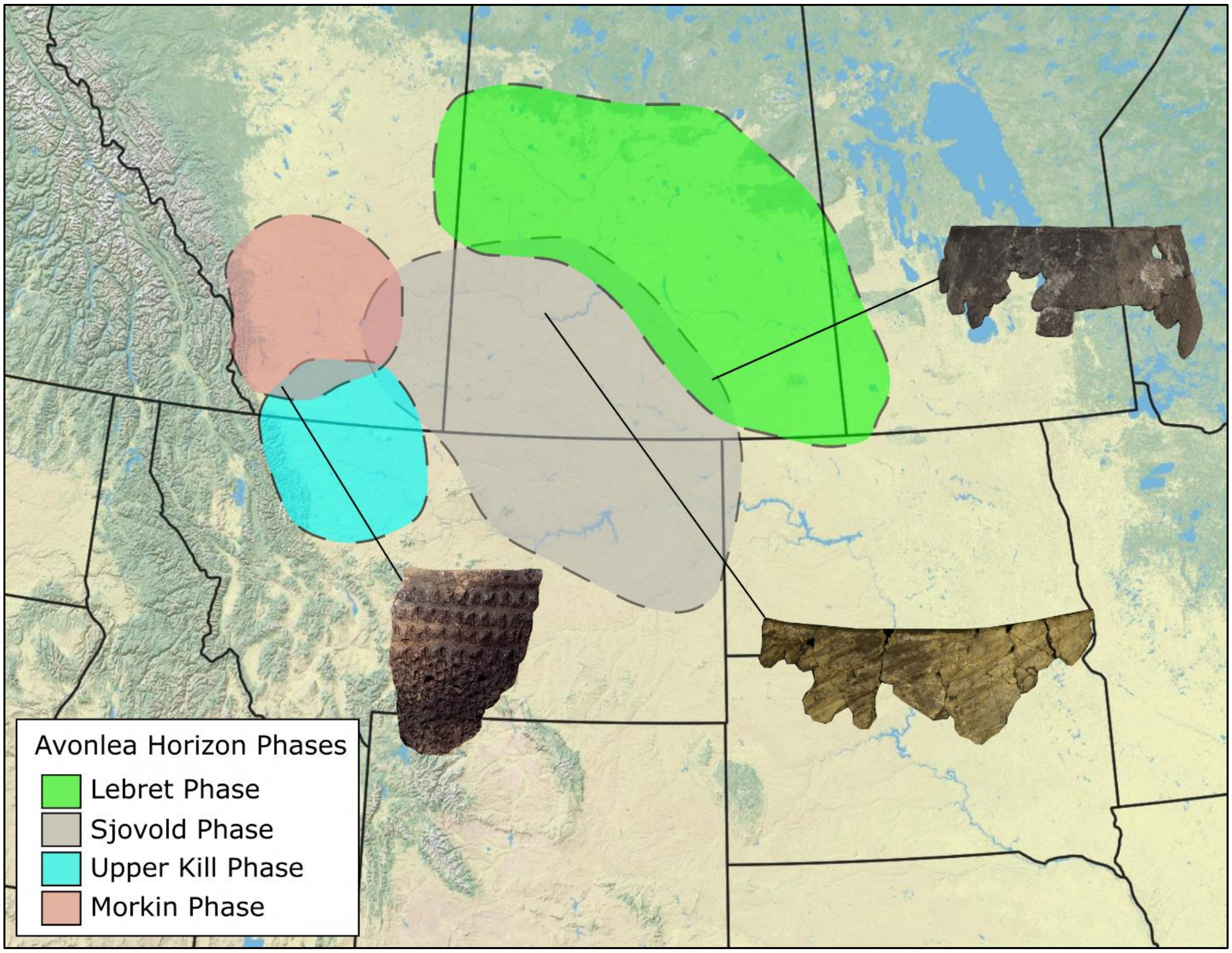


Figure 2.16 Geographic distribution of the Avonlea Horizon Phases represented by pottery examples from the Mann site (Lebret Phase), Sjovold site (Sjovold Phase), and the Head-Smashed-In site (Morkin Phase) (adapted from Meyer and Walde 2009:65). Examples of plain/undecorated and Ethridge cord roughened (Meyer and Walde 2009) are not pictured. Pottery images are courtesy of the Royal Alberta Museum and the Royal Saskatchewan Museum.

Chapter 3: Use of Pottery by Mobile Hunter Gatherers

Although pottery is often used as an indicator of sedentary lifestyles, pottery was an invention of mobile hunter-gatherers (Chi and Hung 2012). The oldest known pottery in the world is from southern China, Japan, and the Amur Basin of Russia (Shoda et al. 2019). In the Hunan Province of China, pottery occurs at roughly 18,000 BP, approximately 11,000 years prior to rice agriculture, and was tied to the handling of small packages of food. In this region, the earliest pottery vessels were made, and used, by peoples inhabiting woodland environments. These groups practiced low-level food production of local foods, including wild rice. Aquatic resources are also hypothesized for these early Chinese wares, as the sites bearing pottery were created during the late Pleistocene (Kawahata et al. 2017; Meyer et al. 2017). Shoda and colleagues (2019) believed that the rendering and storing of fish and sea mammal oils were completed in response to the depleted terrestrial game during this period. Alternatively, extended cold weather conditions may have encouraged hunter-gathering communities to gather more frequently, share ideas, and discover ways to store fish and oils for consumption. Hence, pottery may have been born from this gathering.

In the Amur Basin, pottery dates between 16,200 and 10,200 cal BP. In their findings, Shoda et al. (2019) found that these early pottery makers used these vessels for different tasks when in different areas. Aquatic resources were prepared within pottery vessels of the Osipovka culture on the Lower Amur while products from terrestrial ruminants were prepared in the Middle Amur. Despite the connection between pottery making and aquatic resource intensification, this did not lead Shoda et al. (2019) to hypothesize a growing trend of sedentism by these people. Rather, pottery from these sites is of limited quantity, which is interpreted by

Shoda and colleagues (2019) as signs pottery was restricted in everyday use and may have been reserved for special occasions.

Once pottery use is practiced by peoples in a new area, rarely is it freely adopted and diffused across entire regions. These phases of rapid development are followed by 'stop lines' where pottery is not adopted, but only to reappear later in following traditions (Admiraal et al. 2020). Examples of such abandonment of pottery have been reported within areas of Hokkaido Island (Robson et al. 2019), Lake Baikal (Piezonka et al. 2020), and northeast Asia (Fitzhugh 2016). Concerning early vessels of the northern Great Plains, there does appear to be a restriction of adoption marked by a low number of pottery vessels within sites. Pottery was not universally accepted by northern Great Plains peoples during this period; yet, it *has* been found within sites of importance.

In North America, the first pottery vessels appeared in the southeastern Woodlands of the Carolinas during the Late Archaic period. These appear in the archaeological record as low-fired open bowls or jar forms that were tempered with organic matter (Sassaman 1993, 1995). The use of these vessels is believed by Sassaman (1993, 1995) to also be connected to aquatic resources, namely shellfish, and driven by the need to replace soapstone vessels that were acquired through long-distance trade. By examining soot on the exterior of these earlier wares, Reid (1990) and Sassaman (1993, 1995) hypothesized that these markings were directly caused by the indirect cooking of foods. Reid (1990) and Sassaman (1993, 1995) both suggested that these early wares were used as containers for stone boiling activities whereby foods were cooked by adding heated stones to water held within the pot.

Based on the earliest forms of pottery within each of the regions discussed so far, understanding the adoption and later spread of pottery is a complicated process. A shared viewpoint by many archaeologists is that this process was driven by many factors such as diet, economy, climate, ritual activities, and other social aspects of past culture (Brown 1989; Jordan and Zvelebil 2009; Reid 1984; Rice 1999).

From a northern Great Plains perspective, theories regarding the spread of pottery onto the northern Great Plains involved the direct trade of vessels or the exchange of ideas regarding pottery making. While identifying a source region for pottery provides some answers, this does not explain why pottery was adopted in some northern Great Plains areas yet rejected in others. For the remainder of this chapter, theories regarding pottery adoption will be discussed and additional theories will be presented based on the suitability of pottery within a northern Great Plains setting.

3.1. Theories on Pottery Adoption

In North America, theories of pottery adoption have been wide-ranging. For example, Skibo and Schiffer (2008) hypothesized three scenarios for the adoption of pottery in North America: 1) complex cereal grains cultivated by sedentary cultures required a tool to process and transform cereals into digestible resources; 2) sedentary groups that were mobile during large portions of a season used indirect heating to process complex plant foods such as seeds and nuts in addition to rendering animal products; and 3) early groups that created and used pottery vessels may have first done this to fulfill a spiritual or symbolic need. The third scenario offered by Skibo and Schiffer (2008) could be used to address pottery adoption by Besant-Sonota era peoples as most early wares were uncovered from burial contexts. Burial contexts are only part of the story, as pottery is also noted in other sites, including campsites and kill sites.

Other models take an economic approach to the adoption of pottery. Brown's (1989) theoretical model outlined that hunter-gatherer societies held a pre-existing knowledge of pottery before adopting this technology, but only committed to pottery use when individuals had no other alternative. Brown places emphasis in this model on alternatives to pottery by outlining that within these societies, pottery was not the only container used for heating and boiling foods (Brown 1989:208). Pottery holds some advantages over other containers as these vessels are portable, watertight, and offer a fireproof method of preparing foods. The everyday use of pottery does not occur until these advantages are identified and needed by the hunter-gatherer society considering the adoption of pottery (Brown 1989). Furthermore, Brown (1989) suggested that these groups were likely semi-sedentary, and their baskets and skins were no longer suitable for growing family sizes and food requirements. Brown (1989) also theorized that pottery would have provided the means to present or display foods during important events. Rather than cooking foods within permanent boiling pits, foods could be displayed across a campsite and held within vessels decorated by the culture hosting the meal. This line of thinking also fits with the Besant-Sonota era as stone boiling was commonplace during this period.

Others, such as Hayden (1993, 1995), placed a greater emphasis on food production. According to Hayden (1993, 1995), the acceptance of pottery within a hunter-gatherer society is the result of economic competition among neighboring communities. As people became more sedentary and sharing of foods was less imperative for survival, Hayden (1993, 1995) believed that competition and inequality among members of a society would increase. In this case, hunter-gather societies that became less mobile began to use pottery as a prestige food container made by individuals of their society to compete with neighbors. The degree of this competition is not stated by Hayden (1993, 1995), but it is worth mentioning that competition does not necessarily equate to hostility as friendly competition has been noted as a useful way to build alliances while also solidifying group independence. The idea that pottery would provide such a means for competition has some merit. The malleability of clays provided potters with a canvas to reinforce the social norms of their society. This community design—when placed at the forefront of everyday meals and those of significance—would have provided a means to showcase prestige to non-members or outsiders.

Brown (1989), Hayden (1993, 1995), and Skibo and Schiffer (2008) have all provided theories of pottery adoption that merit consideration when hypothesizing the adoption of pottery by Besant-Sonota era peoples. What these theories did not cover, however, was the direct movement of vessels between pottery producing and non-pottery producing cultures.

One of the more prominently used scenarios for the exchange of pottery between cultures involves marriage and the formation of new kin relationships. Hanna (1984) analyzed exogamous and endogamous traits of foraging societies and compared this to Late Woodland pottery decoration styles used within West-Central Manitoba. Analysis of Late Woodland pottery and non-local lithic materials within the Aschkibokahn (FbMb-1) site led Hanna (1984) to hypothesize that non-local lithic materials and the presence of northern Great Plains characteristics on boreal forest pottery represented exogamous marriages among both regions. Presuming that women were responsible for pottery making, Hanna (1984) theorized that the outside traits noted on Duck Bay pottery were likely produced by women, arriving in a new community via marriage.

A similar study was conducted by Paquin (1995) on the Late Woodland Kisis complex within the Churchill River Basin of Saskatchewan. Analysis of marriage isolates and partnerships (Figure 3.1) led Paquin (1995) to hypothesize that the geographically constricted appearance of Kisis pottery characteristics represented an endogamous marriage isolate within a defined social unit. Further evidence is derived from the lack of Kisis characteristics within adjacent Old Women's or Mortlach pottery producing cultures on the northern Great Plains (Paquin 1995). Paquin (1995) noted that proto-historic Cree family groups were known to travel over 300 km for seasonal aggregations with other cultures (Wertman 1976). Exogamous marriage with unrelated marriage isolates within these groups contributed to 20 percent of total marriages (Paquin 1995).

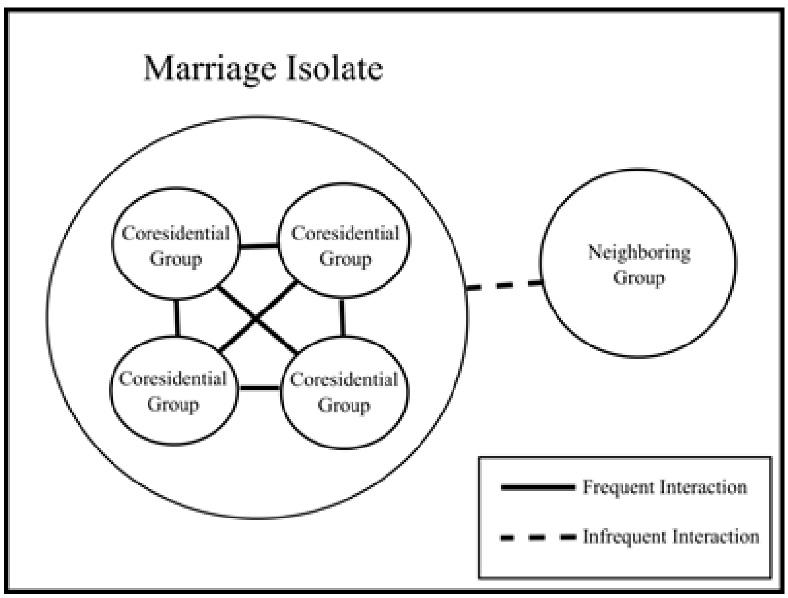


Figure 3.1 Representation of marriage patterns among the Kisis complex (from Paquin 1995:108).

Completion of marriage between communities was also mentioned to have occurred during times of seasonal gatherings (Paquin 1995). Some gatherings coincided with seasonal changes, such as the meeting of people during winter months (Nicholson et al. 2003), while others were completed for important events (Boyd et al. 2019). Marriage presents another viewpoint for the adoption of pottery by Besant-Sonota era peoples. These first northern Great Plains vessels may represent individuals from pottery-producing cultures living within new communities after marriage. Gatherings have also been interpreted based on the data collected from Besant and Sonota sites. For instance, the Stelzer campsite was an expansive archaeological site but used within a narrow window of time (Graham 2014), seemingly suggesting a few large gatherings of peoples.

Another scenario for the arrival of pottery in a new community is trade. While the exact social explanation for the trade may be impossible to identify, the exchange is often marked by the presence or absence of items common to one area, but in a new location (e.g., Renfrew 1972). Although evidence of trade is difficult to determine, it is conceivable that pottery vessels were traded between cultures within the northern Great Plains. The Besant-Sonota era occurred precisely when the Hopewell Interaction Sphere was driving the movement of items across vast distances (e.g., DeBoer 2004). Besant-Sonota sites have been reported to contain pottery reminiscent of Valley, Rowe, and Havana Hopewell types, but these similarities have been described as "influences." It is possible that pottery was another 'exotic' item that was delivered to the northern Great Plains during this time.

3.2. Perceived Advantages and Disadvantages of Pottery Use

Exploring the advantages or disadvantages (or benefits and costs) of pottery may provide additional insight into why this technology was adopted, or rejected, by past peoples. By outlining the potential benefits and costs involved with pottery use, we may be able to provide subtle insight into the experiences of people living within the Besant-Sonota era.

3.2.A. Advantages of Pottery Use

Arnold (1985) identified three key advantages of pottery use: 1) it allowed for an expansion of available foods that can be included in the diet; 2) it increased the overall nutritional value of cooked foods versus other methods (e.g., stone boiling); and 3) it required less time and fuel to cook foods. In agreement with Arnold (1985), Rice (1999) added that pottery was useful to hunter-gatherer groups occupying coastal areas for its ability to quickly cook shellfish in large quantities. Nutritional benefits have also been noted in the preparation of nuts or meat within vessels (Harry and Frink 2009; Reid 1989, 1990).

Another nutritional benefit may have been that the use of pottery to boil foods increased community health (Jordan and Zvelebil 2009). Boiling of foods enables foragers to detoxify plants that would otherwise be unpalatable, or poisonous (Barnett and Hoopes 1995; Jordan and Zvelebil 2009; Meiklejohn and Zvelebil 1991). In addition, Jordan and Zvelebil (2009) suggested that the retained nutrients held within pottery vessels also increased overall female fertility and improved child survival rates. Boiling also improves the overall health of both children and elders within a population by softening foods so they can be more easily consumed. This is especially beneficial for young children as the softening of foods may result in advanced weaning by foraging communities. This may have increased birthing rates and has been seen by Shennan (2002) as a contributing factor that led to population growth within foraging societies.

Another practical benefit of pottery is the ability to slowly simmer foods, potentially freeing up the time of individuals involved in cooking duties to participate in other tasks (Jordan and Zvelebil 2009). This would be advantageous to foraging communities as additional time could be allocated to alternative site activities, processing activities, artistic endeavors, or investment in child nutrition (Jordan and Zvelebil 2009; Pavlu 1996; Skibo 1992).

A final advantage of pottery production was an increase in overall food security (Jordan and Zvelebil 2009; Skibo 1992). Unlike traditional bags and baskets, pottery provided a means to protect stored food from pests (Gregg 1985:117). This would be important during leaner months when food resources were less readily available (Jordan and Zvelebil 2009; Pavlu 1996). Another benefit of this storage is the ability to seal and separate supplies, resulting in an increased potential to store and transport foods (Núñez 1990). Moreover, the advantages of storage may have profound implications for social structure, territorial organization, and economy (Bird-David 1990, 1992; Ingold et al. 1988; Rowley-Conwy and Zvelebil 1989).

So far in this chapter, we have seen that the use of pottery may have enabled an increase in overall diet breadth, sterilization of foods, and provided additional time to be allocated to other activities, or storage of food items, all of which may have promoted overall increases in group health and population sizes. While these factors may have affected pottery adoption in some regions, the transition from stone-boiling to pottery on the northern Great Plains for the Besant-Sonota and Avonlea eras was not widespread. Perhaps the rationale for the persistence of stone boiling can be found by exploring the disadvantages of pottery use.

3.2.B. Disadvantages of Pottery Use

Despite the numerous benefits of pottery production, Rice (1999) argues that many of these benefits were unnoticeable until pottery was utilized daily. If pottery vessels were only occasionally used to prepare food, nutritional benefits would have had little effect on overall group health (Rice 1999). The use of pottery on a routine basis would have required groups to prepare numerous vessels, as pottery was prone to damage and was more challenging to repair compared to basketry or skin bags.

Further disadvantages of pottery use can be found when analyzing group mobility. Compared to baskets and bags, pottery is heavy, fragile, and cumbersome (Jordan and Zvelebil 2009; Rice 1999). For cultures practicing a mobile lifestyle, pottery could have been physically taxing and prone to breakage during transportation. Considering this, Eerkens et al. (2002) found that mobile groups tended to produce pottery less frequently than groups tethered to certain areas. One must also consider the possibility of caching pottery at strategic locations or fashioning these wares during strategic periods of the year (Jordan and Zvelebil 2009; Shoda et al. 2019). Evidence of such practices has been identified at the Milk Creek Cache (24ME45) site in Montana where several complete Late Woodland vessels were recovered in a stone cache structure (Keyser 1979).

It is important to recognize that the relationship between mobility and pottery production is more complex than Eerkens et al. (2002) suggested. For instance, if environmental conditions (e.g., suitable clays and abundant fuel) are adequate, numerous vessels can be produced within a week (Jordan and Zvelebil 2009). Archaeological evidence on the northern Great Plains indicates that Besant-Sonota era groups remained at strategic locations for extended periods before moving to more optimal locations. Analyses of the Muddy Creek site in Wyoming resulted in the identification of over 60 tipi rings in association with a bison drive structure, potentially indicating intensive use of this location rather than short-term camping (Reher 1989).

Hunter-gatherers of the northern Great Plains were also well versed in the transport of large amounts of materials as hides used for tipis, clothing, and other belongings were carried with communities throughout their seasonal round (Reilly 2015). Adding one or several pottery vessels to their belongings may not have hindered their mobile lifestyle. Based on ethnographic data, hunter-gatherers brought pottery vessels with them while moving between campsites (Arnold 1985; McGee 1971; Sapir 1923).

Climate may have also been a factor. Cold and damp climates limited the time available for hunter-gatherers to produce pottery, which may have also competed with other seasonal activities (Harry and Frink 2009). Inevitably, the presence of suitable clays, the fuel necessary to fire vessels, and the time required to fashion the wares weighed heavily on decisions to adopt pottery (Pavlu 1996; Rice 1999; Sinopoli 1991).

Within the northern Great Plains, pottery making would be limited to the spring, summer, and fall seasons. In cases where pottery-making is limited to the summer and fall—a time of year when many food-collecting activities are completed—some question if sufficient time was available to make pottery (Arnold 1985). However, ethnographic records mentioned in Chapter 2 suggested that pottery production would not have hindered foraging activities. For instance, multiple vessels can be prepared at once and suitable clays may be found in river systems containing plant food resources (Wilson 1910). Therefore, the production of pottery vessels would not have prevented an entire community from collecting edible plants and other resources.

Another potential limiting factor for pottery production is the availability of fuel to fire vessels. While this may have made firing vessels difficult in some areas, it is crucial to consider that the open grasslands of the northern Great Plains were bordered by aspen parkland and foothills environments, were crossed by major river valleys, and contained prominent uplands (such as the Cypress Hills), to which people could travel. While excavating the Stelzer site, Neuman (1975) reported dense Missouri River deciduous tree stands with cottonwood (*Populus* sect. *Aigeiros*), ash (*Fraxinus* sp.), willow (*Salix* sp.), elm (*Ulmus americana*), boxelder (*Acer* *negundo*), hackberry (*Celtis occidentalis*), and burr oak (*Quercus macrocarpa*) as well as shrubs like chokecherry (*Prunus virginiana*), saskatoon berry (*Amelanchier alnifolia*), buffalo berry (*Shepherdia canadensis*), gooseberry (*Ribes uva-crispa*), wild currants (*Ribes americanum*), and wild rose (*Rosa acicularis*). Consequently, the lack of fuel resources cannot be used as an explanation as to why northern Great Plains hunter-gatherers did not universally adopt pottery.

Many of the disadvantages of pottery production discussed thus far have focused on economic considerations and the environment. But what about the social consequences that may have restricted the adoption of pottery? Perhaps greater clarity can be obtained from exploring societal changes that have involved pottery use.

The introduction of pottery into Besant-Sonota era communities provided an alternative form of cooking previously unseen on the northern Great Plains. The use of pottery, albeit occasional, would require the addition of new knowledge and practices by Besant-Sonota era peoples. This 'new' knowledge would extend to pottery production and cooking practices. The production of pottery involved the manipulation of clay (Hanna 1984; Jacob and Zvelebil 2009), the inclusion of temper to increase vessel strength (Feathers 2006), and the creation of large fires to sufficiently fire wares (Kramer 1996). Jordan and Zvelebil (2009) indicated that the firing of vessels may have provided a form of public spectacle in which community members would have been invited to participate in non-religious or religious activities to increase the success of pottery making. Analysis of pottery production led Childe (1939) to suggest that firing was the riskiest stage of pottery production and this may have led to the creation of additional ceremonial practices to bring success to pottery production. Jordan and Zvelebil (2009) argue that this associated risk may lead to the exclusion of specific individuals or genders in such firing activities.

Thus, not only would the production of this 'new' technology bring about a change in practical knowledge, but spiritual knowledge could also be altered to accommodate pottery production rituals. As pottery production became more integral to the identity of past groups, this likely led to a replacement of previous knowledge held by individuals regarding alternative cooking techniques and potentially a shift in social status. Frink (2009) indicated that the replacement of pottery with iron wares in Alaska resulted in shifting power away from individuals proficient in producing pottery wares. This is an important consideration for this study, as pottery appears for the first time in some Besant and Sonota sites but does not appear to have been thoroughly adopted by the people responsible for these sites.

3.3. Adoption of Pottery During the Besant-Sonota Era

This chapter has presented several theoretical perspectives on why hunter-gatherers created and adopted pottery. From approaches involving food production (Brown 1989; Hayden 1993; Rice 1999) to those investigating the role of marriages between cultures (Hanna 1984), understanding pottery adoption is a complex undertaking involving consideration of economic, environmental, and cross-cultural interaction factors (Skibo and Schiffer 2008). As we have seen, pottery is not abundant in Besant-Sonota sites, yet it did occur in sites that can readily be construed as having unusually high cultural significance. In evaluating this unusual pattern of initial northern Great Plains adoption, it is important to be aware of alternative theoretical approaches that can complement the detailed pottery analysis and paleodietary evidence developed in the following chapters.

Chapter 4: Methods

4.1. Pottery and Archaeological Inquiry

Methods for examining pottery from the northern Great Plains have been shared, adapted, and further refined by individuals such as Kehoe (1959), Byrne (1973), Malainey (1991), Walde (2003), and Young (2006). Today, pottery analyses represent a cornerstone of archaeological research that has enabled researchers to answer questions about ancient societies from across the globe.

A goal of this research project was to collect information from previously discovered sites to interpret how the first northern Great Plains pottery vessels were used. The vessel shape, decoration and surface finish, and manufacturing methods were recorded for each specimen during the examination of pottery samples from several federal and provincial institutions across Canada and the United States. Carbonized food residue samples, if present, were removed from each vessel to provide insight into the use of these cooking instruments following documentation of vessel appearance. Examination of each specimen involved first a visual analysis of design and evidence of use, which was followed by a more detailed analysis of carbonized residues to determine food contents.

4.2. Vessel Size, Shape, and Surface Expressions

As outlined by Rice (1987:215), the overall shape of a vessel has some relation to its intended function. Archaeologists often divide vessels into separate portions known as the lip, rim, neck, shoulder, body, and base (Figure 4.1). During the Besant-Sonota era, all vessels were conoidal in shape, with the widest point occurring just beneath the rim. Vessels that were used later within the northern Great Plains, exhibited a more globular appearance. Some, such as Rye (1981:27), hypothesized that this change in overall shape enabled clay vessels to withstand greater thermal stress during firing and cooking activities.

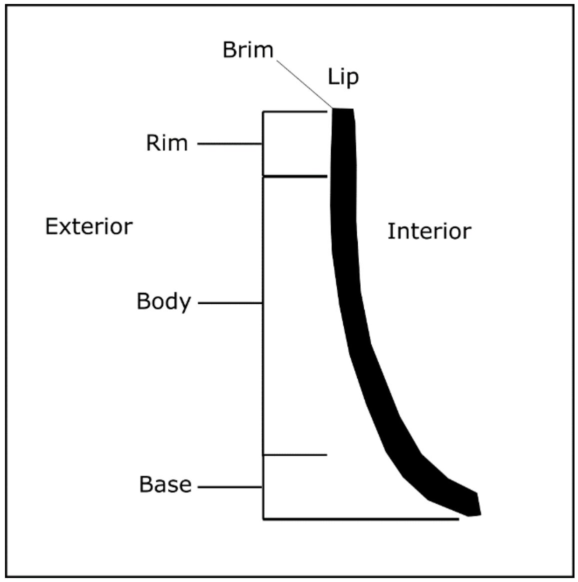


Figure 4.1 Pottery anatomy and terminology for conoidal shaped vessels. Profile was digitally traced using photographs of the Arpan Mound vessel, SD.

When examining the physical appearance of pottery, different areas are more useful when building taxonomic guides. This is particularly true when considering the lip, which is part of the rim and is the uppermost surface of a pottery vessel (see Figure 4.1). While differences in lip shapes can be used to distinguish some vessels from others, it is important to note that these can also be inconsistent within the same vessel (MacDonald 2008:41). This variability inevitably led Walde (2003:12) to avoid the use of lip shape when examining Mortlach pottery from Saskatchewan. As a detailed taxonomic survey of Besant-Sonota pottery has been somewhat limited, the lip profile (Figure 4.2) was recorded by following the methodology created by Byrne (1973), Paquin (1995:35), and Young (2006:35).

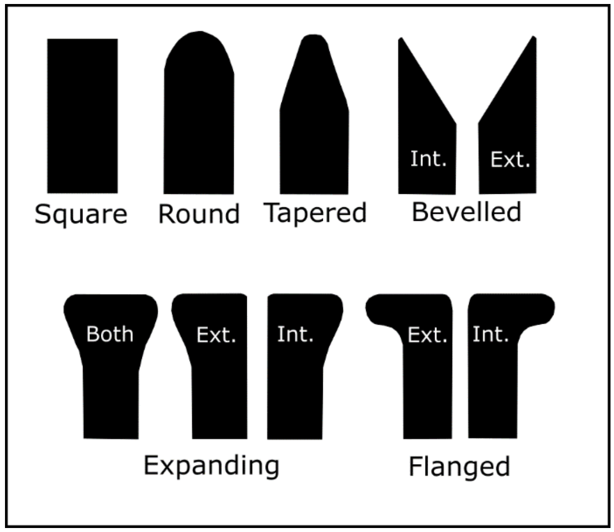


Figure 4.2 Rim shapes common to pottery vessels of the northern Great Plains (adapted from Young 2006:35).

The rim, which forms the orifice of the pottery vessel, is also useful when identifying and comparing pottery specimens. As the rim holds most of the decoration in many pre-contact pottery traditions, this portion of the vessel has received much attention from archaeologists (Byrne 1973; Malainey 1991:39-42; Paquin 1995:37-38; Walde 2003:10-11). Besant-Sonota vessels have rims that are generally straight with an occasional slight curvature (Scribe 1997). The overall shape of Besant-Sonota pottery was recorded using techniques developed by Byrne (1973); Malainey (1991:39-42), Paquin (1995:37-38), and Walde (2003:10-11). In some cases, reconstruction of rim fragments enables archaeologists to determine the percentage of the rim present using diameter-measurement templates based on concentric circular designs (Sutton and Arkush 2006). When reconstructed rims of sufficient size (more than 15 cm in width) were observed, these rim sections were placed within the standard diameter-measurement templates to determine the percentage of the rim present.

The remaining areas of conoidal pottery vessels, the body, and the base, are the most limited in terms of what information can be recorded. The basal area of a vessel is often poorly preserved at archaeological sites due to internal and external abrasions on the surfaces (MacDonald 2008). For the body and basal portions, the thickness of each specimen was measured to the nearest 0.1 mm with digital calipers.

4.2.A. Decoration and Surface Finish

Decorations applied to pottery vessels have provided archaeologists with a means to decipher information about culture from societies across the world. Within the northern Great Plains, choices of specific decoration elements and their arrangement on past cooking wares have been the centre of much debate regarding how, and if, these decorations expressed social identity (Sackett 1977,1985; Wiessner 1983,1985). As a detailed comparison of Besant-Sonota pottery from multiple regions of this study area has not been completed, decorations were identified and recorded using terminology commonly applied to northern Great Plains pottery vessels (see Byrne 1973, Kehoe 1959, Meyer 1988, Walde and Meyer 2003, Wedel 1951). Such terminology included decorations that are frequent for northern Great Plains pottery vessels including cord-wrapped tool (CWT) impressions, punctates, incised lines, dentate, and stamp-and-drag impressions (Figure 4.3).

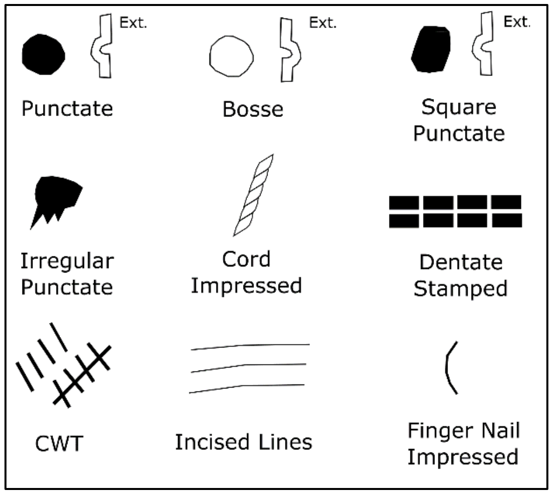


Figure 4.3 Pottery decoration techniques common to the Besant-Sonota era and the northern Great Plains. Decorations were traced from Besant-Sonota pottery photographs. (CWT = cord-wrapped tool).

Design elements in a repetitive pattern or in a specific arrangement were also identified in this study. All design elements found within patterns were counted and measured in terms of their placement on the vessel and their relation to other design features. Such a practice was completed by Malainey (1991:50-53) during her examination of Mortlach pottery from southern Saskatchewan and served as a useful template for this study.

It is important to consider the exterior and interior surface treatment applied to clay wares by past peoples, in addition to the examination of decorative elements. Surface treatment is an aspect of ancient pottery that may have served a functional need for past peoples, and a stylistic choice used as a means of social expression. This functional yet stylistic explanation was observed by Syms (1977:62) in the examination of Late Woodland pottery vessels from southern Manitoba. Syms (1977) hypothesized that surface treatment may have provided a practical use such as gripping texture or compacting vessel clays to increase thermal shock resistance. Continual use of such a treatment eventually led to a style of pottery making that was distinct.

Other researchers such as Herron (1986) and Rice (1987:232) found that surfaces with a defined texture improved cooking properties by allowing more surface area to be exposed to and therefore absorb heat. Meyer and Walde (2009) also used surface treatment to differentiate between Avonlea forms of pottery which occurred in two separate 'zones' across the northern Great Plains. Net-impressed surface expressions were noted to be more prominent in Manitoba and parts of eastern Saskatchewan while parallel grooved surface expressions occurred more frequently in central Saskatchewan (Meyer and Walde 2009). Although pottery within the Besant-Sonota era has primarily been described as cord roughened, it is important to identify if other surface treatment methods were used during this time on the northern Great Plains (Figure 4.4). Cord-roughened pottery typically bears a vertical or slightly oblique pattern of cord impressions on the exterior of pottery vessels that were either applied by a paddle or a cord bag (Scribe 1997).

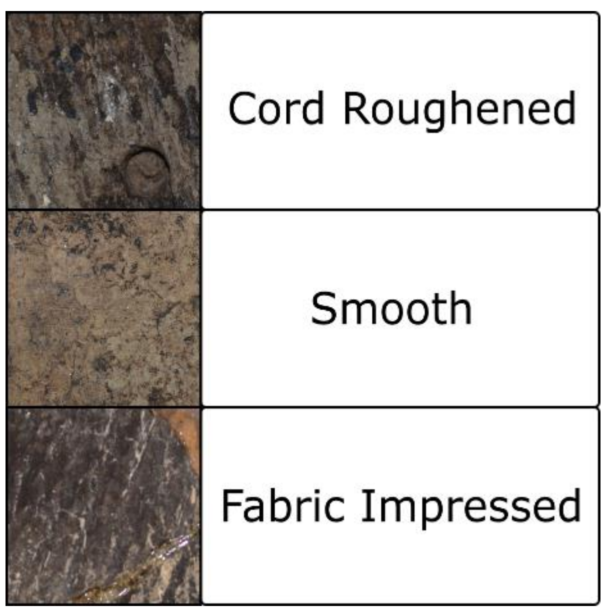


Figure 4.4 Common exterior surface expressions observed on pottery from the Besant-Sonota era.

Other common surface treatments include smoothed, textile impressed, and brushed. Smoothed pottery vessels are known for this period in areas outside of the northern Great Plains such as Minnesota and Iowa (Neuman 1975; Tiffany 1978). Vessels with this exterior surface treatment typically contain some signs of smoothing in the form of linear striations caused by imperfections on the surface of bone, shell, or wood smoothing tools. Textile impressed vessels are named for an observable woven material impression found on the exterior surface of the vessel. Surface treatment was documented using the above terminology and photography for this research.

4.2.B. Manufacturing Techniques

As summarized in the archaeological background chapter, several manufacturing techniques have been proposed for Besant-Sonota pottery including the patch method, ground mold method, paddle and anvil, or the use of a woven bag. The patch method was identified by examining the profile and the break patterns of pottery fragments. If patching was completed by ancient potters, the presence of visible layers might indicate the practice of adding layers of clays in intervals. Inconsistencies in the thickness of the vessels were recorded as variations that may represent paddle and anvil techniques where clays were pressed between a paddle and anvil to achieve the desired shape.

Another attribute of pottery manufacturing that was recorded in this study was the type and size of the temper added to the clays during manufacturing. On the northern Great Plains, potters mixed materials such as FCR, crushed fragments of pottery, shells, and plant fibers into clays to aid in thermal shock resistance as clays were fired. Within some archaeological traditions, the type of temper used in the creation of ancient vessels can be used to identify cultural affiliations between archaeological sites (e.g., Isendoorn et al. 2008). The size and type of temper were recorded for each pottery specimen within this study.

4.3. Use-Alteration Analysis

The identification of vessel use is emerging as a more common form of pottery research (see Hally 1983; Skibo 1992; Vieugue 2014, 2015). One technique applied by many is a visual survey of pottery vessels to interpret use (Duddleson 2008; Helton-Croll 2010; Skibo 1992). This visual inspection approach has shown success in North America through research by Skibo (1992), Helton-Croll (2010), and Duddleson (2008). For example, an analysis of 3,128 body sherds, 256 rim sherds, and five restored vessels from a Plains Woodland site in Nebraska by Duddleson (2008) established that daily use and handling of pottery altered its overall appearance. Analyzing pottery vessels for these signs of alteration could therefore provide a visual record of past activities.

For this study, use-alteration analyses began with the inspection of the exterior and interior surfaces of pottery for carbonized residue, sooting, or oxidization (Duddleson 2008). During the production and use of pottery, discolorations appear on the surfaces, and in some cases, cooked items may carbonize and adhere to the vessel. Ethnographic and archaeological records have shown that pottery vessels were used in different ways depending on the role of the item (Figure 4.5), the foods that were being produced, and the shape of the vessel (Skibo 1992). Therefore, exterior and interior discolorations were recorded on all pottery specimens examined in this study to decipher how these vessels were placed alongside heat sources to prepare food.

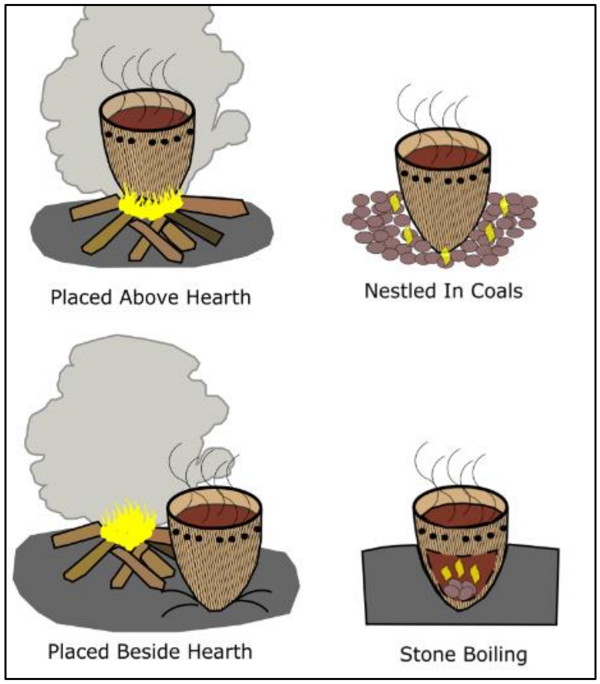


Figure 4.5 Depiction of potential cooking arrangements for Besant-Sonota pottery vessels.

The identification of repairs, abrasions, polishing, chipping, or incisions all can be used to infer how a pottery vessel was used (Duddleson 2008). Variations in physical alterations appear depending on movement or use during daily or seasonal activity. For instance, Duddleson (2008) inferred that groups practicing frequent residential mobility left behind pottery wares exhibiting increased amounts of exterior surface damage caused by the movement and use of these vessels. Pottery vessels used solely for feasting events, or otherwise selectively used, were posited to exhibit fewer signs of physical alterations. As pottery from the Besant-Sonota era includes examples found in what appear to be both everyday and ritual contexts, identification of such traits provides valuable evidence concerning the uses of these first northern Great Plains vessels. It is important to also consider the possibility that alterations occurred during a different event at another location.

For this research, visual inspection of samples was limited to larger sherds measuring from 5 to 10 cm in height and width, rim sections, and reconstructed vessels. Each pottery sample was examined for visual traits identified by Skibo (1992) and Duddleson (2008). These traits included the location of residues, decoration style, location of sooting, abrasions, repair or alterations, overall vessel shape, polishing, thickness, incisions or cut marks, temper, and non-cultural modifications.

Visual inspection and use-alteration analyses represented the first phase of this dissertation and were meant to provide information on how vessels were made and used by Besant-Sonota era peoples. The second phase of this study involved the analysis of carbonized food residues from these first northern Great Plains vessels to identify what plant foods were boiled within them. The next section of this chapter is devoted to a literature review of paleodietary techniques used in this dissertation.

4.4. Paleodietary Reconstructions

The analysis of carbonized residues is a common and effective paleodietary approach for determining what foods were prepared within ancient pottery vessels (e.g., Horiuchi et al. 2015). This technique is more favorable than absorbed residue analysis when dealing with rare archaeological specimens as analysis of adhering residues causes little to no damage. Carbonized residues are created over time as foods are burnt on the surfaces of cooking instruments. When removing these burnt layers from a cooking instrument, one can essentially examine a detailed record of foodstuffs recently cooked within a vessel (Miller et al. 2020).

Over the past 40 years, there has been exponential growth in the number of studies using carbonized food residues. Multiple fields of analysis have been developed using materials such as plant microfossils, stable isotopes, and organic residues. For this study, plant microfossils were the primary research focus. Owing to poor preservation, plant remains are seldom uncovered at open-air northern Great Plains archaeological sites. Therefore, our understanding of what local and domesticated plants were being consumed by peoples at this time has been difficult to interpret. Plant microfossils were used to fill in this knowledge gap. In addition to plant microfossils, isotopic analyses were conducted on vessels containing residues higher than 100 mg. Although isotopic analyses were a complementary data source for this study, using more than one approach alongside visual pottery analysis provides a holistic perspective on how pottery vessels were made, used, and what role they served within Besant-Sonota societies.

4.4.A. Background to Plant Microfossil Analysis

As faunal remains preserve well within most northern Great Plains contexts, an abundance of information is already known regarding which faunal resources were likely prepared within these first pottery vessels. The same cannot be said about plant remains. Apart from carbonized macrobotanical remains, plants simply do not preserve well within most open-air archaeological sites. While ethnographic studies of hunter-gatherer societies have shown that plants contributed greatly to the diet of foragers (Gott et al. 2006), the plant component of the Besant-Sonota era paleodiet has gone largely unexplored. To fill in this knowledge gap, plant microfossils served as the primary source of data collection for this study.

Two main types of plant microfossils employed in paleodietary reconstructions are phytoliths and starch grains. Phytoliths and starch grains preserve well in a wide variety of archaeological contexts including carbonized food residues, soils and features, dental calculus, and within microfissures on the surfaces of stone tools (Babot and Apella 2003; Barton 2007; Boyd and Surette 2010; Cabanes et al. 2010; Duncan et al. 2009; Fox et al. 1996; Hardy et al. 2009; Hart et al. 2003; Haslam 2004; Kononenko et al. 2010; Lamb and Loy 2005; Li et al. 2010; Lui et al. 2010; Mercador 2009; Nelson 1997; Perry 2004; Wesolowski et al. 2010; Zarrillo 2008; Zarrillo and Kooyman 2006).

Another favorable attribute of phytoliths and starch grains is their ability to preserve in depositional contexts for extensive periods. Phytoliths have been recovered from contexts dating to 64 million years, while starch grains have been recovered from archaeological materials dating to approximately 105,000 years ago. (Mercador 2009; Prasad et al. 2005). Plant microfossil reconstructions have also enabled archaeologists to identify ancient campsite bedding, food processing activities, and ritual feasts (Barton 2007; Cabanes et al. 2010; Duncan et al. 2009; Gott et al. 2006; Lui et al. 2010). Plant microfossils also provide a favourable alternative to conventional macrofossil analyses. Whereas plant macrofossils preserve poorly in most contexts, plant microfossils have proven quite durable within archaeological sites.

Within North and South America, plant microfossil analyses have played an important role in tracking food domestication, particularly maize and beans (*Phaseolus vulgaris*) (Piperno 2006). A tremendous amount of information has been made available concerning the identification of North American domesticated food products such as maize, beans, squash, and chili peppers (*Capsicum annuum*) (Bozarth 1987, 1990; Pearsall et al. 2004; Perry 2007).

The reason for the durability of phytoliths and starch grains lies in how these microfossils are produced. Phytoliths are composed of non-crystalline silica dioxide ($SiO_2 \cdot nH_2O$) formed as the result of mono-silica acid that is drawn up through the vascular system of plants and deposited within plant cells (Piperno 2006). The mono-silica acid deposited within the cells of plants eventually mimics the area in which they are deposited (Piperno 2006). This is an important attribute of phytoliths because plant cell shapes differ among many species. Upon decomposition of the plant materials, phytoliths held within the cells of plants are deposited in the surrounding environment (Li et al. 2010). Since phytoliths are inorganic, these microfossils have been found to persist in most archaeological and paleontological contexts. One exception to this would be highly acidic environments, such as karst cave sediments, which have been shown to accelerate the dissolution of phytoliths deposited in soils (Cabanes et al. 2010). Overall, phytoliths are produced in abundance by many plants and vary depending on the plant type and location within the plant at which they are deposited, thus providing taxonomic identifications (Pearsall et al. 2003; Piperno 2006).

Although all plant species do not produce phytoliths, they are abundant in many types of grasses (Twiss 1992). This is valuable for archaeologists, as phytoliths have been used to differentiate between C_3 and C_4 plants to reconstruct climate and vegetation histories (Twiss 1992). The primary difference between C_3 and C_4 plants is how they conduct photosynthesis. Many types of grasses on the northern Great Plains utilize the Calvin Cycle (C_3) as a photosynthetic pathway rather than the Hatch-Slack pathway used by C_4 plants (Finucane et al. 2006). Furthermore, cold species grasses (C_3) are typically found in cooler northern grassland and alpine environments whereas warm species grasses (C_4) are found in environments with an overall warmer climate.

While Twiss (1992) and Fredlund and Tieszen (1994) indicate difficulties in differentiating specific grass species based upon phytolith assemblages, differentiation between photosynthetic pathways can be more easily completed. After analyzing modern phytolith assemblages from C_3 and C_4 grasses, Twiss (1992) identified that pooid phytoliths (rectangular, elliptical, crescent, and oblong forms) are produced primarily by C_3 grasses whereas chloridoid (saddle-shaped) and panicoid (bilobates, crosses, and polylobates) phytoliths are produced by C_4 grasses. Additionally, Twiss (1992) and Fredlund and Tieszen (1994) indicated that comparing percentages of these phytolith types from archaeological samples can be used to identify local and regional vegetation communities. The durability and number of plant microfossils produced by plants make this form of study invaluable for the reconstruction of past environments and dietary trends, particularly in areas such as the northern Great Plains where plants are not well documented in most archaeological contexts (Figure 4.6).

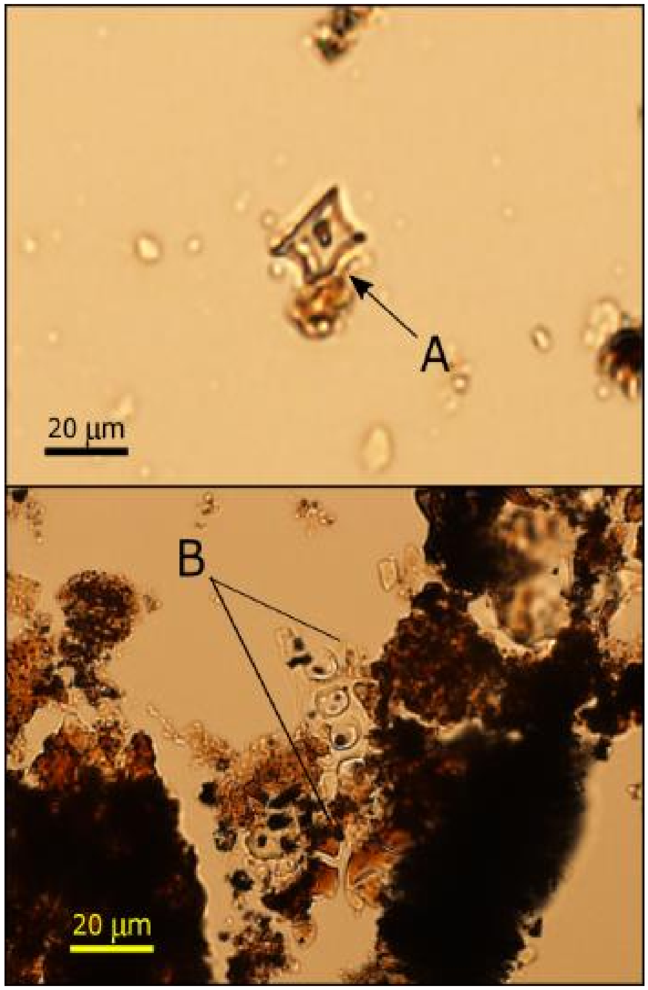


Figure 4.6 Examples of maize phytoliths from a Devil's Lake Sourisford (AD 900 to 1400) vessel, Saskatchewan: A) diagnostic 'wavy top' rondel cob phytolith, and B) row of saddle shaped phytoliths.

Starch grains are also produced by plants in large numbers and can, akin to phytoliths, provide taxonomic identifications (Gott et al. 2006). Unlike phytoliths, starch grains are composed of amylose and amylopectin, which are deposited in sequential layers around a central point, known as the hilum, of an individual starch grain (Gott et al. 2006). These plant microfossils are designed to act as a means for plants to store energy for daily or reserve use (Gott et al. 2006). This stored energy is an important reason why humans targeted plant foods in the past for consumption. Serving as energy storage containers, starch grains are commonly found within the seeds, tubers, and roots of many edible plant species (Gott et al. 2006). As plants store and create starch grains in different ways, variations occur in their size, shape, and appearance (Figure 4.7).

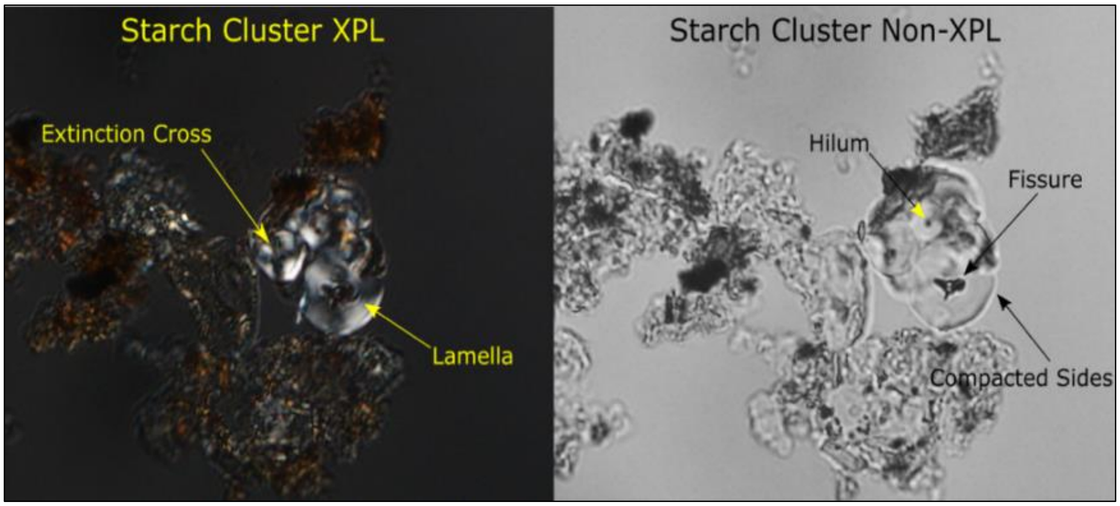


Figure 4.7 Example of a y-fissure maize starch grain surrounded by non-diagnostic maize starch grains in both cross polarized light (XPL) and non-cross polarized light (non-XPL).

Although plant microfossils are useful proxies within environmental and paleodietary reconstructions, there are several limitations to analyzing them. A major limitation of such analyses is the potential for modern starch contamination. While investigating possible laboratory contamination of archaeological samples, Crowther et al. (2014) found that maize starch contamination occurred in both the University of Calgary and Oxford University laboratories. Researchers found that due to the prominence of maize starch in industrial settings, laboratory materials also were noted to contain maize and other starch grains (Crowther et al. 2014). The presence of airborne maize starch led the authors to conclude that all paleodietary investigations should address potential sources of contamination during the planning of research activities. The results of this paper, and general concern within the academic community, led to the creation of a starch symposium at the Society for American Archaeology in San Francisco in 2015, based upon the threat of contamination and how the field should address these concerns (Hart et al. 2015). Moderated by Thomas Hart, Sonia Zarrillo, and Linda Perry (2015), this symposium aimed to provide advice on mitigating the effects of starch contamination.

Based on discussions at the symposium, several suggestions were made. Firstly, Dr. Piperno found that weekly or bi-weekly cleaning of laboratory facilities with boiling water aided in the reduction of outside starch contamination (Hart et al. 2015). Hart and Zarrillo suggested that rigorous testing of laboratory settings for airborne starch contamination benefits the identification and prevention of starch contamination (Hart et al. 2015). Examples of testing techniques included utilizing blank samples during all laboratory activities and placing microfossil traps in strategic locations to catch airborne starch grains.

While these techniques may reduce contamination, the use of phytoliths alongside starch grains provides an additional means to strengthen identification made from ancient residues. Using maize as an example, most industrial products contain starch grains from maize kernels whereas phytoliths are found within the leaves and inflorescence. Therefore, it is less likely that maize phytoliths will be present within industrial products.

Regardless of potential contamination, plant microfossil analysis remains the only paleodietary approach that can provide a species-level identification of past plants found within carbonized food residues. Alternatives to this approach, such as stable isotope analysis, provide more general identifications of food types.

4.4.B. Background to Stable Isotope Analysis

Applying stable carbon and nitrogen isotopes to paleodietary investigations is an established practice that has been used successfully in various contexts and time periods around the world (Ambrose 1993). Although stable isotope analysis only represented a small portion of this study, and more research is recommended, it is worth discussing the fundamentals of this field of study. The basis for stable isotope analysis lies in the examination of skeletal remains or archaeological residues for their isotopic composition (Schwarcz and Schoeninger 2012). As plants and animals intake nutrients, they also accumulate isotopes. Applications of stable isotope analysis span from interpreting past diets to the planning and protection of currently endangered species (Barberena et al. 2011; Pfeiffer et al. 2014). To understand this paleodietary approach, archaeologists must be aware of the natural living systems that were present during the creation of archaeological residues. Aspects of the surrounding environment such as trophic level, vegetation types (C_3 and C_4 plant communities), and climate must be understood due to the emphasis on carbon and nitrogen isotopes within this methodology.

Most elements in the natural environment consist of two or more isotopes. Isotopes are atoms that differ in the number of neutrons in their nuclei yet contain the exact number of protons and electrons as their base element (Hoefs 1987). As these elements contain the same number of electrons, they behave similarly in chemical reactions while differing in mass. By measuring the mass of elements extracted from the source material (e.g., skeletal remains or carbonized food residues) with a mass spectrometer and comparing this information to known comparative values, archaeologists can isolate general dietary trends. Common examples include isotopes of carbon, nitrogen, oxygen, hydrogen, sulfur, and strontium. Of these, most paleodietary reconstructions have focused on both carbon and nitrogen. To extract the stable isotopes, the source material can either be chemically treated or combusted to free gases such as carbon dioxide and nitrogen. Using carbon dioxide as an example, when such gases are released within a mass spectrometer, the electronic detector identifies the value of the stable isotopes by comparing the concentration of molecules containing a mass of 44 to those of mass 45 and 46 (Schoeninger and Moore 1992).

Understanding the pathways of carbon collection by different plant species is essential when attempting to identify plant signatures through stable isotopes. Most North American plant species obtain carbon through three photosynthetic pathways: C_3, C_4, and CAM. Plants that operate through C_3 pathways thrive in cool and dry climates and therefore are more abundant within the northern Great Plains (Tieszen 1994). In tropical areas (warm and humid), C_4 plants are common and include many domesticated plant species, such as maize (Tieszen 1994). The cooler C_3 plants contain lower $\delta^{13}C$ isotope values, ranging from -20 to -34‰ whereas tropical C_4 plants such as maize and millet, contain isotope values ranging from -9‰ to -16‰. Researchers can determine whether animals or people were consuming C_3 or C_4 plants based on the $\delta^{13}C$ isotope values held within their skeletal materials or within cooking residues.

In addition to understanding photosynthetic pathways, archaeologists must also consider trophic level effects on stable isotopic values. With an increase in trophic levels, there is an increase in the $\delta^{13}C$ and $\delta^{15}N$ isotope values (McConnaughey and McRoy 1979; Wada 1980). In herbivores, there is an enrichment of ^{15}N isotope relative to ^{14}N as species consume vegetation. As a direct result of this change in trophic levels, herbivores contain more positive $^{15}N/^{14}N$ ratios than plants (Schoeninger and Moore 1992). When carnivores feed on herbivores, this trend continues as carnivores contain more ^{15}N relative to ^{14}N. By understanding these changes in values, archaeologists can interpret the types of food products humans were consuming. To understand these changes, isotopic data from current vegetation and animal resources from within a given area must be examined and compared to archaeological isotopic data. If individuals consume a plant-rich diet, nitrogen stable isotopes from human bone collagen should contain a lower isotopic value than a meat-based diet (Figure 4.8).

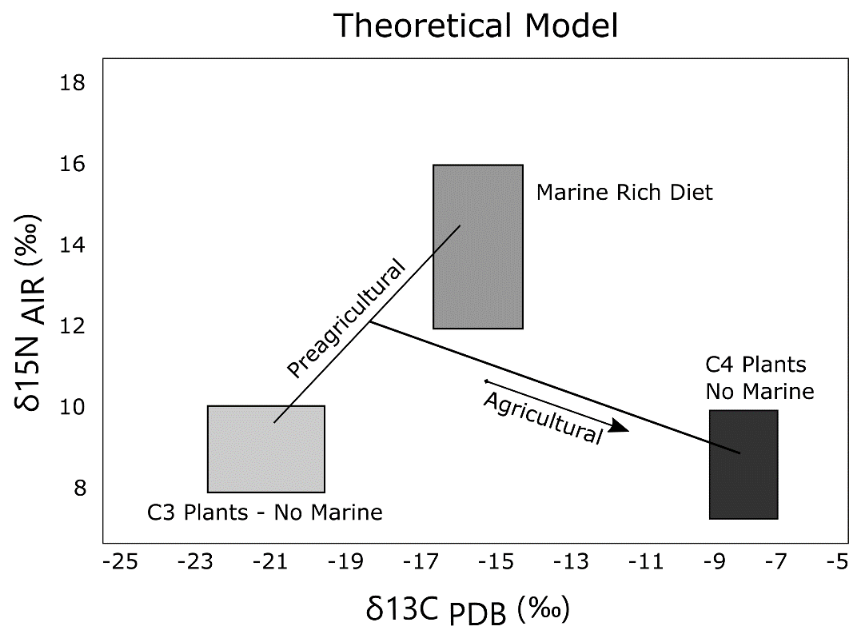


Figure 4.8 Theoretical stable isotope model. The model outlines the predicted results of three separate hunter-gatherer populations employing differing subsistence strategies and within different environments. Adapted from Schoeninger and Moore (1992:260).

Within the northern Great Plains, the natural vegetation was and remains predominantly C_3 with variable amounts of C_4 plants (Boyd et al. 2008; Tieszen 1994). Although this is largely the case, it is important to note the existence of small micro-climates within this region that contain higher proportions of C_4 plant communities (e.g., big bluestem [*Andropogon gerardii*]) relative to typical C_3 varieties (Munson-Scullin 2017; Tober and Chamrad 1992). It is also important to note that animals consuming this vegetation may have spent portions of their lifespan in both regions, as species such as bison traveled across the northern Great Plains and perhaps into surrounding ecozones (e.g., Aspen Parklands or Great Basin) on a seasonal basis. If this were the case, stable isotope values may be affected. Consequently, the type of vegetation has been seen by some to have an influence on stable isotope values from archaeological residues. Research by Garvie (1993) and Ens (1998) suggests that residues containing high proportions of bison that consumed C_4 forage during their adult life would contain higher ^{13}C values than bison consuming mostly C_3 forage. These depleted values may prove troublesome when attempting to identify C_4 plants, such as maize, through ^{13}C values.

Since maize is a C_4 tropical plant, many researchers have used stable isotope signatures to identify and distinguish maize from cooking residues. Although one would expect maize to produce a clear isotopic signature, this is not always the case. In areas where both maize and C_4 consuming herbivores contributed to the diet of past societies, Katzenberg (1989) and Tuross and Fogel (1994) both found that it may be complicated to distinguish the source of the isotope values (e.g., maize or animals consuming C_4 vegetation). Considering that maize and bison are located at differing trophic levels, it would seem logical that nitrogen isotopes would provide a more suitable area for interpretation. Again, this is not always the case as bison and maize have been reported on occasion to contain overlapping ^{15}N isotope values (DeNiro and Hastorf 1985; Ens 1998; Habicht-Mauche et al. 1991; Morton and Schwarcz 2004; Schoeninger et al. 1984; Varney et al. 2001).

Aside from this masking effect of C_4 foraging animals, further complications arise in the misrepresentation of maize within archaeological residues. While reconstructing the diet of Indigenous peoples that lived in Ontario from 2630 to 225 cal BP, Morton and Schwarcz (2004) found that cooking residues contained fewer isotopic signatures of maize compared to results obtained from human bone. The authors attributed these lower values as evidence for direct roasting of cobs rather than boiling (Morton and Schwarcz 2004). Although this seems like a logical explanation, experimental research by Hart et al. (2007) offered an alternative viewpoint. Through the experimentation of cooking maize with different portion sizes of C_3 plants, in this case, wild rice, and immature specimens of maize, Hart et al. (2007) observed that both overrepresentation and underrepresentation of maize can occur within directly sampled isotopic signatures. If true, the results of Hart et al. (2007) require archaeologists seeking to identify maize from charred cooking residues to consider prior knowledge of other sources of faunal and floral food resources that may contribute to the overall isotopic signature.

In addition to food contents, boiling over of materials during cooking, changes to isotopic values caused by heating methods, location of residues (e.g., rim compared to base), and differing food preparation techniques, such as the removal of fats during boiling, may also impact stable isotope results (Hart et al. 2007). The results of the research by Hart et al. (2007:811) led the authors to proclaim, "…it is unlikely that independent use of stable carbon isotope analysis of charred residues is a viable technique for extracting paleodietary information."

While Hart et al. (2007:811) took a cautious approach to using stable isotopes for paleodietary reconstructions, new insights have been uncovered relating to tracing what stable isotope data is stored within pottery vessels. In recent experiments by Miller and colleagues (2020), seven mixtures of foodstuffs within equal numbers of unglazed vessels were cooked once per week for a year. During the last couple of meals, the foods cooked within the vessels were switched. Examination of carbonized residues revealed that the isotope values closely matched the most recent meal rather than those cooked throughout the year. This finding has profound consequences for multiple forms of residue analyses (e.g., plant microfossil and stable isotope analyses). If carbonized residues represented the final meals cooked within pottery vessels, this would open the door for archaeologists to further narrow down foods prepared within individual meals. Whereas carbonized food residues have often been viewed as a culmination of all meals cooked within pottery vessels, the results of Miller and colleagues (2020) would suggest otherwise. Indeed, further research is required to identify whether individual meals can be traced from carbonized residues. As more research is needed, the combination of multiple paleodietary approaches is favored.

Despite the challenges of tracing the consumption of maize in North America, researchers such as Boyd and others (2008) identify the use of stable carbon and nitrogen isotopes as a valuable source of general dietary information such as the differentiation between terrestrial and aquatic resources and to compare general food consumption within study areas (Craig et al. 2007).

4.5. Residue Sampling Strategy

Plant microfossil analyses were the primary focus of this study and were processed and examined in the Department of Anthropology Laboratory Facilities at the University of Alberta. Where there were remaining residues, these surplus residues were then analyzed for $\delta^{13}C$ and $\delta^{15}N$ stable isotopes by the Center for Applied Isotope Studies (CAIS). The total percentages of both carbon and nitrogen for each sample were obtained from CAIS in addition to the $\delta^{13}C$ and $\delta^{15}N$ isotope values. The selection of samples for stable isotope analyses was determined by the amount of residue remaining for analyses, the importance of the archaeological site, and the context of the archaeological sample (e.g., those found *in situ* versus those found within disturbed contexts). A more detailed summary of CAIS's procedures will be presented later in this chapter.

4.5.A. Extraction of Plant Microfossils from Carbonized Food Residues

Carbonized food residues were extracted from pottery vessels using a sterile dental pick under low magnification. To ensure that multiple tests could be conducted, approximately 30 to 70 mg of residue were extracted from each pottery specimen, where available. Once the food residue had been lifted from the pottery surface, plant microfossils were extracted following methods established by Boyd and Surette (2010), Hart et al. (2003), Staller and Thompson (2002), and Surette (2008).

Following the removal of residues, carbonized samples were treated with hydrogen peroxide (10 percent) to agitate the samples. These were then further filtered through 180μm Nitex cloth to remove starch samples before digestion in acid. Once the starch samples were removed, the remaining sample was digested in 30 percent nitric acid in a heated bath for 12 hours. This process enables carbon within the samples to break down, leaving phytoliths for extraction and analysis. Occasionally pollen grains were also extracted from the carbonized residues using the techniques described above.

4.5.B. Contamination Testing

Since all the artifacts examined in this study were from curated collections, methods were undertaken to identify contamination. Beginning at the sampling stage, sterile compressed air was used to cleanse archaeological samples before residue removal. Compressed air canisters provided a means to remove any possible surface contaminants located on the pottery specimens before sampling.

As contamination has been observed primarily within laboratory settings, care was taken to limit contamination of archaeological samples during processing (Crowther et al. 2014; Hart et al. 2015). The first step towards sustaining a 'contamination-free lab' was the completion of routine 'boiling' of the laboratory space and contents. The practice of boiling included the use of boiling water to clean laboratory materials. In addition, slides containing a single drop of silicone oil were systematically placed within areas of the laboratory space to track signs of airborne starch contamination (Figure 4.9). Slides were analyzed for potential contaminants on a weekly basis throughout laboratory activities during this study. If contaminants were noted, the laboratory was cleansed, and all processing activities were repeated upon removal of contaminants.

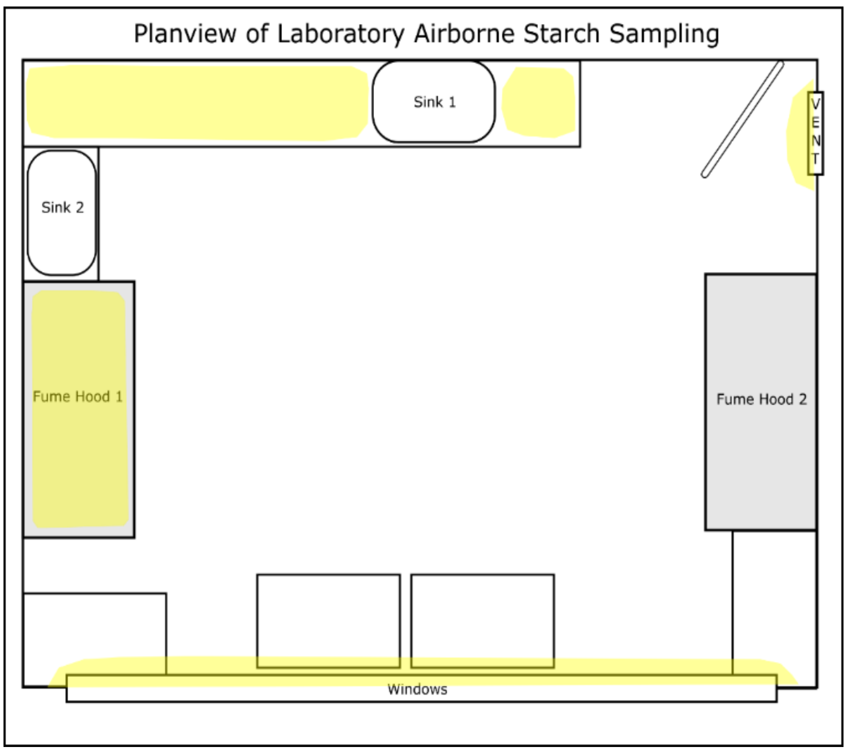


Figure 4.9 Location of airborne starch sampling areas in the palaeobotanical laboratory (highlighted areas on the map).

The final contamination prevention technique was the use of blanks and the repetition of sampling activities. During all laboratory activities, blank samples were processed alongside archaeological samples to enable an additional opportunity to identify contaminants that may have been introduced during the processing stages. If contaminants were identified, the type and frequency of these intrusive plant microfossils were documented, and the processing of the archaeological sample was repeated.

4.6. Identification of Edible Plants via Phytoliths and Starch Grains

4.6.A. Domesticated Plant Species

Of all the domesticated plant species examined for plant microfossils, maize has received the most attention. Concerning this plant species, phytoliths from the leaves and cob have often been relied upon for identification in phytolith studies (Pearsall 2000; Pearsall et al. 2003; Piperno 2006). As such, plant microfossils can not only be used to identify this species, but also specific portions of this plant. Beginning with phytoliths from the leaves of maize, identifications were made using cross-shaped phytoliths with a width of 16 µm or more and exhibiting overall morphologies like the variants reported by Iriarte (2003). To confidently identify these within archaeological samples, measurements of the width and height of the phytoliths were needed to fall within recorded dimensions of modern maize varieties. Later research into other non-domesticated grass varieties complicated this identification technique as such grasses produced similar cross-shaped phytoliths (Pearsall et al. 2003). Therefore, the presence of cross-shaped phytoliths having similar dimensions to those reported by Iriarte (2003) was only used to provide supporting evidence of this domesticated plant species.

Globular robust phytoliths are also used to provide supporting evidence for maize (Pearsall et al. 2003). These phytoliths (found in the cobs) of maize only result in a potential identification of this domesticated plant for similar reasons to those seen with cross-shaped phytoliths. Pearsall et al. (2003) also found globular robust phytoliths in other C_4 grass specimens. In contrast, the most reliable technique used to identify maize is through the study of 'wavy-top,' 'ruffle-top,' and 'half decorated' rondel phytoliths also produced in the cob portion of the plant (Boyd and Surette 2010; Boyd et al. 2019; Hart et al. 2003; Staller and Thompson 2002).

Found within the cupules on cobs of maize, rondel phytoliths (Figure 4.10) have been reported from multiple varieties of maize and from within archaeological contexts spanning from South America to the Canadian Subarctic (Boyd et al. 2019; Lints 2012; Pearsall et al. 2003; Staller and Thompson 2002). Adding strength to this identification technique is the lack of the wavy top rondel phytolith found in other grass species. Studies concerning the identification of taxonomic keys for grass phytoliths found within the northern Great Plains by Bozarth (1993) and the boreal forest by Surette (2008) have not identified this form of rondel phytolith in other grass species. To date, the wavy-top rondel phytolith, which has a crest and a trough along with an entire base, has the most accurate features used to identify maize within archaeological contexts. To ensure an accurate identification, all potential wavy-top rondel phytoliths observed in this study were rotated to allow examination of all sides.

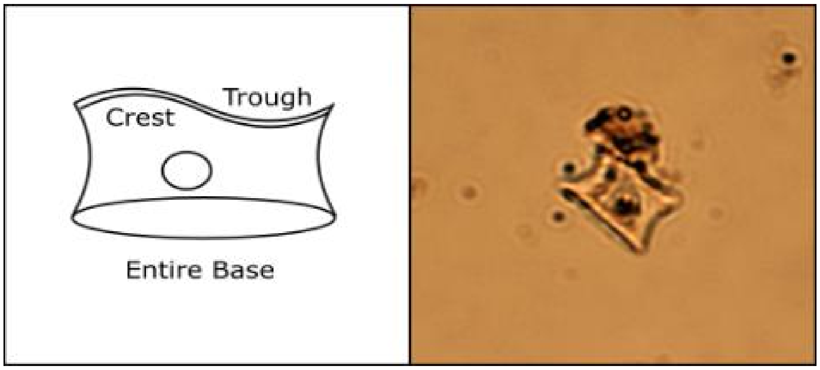


Figure 4.10 Wavy-top rondel phytolith attributes (left) and an example found within residues of the Devil's Lake Sourisford vessel from Saskatchewan (right).

Like wavy-top rondel phytoliths, starch grains produced by maize can also be used to accurately identify this species. Within the kernels of maize, starch grains build in the form of compact-sided grains with a y- or an x-fissure in the centre of the grain (Figure 4.11). When examined under cross-polarized light, a 90º extinction cross can be identified. These starch grains are found in abundance within maize and consistently have widths of 25 µm.

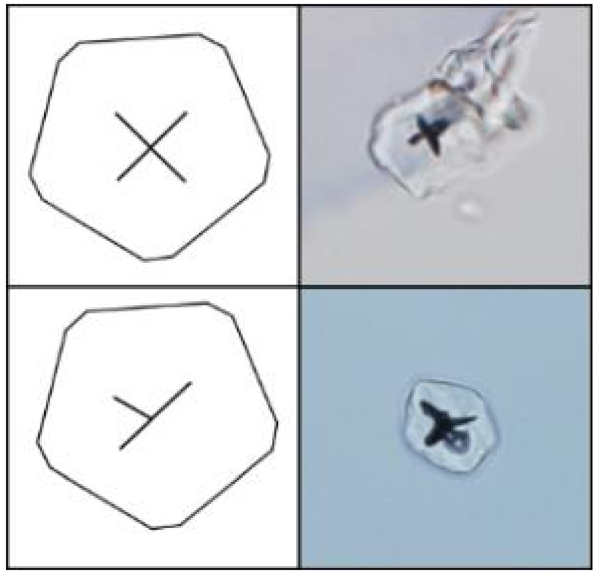


Figure 4.11 Diagram of x- and y-fissure maize starch grains (left) and examples from Devil's Lake Sourisford vessel Saskatchewan (right).

4.6.B. Confirmation of Domesticated Plant Microfossils

Concerns over maize starch contamination during analyses within paleodietary studies dictated how domesticated plant microfossils were identified. For this study, confident identification of maize was only made if 1) diagnostic rondel phytoliths of maize were present and fully rotated to confirm identification; and 2) diagnostic rondel phytoliths of maize were identified from multiple archaeological samples at a site rather than a single source. Using these criteria, results could be viewed with greater confidence and add to the robustness of the present study's findings. A third criterion was used in the event of contamination within facilities at the University of Alberta. If maize starch grains were observed within any of the airborne traps, sample blanks, or on the surface of equipment, the identification of maize from samples analyzed during the testing period was regarded as invalid.

4.6.C. Locally Available Plant Species

Akin to domesticated plants, locally available edible plant species have been identified within archaeological contexts largely through three techniques: phytoliths, pollen, and starch grains. For this study, the term 'locally available plants' will be used to refer to species that were native to the northern Great Plains and may reasonably be expected to have been found within the catchment area of a site. These plants may have been wild or perhaps under management by the peoples living there (e.g., use of fires to manage plant resources). The roles that these plants played were recently examined by Nancy Turner (2014:270-278). Despite this work being focused on traditional plant uses by cultures ancestral to British Columbia, Turner (2014) noted that plants that also grow today in the northern Great Plains (e.g., chokecherry) held significant nutritional, and medicinal, value to past communities. Although important to past societies, poor preservation of organic materials at open-air archaeological sites has resulted in locally available plants being somewhat overlooked by archaeologists. Plant microfossil analyses were conducted in this study to build upon our understanding of past plant consumption by peoples who are more associated with large game hunting by archaeologists.

Analysis of phytoliths has largely been held within the grass family (Bozarth 1993; Brown 1984; Surette 2008; Twiss et al. 1969), while later studies showcased the identification of shrubs and woody species (Piperno 2006). For this study, grass phytoliths were identified based on the taxonomic key developed by Brown (1984), Surette (2008), and Twiss et al. (1969). These phytolith identification keys have led to the reliable identification of a wide range of grass phytoliths that were present on the northern Great Plains during the time of Besant and Sonota.

To identify edible plant species from carbonized residues found in the northern Great Plains, archaeologists only recently turned their attention toward the analysis of starch grains. The first reported uses of starch grains to identify edible plants within the northern Great Plains were completed by Boyd et al. (2008, 2010, 2019) and Zarrillo and Kooyman (2006). Although these research articles focused primarily on the identification of maize, locally available plant species were also noted by Zarrillo and Kooyman (2006). To accurately identify plant specimens, a detailed comparative collection is necessary. For this study, the starch database produced by Lints (2012) was used to identify locally available and domesticated plant specimens. This comparative starch database was built from 48 edible locally available plants collected from the Native Prairie Museum in Winnipeg, Manitoba, and the Lakehead University Herbarium. For this study, an additional 10 edible plant species were examined from the University of Alberta Herbarium (see Appendix B.1). Starch grains from archaeological samples were first compared to known starch examples to aid in identification. If starch grains did not match any known examples, identification was limited to the type of plant by which the starch grain was likely produced.

As starch grains form within storage organs, there are noticeable differences in size and shape among starch grains produced by seeds, nuts, berries, and tubers. Berries produce starch grains that are circular and under 5 µm in width (Lints 2012). For berries, defining features of starch grains include a darkened hilum and an extinction cross with arms that do not intersect with one another (Figure 4.12). Seeds such as goosefoot, typically appear in large clusters of circular starch grains that are 1 to 3 µm in width. In contrast, acorns from bur oak have produced starch grains that are 'clam-shaped' and over 15 µm in width (Lints 2012). Size ranges vary significantly from 10 to 50 µm in width and forms can be compound, elongated, bell-shaped, and circular (Lints 2012). Given the larger size of tuber and rhizome starch grains, greater detail can be observed and additional diagnostic features have been noted (Lints 2012).

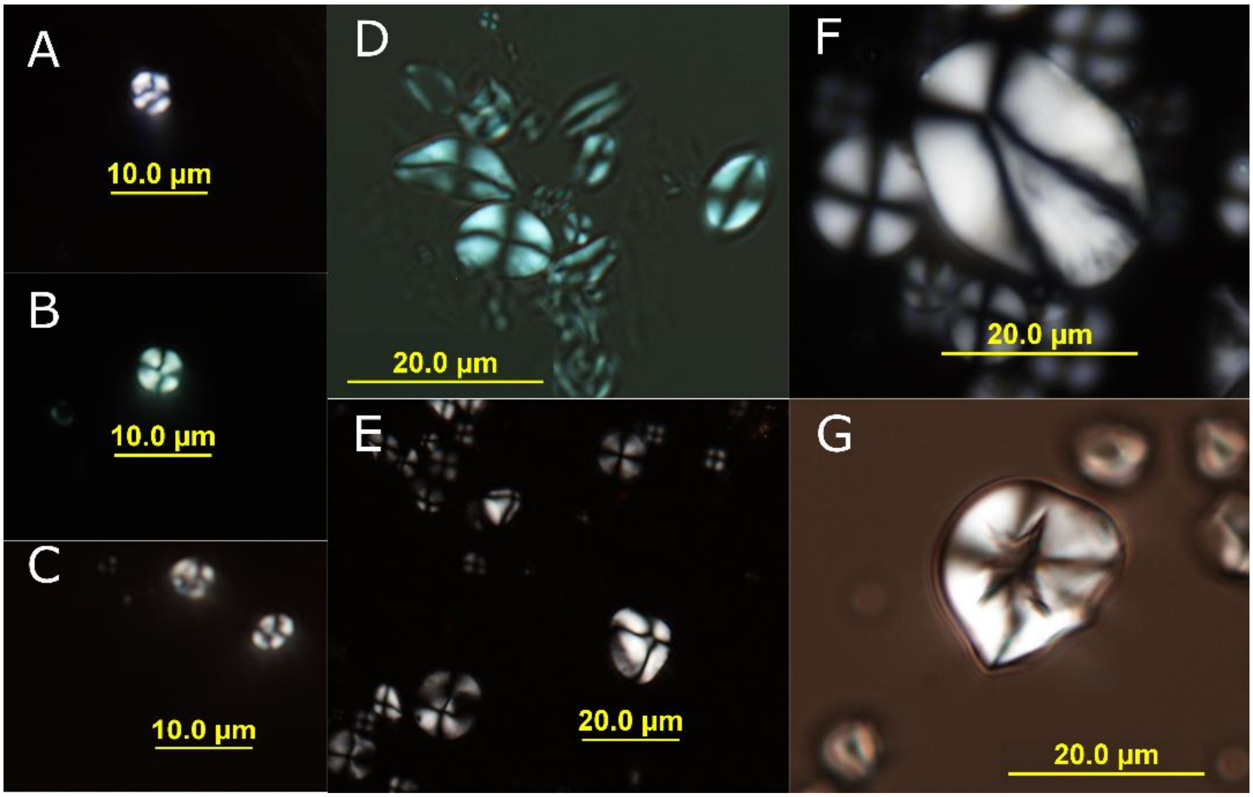


Figure 4.12 Examples of comparative starch grains from viewed under cross polarized light: A) saskatoon berry, B) chokecherry, C) pin cherry, D) bur oak, E) common gourd, F) white pond lily, and G) prairie turnip.

Identification of plant type is useful not only when known examples are not found, but also when starch grains are obscured by damage or other particles on the microscope slide. Starch grains are organic and therefore prone to wear and gelatinization from overcooking. Such attrition from cultural activities can lower the chances of identifying the species responsible for starch grains within residues. Therefore, the identification of the plant type, while not as precise as the identification of species, also provides a valuable contribution to the paleodiet of past cultures.

4.6.D. Identification of C_3 and C_4 Grass Phytolith Ratios

A useful means for comparing C_3 and C_4 grass assemblages through phytolith types is the climatic index (*Ic*) reported by Bremond et al. (2008) and Twiss (1992). This index provides the percentage of pooid short cell phytoliths (C_3) relative to the sum of pooid, chloridoid, and panicoid grasses within a given sample (Bremond et al. 2008). The presence of C_3 grasses should provide high *Ic* values whereas a low *Ic* index is indicative of C_4 plant communities (Bremond et al. 2008).

$$Ic(\%) = \frac{\text{Rondel} + \text{Trapeziform polylobate} + \text{Trapeziform Short Cell}}{\text{Rondel} + \text{Trapeziform polylobate short cell} + \text{Trapeziform short cell} + \text{Saddle} + \text{Cross} + \text{Bilobate short cell}} \times 100$$

Additional insights into the type of C_4 plants can be inferred through the application of the *Iph* index (see below). This index has been used to identify C_4-short grasses versus C_4-tall grasses (Alexandre et al. 1997; Bremond et al. 2005; Fredlund and Tiezsen 1997). It provides a percentage of the chloridoid short cell phytolith types relative to the sum of panicoid and chloridoid phytoliths within a given sample (Diester-Haass et al. 1973). Furthermore, the use of the *Iph* index has proven valuable in reconstructing plant communities within the northern Great Plains (Alexandre et al. 1997; Fredlund and Tieszen 1997).

$$Iph(\%) = \frac{\text{Saddle}}{\text{Saddle} + \text{Cross} + \text{Bilobate short cell}} \times 100$$

Even though these techniques are widely used, recent research by Hyland et al. (2013) reported the possibility of misinterpretation of vegetation reconstructions via phytolith analysis. Their research of modern soils indicated that phytolith analysis does not always reflect the plants present in the area (Hyland et al. 2013). This is mainly due to differential preservation and environmental factors (e.g., temperature, precipitation, and climate), which may create a bias in observed phytolith assemblages. For this study, phytolith records are only being used to spot differences between carbonized residue samples, rather than reconstruct the surrounding vegetation history.

4.7. $\delta^{13}C$ and $\delta^{15}N$ Stable Isotope Analyses of Carbonized Food Residues

Samples that yielded sufficient residues to merit testing after plant microfossil analyses were submitted to CAIS. Pre-treatment and analyses were completed at the CAIS. CAIS has a total of 6 elemental analyzer systems coupled to an isotope ratio mass spectrometer (IRMS). The IRMS systems were manufactured by Thermo in Germany and the elemental analyzer systems were manufactured by Carlo Erba in Italy.

For $\delta^{13}C$ and $\delta^{15}N$ analysis of Besant and Sonota carbonized residues, an elemental analyzer was used to convert samples into carbon dioxide (CO_2) and nitrogen (N_2) gases. Once separated and dried, CO_2 and N_2 from the elemental analyzer were swept via helium carrier gas into the Thermo Conflo interface. From the Conflo interface, a sub 0.5 mm (inner diameter) fused silica capillary carried a reduced volume of carrier and sample gas to the ion source of the IRMS. This carrier and sample gas flow was approximately 300 microliters per minute. The Thermo Conflo interface also provided reference gas pulses for every sample and for each of the measured gases.

CAIS used a variety of primary reference materials from both the National Institute of Standards and Technology (NIST) and the United States Geological Survey (USGS) to validate the results of this study. Secondary reference materials were also employed by CAIS. These calibrated, primary and secondary reference materials were included at regular intervals throughout analytical experiments with residues. In summary, the verification of isotopic values was done via two approaches: 1) calibration through the use of reference material from the NIST and the USGS; and 2) secondary reference samples, in this case spinach and bovine isotopic values that have been calibrated to the NIST calibration material.

4.8. Radiocarbon Analyses of Bone Collagen and Carbonized Food Residues

All radiocarbon analyses were conducted at A.E. Lalonde AMS Laboratory which is the Canadian center for AMS and environmental radionuclide research. Pre-treating and processing of samples were completed at the Lalonde AMS Laboratory following published techniques by Crann et al. (2017) and Murseli et al. (2019).

Radiocarbon analyses were performed on a 3MV tandem accelerator mass spectrometer built by High Voltage Engineering (HVE). The fraction of modern carbon, $F^{14}C$, was calculated according to Reimer et al. (2004) as the ratio of the sample $^{14}C/^{12}C$ ratio to the standard $^{14}C/^{12}C$ ratio measured in the same data block. Both $^{14}C/^{12}C$ ratios are background-corrected and the results were corrected for spectrometer and preparation fractionation using the AMS measured $^{13}C/^{12}C$ ratio and were normalized to $\delta^{13}C$ (PDB). Radiocarbon ages were calculated as -8033ln ($F^{14}C$) and reported in ^{14}C yr BP (BP=AD 1950) as described by Stuiver and Polach (1977). The errors on ^{14}C ages (1σ) are based on counting statistics and $^{14}C/^{12}C$ and $^{13}C/^{12}C$ variation between data blocks.

Calibration on all samples sent for dating was performed by scientists at Lalonde using OxCal version 4.4 for bone collagen samples and OxCal version 4.4.4 for archaeological residues (Ramsey 2009). The version of calibration software was based upon which version was available when the bone and residue samples were submitted. Bone collagen samples were submitted for dating in March of 2020 and archaeological residues were submitted in April of

2021. Samples that calibrated between the 1700s and early 1950s will always result in a calibrated age range covering that period owing to the Suess Effect. The Suess effect is a flat portion of the calibration curve owing to the burning of fossil fuels.

For non-calibrated radiocarbon dates collected by other researchers, calibration was performed using OxCal version 4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020). Calibrated results were provided as a range with an associated probability as point estimates (e.g., mean or median) cannot represent the uncertainties involved (Millard 2014).

4.9. Data Sources

Archaeological data for this research were collected from sites located across the northern Great Plains. Consequently, university and government archaeological repositories located in Alberta, Saskatchewan, Manitoba, Montana, Wyoming, North Dakota, and South Dakota were visited to collect residues from the Besant-Sonota pottery (see Appendix A.2). In addition, pottery from the Sonota mound sites held in the Smithsonian National Museum of Natural History was also sampled for carbonized food residues.

In total, 56 Besant-Sonota sites were identified as containing pottery with the bulk of these sites being located within North and South Dakota. Out of these sites, only 22 contained sufficient carbonized food residues for Analyses (See Appendix A.2.). It is important to note that on multiple occasions, well-documented examples of pottery from the Besant-Sonota era could not be examined because they had disappeared from archaeological repositories. Reconstructed vessels from the High Butte (32ME13), Whiskey Hill (24DW1001), Balzac (EhPm-34), and the Stelzer sites were all missing from local archaeological repositories, with their whereabouts unknown.

4.10. Summary of Methods

Pottery from the Besant and Sonota phases has largely been overlooked in favor of lithics and faunal remains, and perhaps for good reason as this form of material culture is infrequently found at sites from this time. In addition, most archaeological studies have focused on faunal remains rather than plants when considering the culinary trends of the people responsible for these sites. As a result, there is a significant gap in our understanding of this time regarding pottery use and food production. The goal of this study was to better understand the role pottery played within the Besant and Sonota phases by conducting use-alteration analyses and supplementing this data with analyses of carbonized food residues for plant microfossils and isotopes. Identification of alterations revealed how these vessels were used by peoples, while recording their appearance offered insight into interactions that occurred with distant cultures.

Prior to the use of pottery in Besant and Sonota sites, roasting and stone boiling were the only means of cooking food, even though pottery existed elsewhere in the Eastern Woodlands and American Southwest. A subsequent goal of this study was to examine how 'new' materials from outside cultures were adopted or even failed to see frequent use, by mobile hunter-gatherers. There have been no previous multi-disciplinary approaches to Besant and Sonota pottery analysis that encompasses both diet and function. This broader spectrum of data collection led to new perspectives on diet, technology, and society during the time of Besant and Sonota.

Chapter 5: A Visual Survey of Besant-Sonota Pottery

A thorough analysis of pottery recovered from Besant and Sonota contexts is provided in this chapter. Results of this visual survey are presented for each site individually, beginning with the Stelzer site in South Dakota. The decorations, manufacturing techniques, and exterior treatments will be presented first and followed by information relating to use-alteration.

5.1. The Stelzer Site

Perhaps best known for its proximity to a series of small burial mounds, the pottery recovered from Neuman's 1960s excavation and later surface collections from the Stelzer site represent the largest pottery assemblage from any Besant-Sonota site. While most Besant-Sonota sites containing pottery may yield fragments from no more than five vessels, research by Neuman (1975), and later Haberman and Travis (1995), resulted in the recovery of 186 pottery fragments and based on the descriptions below, a minimum of 11 variants of decoration and 20 individual vessels (Figure 5.1). Because of small sample sizes, the term 'variant' in this study was chosen as a means of referring to different designs at the Stelzer site without prematurely designating a formalized pottery type or style. Frequencies of pottery recovered at this site and a detailed breakdown of each of these variants are provided in Appendix A.1. A summary of the visual survey and use-alteration analyses is presented in this chapter.

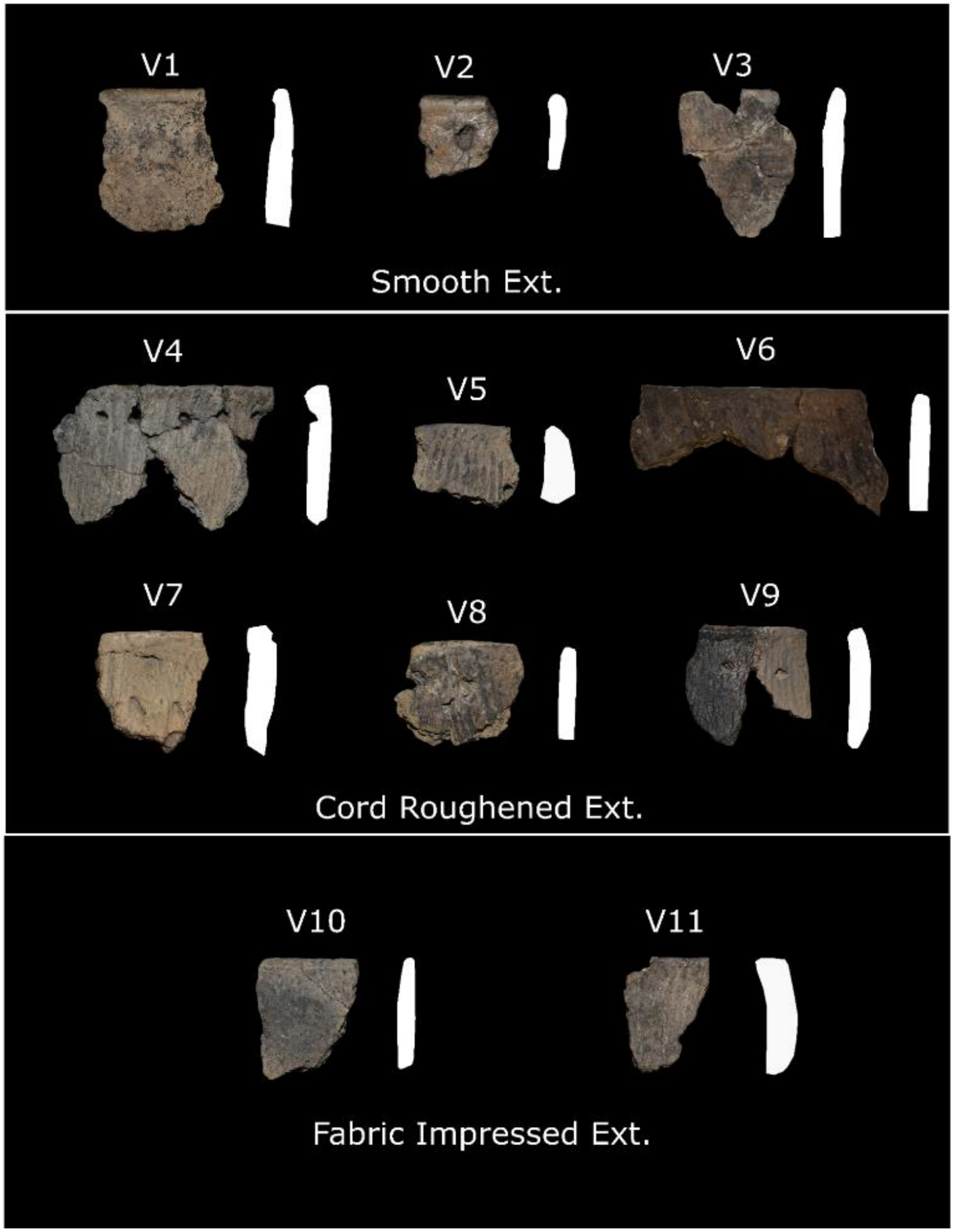


Figure 5.1 Rim variants observed at the Stelzer site. Images are not shown to scale but are displayed for comparisons. Profiles are all facing to the left. Photographed by the author courtesy of the Smithsonian National Museum of Natural History and the South Dakota State Historical Society.

The Stelzer site collection of rims has unprecedented diversity amongst other Besant-Sonota sites. We should also note that each of the variants only represents a single vessel type found at the site and that others bearing similar attributes may increase the total number of vessels. Neuman (1975) estimated that somewhere between 15 and 20 vessels were being used at this site. Pottery at this site is diverse in every aspect of its manufacture (Table 5.1). Rim angles, construction methods, decorations, sizes, and design placement on the vessels all varied. Decorations included circular and irregular punctates, rows of CWT, incised lines, and stab-and-drag impressions. In addition, fingernail designs were noted on a basal section (catalogue #498767) of a vessel (refer to Figure A.14 of Appendix A.1).

Table 5.1 Summary of attributes observed during the visual survey of Stelzer site pottery.

Specimen	Exterior	Decoration	Rim Profile	Temper	Manufacturing Technique	Alteration
Variant 1 (Rim)	Smooth, polished	Irregular punctates (interior)	Tapered, exterior bevel	Coarse grit	Paddle and anvil, smoothing, interior layering of paste	None
Variant 2 (Rim)	Smooth, polished	Irregular punctates (exterior and interior)	Expanding, rounded	Intermediate grit	Paddle and anvil, smoothing	None
Variant 3 (Rim)	Smooth	Circular punctates (exterior and interior), CWT (horizontal and oblique), stamping	Tapered	Intermediate grit	Paddle and anvil, smoothing	None
Variant 4 (Rim)	Cord roughened	Circular punctates (exterior)	Slight exterior expanding profile	Coarse grit	Paddle and anvil	Drilled hole, wear directly above the hole
Variant 5 (Rim)	Cord roughened	Circular punctates (exterior)	Tapered	Coarse grit	Indeterminate	None
Variant 6 (Rim)	Cord roughened	Circular punctates (interior)	Slight exterior bevel	Coarse grit	Indeterminate	None
Variant 7	Cord	Stab-and-drag	Exterior	Coarse grit	Indeterminate	None

(Rim)	roughened	(exterior)	flanged			
Variant 8 (Rim)	Cord roughened	Irregular punctates (exterior)	Tapered	Coarse grit	Indeterminate	None
Variant 9 (Rim)	Cord roughened	Irregular punctates (exterior)	Tapered	Intermediate to coarse grit	Indeterminate	None
Variant 10 (Rim)	Fabric impressed	None	Tapered	Intermediate to coarse grit	Indeterminate	None
Variant 11 (Rim)	Fabric impressed	Horizontal incised lines on the lip	Square	Intermediate to coarse grit	Indeterminate	None

Besant-Sonota pottery is more well known for cord impressed exteriors (e.g., Scribe 1997), yet the Stelzer site pottery assemblage included smooth and fabric impressed exteriors. Vessels exhibiting smooth exteriors (Variants 1 to 3) were noted within this site and represented 17 percent of the rims recovered from Neuman's excavation. The next set of variants (Variants 4 to 9) at the Stelzer site exhibit visible signs of cord marking or roughening. This type of exterior was more dominant in the Stelzer rim assemblage than the smooth variants, representing 83 percent of the rim fragments recovered from the site. Fabric impressed vessels were also found at this site and were represented by Variant 10 and 11 (refer to Figure 5.1).

Rim profiles also varied. Tapered, square, exterior flanged, rounded, and expanding rims were observed (See Table 5.1). Brian Scribe (1997) noted that vessel curvature varied among Besant-Sonota pottery assemblages and this was noted at the Stelzer site as a uniform vessel style was not observed. The profiles of the Stelzer variants also provided clues relating to how these vessels were crafted. While most vessels at this site appear to have been formed by a single layer of clay, Variants 1, 3, and 4 had three visible layers of paste running vertically from the rim to the bottom of each fragment (see Figure A.1 of Appendix A.1).

Outside of the unusually diverse decorations, vessel shapes, and composition, one of the larger cord-roughened vessels exhibited signs of post-firing alterations. On Variant 4, a single punctate shows signs of internal beveling on the interior around the punctate (Figure 5.2). This is a common trait of holes that were intentionally drilled through the wall of a pottery vessel. In addition, around this punctate on the exterior surface is a large section of the rim (approximately 2 cm) that has been smoothed over. This section is in stark contrast to the remaining vessel that exhibited distinct cord marking. Though many pottery vessels were uncovered at the Stelzer site, Variant 4 was the only vessel fragment larger than 10 cm in width and therefore the only specimen to fall within the size criteria for use-alteration analyses. Interpretation of this alteration will be presented in Chapter 7.

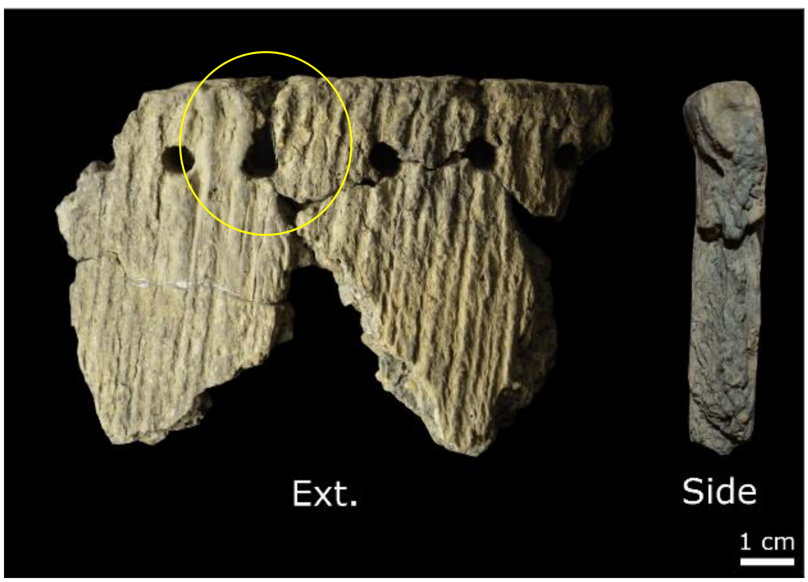


Figure 5.2 Cord roughened Variant 4 rim sample exhibiting a single row of exterior punctates. The yellow circle indicates the location of a single smoothed and drilled hole. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

In summary, after visual analyses of Stelzer rim fragments, three main groupings of surface treatment were identified:

1. Vessels that have been smoothed and decorated with minimal or complex designs;
2. Vessels that have been cord roughened and decorated with punctates or stab-and-drag markings; and
3. Vessels that have been fabric impressed and exhibit minimal decoration.

Further, visual analyses identified that manufacturing techniques could be divided into two groups:

1. Vessels that were created using a single layer of clay; and
2. Vessels that were formed by multiple vertical layers of clays.

The diversity in vessel types and manufacturing techniques at the Stelzer site exceeds expectations for Besant-Sonota sites that had infrequent pottery use. No other site examined in this study showcased as many styles and manufacturing techniques. This data combined with the results from paleodietary analyses will shed light on how the Stelzer site vessels were used and why there is such a diversity of wares.

5.2. The Arpan Mound Site

The Arpan Mound Site represents an opportunity to study pottery from a mortuary context. Placed within a circle of bundle burials, a mostly complete pottery vessel was discovered and was called 'Arpan Punctate' by Neuman (1975). Similar rims (Variants 1 and 2 of Figure 5.1, Figure A.1 and A.2 of Appendix A.1) were also found at the Stelzer site. Since these smooth wares do share similarities, there is an intriguing connection between the Stelzer and Arpan Mound sites that goes beyond their proximity and broad contemporaneity.

The Arpan Mound vessel has a conoidal shape that tapers towards the base and is widest at approximately 15 cm from the top (Figure 5.3). The overall height of this vessel from the base to the orifice is 28.5 cm, with a total circumference of 59.5 cm (19 cm in diameter). Decorations are limited to a single, horizontal row of irregular punctates that resemble the decorations on Variants 1 and 2. These appear in a series of five, followed by an additional punctate that is placed slightly higher than the others. The vessel's exterior is smooth, with excess paste rolled over the rim to create a slight lip. The basal section is not pointed but has an angular yet flattened appearance. This pot was made by hand forming as its thick walls (11 mm in width) were noticeably uneven. This unevenness is also linked to the presence of lamination that is visible when looking at the profile of this vessel, particularly in the body and basal sections.

Figure 5.3 Reconstructed rim fragments from the Arpan Mound site. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Insight concerning how this pot was used can be seen by searching the interior and exterior for both carbonized residues and carbon staining. The interior of the vessel contained a thick layering of carbonized residues located just beneath the row of exterior punctates. On the exterior, residues were most observable within the row of punctates as each was filled with carbonized residues (Figure 5.4).

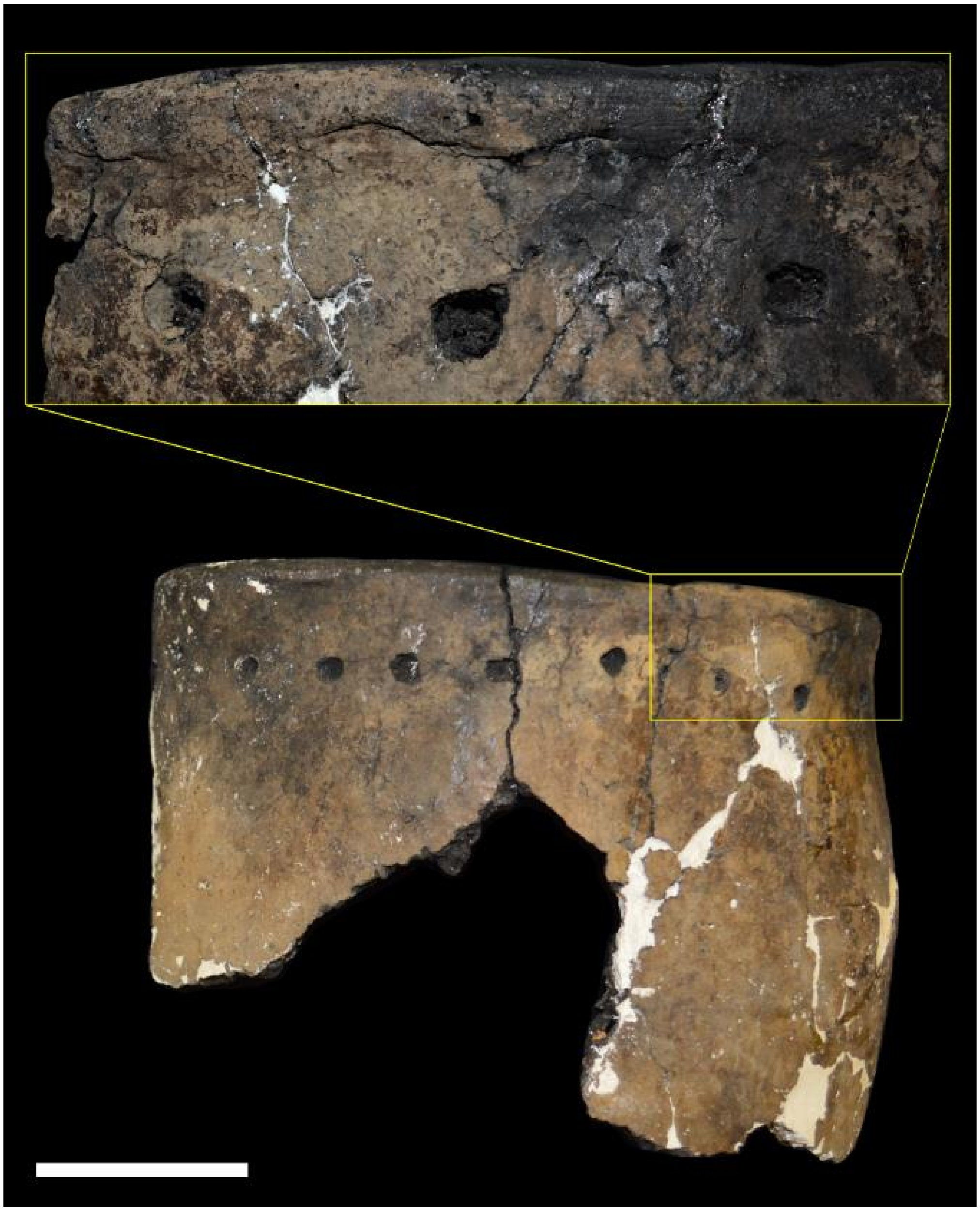
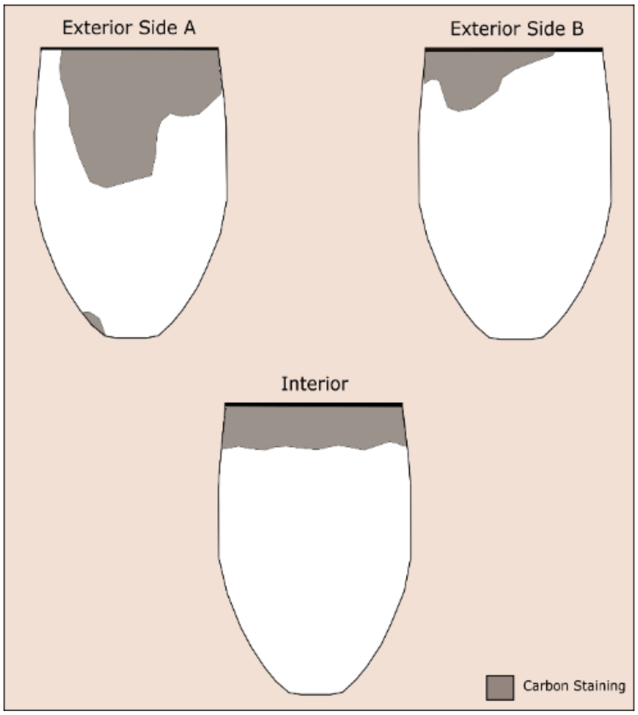


Figure 5.4 Carbonized residues within the irregular punctates of the Arpan Mound vessel. Photographed by the author courtesy of the Smithsonian National Museum of Natural History. The scale bar represents 5 cm.

Carbon staining on the exterior appears as a large v-shaped black pattern spanning from the rim of the vessel to the midsection (Table 5.2). The stains recorded on the Arpan pot may have resulted when this vessel was placed beside a fire while foods were cooked, rather than over an open fire.

Table 5.2 List of traits observed during use-alteration analyses of the Arpan Mound vessel.



Arpan Mound Vessel	**Observations**
Location of Residues	Upper interior and v-shaped pattern on the exterior; irregular punctates filled with carbonized residues
Decoration	Horizontal irregular punctates; Smooth exterior
Location of Sooting	Exterior with no patterning
Abrasions	No visible abrasions
Repair/Alterations	No visible repairs
Vessel Shape	Conoidal
Polishing	No polishing
Thickness	9 to 11 mm
Incisions	Few on interior and exterior
Temper	Fine with lamination occurring
Post-deposition Modifications	None

A visual inspection with a Dino-Lite USB hand-held microscope confirmed suspicions that this vessel was not frequently used. Under view of this microscope, no signs of alteration to the vessel were recorded. Alterations caused by repeated use of a vessel include scratching, polishing, scraping, and chipping; all of these are missing on the Arpan pot. This clean appearance of the vessel leads one to question how often it was used, and more specifically to ask if it was purposely made for this burial ceremony.

5.3. The Grover Hand Site

The Grover Hand site is situated adjacent to the Stelzer site, and consists of four burial mounds, three of which were excavated (Neuman 1975:47). The largest of these mounds was approximately 24.38 m in diameter and 1.28 m high (Neuman 1975:48). This mound shared similarities with the Arpan mound site such as the inclusion of multiple bundle burials, articulated bison remains, and exotic goods. Approximately 51 individuals were buried in Mound 1 and the largest age category belonged to ages three and under (Neuman 1975:110). Burial Mound 2 contained 25 individuals within six burial groupings while three were buried within Mound 3. Unlike Mounds 1 and 2, human remains were also found in the fill of Mound 3 and one young adult in burial grouping 1 was found in an articulated position next to two large conch shells coated with red ochre rather than bundle burial (Neuman 1975:56). Radiocarbon dates were obtained from each of these mounds and can be viewed in Table 5.3. Of note is a charcoal date collected from Mound 1, which is well outside the temporal range of the Besant and Sonota phases. During recent analyses of the Sonota mounds, Graham (2014:335) argued for the collection of new radiocarbon dates, given that the diagnostic artifacts were identified as belonging to the Besant and Sonota phases and the impreciseness of radiocarbon dates from charcoal.

Table 5.3 Radiocarbon results from the Grover Hand Burial Mound reported by Neuman (1975:110). Calibration was performed using OxCal v4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Context	Material	Sample ID	^{14}C yr BP	2 σ Cal. AD
Mound 1	Charcoal	SI-167	650 ± 200 BP	AD 899 – 1795
Mound 2	Wood	SI-168	1640 ± 80 BP	AD 303 – 582
Mound 3	Wood	SI-48	1720 ±75 BP	AD 203 – 541

Excavation of the Grover Hand Burial Mounds revealed only five pottery fragments and only one rim. This rim, catalogued as 498679, is unlike other pottery examples from the nearby Stelzer and Arpan Mound sites. Rather than having a subtle lip design, this rim has a flaring lip that extends outwards from the top of the vessel. The surface expression of this rim fragment is cord roughened (Figure 5.5). This specimen was marked with a row of widely spaced circular punctates on the exterior and horizontal incised lines on the interior.

Figure 5.5 Cord roughened rim fragment from the Grover Hand Site. Photographed by the author courtesy of the Smithsonian National Museum of Natural History. Scale bar represents 2 cm.

5.3.A. Grover Hand Pipe Fragment

A conical pipe bowl (Figure 5.6) made from either clay or greenstone (Neuman 1975) was also uncovered within the Grover Hand burial and is reminiscent of conical pipes uncovered from Hopewell mounds in Illinois and Ohio. During the inspection of this pipe bowl, tube-shaped markings were found extending outward from the base of the bowl. The bottom of this item is broken, and the stem is now missing. In its shape and decoration, this small pipe bowl bears a striking resemblance to pottery styles observed at Sonota sites. This resemblance suggests that there may be a symbolic or conceptual link to the pottery found at the Sonota mound sites.

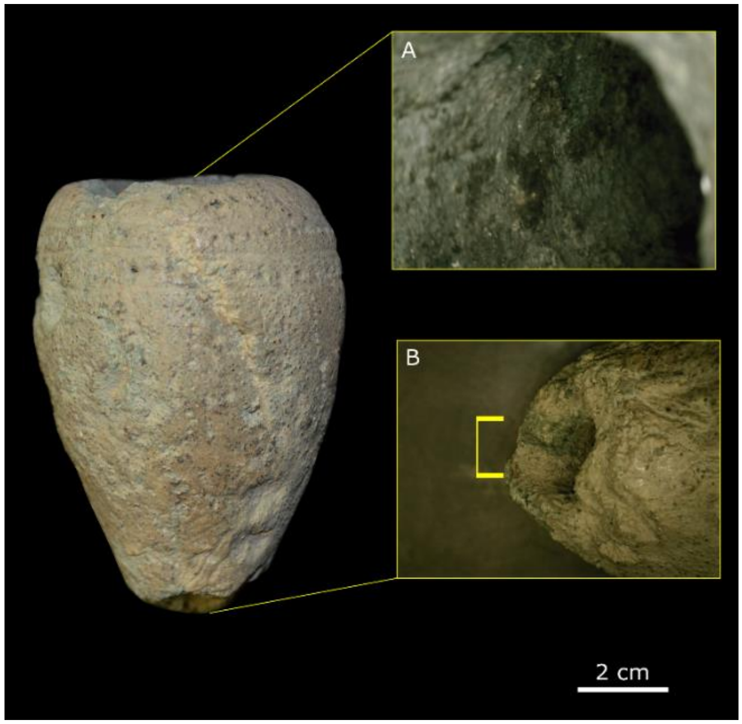


Figure 5.6 Conoidal pipe bowl (A498730) decorated with two rows of punctates and three horizontal incised lines. Dino-lite image of the interior residues (A) and two indentations on the base where the bowl would have been attached to the stem (B). Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

5.4. Surrounding Sites: 39DW255 and 39DW256 of the Oahe Reservoir

Additional pottery specimens examined in this study from the Sonota mounds were recovered during later surveys by Haberman and Travis (1995) and are isolated surface finds. The first obtained from 39DW256 was a large rim section with traits akin to Variant 4 (see Appendix A.1) of the Stelzer site (Figure 5.7).

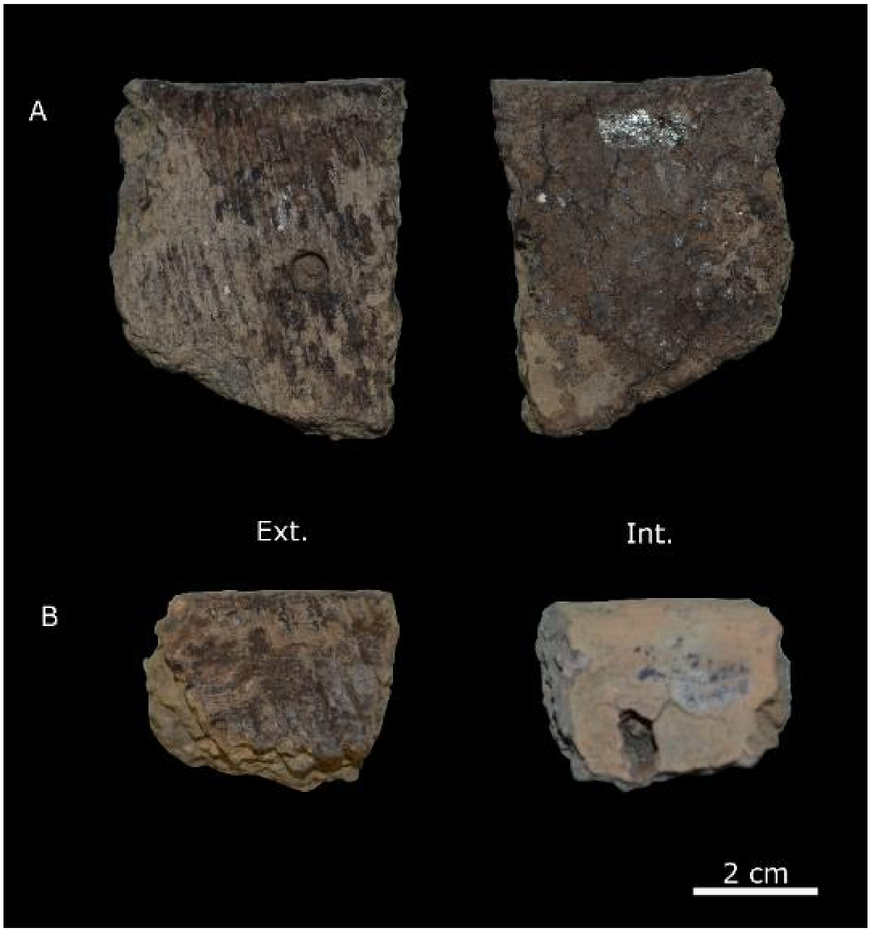


Figure 5.7 Cord roughened rim samples from sites 39DW256 (A) and 39DW255 (B). Photographed by the author courtesy of the South Dakota State Historical Society.

The specimen recovered from 39DW255 also shares a similar exterior surface as the previous 39DW256 sample, but there are differences in decoration and overall thickness. A single narrow punctate that was filled with carbonized food residue was identified on the interior of the fragment. This specimen contained a coarse grit temper and was approximately 14 mm thick.

5.5. 39JK63, South Dakota

Outside of the Sonota mounds, the amount of pottery found within Besant-Sonota contexts significantly decreases. Staying within South Dakota, I will next discuss one of the southernmost vessels examined in this study, from the 39JK63 site. This is a mostly complete South Platte vessel (Figure 5.8). Discovered in 1983 during the White River Badlands Regional Research Project by Keller et al. (1984), site 39JK63 consisted of two bands of cultural materials in butte terrain of the South Dakota Badlands. Only a single 2m by 2m excavation unit was completed and although radiocarbon samples of charcoal were collected in 1983, no radiocarbon dating has been completed. A single hearth feature was uncovered from this excavation and within it were several large fragments of pottery that refit into two large pottery vessels. Other artifacts included one biface, two cores, two scrapers, a bone tool, and several retouched flakes.

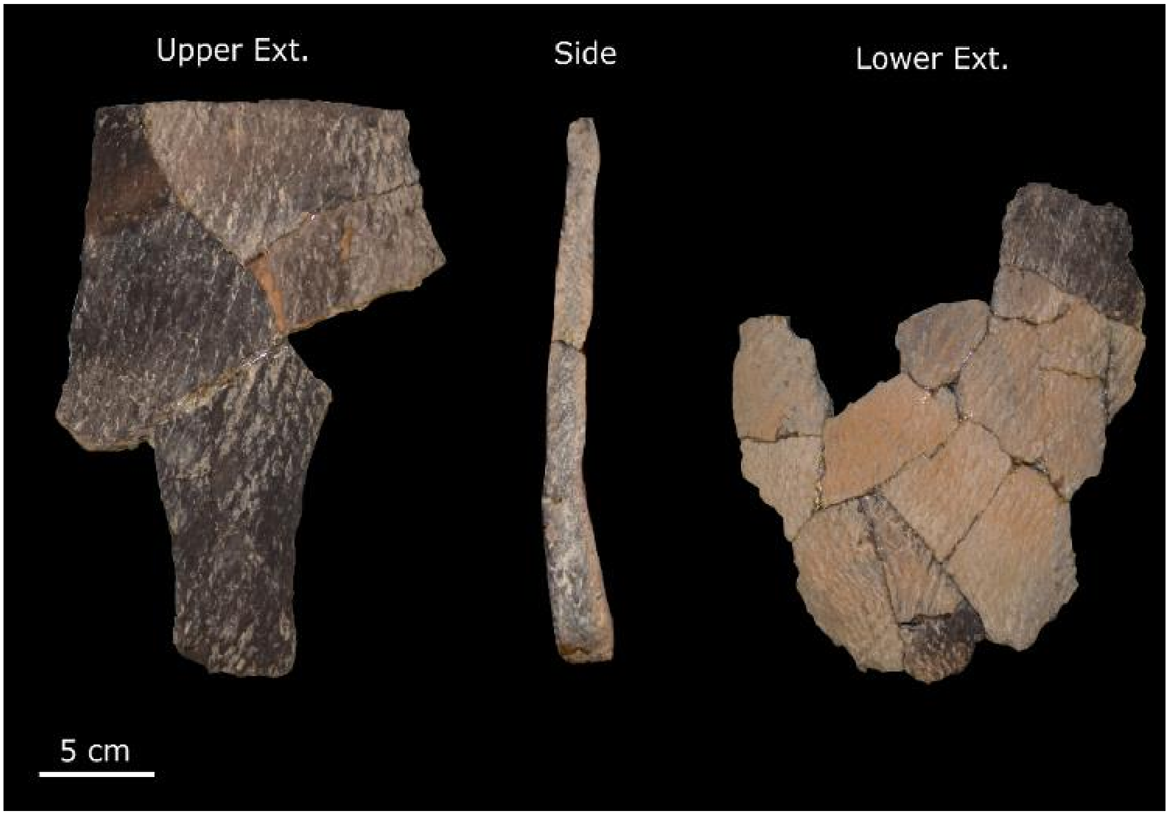
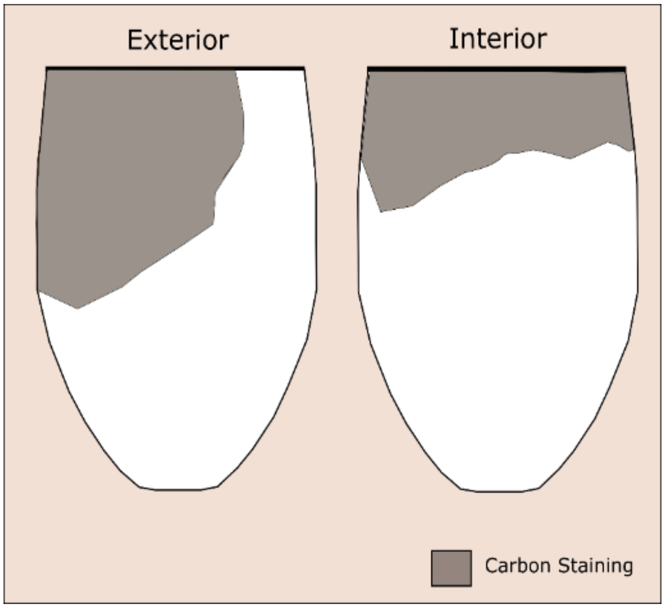


Figure 5.8 Upper and lower portions of a reconstructed fabric impressed vessel from the 39JK63 site. Photographed by the author courtesy of the South Dakota State Historical Society.

Measuring from the midsection to the rim, we find a total length of 18.5 cm. Another reconstructed portion of the vessel spans from the midsection to the base, and this measures a length of approximately 23 cm. If we were to combine these measurements, this vessel would have reached an estimated height of 41.5 cm. Compared to the Arpan Mound vessel, this fabric impressed pot is approximately 13 cm taller.

The JK63 vessel is entirely undecorated with only fabric impressions visible on the exterior surface (Table 5.4). This form of fabric differs from anything else by having a woven appearance as linear patterns on the exterior of the vessel appear to overlap.

Table 5.4 Data collected from visual analysis of the 39JK63 vessel.



JK63	**Observations**
Location of Residues	Isolated clusters within interior and exterior
Decoration	Fabric impressed woven bag
Location of Sooting	Exterior with no patterning
Abrasions	No visible abrasions
Repair/Alterations	Additional clay patches
Vessel Shape	Conoidal
Polishing	None
Thickness	10 to 14 mm
Incisions	Few on interior
Temper	Coarse
Post-deposition Modifications	None

On the exterior of this vessel, raised layers of paste of a slightly lighter colour can be observed covering an original exterior surface (Figure 5.9). Fabric impressions are present on both the pasted layer of clay and the original exterior surface of the vessel. Therefore, this unusual vessel was initially constructed and marked with fabric impressions. Sometime later, additional clays were added and impressed with fabric before being fired once more.

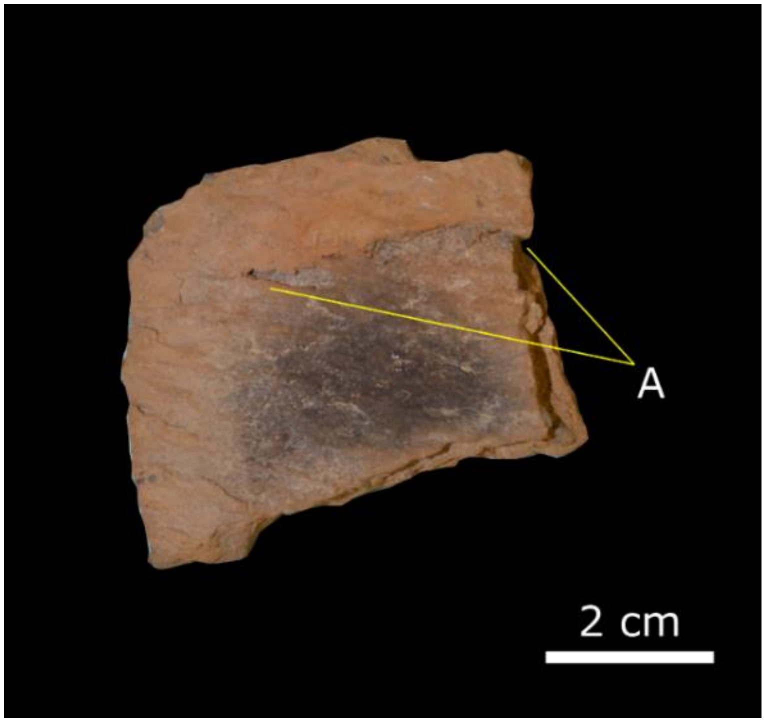


Figure 5.9 Additional clays added above fabric impressed exterior. New clays added to the vessel were also fabric impressed. Photographed by the author courtesy of the South Dakota State Historical Society.

5.6. Other South Dakota Sites

Pottery examples from additional South Dakota sites such as Dirt Lodge Village (39SP11), La Roche, and 39BF44, unfortunately, were of small size and therefore could not provide information regarding manufacturing technique and use. Decorations expressed on these samples appear to contain similar traits to wares already discussed thus far, including cord roughened exteriors, use of punctate decorations, and thick vessel walls.

5.7. North Dakota and Montana Pottery

Although several small fragments were recovered from the Dune Buggy (24RV1) site of Montana, as well as the High Butte (32ME13), Indian Hill (32MZ2), and Schmidt (32MO20) sites of North Dakota, these were also found in small numbers and sizes (Figure 5.10).

Therefore, information regarding the use of these vessels was limited. During examinations of North Dakota pottery, rim fragments from the Beeber (32LM235) and Naze sites provided examples of Laurel (Figure 5.10:A) and Black Sand (Figure 5.10:G) pottery traditions.

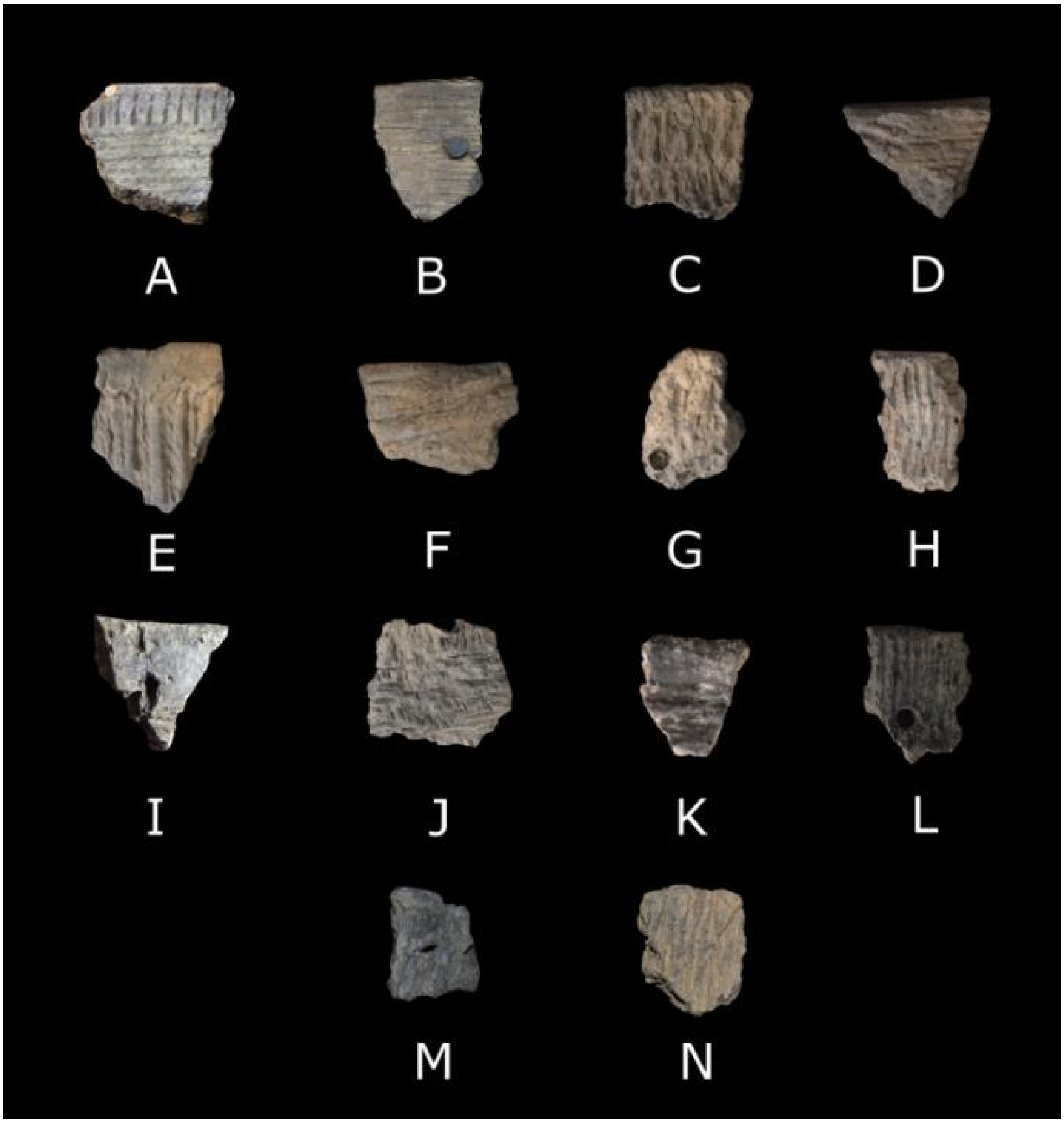


Figure 5.10 Pottery rim and near rim specimens examined from North Dakota and Montana sites: Beeber site (A), Indian Hill (B to D), Schmidt (E to G), Naze (H to L), and Dune Buggy (M, N). Scale bar represents 5 cm. Photographed by the author courtesy of the North Dakota State Historical Society and the Smithsonian National Museum of Natural History.

5.8. The Butler-Rissler Site

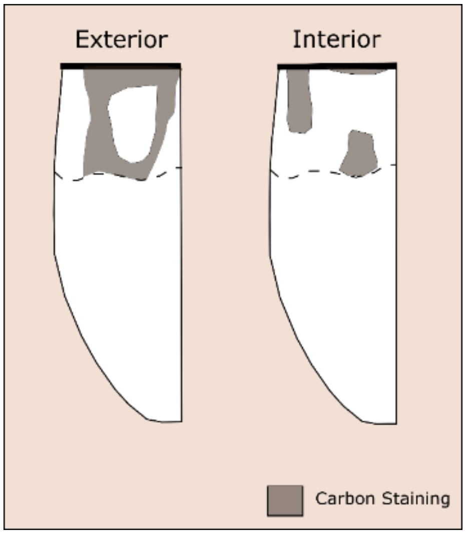
The Butler-Rissler site is situated along the Platte River of Wyoming and contained two pottery vessels, one of which was partially reconstructed (Figure 5.11). Carbonized residues from the larger of these vessels (Vessel 1) were submitted for AMS radiocarbon dating and this produced an uncorrected age of 1660 ± 90 ^{14}C yrs BP (Beta-17830) (Miller and Waitkus 1989). Along with the reconstructed vessels, there was a prominent central hearth feature that contained numerous mussel shells, carbonized prickly pear (*Opuntia macrorhiza*) seeds, and pottery fragments. Adjacent to this hearth was a large grinding stone and pestles, suggestive of food processing activities.

Well preserved cord marked pottery was a notable feature of this site. While the two vessels found at the Butler-Rissler site are over 595 km from the Sonota mounds, they are similar in terms of shape. Both vessels share common design elements with Variant 4 from the Stelzer site. The use of a Dino-Lite microscope revealed that the cord marking was composed of two-ply z-twisted cord impressions. This almost complete vessel was of significant size, with a diameter of 26 cm.

Figure 5.11 Reconstructed vessel from the Butler-Rissler site. Photographed by the author courtesy of the University of Wyoming Archaeological Repository (UWAR).

During the visual inspection of Vessel 1 from the Butler-Rissler site (Table 5.5), this vessel exhibited minimal signs of alteration apart from a drilled perforation placed upon a punctate decoration (Figure 5.12). Similar perforations have been noted within pre-contact pottery collections and are typically attributed to either repair of pottery vessels, as a form of decoration, or to enable the addition of a carrying strap (Brindley 2019; Miller and Waitkus 1989).

Table 5.5 Non-metric analysis of Vessel 1 from the Butler-Rissler Site.



Butler-Rissler Vessel 1	**Observations**
Location of Residues	Beneath lip and within punctates
Decoration	Three punctate pattern, z-twist cord
Location of Sooting	Exterior with no patterning
Abrasions	No visible abrasions
Repair/Alterations	Drill perforation with exterior bevel
Vessel Shape	Conoidal
Polishing	Polishing above drill perforation
Thickness	9 to 11 mm
Incisions	Few on interior
Temper	Fine with lamination occurring
Post-deposition Modifications	None

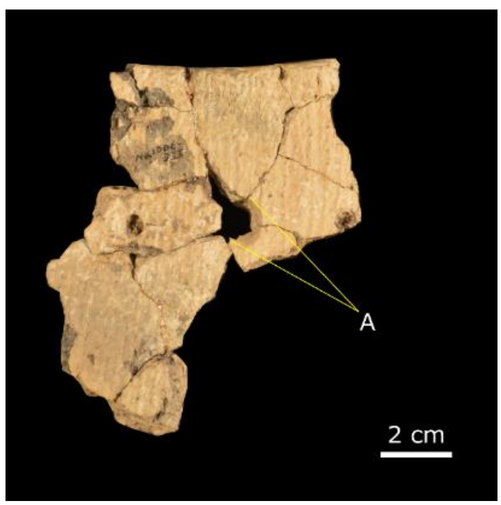


Figure 5.12 Drilled hole observed on a reconstructed rim fragment from the Butler-Rissler site. Photographed by the author courtesy of the University of Wyoming Archaeological Repository (UWAR).

Much like the Arpan Mound vessel, staining is found on the exterior extending from just above the midsection to the rim of the vessel. This staining occurs in a v-shaped pattern with the widest portion appearing along the rim. The interior of this vessel contained patches of carbonized food residue which coincided with the exterior staining on the vessel.

5.9. The Cedar Gap Site

Another Wyoming site that contained post-firing alterations to pottery was the Cedar Gap site (48NA83) (Figure 5.13). The Cedar Gap site is situated in the southernmost foothills of the Bighorn Mountain Range and the eastern fringe of the Wind River Basin. Features found at this site included at least 68 stone circles, 34 cairns, a stone lined pit, and a bison bone bed intermixed with chipped stone and a small amount of pottery (Eckles et al. 2012). A total of four radiocarbon dates were obtained from charcoal at the site and these uncorrected dates range from 2540 ± 130 to 185 ± 30 ^{14}C yrs BP (Table 5.6). Other notable finds included a mussel shell fragment of the genus *Lampsilis* that was similar in general morphology to those recovered from the Butler-Rissler site.

Table 5.6 Radiocarbon results from the Cedar Gap site reported by Eckles et al. (2012:35). Calibration was performed using OxCal v4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Context	**Phase**	**Material**	**Sample ID**	**^{14}C yr BP**	**2 σ Cal. AD**
Stone Circle	Proto-Historic	Charcoal	QL-4725	185 ± 30 BP	Out of range (1653 AD to unknown)
Area B	Besant	Charcoal	QL-4724	1960 ± 60 BP	BC 55 – AD 222
Bone bed	Besant	Charcoal	Beta-37559	1820 ± 130 BP	BC 54 – AD 542
Area A	Pelican Lake	Charcoal	Beta-62486	2540 ± 130 BP	BC 939 – 379

In total, 120 cord marked pottery fragments were found and according to Day (1996), the laminar structure of their profiles suggests these were made via paddle and anvil construction.

Akin to Vessel 1 from the Butler-Rissler site, a near rim fragment also showed signs of drilling. In this case, specimen 3035 contained two punctates that both exhibited signs of complete drilling in addition to bevelling along the edges of the punctates. A second drilled mark was observed on rim 3556 from the Cedar Gap site. For this specimen, only half of the drilled hole is present. Signs of drilling are indicated by the bevelling along the interior and exterior surface of the drilled hole.

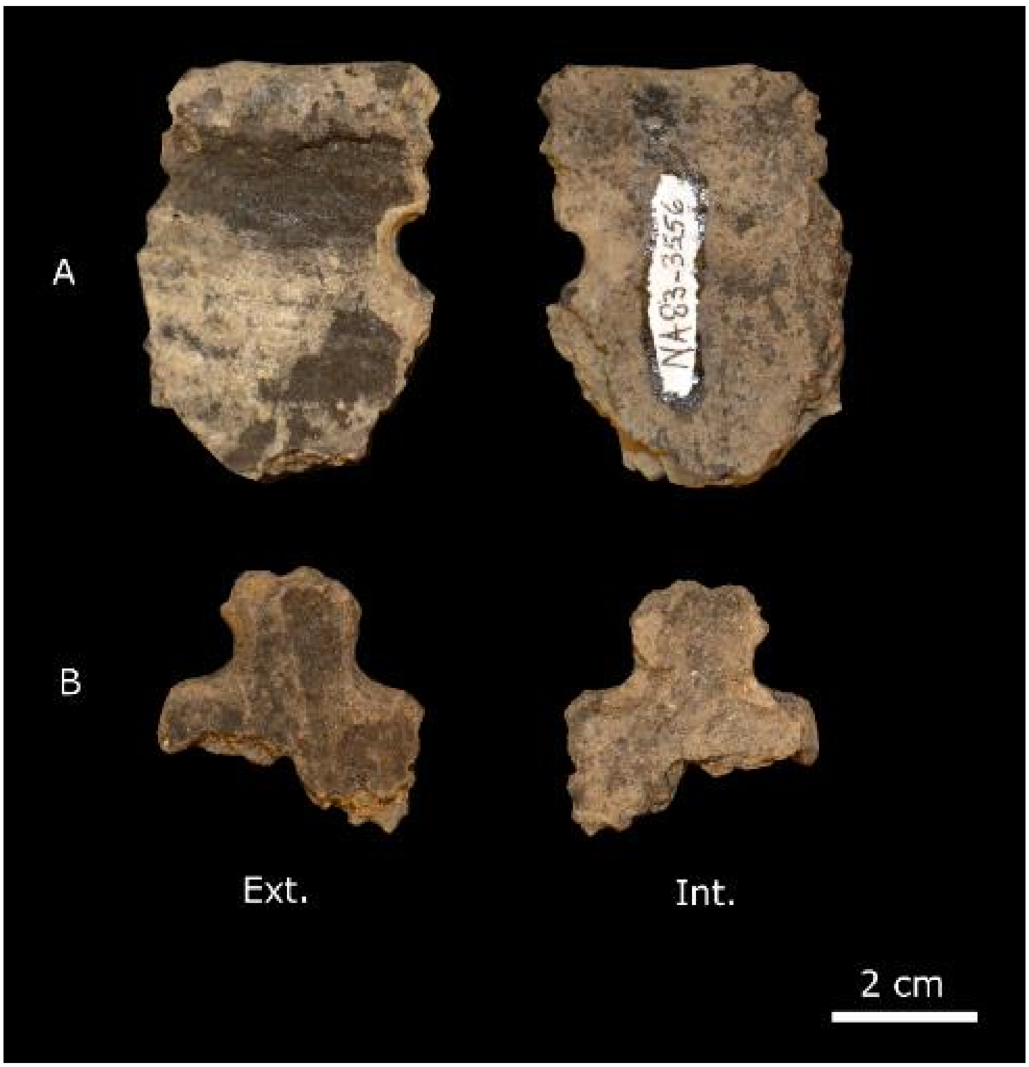


Figure 5.13 Drilled pottery rim (A) and near-rim (B) fragments from the Cedar Gap site. Photographed by the author courtesy of the University of Wyoming Archaeological Repository (UWAR).

Carbonized residues were so abundant on specimens from the Cedar Gap site that any signs of decoration or exterior treatment were hidden. Not until residues were gently lifted off the surface of the pottery were decorations and surface treatment reminiscent of Valley wares visible. Surface exteriors reported at this site consisted of both horizontal cord marking and smooth treatments, with decorations limited to punctates and vertical stamps below the rim.

5.10. The Greyrocks Site

The Greyrocks site (49PL65) is a multicomponent campsite situated along the east bank of Cottonwood Draw, a drainage which flows into the Laramie River of Wyoming (Tibesar 1980:23). Non calibrated radiocarbon dates collected from the Besant component place this site as occupied sometime around 1750 ± 110 (RL-955) and 1890 ± 120 ^{14}C yr BP (RL-955) (Table 5.7).

Table 5.7 Radiocarbon results from the Greyrocks site reported by Tibesar (1980:23). Calibration was performed using OxCal v4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Context	Phase	Material	Sample ID	^{14}C yr BP	2 σ Cal. AD
Hearth	Besant	Charcoal	RL-704	1750 ± 110 BP	AD 61 – 554
Camp	Besant	Charcoal	RL-955	1890 ± 120 BP	BC 162 – AD 414

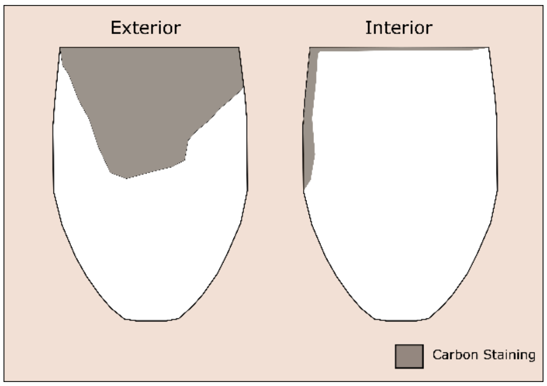
The Besant component of this site is defined by a diagnostic projectile point and an almost complete cord marked pottery vessel (Figure 5.14). The location of this vessel near a basin-shaped hearth and quartzite cobbles led Tibesar (1980:30) to hypothesize that stones were used to prepare foods in this vessel as its straight walls did not allow it to be hung over a fire. Tibesar (1980:30) presented the conclusions of Iliff (cited in Vehik 1977) that the placement of such cobbles within vessels filled with water caused them, and the vessel, to break.

Figure 5.14 Reconstructed portions of the Greyrocks vessel showing v-shaped carbon staining and "rising' rim profile. Photographed by the author courtesy of the University of Wyoming Archaeological Repository (UWAR).

This vessel measures approximately 21 cm in height and 14 cm in diameter, which makes this pot slightly shorter than the one found within Arpan Mound (28.5 cm in height and 19 cm in width). The lip of this vessel is gently rounded and it bears no decorations. The unevenness of the wall profile and overall shape of the vessel is reminiscent of paddle and anvil construction. The exterior surface is marked by irregularly spaced, and sometimes overlapping, oblique cord-marking that is tighter and more horizontal near the rim (Tibesar 1980:58). Carbon staining on the exterior mirrors the v-shaped staining observed on the Arpan Mound, 39JK63, and Butler-Rissler vessels. These patterns on the Greyrocks vessel suggest that it was placed beside the fire and carbonized food residues on the upper interior provide additional evidence of this practice.

Although not bearing any decoration, the lip of this vessel rises to form a hump when viewed from the side (see Figure 5.14). This 'rising rim' is present on the Butler-Rissler vessel, but is more pronounced in this small pot. Visual analyses of this vessel did not yield any evidence of cultural modification through maintenance and repair (Table 5.8). Owing to its placement near a fire and carbonized encrustations along all surfaces of the vessel, including breakage points, it is likely that it broke during use.

Table 5.8 List of traits observed during use-alteration analyses of the Greyrocks vessel.



Greyrocks Vessel	Observations
Location of Residues	Beneath the lip, along broken edges, and on exterior
Decoration	Irregularly spaced z-twist cord
Location of Sooting	Exterior with no patterning
Abrasions	No visible abrasions
Repair/Alterations	None
Vessel Shape	Conoidal
Polishing	None
Thickness	8 to 10 mm
Incisions	None
Temper	Fine to intermediate
Post-deposition Modifications	None

5.11. The Walter Felt and Ratigan Sites

The northernmost pottery specimens in this study were recovered from the Ratigan (DhMs-10) and Walter Felt sites in south-central Saskatchewan. The latter of these sites is considered by some to represent the oldest pottery recovered within Saskatchewan, and possibly the Canadian northern Great Plains (Watson 1966). The visual analyses from the Walter Felt site will be presented first, followed by the results from the pottery of the Ratigan site.

5.11.A. The Walter Felt Site

The Walter Felt site contains dense archaeological deposits from multiple periods. Starting at the surface, deposits include a Late Period bison kill along with horticultural equipment, clay gambling dice, a Besant-Sonota campsite, and an earlier Pelican Lake campsite (Watson 1966). In total, 20 stratigraphic layers were identified, with Besant-Sonota materials being identified in layers 10 to 13 (approximately 80 to 100 cm below surface level). Upon excavations of this site in the late 1950s, several radiocarbon dates were collected from samples of charcoal (Table 5.9). Besant-Sonota pottery from this site is both typical and atypical. Descriptions of Walter Felt site pottery will begin with the atypical vessel.

Table 5.9 Radiocarbon results from the Walter Felt site excavations reported by Watson (1966). Calibration was performed using OxCal v4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Context	**Phase**	**Sample ID**	**Material**	**^{14}C yr BP**	**2 σ Cal. AD**
Layer 4	Plains Woodland	S-280	Charcoal	400 ± 40 BP	AD 1434 – 1526
Layer 6	Prairie Side-Notch	S-203	Charcoal	700 ± 80 BP	AD 1203 – 1412
Layer 7	Prairie Side-Notch	S-202	Charcoal	1260 ± 70 BP	AD 649 – 896
Layer 10	Besant	S-201	Charcoal	1535 ± 80 BP	AD 381 – 655
Layer 10	Besant	S-260	Charcoal	1535 ± 90 BP	AD 350 – 659
Layer 13	Besant	S-200	Charcoal	1610 ± 70 BP	AD 329 – 599
Layer 15b	Pelican Lake	S-279	Charcoal	2430 ± 90 BP	BC 793 – 379

5.11.A.i. Rim 4452

While punctates and oblique CWT markings are not too different from variants of the Stelzer site, what is remarkable is the design of the lip of the vessel. In this case, the rim has been indented to resemble a pseudo-wave profile when viewed from above (Figure 5.15). Within these indents on the interior and exterior are the CWT designs. This rim was found in Level 13c, placing this item within the Besant occupation of the site. This distinct vessel design is not seen in any of the pottery specimens examined in this study. This rim section also does not contain evidence of a shoulder, which is an attribute defining many Late Woodland traditions in Saskatchewan such as Sandy Lake, Clearwater Lake Punctate, and Mortlach (Meyer 1987; Taylor-Hollings 1999).

Figure 5.15 Cord roughened rim fragments from the Walter Felt site having CWT impressions and a scalloped shaped lip. Photographed by the author courtesy of the Royal Saskatchewan Museum.

Paddle and anvil construction appears to have been used for Rim 4452 as the cross-section of this specimen had a layered appearance. Carbonized residues were present on the interior and exterior of the vessel with many residues being recovered from the interior CWT markings.

5.11.A.ii. Rim 14 and Rim 15/16

The remaining Level 13 rims have cord roughened exteriors, yet the arrangement of these markings is opposite from one another (Figure 5.16). Again, decorations are not out of the ordinary for pottery of this time as Rim 15/16 is undecorated and Rim 14 has a single row of punctates immediately below the rim.

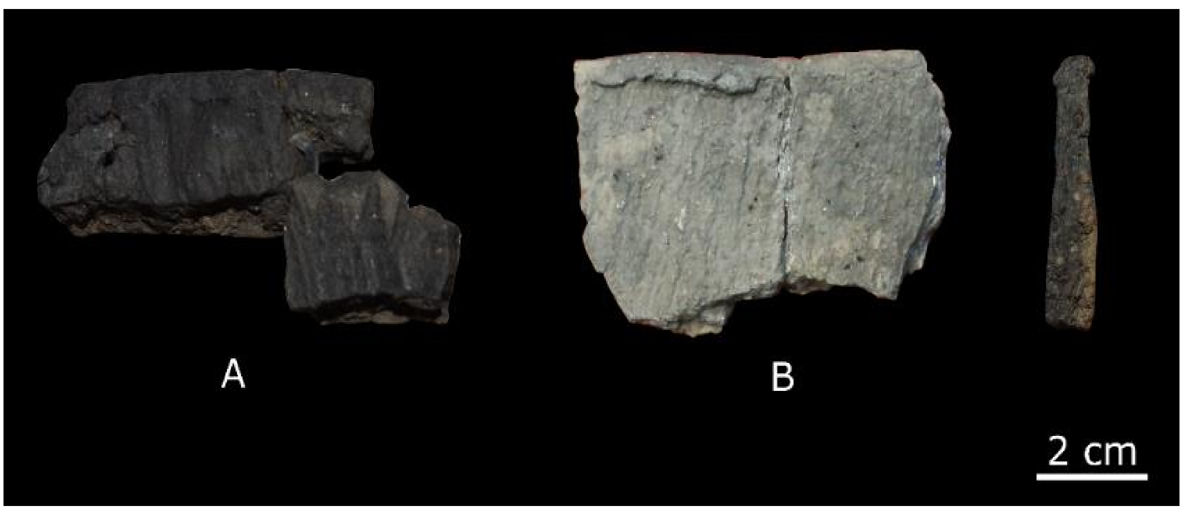


Figure 5.16 Cord roughened rim specimens from the Walter Felt site. Rim 14 (A) exhibits a single row of horizontal punctates and rim 15/16 (B) is undecorated. Photographed by the author courtesy of the Royal Saskatchewan Museum.

5.11.B. Ratigan Site

The Ratigan site had 50 tipi rings, numerous features, Besant projectile points, and pottery. It is important to note that later components were also present at this site, and therefore pottery that was analyzed in this study was limited to rim sherds of sufficient size to allow identification. At the time of this study, radiocarbon dates were unavailable. At the Ratigan site, Besant-Sonota looking rims were found with fabric impressions on both the interior and exterior. This is quite unusual for pottery of this period. These markings are placed in a different orientation on the interior and exterior, eliminating the possibility that these were made by the excess fabric, clothing, or other materials being folded over the rim of the vessel (Figure 5.17). The exact cause of these markings may truly be impossible to determine.

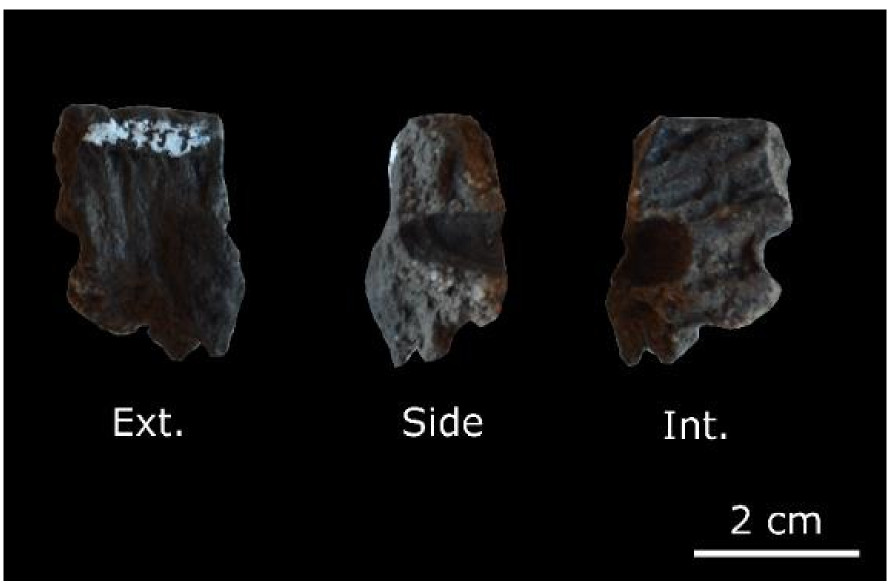


Figure 5.17 Rim specimen 3959 from the Ratigan site (DhMs-10) having interior and exterior cord roughened surfaces. Photographed by the author courtesy of the Royal Saskatchewan Museum.

5.12. Summary of Besant-Sonota Pottery

Examination of pottery fragments that were of sufficient size or contained idiosyncratic design elements from the northern Great Plains during the Besant-Sonota timeframe led to the identification of several trends in terms of decoration techniques, vessel construction, and vessel use.

5.12.A. Decoration Techniques

Apart from research by Scribe (1997), most archaeological literature on Besant-Sonota pottery provides limited discussions on decoration applied to the earliest pottery wares from the northern Great Plains. Such descriptions focus on the exterior surface treatment, the use of punctates, and the thickness of the vessel walls.

After analysis of pottery in this study, decorations were noted in the form of punctates, CWT impressions, incised lines, stamping, and stamp-and-drag designs. A consistent trend for pottery in this time range was the placement of design features just beneath the rim of these vessels. Decorations were also not limited to the neck and rim of the vessel, as design elements were placed on the body and basal specimens recovered from the Stelzer site (see Appendix A.1). Another trend was the placement of decorations in repeated intervals. This became most evident when examining the reconstructed Arpan Mound and Butler-Rissler vessels as punctates were imprinted in a numerical pattern. In the case of the Butler-Rissler vessel, punctates were placed in a horizontal line in groups of three and on the Arpan Mound vessel, every fifth punctate was placed slightly higher than the previous four.

5.12.B. Manufacturing Techniques

Like the few detailed studies of Besant-Sonota pottery decorations, archaeological literature manufacturing focuses on the conoidal shape of these vessels and surface treatment when discussing Besant-Sonota pottery (Scribe 1997; Walde et al. 1995). Examination of pottery specimens in this study led to the identification of two types of wall profiles:

1. A single colour of paste with no vertical laminations, and
2. Multiple vertical layers that appear to sandwich an internal layer of paste that may or may not contain a different colour.

The first type represented the typical design profile of pottery vessels from this survey and was likely produced by the placement of a single portion of clay that was formed via paddle and anvil construction. This is most evident in the uneven interior surfaces of pottery samples examined in this study. It is important to note here that fabric or cord impressions are often recorded in this technique as this type of material would be placed on the exterior side of the vessel while the wooden paddle or stone anvil was pressed against the interior of the pottery vessel. The other manufacturing style noted earlier (exhibiting the vertical layering observed in the cross-section) may have been formed as sequential layers were added during the paddle and anvil technique (Figure 5.18). Again, the manufacturing techniques used to prepare these vessels add diversity to Besant-Sonota pottery.

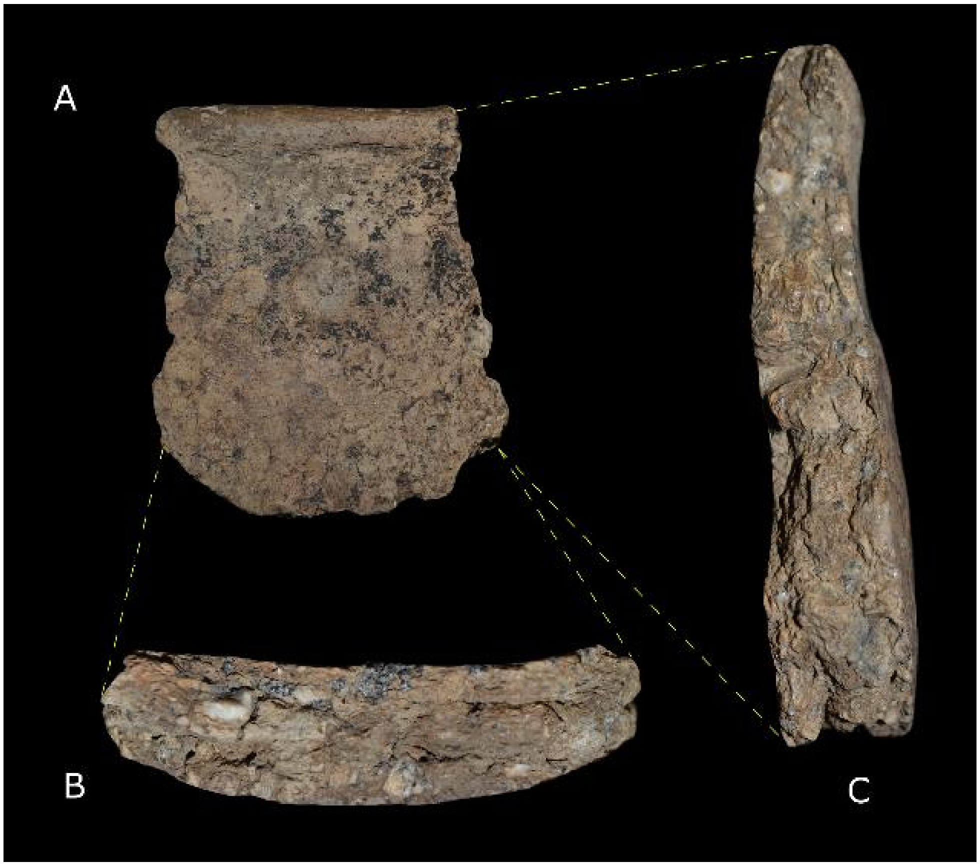


Figure 5.18 Examples of layering within the walls of pottery recovered from the Stelzer site. (A) Exterior rim, (B) view from the base of the fragment, and (C) side profile. Images from Variant 1 are not to scale but enhanced for comparison. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

In addition, a variety of rim shapes were also noted within this study, particularly at the Stelzer site where 11 distinct variants were observed at a single archaeological deposit. The Stelzer collection has a wide variety of shapes ranging from angular to rounded forms. This diversity in rims is typical for pottery in this time range, as also noted by Tiffany (1978) in contemporaneous assemblages from Iowa.

5.12.C. Visual Analysis of Besant-Sonota Pottery

Prior to this survey of Besant-Sonota pottery of the northern Great Plains, the archaeological literature often reported a lack of diversity in pottery styles of this time. This statement is true in some respects, especially when considering how these vessels were used. The presence of v-shaped stains on one side of reconstructed vessels from the Butler-Rissler, JK63, and Arpan Mound sites all suggest that these large conoidal vessels were placed alongside a fire while foods were boiled in the clay pot. This similarity provides a glimpse into food preparation activities that northern Great Plains adapted peoples completed during this time.

Nevertheless, the results of this pottery survey revealed a diversity of forms that included the use of multiple decoration techniques, differing manufacturing techniques, a minimum of three separate exterior surface treatments (smooth, cord roughened, and fabric impressed), and vessels of different rim profiles and sizes. Perhaps the most telling evidence of this diversity was observed at the Stelzer site, a single component and briefly occupied site, where 11 distinct variants were observed. This diversity in pottery styles at a single site occupied over a brief window of time leads us to reflect upon the people responsible for the Stelzer site, the nearby burial mounds, and the question of how pottery fit within their lifestyle. By identifying what foods were prepared within these vessels, we can further our understanding of these issues.

Chapter 6: Analyses of Carbonized Food Residues

Pottery specimens within this study were analyzed through multiple techniques to extract information about what foods were cooked or processed within Besant-Sonota pottery vessels. The results of this paleodietary research will be discussed for each site examined on the northern Great Plains, beginning with the plant microfossil analysis and then leading to isotopes.

6.1. Contamination Testing

Recently, there has been some skepticism directed toward starch grains identified from ancient contexts (Crowther et al. 2014). The present study addressed this valid concern through comprehensive contamination testing during all laboratory activities. For the entire study, which occurred periodically between April and August of 2017, only 12 starch grains were identified during contamination testing (Appendix B.3). All these grains were circular and of small size. Although these starch grains could not be identified, their presence was noted and compared to analyses that were being performed in the laboratory. Phytoliths were absent from contamination testing. Pollen from pine (*Pinus* sp.) and birch (*Betula* sp.) were identified on two separate occasions.

After the discovery of these airborne contaminants, protocols involving cleansing of the lab were completed and samples were processed again after one week to compare against the findings of the initial processing. Comparisons of these results appeared to confirm that while unidentifiable starch grains were occasionally present within the laboratory, contamination protocols such as the use of sterile and powder-free disposable equipment, and limited handling of residues within the laboratory were successful in limiting contamination.

6.2. Phytoliths, Starch Grains, and Pollen

The first paleodietary data obtained from this dissertation was the reconstruction of the plant component of diet, namely the identification of phytoliths and starch grains. The results of the Stelzer site are discussed first.

6.2.A. The Stelzer Site, South Dakota

Representing the largest assemblage of Besant-Sonota pottery in this study, the Stelzer site presents a fascinating opportunity to examine foods boiled within pottery vessels during this time on the northern Great Plains. Samples of carbonized residues on these pottery fragments varied from 10 mg to over 120 mg (see Appendix A.2). In total, 30 pottery samples were examined from the collections held at the Smithsonian National Institute of Natural History and the South Dakota State Historical Society, representing a minimum number of 20 vessels. It should be noted that these were the only samples to have sufficient carbonized residues out of a total of 186 pottery specimens.

6.2.A.i. Plant Microfossils

Pottery from the Stelzer site was not only unique in terms of vessel variation, but also in the presence of maize within carbonized residues (Table 6.1). Out of the 30 pottery samples examined from the Stelzer site, diagnostic plant microfossils from the leaves, cob, or kernels of maize were identified in 15 of the samples. In total, seven diagnostic wavy-top rondel phytoliths, which are produced in the cob portion of maize, were detected in Stelzer rims 525, 644, 645, and A498760 (Figure 6.1). A total of 11 cross-shaped phytoliths, which are produced in the leaves of maize, were also observed for Stelzer sample 498862, as well as Rim 644 and Rim 525.

Table 6.1 Maize plant microfossils identified within Stelzer and Arpan Mound site residues.

	Cross-Shaped Phytolith	Globular Robust Phytolith	Rondel Phytolith	Starch Grain
Arpan P1	2	2	2	3
Arpan P3	1	0	3	1
Arpan P6	0	0	2	10
Arpan Interior	1	1	1	9
Stelzer 2511	1	0	0	1
Stelzer 02-A	0	0	0	0
Stelzer A498760	0	0	1	0
Stelzer 525	5	1	1	2
Stelzer 645	0	0	2	1
Stelzer 644	3	0	3	0
Stelzer HD	0	0	0	4
Stelzer 258	0	0	0	0
Stelzer A498802	1	0	0	0
Stelzer 22A	0	0	0	1
Stelzer 192	0	0	0	0
Stelzer A498861	0	0	0	11
Stelzer A49886	0	0	0	0
Stelzer 871	0	0	0	4
Stelzer A499076	0	0	0	0
Stelzer 02-D	0	0	0	1
Stelzer IntRim	0	0	0	2
Stelzer 06	0	0	0	3
Stelzer 10-23-83	0	0	0	2
Stelzer A498862	2	0	0	0
Stelzer 02-C	0	0	0	0
Stelzer 690	0	0	0	5

Stelzer 242	0	0	0	0
Stelzer 02-B	0	0	0	3
Stelzer 08	0	0	0	0
Stelzer TC 09	0	0	0	0
Stelzer TC 10	0	0	0	0
Stelzer TC 11	0	0	0	0
Stelzer TC 12	0	0	0	0
Stelzer TC 13	0	0	0	0

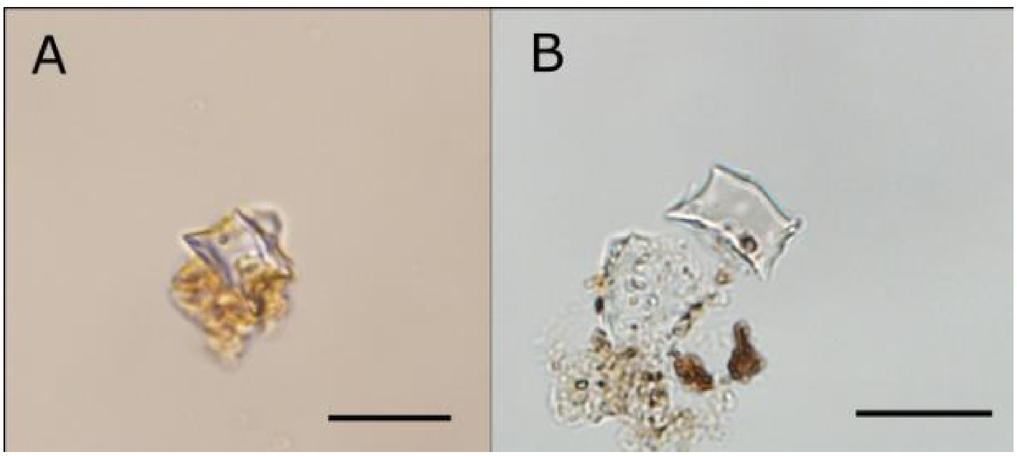


Figure 6.1 Wavy-top rondel phytoliths recovered from the Stelzer (A) and Arpan Mound sites (B). Scale bar represents 20 µm.

The remaining evidence of maize consisted of 18 y-fissure and 22 x-fissure starch grains (Figure 6.2). The overall condition of starch grains from the Stelzer site was poor, as numerous damaged starch grains bearing signs of swelling and gelatinization were observed. Other domesticated plants such as the common bean and squash were not identified in any of the Stelzer samples. In addition to maize, possible evidence of wild rice was identified via rondel phytoliths. This identification is not convincing, as the bases of these four-spiked rondel phytoliths were not visible. Hence, it was impossible to distinguish whether this was a spiked common grass phytolith or an indented base spiked wild rice phytolith. Even upon rotation, the rondel phytolith could not be freed from the encasing carbonized material. This was also an isolated occurrence; therefore, it is impossible to diagnose a confident identification of wild rice consumption.

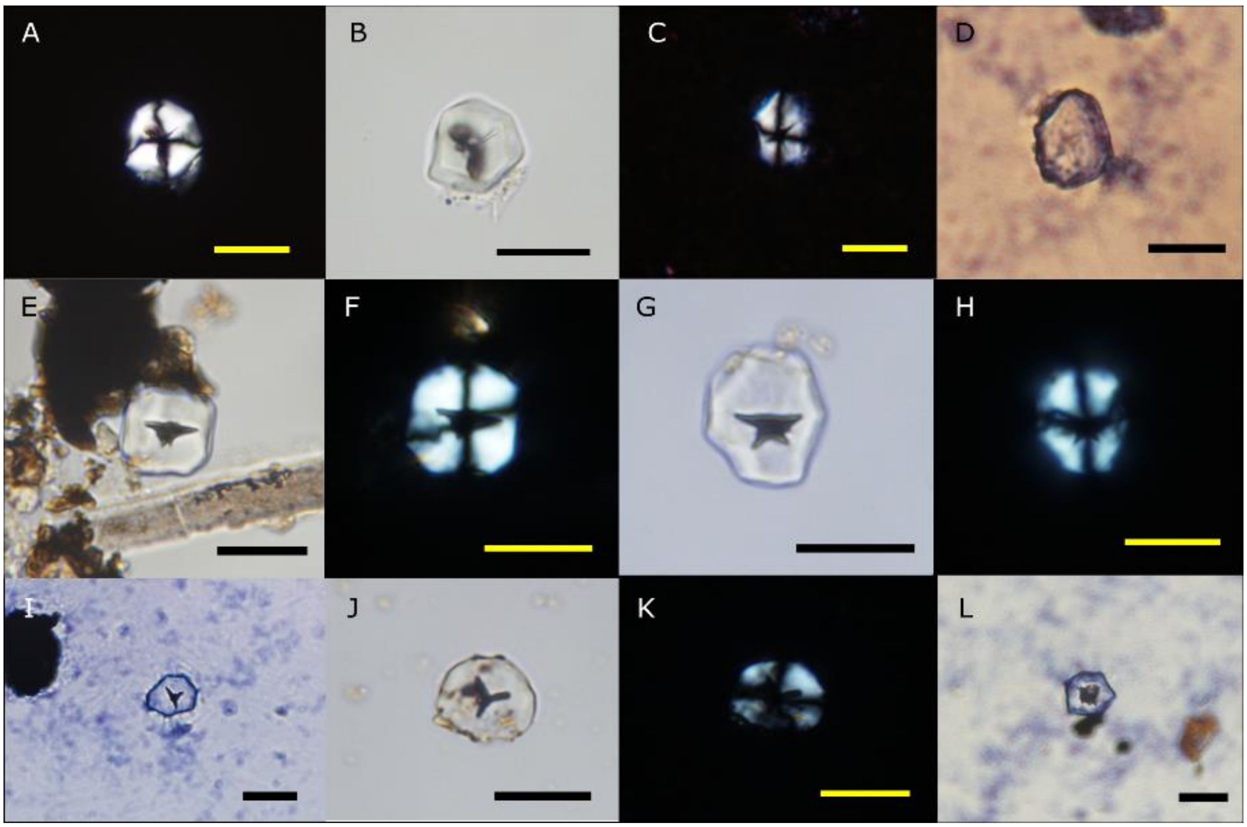


Figure 6.2 Maize y-fissure starch grains from the Stelzer (A-F) and Arpan Mound sites (G-L). Scale bar represents 25 µm.

Evidence of local edible plants was quite limited due to the amount of gelatinized or damaged starch grains that were observed. Although phytoliths were observed within these samples, these are often produced in the inedible portions of plants and consequently, starch grains serve as a more useful indicator of plant consumption. Throughout this study, starch grains were swollen and showed signs of disintegrating from prolonged exposure to heat. Despite the high number of damaged starch grains observed from the Stelzer site specimens, a few starch grains from local plants were also observed. Within residues from specimen 22A and body section 871, elongated starch grains of those produced within the tubers of white pond lily (*Nymphaea odorata*) and prairie turnip (*Psoralea esculenta*) were observed. Other plants that were observed within the Stelzer materials were tiny starch grains found in large clusters of goosefoot varieties, and small berry starches of saskatoon berry and chokecherry (Figure 6.3).

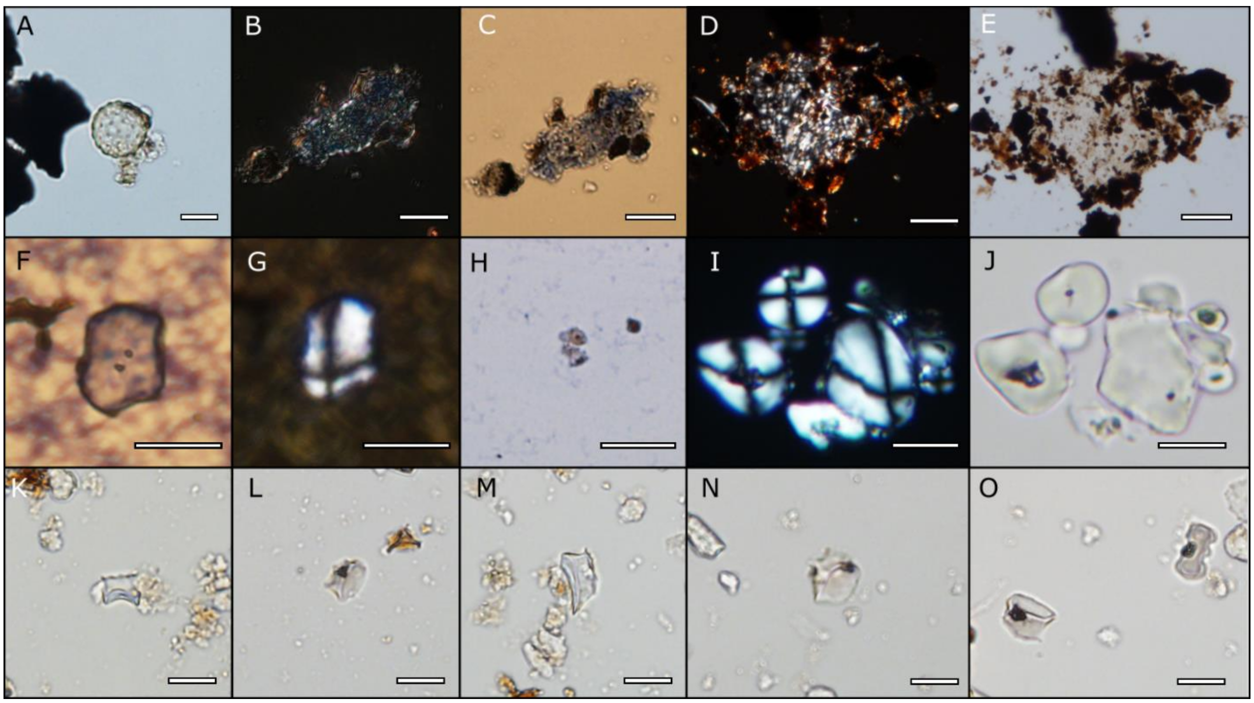


Figure 6.3 Plant microfossils identifying locally available plants from within carbonized food residues. Goosefoot (*Chenopodium*) pollen and starch grains from the Arpan Mound vessel (A to C); berry starch grains from the Stelzer site (D, E); Bell shaped starch grains from the 39JK63 vessel (F, G); berry starch grains from the Butler Rissler vessel (H); tuber starch grains from the Cedar Gap site (I-J); rondel stipa phytoliths from the Walter Felt site (K to O). Scale bar represents 20 ųm.

6.2.B. Arpan Mound Site, South Dakota

Unlike the Stelzer materials, phytoliths and starch grains from the Arpan pot were much better preserved. For instance, many phytoliths were found in their natural position as they were still encased in organic tissue (Figure 6.4).

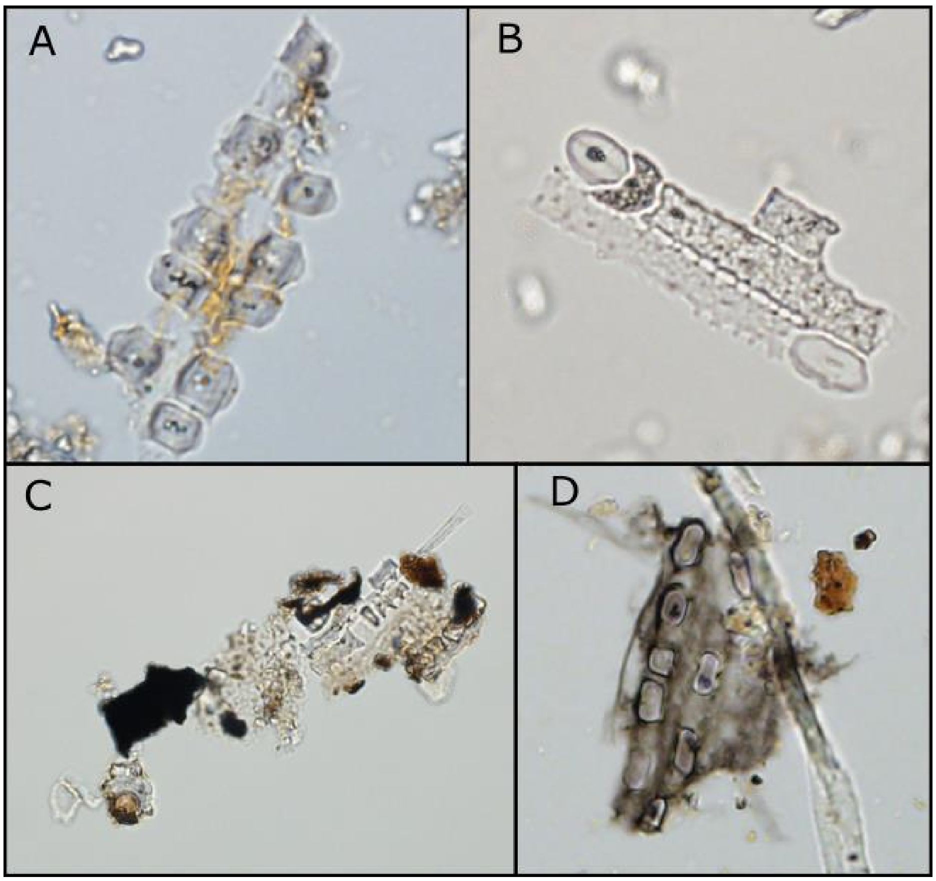


Figure 6.4 C_4 type grass phytoliths observed still encased within organic tissues and other phytoliths in their natural position within the Arpan Mound vessel (A to D).

6.2.B.i. Plant Microfossils

The Arpan Mound vessel shared similarities with residues collected from the Stelzer site. These similarities included eight wavy-top rondel phytoliths and 14 diagnostic maize starch grains. Gelatinization or overcooking evidence was noted as starch grains exhibited signs of swelling. Outside of maize, no other domesticated plant type was observed in any of the residues from the Arpan Mound vessel.

In contrast to results from the Stelzer site, the Arpan pot exhibited more numerous instances of goosefoot (*Chenopodium*), berry type starches from chokecherry and saskatoon berry, and large starches from tubers such as white pond lily. Evidence of goosefoot was identified by both pollen and starch grain evidence. Additional evidence of goosefoot was collected in the form of large clusters of starch grains of very small size, ranging from 2 to 5 µm.

In total, 56 berry starch grains were found within the interior and exterior residues examined from the Arpan pot. These starch grains resembled those produced by chokecherry and saskatoon berry in size, extinction cross, visible hilum, and overall shape. There were other elongated starch grains that, in many cases, were heavily gelatinized (Figure 6.5). One of these examples had sufficient features for possible identification. A large starch grain with a length of over 30 µm was partially concealed by carbonized material, yet the hilum and extinction cross could be deciphered. The orientation and placement of the extinction cross and hilum were comparable to those reported by the underground storage units of white pond lily (see Figure 6.5).

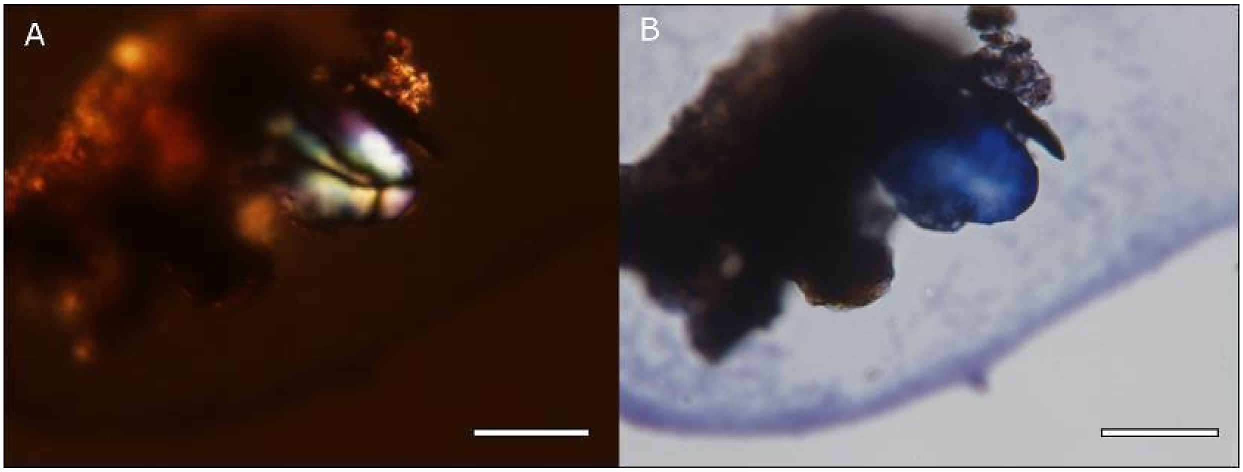


Figure 6.5 A gelatinized, elongated starch grain resembling those produced by white pond lily from the Arpan Mound vessel (A and B). Scale bar represents 20 ųm.

6.2.B.ii. AMS Dates from Carbonized Residues

In addition to the microfossil and isotope analyses, three carbonized residue samples from the exterior punctates of the Arpan vessel were sent to the André E. Lalonde AMS Laboratory for analysis. These specimens were from punctate 4 (5 mg), punctate 5 (45 mg), and punctate 11 (35 mg). Of these three samples, all were successful in yielding a radiocarbon date (Table 6.2; Figure 6.6).

Table 6.2 Radiocarbon results from the Arpan Mound vessel (carbonized residues). Calibration was performed using OxCal v4.4 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Lab ID	Material	^{14}C yr BP	2 σ Cal. AD
UOC-15139	Carbonized food residues	1640 ± 31	267-272 (0.8%) 361-539 (94.6%)
UOC-15140	Carbonized food residues	1746 ± 29	242-401 (95.4%)
UOC-15141	Carbonized food residues	1718 ± 32	250-295 (27.5%) 310-412 (68%)

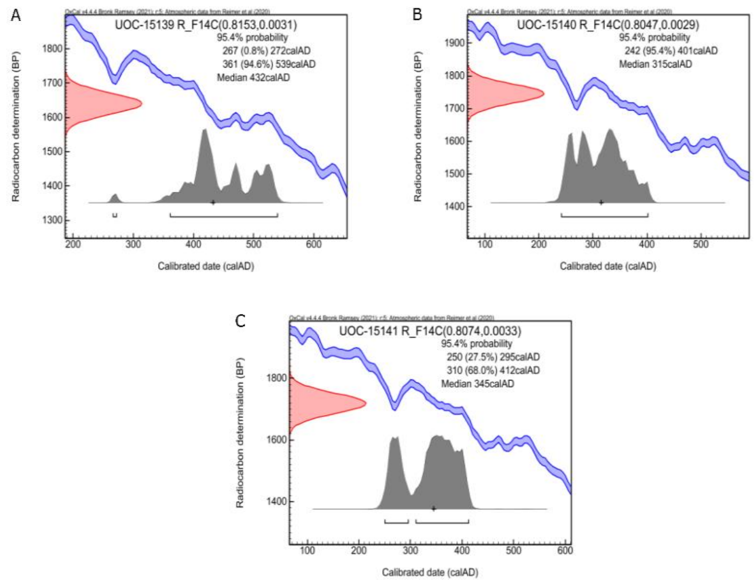


Figure 6.6 Calibration curves of three archaeological residue samples from the Arpan Mound Vessel: A) UOC-15139, B) UOC-15140, and C) UOC-15141.

A previous, conventional radiocarbon age from the Arpan Mound site resulted in a date of 1850 ± 90 ^{14}C yrs BP (Neuman 1975:53). The large standard deviation made for a lengthy intercept range extending from 2103 to 1416 years BP when 2 σ calibrated. One new date (UOC-15139) had the smallest amount of carbon, a factor that may have influenced the accuracy of that date, which produced a slightly later range of calibrated values (Figure 6.7). The other two new AMS ages (UOC-15140 and UOC-15141) are contemporaneous with calibrated values for the Stelzer site occupation (Figure 6.8).

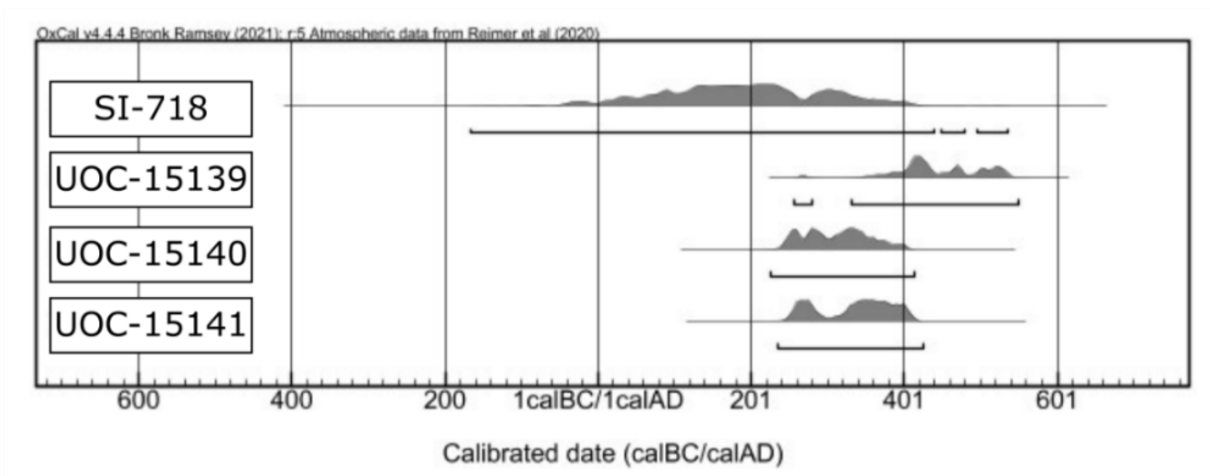


Figure 6.7 Calibration age range probabilities (Reimer et al. 2020) from three AMS radiocarbon samples obtained from the Arpan Mound vessel compared to the single date collected by Neuman (1975:53).

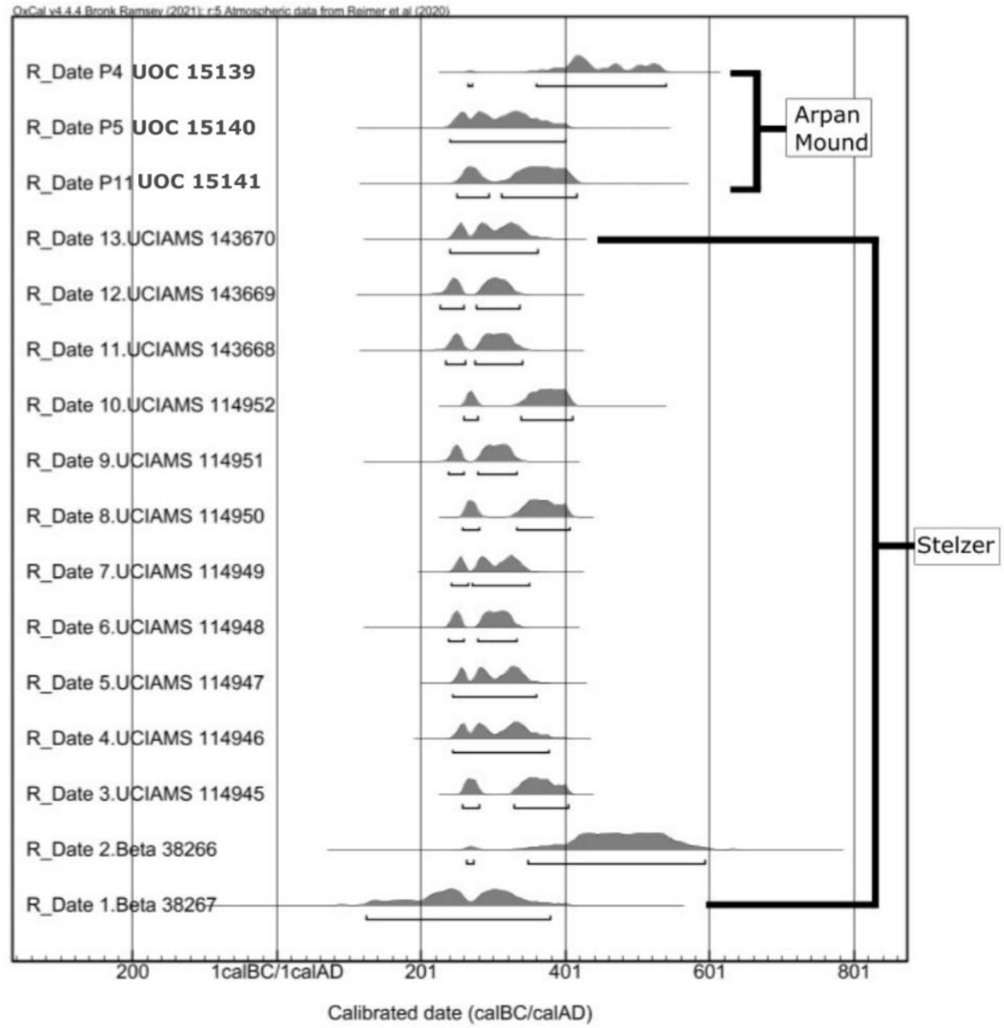


Figure 6.8 Calibration age range probabilities from AMS and conventional dates collected from the Stelzer site (Graham 2014; Haberman and Travis 1995) and the Arpan Mound (this study).

Together, the Stelzer and Arpan data provide a clear indication of early maize consumption by Besant and Sonota era hunter-gatherers living on the northern Great Plains. This topic will be further discussed in Chapter 9.

6.2.C. Grover Hand Pipe Bowl, South Dakota

Carbonized residues (15 mg) were also examined from the interior of the Grover Hand pipe bowl. Several small (under 10 µm), square-shaped starch grains with a 90º extinction cross (Figure 6.9) were identified. Unfortunately, the starch grains identified from this sample do not yield a defining trait that could be used to provide a confident identification of plant type.

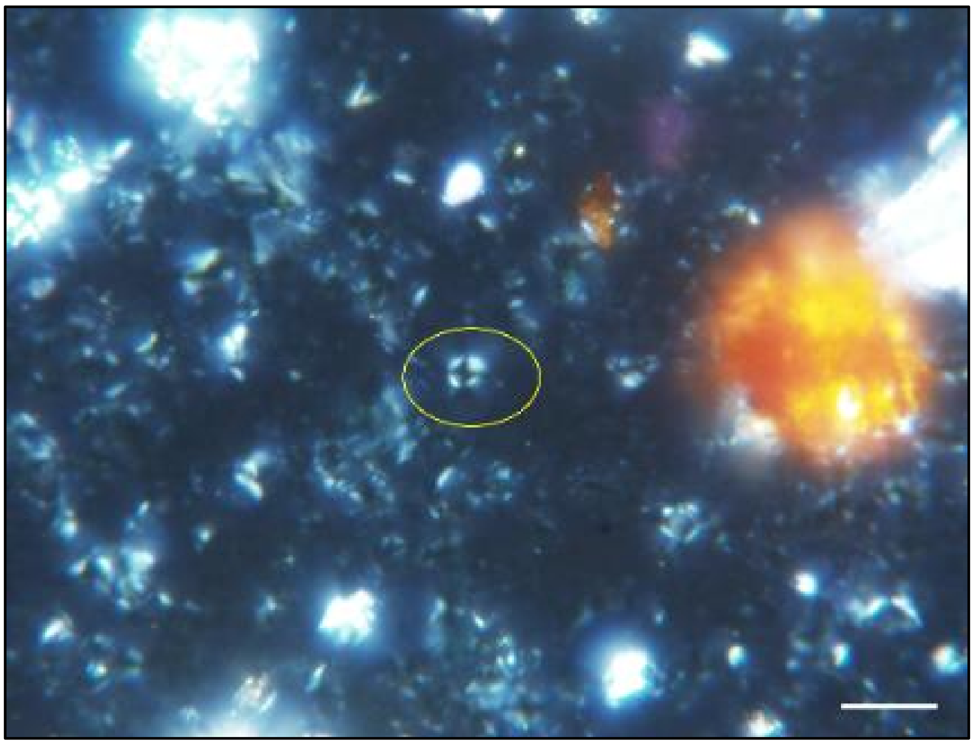


Figure 6.9 A single, square starch grain observed from residues collected from the Grover Hand pipe bowl (circled in yellow). Scale bar represents 20 ųm.

6.2.D. Site 39JK63, South Dakota

6.2.D.i. Plant Microfossils

Despite the large size of the 39JK63 vessel, carbonized residues were found in limited quantities for three separate samples from the rim and midsection of the cooking vessel.

Phytolith counts were achieved through multiple testing of residues, yet these did not yield evidence for domesticated plants.

In terms of starch grains, on the other hand, three bell-shaped starch grains comparable to those produced by squash varieties were identified. These starch grains were in the size range of 25 to 35 μm and exhibited faceted bases where additional starch grains would have been attached. One of these starch grains had a small hilum near the base and signs of damage along the sides (see Figure 6.4). This damage was highlighted using Trypan Blue, a dye that is absorbed by damaged areas of organic tissue. In addition to the bell-shaped starch grains, two fragments of scalloped shaped phytoliths were also reported. Although it is tempting to use these partial fragments to identify squash, a definitive conclusion was not possible owing to their incompleteness.

Berry starch grains that appeared in five clusters ranging from 20 to 40 μm in residues gathered from the 39JK63 vessel. A total of 78 berry starch grains, approximately 5 to 10 μm in size, were in the process of gelatinization.

6.2.E. The Butler-Rissler Site, Wyoming

The Butler-Rissler site represents a unique opportunity to examine a largely reconstructed vessel that was recovered from within a large hearth feature. Although a second rim fragment was recovered from this site, no carbonized residues were present. In addition to evidence of freshwater mussel consumption at this site, macrobotanical evidence of prickly pear was also reported by Miller et al. (1986).

6.2.E.i. Plant Microfossils

Plants that were identified via phytoliths were limited to common grass species such as fowl blue grass (*Poa palustris*). The overall majority of phytoliths observed during counts of these residues represented C_3 grasses. As for starch grains, both vessels yielded a large amount of small circular starch grains found in clusters. At least 150 small circular starch grains were found within one of these clustered deposits (see Figure 6.4). Some of these berry starch grains closely resemble those produced by chokecherry. While many of these appear to be in the berry range of size, others were more consistent with smaller types produced by goosefoot. It is important to note that plant microfossil evidence of prickly pear was not observed, despite the presence of macrobotanicals within the hearth feature.

6.2.F. Cedar Gap, Wyoming

The Cedar Gap site of Wyoming produced pottery vessels that were encrusted with thick layers of carbonized residues. In total, eight samples were examined representing a minimum number of two separate pottery vessels.

6.2.F.i. Plant Microfossils

Despite a large amount of carbonized food residues, no diagnostic plant microfossils were reported. Of the samples that yielded sufficient phytolith counts, common grass varieties were reported in samples 3352 and 3662 in abundance, largely in the form of those more typical of C_3 grasses. Although 18 circular starch grains were reported in each of the vessels, none of these exhibited any diagnostic features. These circular starch grains were approximately 20 to 25 µm in width, had a circular hilum at the centre, and a 90º extinction cross. While these characteristics are found in maize starch grains, no x- or y-fissures were observed. Therefore, these grains cannot be identified as maize. Analogous to other sites already reported, gelatinized starch grains were also common within residues from the Cedar Gap site.

6.2.G. The Greyrocks Site, Wyoming

The last Wyoming site examined in this study provided an almost complete vessel for carbonized food residue analysis. A single maize cross-shaped phytolith was identified within a soil sample collected at the site (Tibesar 1980:69). It should be noted that cross-shaped phytoliths are also commonly produced by many types of grasses and are no longer used to confidently identify the presence of this domesticated plant. No other diagnostic maize phytoliths were identified and Tibesar (1980:69) indicated a need for future research to gauge the antiquity of this plant microfossil.

6.2.G.i. Plant Microfossils

Despite the abundance of residues from the Greyrocks vessel, limited plant microfossils were identified. Phytoliths were identified and mostly belonged to common grass phytolith types, but none from maize. Unlike the Butler-Rissler and Cedar Gap sites, no starch grains could be identified as these were gelatinized beyond the point of recognition. In Chapter 5, I noted the presence of residues along the sides of rim fragments revealing that this vessel may have broken in place during cooking activities. If this was indeed the case, it provides a suitable explanation for the high number of gelatinized starch grains as foods were directly exposed to fire for an extended interval of time.

6.2.H. The Walter Felt Site, Saskatchewan

At the time of the discovery of the Walter Felt site, conventional radiocarbon dates were acquired placing the Besant-Sonota contexts at some time between 1710 and 1305 cal BP (Watson 1966) (Figure 6.10). As these radiocarbon results were obtained over 60 years ago, new bone collagen dates were sent to the André E. Lalonde AMS Laboratory for analysis. Of all the materials collected from Besant-Sonota contexts, only two bone fragments were curated at the Royal Saskatchewan Museum (Table 6.3). In addition, from the two bone samples reportedly from Level 13, another two samples were collected from two scapula hoes (one from Level 1 and another from Level 3) and a scapula fragment with an embedded projectile point from Level 3. While not related to Besant-Sonota contexts, these two samples provided an opportunity to further refine the chronology of pre-contact gardening in Saskatchewan. Calibration curves can be viewed in Appendix C.2.

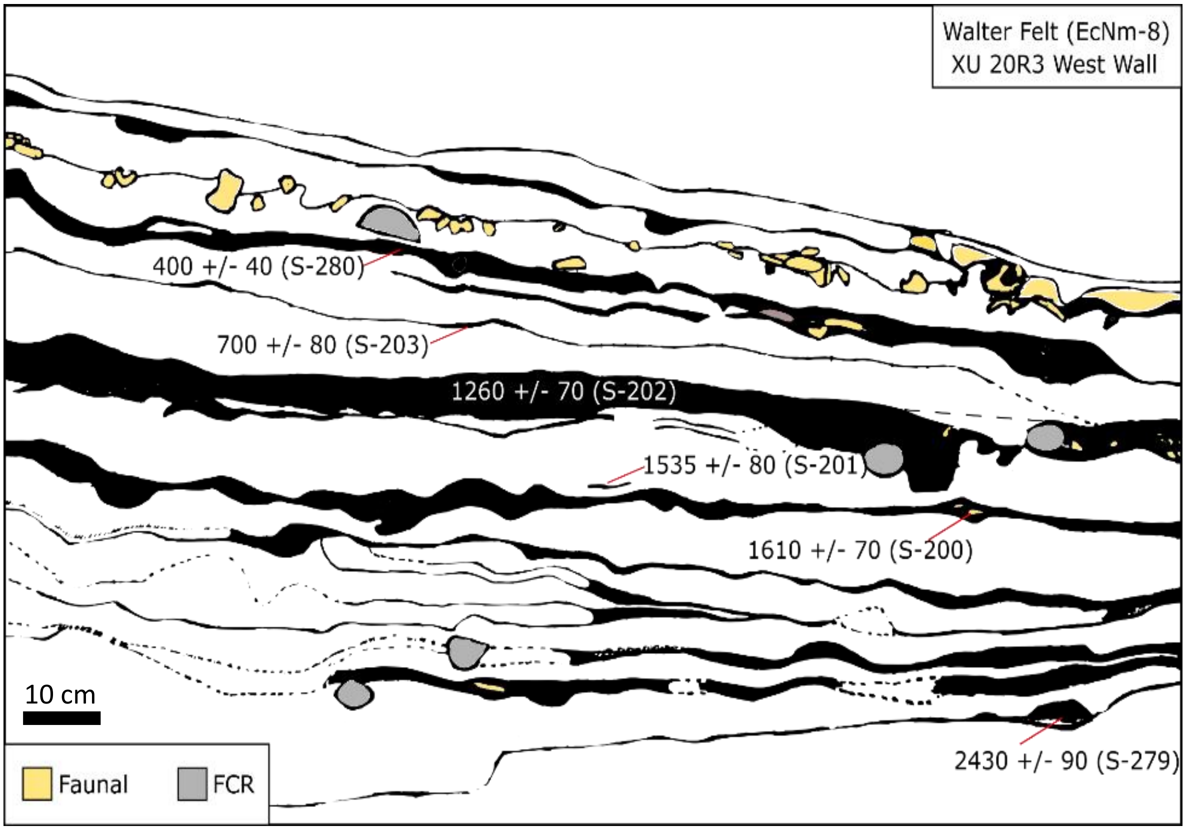


Figure 6.10 Stratigraphic wall profile of excavation unit 20R3 of the Walter Felt site and associated radiocarbon and obsidian hydration dates obtained by Kehoe in 1955.

Table 6.3 AMS radiocarbon analyses of five bone collagen samples from the Walter Felt site. Calibration was performed using OxCal v4.3 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Sample ID	Level	Material	^{14}C yr BP	±	2 σ Cal. AD
UOC-12277	13	Bone	319	33	1481-1646 (95.4%)
UOC-12278	13	Bone	Failed	Failed	Failed
UOC-12279	3	Bone	400	40	1431-1527 (66.3%) 1555-1633 (29.1%)
UOC-12280	1	Bone	124	27	1678-1765 (33.4%) 1800-1896 (46.6%) 1903-1940 (14.9%)
UOC-12281	3	Bone	Failed	Failed	Failed

Unfortunately, new radiocarbon analyses did little to clarify the chronology of the Walter Felt site. With respect to the five samples, only three yielded sufficient collagen for testing. The one sample that revealed a date for Level 13 (UOC-12277), the supposed Besant deposit at the Walter Felt site, was later than anticipated. It should be noted that only two bone samples from Level 13 were available for dating and both had been covered with resin during curation activities. The other two ages came from later scapula hoes (UOC-12279 and UOC-12280) discovered in Levels 1 and 3 of the site. These fell within the Late Woodland timeframe expected for horticultural materials (Figure 6.11). These two dates provide important insights into the timing of horticulture just prior to European contact.

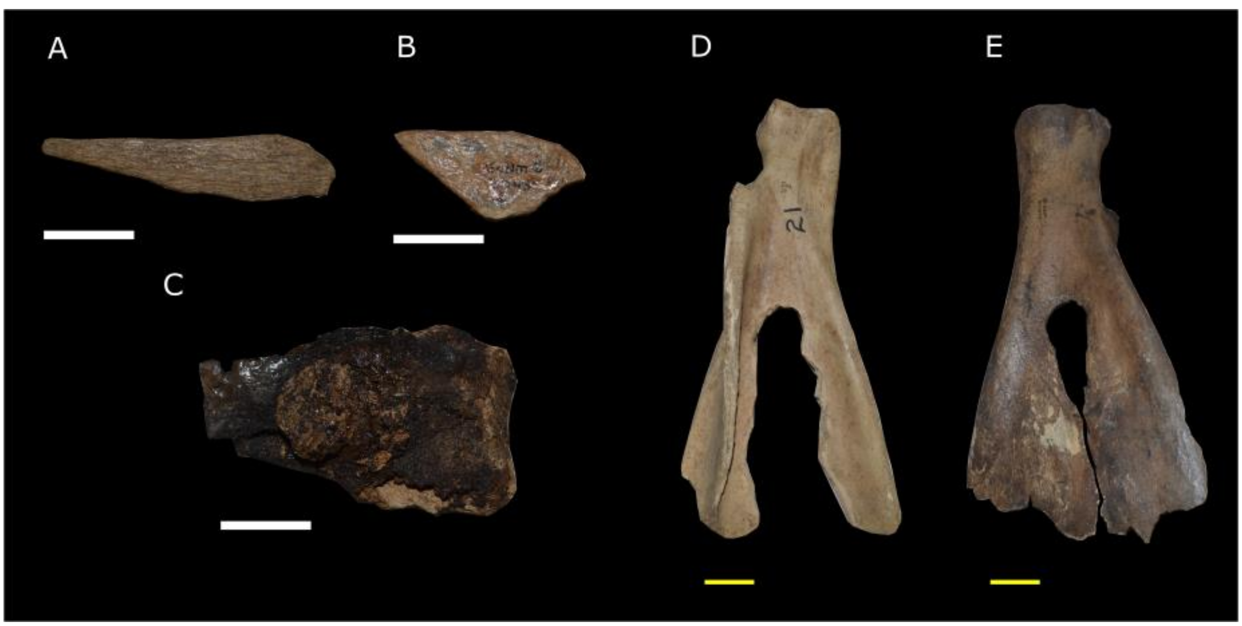


Figure 6.11 Bone specimens from the Walter Felt site sampled for AMS radiocarbon analyses: A) bone fragment (WF_3345_13a), B) bone fragment (WF_3720_13b), C) scapula fragment with embedded side notched-projectile point (WF_2133_03b), D) layer 1 scapula hoe (WF_3588_1), and E) layer 3 scapula hoe (WF_3588_3a). Scale bars (white and yellow) represent 2 cm. Photographed by the author and courtesy of the Royal Saskatchewan Museum.

6.2.H.i. Plant Microfossils

Phytolith deposits within carbonized residues from Rim 4452, Rim 427, and Rim 430 all provided the highest number of C_3 grass phytoliths recorded in this study. As these phytolith counts seemed unusually abundant compared to previous sites examined, residues were tested on multiple occasions to confirm these results. All tests resulted in abundant C_3 phytoliths with several identifiable grass species. These identified plants included needle-and-thread (*Hesperostipa comata*), meadow fescue (*Festuca pratensis*), slough grass/teal grass (*Beckmannia syzigachne*), and fowl blue grass (see Figure 6.4). These grasses that were found within the residues are commonly found growing in the Walter Felt site area today. Starch grains were absent on all the samples apart from Rim 4452. This rim produced a total of 14 starch grains, but unfortunately, no diagnostic features were visible.

6.2.I. The Ratigan and Crane (DiMv-93) Sites, Saskatchewan

The Ratigan and Crane sites represent two pottery-bearing Besant-Sonota sites from southern Saskatchewan. Ratigan is a tipi ring site and the Crane site is a multicomponent campsite with occupations from the Pelican Lake phase through to the historic period (Gibson and McKeand 1992). While the Besant components of the Crane site were dated to 1680 ± 75 ^{14}C yrs BP (S-3213), AMS radiocarbon dating of the Ratigan site had yet to be completed. As the Ratigan site yielded pottery with unique interior and exterior surface expressions, additional radiocarbon dates were acquired to aid comparisons between other sites bearing pottery. Bone collagen samples were obtained from five specimens recovered from Tipi Ring 5, which produced Besant-Sonota pottery (Table 6.4). Only one of these dates (UOC-12283) fit precisely within the proposed timelines for Besant and Sonota of 2000 to 1150 BP (Epp and Dyck 1983; Reeves 1983) and 2400 to 1000 BP (Duke 1991; Peck 2011). As the Ratigan site was also occupied several times by hunter-gatherer societies, these AMS radiocarbon dates likely reflect repeated occupation and re-use of tipi rings. Calibration curves can be viewed in Appendix C.2.

Table 6.4 AMS radiocarbon analyses of five specimens from the Ratigan site. Calibration was performed using OxCal v4.3 (Ramsey 2009) and the IntCal20 calibration curve (Reimer et al. 2020).

Sample ID	Material	^{14}C yr BP	2 σ Cal. AD
UOC-12282	Bone	533 ± 24	1324-1345 (14.7%) 1393-1436 (80.7%)
UOC-12283	Bone	1857 ± 26	85-228 (95.4%)
UOC-12284	Bone	268 ± 24	1521-1575 (33.0%) 1585-1590 (0.7%) 1626-1668 (56.9%) 1782-1797 (4.8%)
UOC-12285	Bone	498 ± 24	1407-1445 (95.4%)
UOC-12286	Bone	836 ± 26	1160-1260 (95.4%)

Carbonized residues were in low amounts and although phytolith counts were achieved, no diagnostic phytoliths were reported. By the same token, no starch grains were observed exhibiting diagnostic features. Although numerous starch grains were identified from samples of the Ratigan (n=11) and Crane sites (n=38), all of these occurred in clusters and showed signs of significant gelatinization and mechanical wear.

6.2.J. Specimens with No Diagnostic Microfossils

Pottery from several sites in this study failed to yield sufficient plant microfossils or any diagnostic forms from locally available or domesticated plants. These sites included the Grover

Hand, 39DW256, 39DW255, Dirt Lodge Village (39SP11), and 39BF04 sites from South Dakota; the Naze, Indian Hill, and Schmidt sites from North Dakota; the Dune Buggy site (24RV1) from Montana; and the Smith-Swainson and Ross Glen sites from Alberta.

A persistent theme amongst these sites was the scarce supply of carbonized food residues found adhering to these vessels (see Appendix A.1). In many cases, less than 15 mg was recovered, which only permitted a single round of testing. Although diagnostic forms were not present, another common theme amongst all these sites was the heavy gelatinization and wear observed on starch grains. Multiple perspectives might explain this lack of data: 1) these vessels were used to cook foods at high temperatures that decimated organic starch residues, leaving none behind for identification; 2) these pottery vessels were infrequently used; and 3) these vessels were not used to prepare plant foods. The poor preservation of starch grains provides some insight into how these vessels were used, and this will be returned to in Chapter 8.

6.3. Carbon and Nitrogen Isotopes from Carbonized Food Residues

In total, 24 carbonized food residues that were previously sampled for plant microfossils, were submitted to the Centre of Applied Isotope Studies for pre-treatment, encapsulation, and isotopic analyses (Figure 6.12). The analytical precision of the stable isotopic analyses was ±0.2‰ for both carbon and nitrogen. For this study, carbon and nitrogen ratios are expressed as $\delta^{13}C$ and $\delta^{15}N$ values as parts per thousand (per mil, ‰) relative to the PDB and atmospheric N2 international standards. A complete breakdown of these results can be viewed in Appendix C.1. The Stelzer site represented the bulk of this data with 16 carbonized food residue samples analyzed for isotopes.

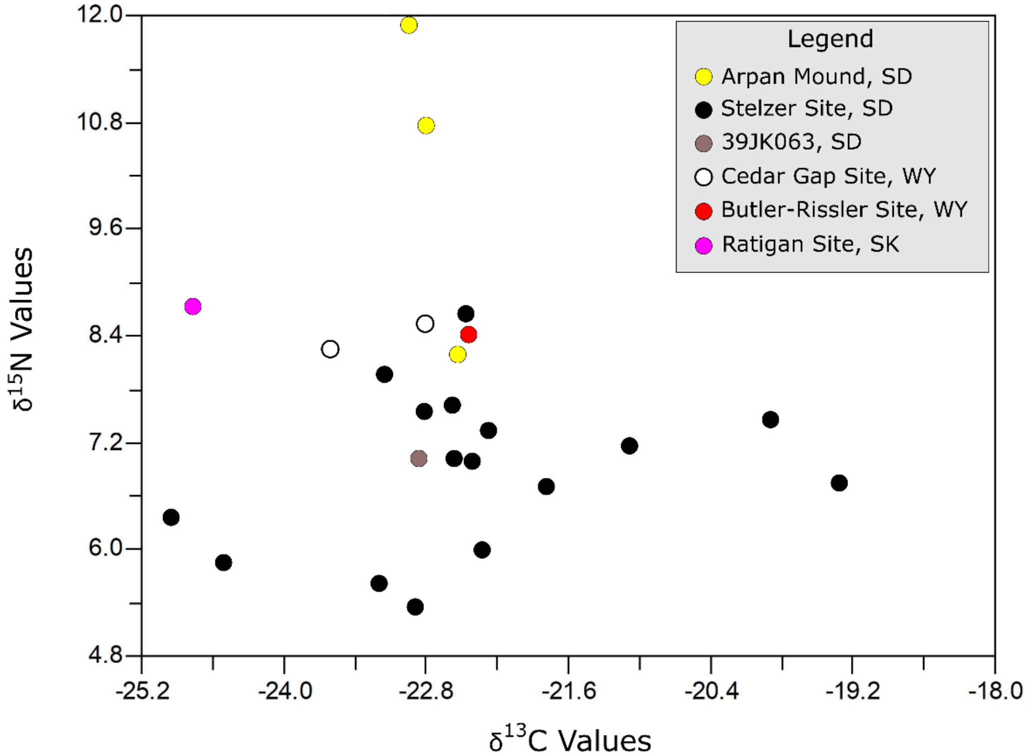


Figure 6.12 Isotopic values from Besant and Sonota carbonized residues obtained from pottery examined in this study.

The 16 specimens analyzed for isotopes from the Stelzer site represent just over half of the total residues examined from this key site. They provide an excellent gauge for determining isotopic values of food contents cooked within these early pottery vessels (Table 6.5). Resulting $\delta^{13}C$ values appear to cluster somewhat tightly around the -19.9 to -24.9‰ range and $\delta^{15}N$ values vary from as low as 5.3 to 8.6‰. The mean $\delta^{13}C$ value for the Stelzer site vessels is -22.4‰ while the mean $\delta^{15}N$ value is 6.8‰. As the Stelzer site was the only site to produce more than two carbonized samples for isotopic analyses, the mean and standard deviations were calculated for this site only. The standard deviation for the Stelzer residue values is -1.42‰ for $\delta^{13}C$ and 0.89‰ for $\delta^{15}N$.

Table 6.5 Comparison of $\delta^{13}C$ and $\delta 1^{5}N$ isotopic values with evidence for maize (P=phytolith, S=starch, and N=negative).

Sample ID	Site/Specimen	Maize	$\delta^{15}N$	$\delta^{13}C$	Summary Statistics
SD-AEX9	Arpan Pot Exterior Rim	P,S	11.9	-22.9	n/a
SD-AINR	Arpan Pot Interior Rim	P,S	8.4	-22.4	n/a
SD-AP2710	Arpan Punctates	P,S	10.7	-22.8	n/a
WY-BRV1	Butler-Rissler Vessel 1	N	8.2	-22.5	n/a
WY-BLKA	Cedar Gap 2-6	N	8.5	-22.8	n/a
WY-3556	Cedar Gap 3556	N	8.2	-23.6	n/a
SD-JK63	JK63 Vessel	N	7.0	-22.8	n/a
SK-RAT09	Ratigan Rim 3009	N	8.7	-24.8	n/a
SD-DEN	Stelzer Body A498886	P,S	7.5	-22.8	**Stelzer Site** (*n*=16) δ^{13}Carbon Mean: -22.4 Max: -19.3 Min: -24.9 Std Dev: 1.42 δ^{15}Nitrogen Mean: 6.8 Max: 8.6 Min: 5.3 Std Dev: 0.89
SD-252/2	Stelzer Body A498903	N	7.3	-22.3	
SD-1579/2	Stelzer Body A499116	N	7.0	-22.5	
SD-1292/2	Stelzer Body A499472	P,S	6.7	-19.3	
SD-1278/2	Stelzer Body A499463	N	6.7	-21.8	
SD-R222	Stelzer Rim A498880	P,S	5.3	-22.9	
SD49884	Stelzer Rim A49884	S	7.6	-22.6	
SD498885	Stelzer Rim A498885	S	7.0	-22.4	
SD-525	Stelzer Rim A499084	P	6.0	-22.3	
SD-RIM644	Stelzer Rim A499144	N	5.6	-23.2	
SD-RIM645	Stelzer Rim A499145	P	8.6	-22.5	
SD-5512	Stelzer Rim A498766	P	7.1	-21.1	
SD21073	Stelzer Collection 10	P,S	7.4	-19.9	
SD-TR09	Stelzer Collection 09	N	5.8	-24.5	
SD-TR12	Stelzer Collection 12	P	8.0	-23.1	
SD-TR13	Stelzer Collection 13	N	6.3	-24.9	

At the nearby Arpan Mound site, three specimens were examined from the large, reconstructed vessel, with two collected from the exterior punctates and the other from the interior residues. The $\delta^{13}C$ values for these three samples are almost identical, with values listed at -22.9‰, -22.4‰, and -22.8‰. The $\delta^{15}N$ values, on the other hand, were much higher on the exterior, with samples ranging from 10.7 to 11.9‰, than from the interior, which expressed values at 8.4‰. This difference in $\delta^{15}N$ values is unique as this was also the only vessel capable of providing a comparison between interior and exterior residues.

Outside of the Sonota mound area, only five residue samples were submitted for isotopic analyses and these were from the large, reconstructed vessel from the Butler-Rissler site (WY), two rim fragments from the Cedar Gap site (WY), a single residue sample from the large 39JK63 vessel (SD), and a single sample from the Ratigan site (SK). All these residues yielded isotopic values ranging between -22.5 to -24.8‰ for $\delta^{13}C$ and 7.0 to 8.7‰ for $\delta^{15}N$. While these low $\delta^{13}C$ isotopic values would argue against the presence of maize within the Stelzer and Arpan residues, we must recall that the isotopic values reflect all foods prepared within these vessels. It is possible that maize was prepared within these vessels in such small quantities that the isotopic values of this important food were not strong enough to sway the isotopic signatures of the residues. Further interpretation of these isotopic values in relation to what was found during plant microfossil analyses will be discussed in detail in Chapter 8.

6.4. Summary of Besant-Sonota Pottery Residues

Examination of carbonized pottery residues from the Stelzer and Arpan Mound sites resulted in the identification of maize, along with goosefoot, saskatoon, chokecherry, and white pond lily. Outside of these two sites, all other pottery vessels in this study were negative for maize but yielded similar evidence of both locally available berries and tubers common to the northern Great Plains. Unfortunately, many of these vessels held low quantities of phytoliths requiring multiple rounds of testing to achieve sufficient phytolith counts. The exception to this was the abundant number of grass phytoliths from the Walter Felt site. Identification of starch grains was also problematic as many were found bearing signs of overheating. Consequently, overheating of foods was a common practice within vessels used at these sites and this contributed to the low numbers of identifiable local and domesticated plant species.

After plant microfossil analyses, there are two general trends of note: 1) the presence of diagnostic maize starch grains and phytoliths indicates that minor quantities of this plant were consumed by those present at the Stelzer and Arpan Mound sites, the first time such an observation has been made for the Besant-Sonota time frame; and 2) these vessels were primarily used to boil locally available plants likely alongside terrestrial game, such as bison. Stable isotope results from carbonized residues also appear to fit within expected values for the northern Great Plains, with the highest carbon values appearing at the Stelzer site. These values do not provide independent support for maize consumption at the Stelzer and Arpan Mound site and therefore, evidence of maize consumption is limited to plant microfossil data. In addition, further isotopic sampling is recommended to differentiate between isotopic values of bison consumed at this site versus maize. Based on the results of phytolith analyses, maize was only identified in these two sites (the Stelzer and Arpan Mound sites) that we can associate with mortuary activities (mound building) that had not taken place previously in northern Great Plains settings. The presence of maize at these two sites will be further addressed in subsequent chapters.

Chapter 7: Interpreting Besant-Sonota Pottery: Manufacturing, Influences, and Uses

Archaeologists have long described Besant-Sonota pottery as thick, cord roughened conical-shaped vessels that are few in number at any one site (Scribe 1997). While it is correct that pottery within this period occurs infrequently, the sites examined in this dissertation showcase a diversity of decorations, surface expressions, shapes and profiles, and internal compositions. To interpret the findings of Chapter 5, traits observed on Besant-Sonota pottery will be compared with what has been recorded from first- and second-hand observations of pottery-making techniques.

7.1. Manufacturing Techniques

First- and second-hand accounts from northern Great Plains Indigenous pottery makers (see Chapter 2) described similarities with Besant-Sonota pottery traits, including temper choice, construction methods, and decoration techniques. These connections between artifacts and memory provide useful inspiration for interpreting how Besant-Sonota pottery vessels were constructed and used. In other words, the memories of the past can assist in investigating how the first northern Great Plains pottery vessels were made, although this is not to suggest there are direct cultural links between the Besant-Sonota time frame and nineteenth century accounts.

7.1.A. Use of Grit Temper

The type and composition of temper have often been used to infer the nature of relationships among contemporary cultures in archaeological records. For example, limestone, crushed pottery, and shell temper have been used to distinguish pottery assemblages of the southeastern United States from one another (Sassaman 1993, 1995). Every pottery specimen examined in this study was exclusively constructed with grit temper. Besant-Sonota era potters preferred grit derived temper over other alternatives. This preference was also shared by contemporaneous potters adjacent to the northern Great Plains. For instance, Rowe vessels at this time were typically constructed with the use of grit and sand temper (Tiffany 1977), and this is also true for Valley vessels of Nebraska (Adair 2016).

This widespread use of grit temper was also observed in the ethnographic accounts reviewed in Chapter 2. On some occasions, Mandan, Hidatsa, and Arikara potters collected grit temper from spent sweat lodge stones, which are still considered highly symbolic today. Posthumus (2018) noted that stones used in sweat lodges remain incredibly powerful religious symbols for Lakota and Dakota communities. The steam emitted from these stones directly represented spiritual energy moving from the ground to the heavens (Pond 1908). As these vessels needed to withstand high temperatures during firing, it is possible these special stones were incorporated into clays to add a layer of 'spiritual protection' as well as providing a sure means of creating thermal resistance. It could be that, at least in some cases, the ubiquitous grit temper usage across such a large geographic range at this time also had a symbolic dimension in the production of conical vessels (cf. Sackett 1977, 1985; Wiessner 1983, 1985).

7.1.B. Paddle and Anvil Construction

In addition to the widespread use of grit for temper, the ethnographic literature suggests pottery vessels were predominantly made using hand forming techniques, including paddle and anvil. This finding was evocative of the descriptions of pottery making by the Arikara, Mandan, Hidatsa, Cheyenne, and Eastern Dakotas. Within these cultures, hand forming was typically accompanied by some form of paddle and anvil techniques to shape clays into vessels (Grinnell

1923; Newman 1955; Wilson 1910). This technique leaves vessels with uneven interior surfaces, with signs of hands or materials used to squeeze clays being imprinted on the vessel. Scribe (1997:59) hypothesized that this was common throughout much of the Middle Woodland period.

During the visual inspection of pottery vessels in Chapter 5, Scribe's (1997) hypothesis was confirmed as all specimens spanning more than 15 cm in width exhibited signs of paddle and anvil construction. These paddle and anvil shaped vessels had irregular surfaces on the interiors with occasional markings left by a hand or anvil (Figure 7.1).

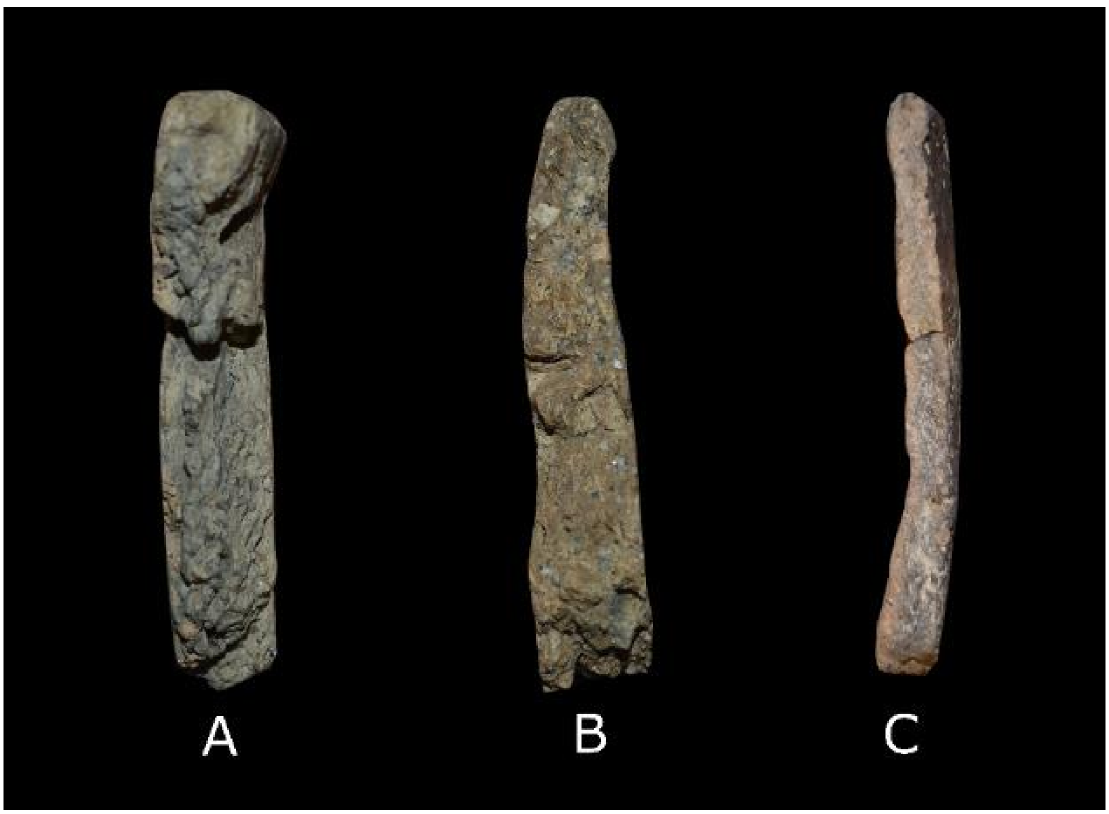


Figure 7.1 Examples of pottery wall profiles from the Stelzer (A and B) and 39JK63 (C) sites displaying an uneven interior surface and layering potentially resulting from paddle and anvil construction. Images are not to scale but are displayed for comparison. Photographed by the author courtesy of the Smithsonian National Museum of Natural History (A, B) and the South Dakota State Historical Society (C).

Another important detail is the presence of cord marked exterior surfaces on pottery found in Besant-Sonota contexts. Many of the specimens exhibited negative impressions of z-twist and s-twist cordage tied to paddles used in pottery making (Wilson 1910:273). On all specimens, these imprints were made just before the addition of decorations such as punctates and incised lines that transect these cordage markings.

These cordage markings could also have been added as an additional form of decoration. Rarely were there any signs of cord-wrapped implements being stamped, rolled, or otherwise placed on top of one another. In contrast, it appears that cordage marks were carefully placed to ensure that no impressions overlapped. This is most evident in larger samples such as Vessel 1 from the Butler-Rissler site and Variant 4 from the Stelzer site (Figure 7.2). In both cases, large sections of cordage markings are regularly spaced over the entire specimen, with no signs of repeated placement. This patterning suggests that the paddle wrapped with cordage was large enough to be pressed against sufficiently large enough portions of the vessel that would reduce the need for repetitive pressing.

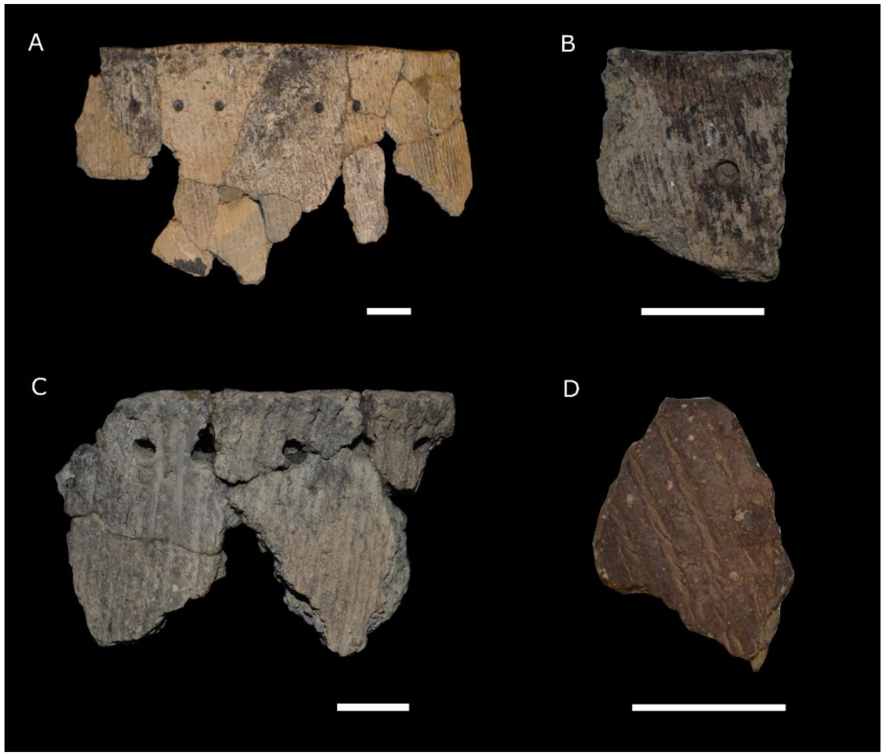


Figure 7.2 Examples of large sections of pottery vessels from the Butler Rissler site (A), 39DW256 site (B), and the Stelzer site (C and D), exhibiting distinct and unbroken patterns of cordage marks. Scale bars represent 2 cm. Photographed by the author courtesy of the University of Wyoming Archaeological Repository (UWAR) (A), the Smithsonian National Museum of Natural History (B, C), and the South Dakota State Historical Society.

Further support of paddle and anvil construction is found when looking closely at the paste of Besant-Sonota vessels. At the Stelzer site, five large vessels had vertical laminations when viewed in cross-section. These laminations may have been created when patches of clays were brought together during hand forming. Clay will fracture along the weakest points of bonding and then shrink during drying. The firing process enhances these patterns so that laminations reflect patches where new clay was added. Patching followed by hand forming, therefore, appears to have been a common technique during this time at the Stelzer site.

Evidence of such a procedure is scant in the archaeological record, although the Stelzer site did present a small fragment of modified clay. This modified clay fragment was the product of an individual squeezing a dob of clay between their fingers and then throwing this into a fire. Fingerprints of the individual's right hand are captured on both sides of the specimen. In Chapter 2, Hides-and-Eats recalled the "saving" of clays by Mandan potters (Wilson 1910:103) for repair work and such a practice was interpreted for the patching observed on vessel 39JK63 (see Figure 5.9). Perhaps this fired clay fragment was intended for use in the repair of pottery vessels, but it was not used and thrown into a campfire at the Stelzer site. Although additional information is needed to confirm whether the clays used for pottery making at the Stelzer site and the clay fingerprint were collected from the same source, the connection between the evidence for paddle and anvil construction and ethnographic accounts of patching opens the door for this to be a possibility. For a more detailed description of the fired clay fingerprint, refer to Appendix A.1.

Lastly, evidence of hand forming is supported by the scarce indications of coiling. Just as coiling was seldom mentioned in ethnographic literature reviewed in Chapter 2, so too was this rarely observed on Besant-Sonota specimens. To identify this alternative means of pottery construction, archaeologists have often searched for the presence of horizontal or angular breaks that occurred where coils of clay were bonded to one another (Kozatsas et al. 2018; Metcalf 1959). Akin to the laminations that were mentioned above, areas where coils were bonded represent potential weak points where drying and firing may create empty gaps within the wall of a vessel (Metcalf 1959). Coiling does not appear to have been a popular method used by Besant-Sonota era potters as only three rim fragments from the Stelzer site could be suspected of coil breakage. Given the small sample size for these fragments, it is difficult to be confident that these rarer breakage patterns truly result from coiling.

7.2. Alterations

Alterations to vessels were noted at the Stelzer, Butler-Rissler, Cedar Gap, and 39JK63 sites. These alterations may have been completed to modify a vessel to suit the needs of a community, to extend the lifespan of a vessel, and/or to add another layer of decoration.

7.2A. Drilled Holes

Within the Butler-Rissler, Cedar Gap, and Stelzer samples, four pottery specimens had bevelled holes suggesting purposeful drilling through the vessel walls (Figure 7.3). Similar holes were noted on pottery by Champe (1946) at Ash Hollow Cave (NE), by Johnson (1977) in Montana pottery collections, by Gill and Lewis (1977) in western Nebraska, and by Adair (2016) within Valley phase vessels of Nebraska.

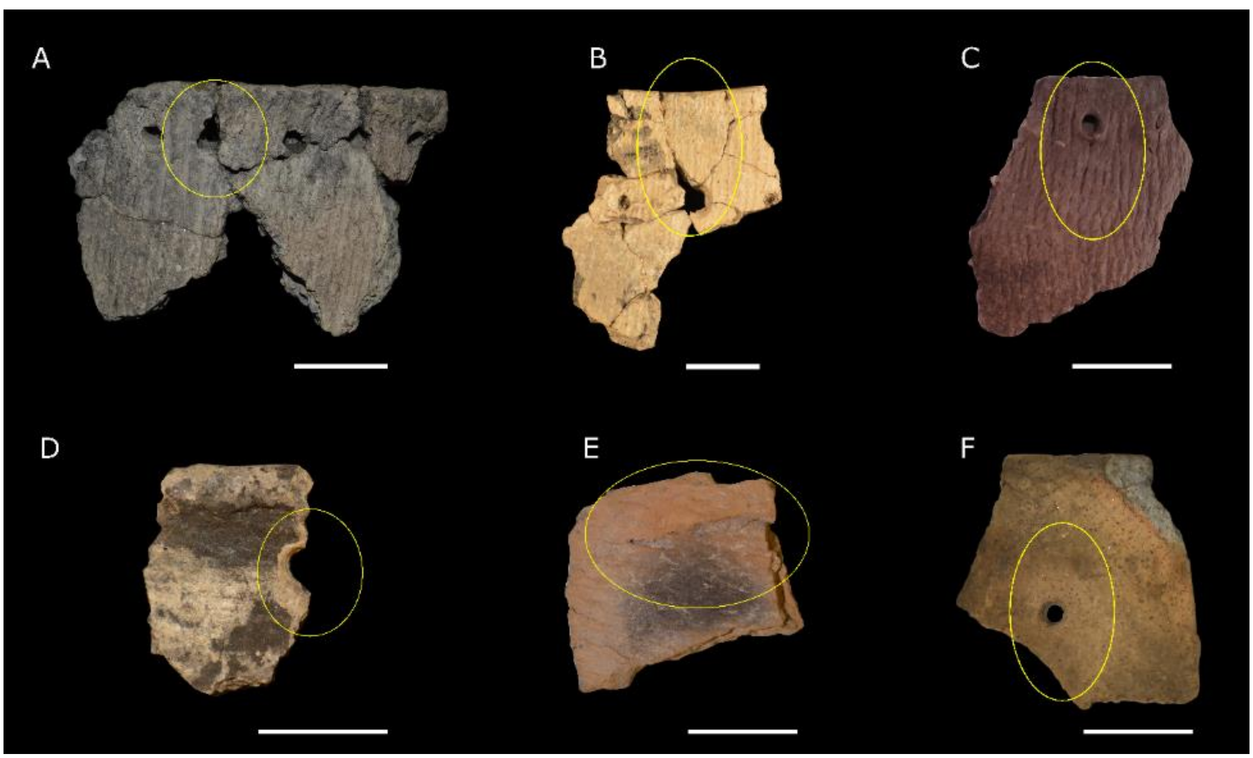


Figure 7.3 Examples of specimens bearing alterations such as drilled holes from the Stelzer site (A), the Butler-Rissler site (B), and the Cedar Gap site (D), and patching seen at the 39JK63 site (E). Additional drilled specimens from Valley (C) and South Platte (F) assemblages. Photographed by the author courtesy

of the Smithsonian National Museum of Natural History (A), the University of Wyoming Archaeological Repository (UWAR) (B, D), and the South Dakota State Historical Society (E). Scale bars represent 2 cm. Additional photographs courtesy of Adair (C) and Fogerty (F) (2021).

Wear markings directly above the drilled holes found on the Butler-Rissler vessel and Variant 4 of the Stelzer site offer some clues about their function. These markings may be the result of an item rubbing against the side of these vessels. This matches the viewpoint of Frison (1978) who believed that holes were added to allow for a carrying strap to be tied to a vessel. Mahidiwiás (Wilson 1910) also recalled the practice of tying rawhide straps to the rims of vessels to assist individuals when transporting water between sites. On some occasions, pots were held above the ground or placed upon willow ringlets to ensure their safety (Wilson 1910). With these observations in mind, the addition of a carrying strap would fit a mobile lifestyle while also providing a means to keep a pottery vessel safe above ground.

From an archaeological standpoint, another instance of this practice was more recently reported in the Valley phase by Adair (2016). A closer examination of photographs from other Valley pottery revealed the presence of drilled holes (see Figure 7.3).

For a more functional explanation of these drilled holes, we must consider the size of these conoidal vessels and the mobile lifestyle of the peoples using them. With an estimated average height of 30 cm and a capacity of six gallons (22 litres), these vessels would have required significant energy to lift (Neuman 1975:83). Even one of the smaller reconstructed vessels would have held almost 4 kilograms of liquids (Neuman 1975:62), without considering the weight of the thick fired clay. The excessive weight may not have been a major deterrent for hunter-gatherer societies, however. Items of prestige in the past were a powerful symbol of status for many communities worldwide (Clark and Blake 1994; Hayden 1995). The size, weight, and fragility of these pots may have been overlooked in favor of their ability to express status.

Lastly, these drilled holes may simply be an additional form of decoration used at this time. During the analysis of Irish prehistoric pottery, Brindley (2019) identified drilled holes along edges and in patterns. He concluded that these holes were added as decoration and that the vessels, despite bearing multiple holes, would still have been serviceable (Brindley 2019). While only four Stelzer vessels were drilled, these alterations were placed near the rim; an area that was the focal point of pottery decoration during this time. If these drilled holes were an alternate form of decoration, then it is logical that these drilled holes would be placed near the rim.

7.2.B. Experimentation with Clays

The second form of alteration was represented by circular patches of clay added to the large, reconstructed vessel from the 39JK63 site in southern South Dakota. The addition of paste to a fired vessel is uncommon within the archaeological literature, but not within ethnographic records. Recalling Chapter 2, Hides-And-Eats remembered a practice of saving clays specifically for reinforcing potential weak spots on a vessel (Wilson 1910). The wall of this pottery vessel is thinner and marked by oxidation where the clays were added. It is possible that early potters of the northern Great Plains also shared this practice. This idiosyncratic trait of the JK63 vessel showcases the ingenuity of early northern Great Plains potters in their ability to increase the lifespan of vessels. Unfortunately, only test excavations were completed at this site and no diagnostic projectile points were uncovered (Keller et al. 1984). This leaves us with further questions regarding the individuals who attempted to restore this cooking vessel by experimenting with additional clay. It is possible that these additions did not extend the lifespan of this vessel as evidence of use was not identified in this study. Aside from the additional patches of clay, the vessel was in pristine condition.

7.2.C. Interpreting the Alterations Made by Besant-Sonota Potters

Interpreting these alterations depends on how common pottery was at this time and whether Besant-Sonota peoples made pottery themselves or acquired these vessels through trade. When estimating the number of pottery vessels identified within Besant-Sonota era contexts, this number is minuscule compared to the overall number of sites. In 2014, Graham mapped over 2500 Besant sites with only 56 of these having pottery. In addition, most of these 56 sites contained less than four vessels. The outlier to this trend is the Stelzer site, which had an estimated 15 to 20 vessels. Neuman (1979) developed the estimates based on his excavated sample from the Stelzer site. Based on the presence of 11 distinct variants, Neuman's estimate is reasonable. Considering that only a small portion of the Stelzer site was excavated, this number may only be a small fraction of the pottery vessels that were used at the site. Indeed, the Stelzer site is anomalous compared to other Besant-Sonota era sites. In total, only an estimated 67 vessels were identified in the current study. This number was established by counting the number of distinct rims that could be identified as belonging to a separate vessel. Body and basal fragments were not used for vessel estimates. This low frequency of both pottery bearing sites and vessels within them should be considered when attempting to interpret why these vessels were repaired or altered. Though present, pottery is indeed rare at Besant-Sonota sites.

Archaeological research on infrequency has some merit here (Smith 2017:4). Infrequent finds have been attributed to the existence of a small number of sites, survey and excavation methods used by archaeologists, and poor preservation (Smith 2017:4). But this does not offer any explanations for items that are significant. Zedeño (2009) has suggested that infrequent finds are statistical outliers whose interpretive ability is dependent on their context. Further, Marshack (1990:460) described low frequency as a visible expression of creative efforts from individuals. Consequently, scarcity does not always equate with a lack of importance. Before an artifact is labelled scarce, its potential for positive and negative effects on community needs must be considered (Smith 2017:4).

In Chapter 3, the positive and negative effects of using pottery were summarized. Rice (1999) outlined the numerous positive health and dietary effects generated by pottery use in hunter-gatherer populations but found that many of these effects only occur with regular pottery use over generations. As the use of pottery was so limited during the Besant-Sonota era and there is limited evidence of intergenerational use, it is doubtful that pottery would have offered many dietary and nutritional benefits to Besant-Sonota era peoples. Perhaps these large conical vessels provided other social benefits.

A possible social benefit may have been the use of these vessels as presentation devices. Larger Besant-Sonota vessels may have held attractive symbolic qualities as these could be placed at the centre of food-related activities and decorated with designs belonging to a community. These pots would not have gone unnoticed by individuals within the community, and potential visitors. The reconstructed vessel from site 39JK63 stood approximately 40 cm tall while the now lost Stelzer completed vessel had a capacity of 33 litres (Neuman 1975). These large pottery vessels may have been prominent during special occasions when a single vessel could be used to prepare a considerable amount of food. If we were to estimate the portion size of foods prepared within a vessel to be conservatively one cup (or 250 ml), 90 to 140 individuals could have received one portion from the contents of a single vessel. Suppose we extrapolate this value for the Stelzer site, which contained an estimated 20 vessels. In that case, this value increases to an estimated 1,800 to 2,800 people assuming all vessels were used at the same time and were of similar size. A larger serving size would diminish the number of servings, but even with that, the vessels could serve a large gathering.

It is no coincidence that the Stelzer site, which is situated among a series of burial mounds, contained the most pottery of all sites examined. Ritual activities are times when symbolism is at its highest within many cultures. Any actions, items of adornment, dress, and other paraphernalia became something more during these events (Levy 2006). If pottery vessels were used as presentation devices, this may explain their increased presence compared to other Besant-Sonota sites.

Pottery vessels were also placed within burials, which were significant ceremonial events. The placement of items within burials and ritual spaces is viewed by Osborne (2004) and Rajan (2008:45) as a visible representation of their importance to past societies. The single, large conical pottery vessel at the Arpan Mound was surrounded by bundle burials (Vehik 1983:283). This is a clear symbolic use of pottery by Besant-Sonota era peoples. The arrangement of deceased community members around a single large vessel likely delivered a powerful message to all participants in burial activities that seem to reflect a feast either for the attendants of the mortuary practice or for the dead or their spirits. This symbolic importance, coupled with evidence for alterations, resonates with a message that these 'rare' items played an important role in these past societies. Pottery vessels that Besant-Sonota era peoples used were adapted to fit their different, more highly mobile lifestyles and were well maintained. In addition, they were left behind at sites where ritual activities were occurring, especially mortuary rites involving ancestors in the Sonota burial mound contexts. Although infrequent, pottery vessels were an important component of the material culture for some Besant-Sonota era communities.

7.3. Decorations and Influences

7.3.A. Decorations

Beginning with the Stelzer site, this study highlighted the variability of pottery crafted by Besant-Sonota era peoples. The Stelzer site provided 11 variants that showcased three forms of surface expression and multiple decoration types, manufacturing techniques, and rim profiles. Design elements often included interior and exterior punctates, dentate stamps, incised lines, CWT markings, irregular markings, and fingernail impressions.

An interesting detail uncovered in Chapter 5 was the placement of decorations in patterned sequences (Figure 7.4). Repeating punctates were visible on Variants 1, 3, and 4 from the Stelzer site, in addition to Vessel 1 of the Butler-Rissler site. Neuman (1975) also reported that the large Stelzer burial pot had a repeating pattern of arching fingernail impressions coinciding with punctates just below the rim (Scribe 1997). The patterns are difficult to determine on the Stelzer variants owing to their incompleteness and, therefore, the emphasis for repeating patterns should be placed on the larger reconstructed vessels where the entire rim is present. On the Butler-Rissler and Arpan Mound vessels, and photographs of the Stelzer site complete vessel that is now lost, raised punctates and fingernail patterns could be seen in a repeating pattern. Although the variants from the Stelzer site are incomplete, these likely followed a similar arrangement. The unevenness of the decorations is further pronounced when comparing these to the precise placement of decorations observed on contemporaneous Laurel and Havana Hopewell vessels.

Figure 7.4 Examples of pottery specimens bearing punctates arranged in a series or showing placement of punctates at differing heights A) Variant 1 Stelzer site, B) Variant 4 Stelzer site, C) Arpan Mound vessel, D) Variant 3 Stelzer site, and E) Butler-Rissler Vessel 1. Scale bars represent 2 cm. Photographed by the author courtesy of the Smithsonian National Museum of Natural History (A to D) and the University of Wyoming Archaeological Repository (UWAR) (E).

Repetition was a common design choice for many Indigenous societies when making pottery. For example, later pottery traditions such as Devil's Lake Sourisford consistently have four tabs along the rim of a vessel, with decorations appearing between these zones (Syms 1977). Some have connected these four tabs to the four directions, a belief system that is shared by many Indigenous communities today (Syms 1977). It is possible that the repeating patterns observed on Besant-Sonota vessels were meant to symbolize a similar, or different, cultural belief. The Arpan Mound vessel contained a single row of exterior punctates with every fifth punctate appearing higher than the others. In total, there are four higher-placed punctates evenly spaced around the rim of the vessel. The possible connection to the four directions and the ceremonial context for this Besant-Sonota vessel make it enticing to interpret this as a pattern that may align with ideas expressed by later northern Great Plains potters.

7.3.A.i. Connecting Vessels Through Decorations

Both Variant 1 and 2 rims had the same smooth, polished exteriors, rounded profiles, linear smoothing striations, internal composition, and irregularly shaped punctate decorations. It should also be noted that these two rim fragments were found within 10 feet of one another (Figure 7.5). These vessels exhibit punctates that are notable for their irregular shape. On each vessel, the protrusions from the object pressed into the pottery were oriented consistently (either facing up or down). It is possible that the same tool was used on these vessels.

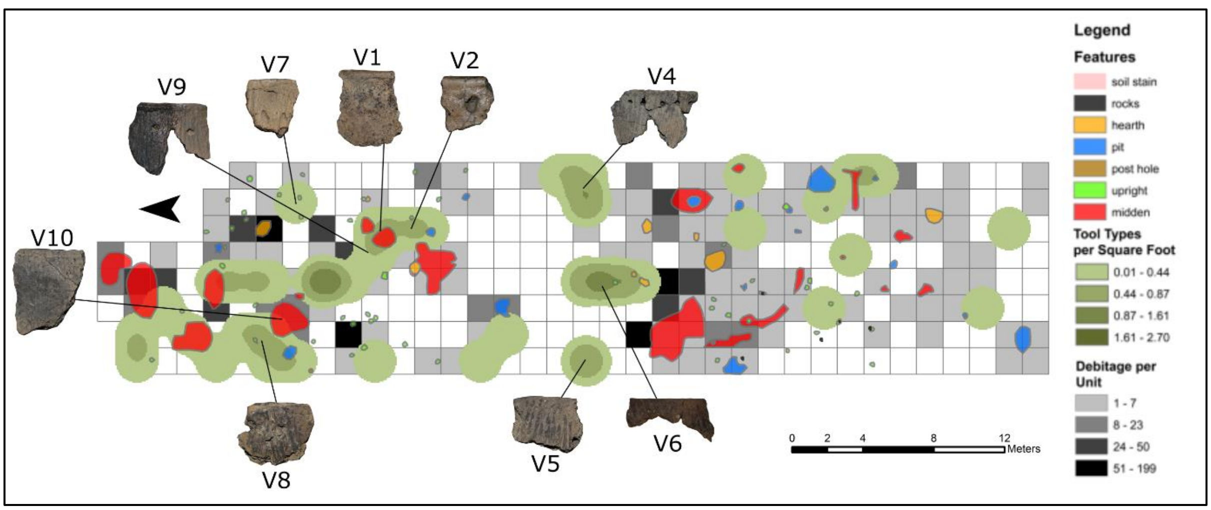


Figure 7.5 Position of rim variants found within the main excavation area of the Stelzer site overlaid on a kernel density map produced by Graham (2014:254). Kernel density is a calculated density of point features around each raster cell of a GIS map. For tool type and debitage, darker colours represent a higher value (or frequency).

The Arpan Mound vessel also shares a similar style of design and decoration. Its smooth exterior, rounded profile, linear striations, and irregular punctates share a likeness to Variants 1 and 2. While these punctates initially appeared circular, their irregular design was masked until carbonized food residues were removed (Figure 7.6). In this study, smooth vessels with irregular-shaped punctates were only found at these two sites. Because the social customs of the potter would guide the placement of designs, the similarities between the Arpan Mound vessel and Variants 1 and 2 lead me to suspect that the community members responsible for the Arpan burial also camped at the Stelzer site and were responsible for making these three vessels. Recall from the AMS radiocarbon dating results in Chapter 6 that the Arpan burial and Stelzer occupations are contemporaneous.

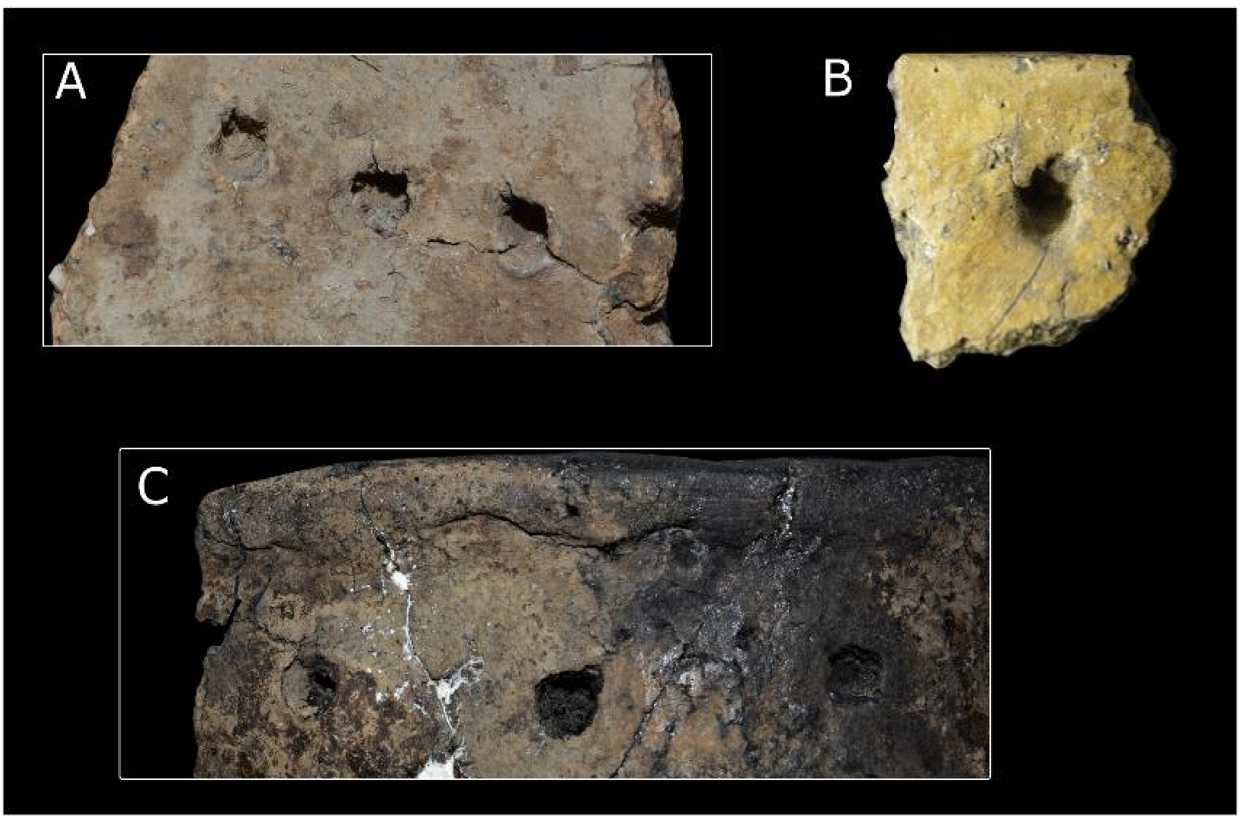


Figure 7.6 Irregular punctates found on the interior of Variant 1 (A), the exteriors of Variant 2 (B), and the Arpan Mound vessel (C). All images are not to scale but are enhanced for comparison. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

What is unclear to this point is whether the pottery variations observed at the Stelzer and Sonota burial mound sites represent styles of Besant-Sonota pottery that were restricted to special occasions such as feasts or ritual activities, or if they might have been made elsewhere for regular use and were then brought by visitors to the Stelzer site. To address this problem, Besant-Sonota vessels will be compared to those of nearby contemporaneous pottery traditions.

7.3.B. Influences

The origin of Besant-Sonota pottery has been debated in the past. Some (e.g., Scribe 1997; Walde et al. 1995) have postulated an eastern origin of pottery within the Besant and Sonota phases. It is helpful to consider specific sources in that direction. Directly east of the northern Great Plains were multiple pottery-producing cultures contemporaneous with Besant-Sonota. Altogether, there are at least four potential sources of influence: 1) Rowe (IA); 2) Valley (NE); 3) Malmo and Laurel (MN); and 4) Havana Hopewell (IA, IL, MO).

Using descriptions of Rowe pottery established by Tiffany (1978), there are similarities to decorations, surface expressions, and manufacturing techniques observed at the Stelzer site. Surface expressions from the Stelzer site were found to be cord-marked, fabric impressed, and plain. At the Stelzer site, seven of the 11 variants were cord marked, and only two were smooth. Within Rowe assemblages, cord marked vessels are also found in greater abundance with a limited number of smooth vessels (Tiffany 1978).

Additionally, sub-variants identified by Tiffany (1978), namely Pony Creek Punctate, Keg Creek Dentate, and Cord Wrapped Stick varieties, also share a similar appearance with variants of the Stelzer site. For instance, Pony Creek Punctate vessels have cord marked exteriors with straight rims, flat lips, and limited use of punctate decorations. This description shares much in common with Variants 4, 6, 7, and 9 of the Stelzer site. Meanwhile, Keg Creek Dentate, Cord Wrapped Stick, and Twisted Cord vessels are described as having a combination of dentates, CWT impressions, and punctates—similar to Variant 3 of the Stelzer site.

These Keg Creek vessels share similarities with Havana types such as Naples Stamped Cord Wrapped Stick and Missouri Bluffs Cord Impressed (Griffin 1952:101-120; Tiffany 1978). Moreover, Tiffany (1978) placed a greater emphasis on Havana traditions as opposed to using Valley Cord Roughened as an overarching classification for pottery of this period. Recent examination of pottery from these traditions has led others to view Rowe ware as a sub-phase of Valley (Adair 2016). Undoubtedly, Rowe ware found in Iowa shares close ties with Valley Cord Roughened materials of Nebraska, including Renner Cord Marked and Scalp Punctate varieties (Tiffany 1978).

Although vessels found at the Stelzer site are reminiscent of Rowe ware, it is important to reflect on the overarching Valley phase that has been used as a blanket classification for Middle Woodland pottery in Iowa and Nebraska. Pottery vessels found within the Valley phase of Nebraska are also similar in design and shape. Valley phase vessels are known to be large, thick-walled, cord-roughened conical pottery wares exhibiting limited decoration (Griffin 1952; Ludwickson and Bozell 1994). The decorations used were predominantly in the form of twisted cord impressions and punctates (Bozell and Winfrey 1994). Like Rowe ware, Valley has also been linked to Hopewell. Griffin (1952) observed that Valley vessels shared many similarities to utilitarian Havana Hopewell vessels.

Finally, the Malmo and Laurel cultures of Minnesota merit some consideration. Traces from this region have already been identified by the presence of native copper from the Great Lakes within Feature 8 and Excavation Unit 3 at the Stelzer site (Neuman 1975:29). Neuman

(1975:87) hypothesized that Malmo was a potential source of influence when examining the trend of smooth pottery vessels being used in burial activities. Specifically, he cited the Orwell Farm site, a Malmo burial mound where smooth pottery was found in association with human remains and 14 bison skulls (Keyser pers. comm. 1966 within Neuman 1975:87). Malmo vessels are known for a smooth exterior with limited decorations, so it is no surprise that Neuman (1975:87) sought a connection to Minnesota when interpreting the smooth Arpan Mound vessel.

Curiously, Neuman (1975) did not consider Laurel a suitable candidate. Laurel vessels are often marked with zoned layers of dentate designs, which can be reminiscent of Variant 3 found at the Stelzer site (See Appendix A.1). Concerning Variant 3, Neuman (1975) suggested this was connected to Havana Zoned Dentate (Griffin 1952). While Havana Zoned Dentate is confined to Iowa, Illinois, and Missouri, Laurel sites have been found within North Dakota, as is the case with the Beeber site, where a single Laurel vessel was found. Since both Minnesota cultures interacted with peoples of the northern Great Plains, they should be considered equally when tracing the origins of Besant-Sonota pottery.

There is no consensus about what cultures sparked the first presence of pottery among northern Great Plains hunter-gatherers. At the Stelzer site alone, Neuman (1975) connected pottery to Irving Plain Ware, Weaver Ware, Havana Zoned Dentate, Naples Ovoid Stamped, and Valley Cord-Roughened. Considering the diversity of styles recovered from the Stelzer site, there is a wide range of influences spanning regions to the south, east, and northeast (Figure 7.7). These wide-ranging connections are amplified by the many exotic items found within the Sonota mounds. Large conch shells from the Gulf Coast of Mexico, copper from the Great Lakes region, obsidian from Wyoming, and dentalium shells from the Pacific Coast were all found within the Sonota mound sites. In this study, maize was also identified at the Stelzer and Arpan Mound sites, further adding to the number of "exotic" products being brought to the Sonota mounds. It appears that the initial adoption of pottery by northern Great Plains hunter-gatherers took place in the context of far-reaching Hopewell interactions.

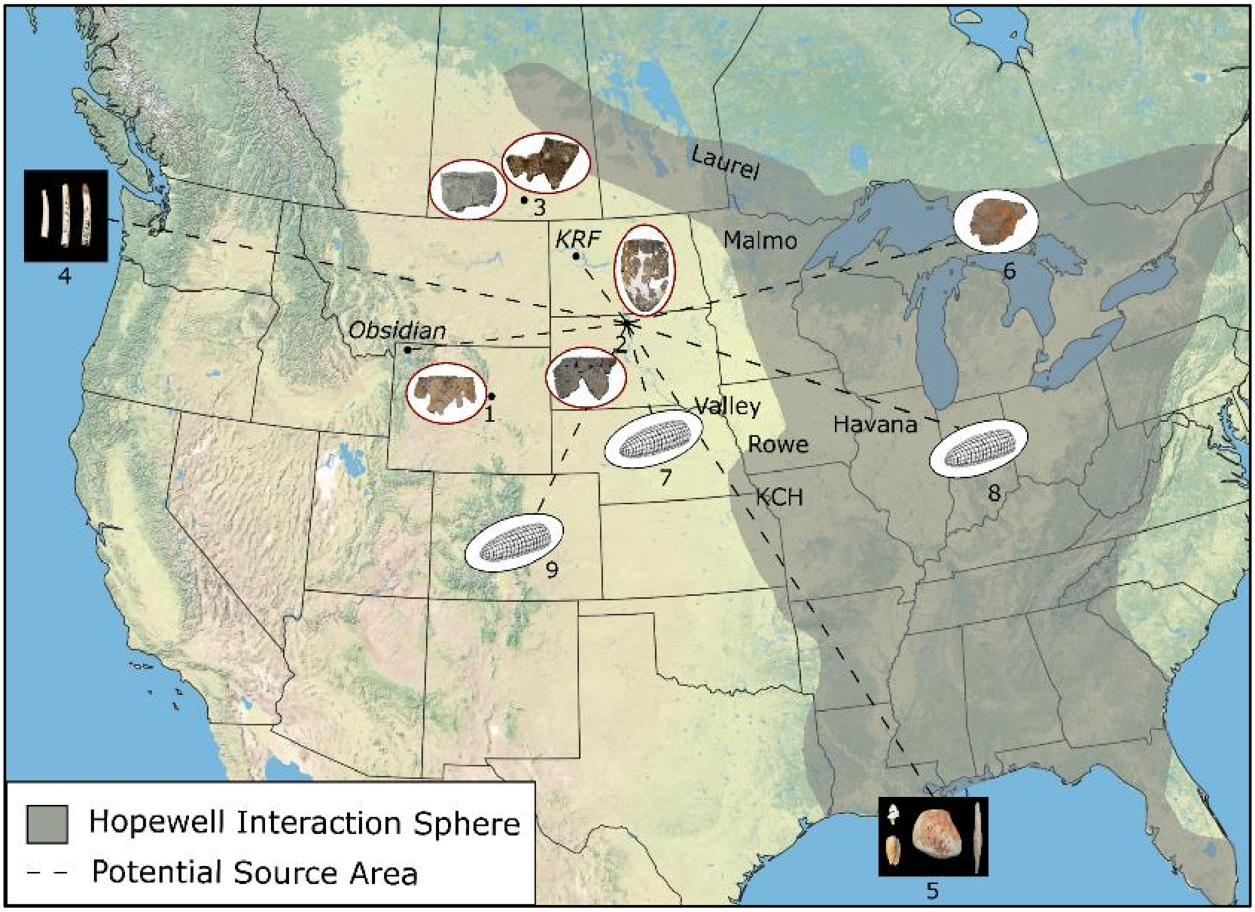


Figure 7.7 Map depicting pottery forms contemporaneous with the Besant-Sonota time frame (1) the Butler-Rissler site, (2) the Sonota mounds, and (3) the Walter Felt site in relation to source regions for exotic shells from the Pacific Ocean (4) and Gulf Coast (5), copper from the Great Lakes region (6), and maize identified at the Sonota mounds (7-9).

While it is tempting to link Besant-Sonota pottery with Valley, Rowe, Malmo, Laurel, or other related Hopewell types, the stylistic elements noted on these vessels need to be more unique to merit a confident identification. With each of these possibilities, there are similarities, but also differences. This pattern of similarities and differences may have been the result of interactions between non-pottery making northern Great Plains communities and Hopewell affiliated pottery making communities during important events, such as mound building. If multiple communities were interacting at such a location, making and leaving behind pottery vessels, this would result in a varied archaeological assemblage. This possibility would, however, require the production of pottery at the Stelzer, something for which there is currently no evidence. Additionally, vessels given to non-pottery making communities of the northern Great Plains as gifts during these events would be small in numbers. This is reflected in the material culture of the Besant and Sonota phase for which there is only a low frequency of pottery. This varied pottery assemblage will be further discussed in Chapter 9. Still, it is worth contemplating the uses that large, conical pottery vessels would have served at sites of significance, such as the Stelzer site.

7.4. Rituals and Feasting During the Besant-Sonota Era

Pottery vessels during this time were used to prepare foods for both everyday meals and special occasions. In this section, I will focus on two important aspects of culture—rituals and feasting—and how pottery was used during these occasions.

7.4.A. Ritual Uses

When interpreting ceremonial sites, some have urged that a cautious approach be taken as their meaning relates to unusual, highly variable, and sometimes infrequent cultural activities (Binford 1971; Yarrow 1880:5). Ceremonies may have been conducted with many factors in mind and evidence of these decisions may be difficult to identify today. In addition, variations in practice may reflect relationships to outside communities as well as within.

For this study, the placement of early pottery vessels within burials is integral to our understanding of the role these vessels played in the past. Meals prepared for the dead were observed among the Dakotas, Omaha, Ponca, and Plains Cree. The late 1800s account from the Dakotas implied that people in this region provided their dead with offerings in the form of meals (Pond 1889:243; Pond 1908:404; Riggs 1883:149). George Bushotter outlined that ghost feast offerings were provided for the dead, whereupon individuals present may have asked for good fortune in life (Dorsey 1889:148; Fletcher 1884:300). Dorsey (1894:421) recalled that the Omaha presented offerings, in the form of meals for the dead and this practice was also shared by the Ponca (Fletcher and La Fleshe 1911:310; Howard 1965:154). For the Plains Cree, these meals were also conducted one year after burial feasts in the form of a *Wikokeo*, a feast of the dead (Skinner 1914:75). The *Wikokeo* took place at the burial site where feasting occurred, with specific members of the family group returning. If the deceased was a child, the participants would be children, and this pattern would follow for other age groups and genders (Skinner 1914:75). In each of these accounts discussed so far, offerings of food were given as part of a larger demonstration.

This act of demonstration was a key component of Hopewell burial sites. Increasingly complex burial ceremonies have been interpreted by the presence of an increase in exotic grave goods and burial mound size (Willey 1966:273-270). Although the Sonota mounds are much smaller than these large Hopewell mounds, the single vessels buried here suggest some form of visual demonstration. In hunter-gathering societies, large pottery vessels were conduits for redistributing food among community members in a manner that demonstrates economic and social identities (Potter 2000).

Aside from the ability to prepare large quantities of food for important meals, other ethnographic accounts shared in Chapter 2 outlined how important these vessels were to past peoples. Accounts of a Mandan potter burying their pottery vessel when they felt near death are of consequence here (Wilson 1910). In addition, Brian Scribe (1997:5) recalled conversations with Edwin Tootooosis about an instance where the breakage of a pottery vessel led the owner to experience significant emotional loss. This emotional connection to pottery transcends its use as a tool to prepare meals. Some pottery vessels were treated with respect and safeguarded by an individual. Archaeological and ethnographical similarities suggest that pottery vessels were important to the communities responsible for the Sonota mounds, and these may have served as a conduit between the living and the deceased.

7.4.B. Feasting

When approaching the topic of feasting, some archaeologists identify this action as being a means to display social inequality within a society (Clark and Blake 1994; Hayden 1995, 1996). While true in some cases, Potter (2000) reports that not all feasts served similar purposes. Whereas feasting may have been used to express some form of competition, it may have also promoted solidarity (Potter 2000:471). In this study, there were three sites where feasting had already been interpreted: 1) Butler-Rissler; 2) Walter Felt; and 3) Stelzer. Each of these sites provided a glimpse into extensive food preparation activities during the Besant-Sonota timeframe.

Starting with the Butler-Rissler site, Miller et al. (1986) reported numerous mussel shells within a large cooking feature. Mussels are abundant in many rivers of the northern Great Plains, particularly the Platte River where the Butler-Rissler site was situated. Although preservation was poor, over 4,000 large *Lampsilis* ssp. *ovata ventricosa* shell fragments were recovered

(Miller and Waitkus 1989). At the time of this excavation, Albanese (1987) informed Miller and Waitkus (1989) that other shell middens had been found near the Butler-Rissler site, suggesting this was a common late-summer or fall activity. There were at least two large vessels present at this site and these would have been useful for boiling mussels for consumption. Unlike meat from bison or other large mammals, freshwater mussels can spoil quickly and therefore meal preparation would have been completed soon after harvesting.

Other important animal remains and stone tools relating to food preparation were also recovered at this site. Approximately 25,000 fragmented faunal remains, likely of bison, and a large grinding stone and pestle were also recovered indicating the grinding of plant and animal tissues (Miller and Waitkus 1989). In addition, charred seeds from prickly pear and goosefoot were also reported. The high number of mussel shells, while unusual for a site of this time and location, would have required immediate consumption. While feasting activities might have been intended to promote an important event involving people from other communities, the time sensitivity of the food materials makes it more reasonable to think that this feast was prepared solely for the local community. Owing to limited carbonized residues, samples were not submitted for gas chromatography mass spectrometry (GC-MS) analyses to detect mussel lipid signatures. Despite these limitations, the presence of two large pottery vessels at this site may have provided a means to prepare this food for this feast.

Northern Great Plains people also conducted feasting during, and after, community-driven bison kills. Dense archaeological deposits from the Walter Felt site provide evidence of bison hunting practices over an estimated 5,000 years. Pottery specimens from the Walter Felt site were examined in this study and shared a likeness with the cord marked variants of the Stelzer site and Keg Creek Cord Wrapped Stick found within Rowe assemblages in Iowa

(Tiffany 1978:178). Only three vessels were recovered from the Walter Felt site; this low number is not unusual for Besant-Sonota era bison kill sites. This would seem to suggest that pottery played a minimal role at these sites, but again, Smith's (2017) belief that infrequency does not indicate a lack of importance should be considered. Although the Besant-Sonota era is known for an increase in large bison kill sites, these were not a regular activity (Walde 2006a). Community-driven hunts required many participants or multiple communities. This gathering of people would have presented an opportunity to hold feasting and other celebrations before, during, and after the kill (Fletcher and La Flesche 1911).

Such activities may have also drawn interest from outside communities. Amongst hunter-gathering societies, events that involved performance and spectacle often drew attendance from within and outside cultures. The drama of a communal kill would have satisfied the requirements of spectacle while the acquisition of thousands of pounds of meat in a single event would support feasting (Brink 2008). Large pottery vessels, though rare, could have been used for these occasions.

Unlike lithics or stone, pottery could be molded and designed in a manner to reflect community identity, which would have been useful in social displays (Mills 1999). In addition, the ability of these vessels to be used in the preparation of large quantities of food, in some cases a minimum of 22 litres per cooking session, would have been beneficial for events where food sharing was occurring.

If people were using pottery vessels as a means of social expression during feasts, the Stelzer site either represents a challenge or additional support for this hypothesis. The use of more than a dozen vessels in what appears to be a narrowly defined period of time has no parallels at other Besant-Sonota sites on the northern Great Plains. Of course, this massive encampment site lies near burial mounds (refer to Figure 2.1). The mortuary rituals conducted there may well have involved several communities, both local and non-local. In his spatial analysis of the Stelzer site, Graham (2014) also explored the idea that multiple communities were present. Artifact densities surrounding campfires and the spacing between activity zones suggested that individuals were together at this site, but conducting tasks separately (Graham 2014). It is not out of the realm of possibility that the separation between these activity loci were the result of different social groups occupying different spaces.

With many possible sources of influence identified earlier in this chapter, this diversity in pottery is consistent with a gathering of people from different regions. Feasts, offerings, and rites of passage among many cultures represent a nexus of cultural interaction and activities for both the living and the dead. People drawn to the ceremonies through direct affiliation with kin relations or to witness and pay respects may have brought along their few large pottery vessels and left some behind.

7.5. Understanding the Role of Besant-Sonota Pottery

Despite their rarity, Besant-Sonota pottery vessels were cared for, adapted for life on the northern Great Plains, used to prepare feasts and ritual meals, and placed alongside community members during incredibly important rites of passage.

The 11 variants at the Stelzer site reflect a diverse assemblage of decorative styles, with patterns, alterations, and various shapes and sizes being employed during a brief window of time. The links these elements share with external pottery traditions parallel the presence of exotic items, such as Gulf Coast shells and Great Lakes copper in nearby burial mounds, suggesting interaction with pottery traditions to the north, east, and south. I believe the anomalous abundance of vessels at the Stelzer site is a reflection of different communities that were present at the Stelzer site, each bringing distinctive vessels with them.

The information discussed in this chapter, particularly the examination of pottery from the Stelzer site, offers a window into multi-community gatherings during a time on the northern Great Plains where information is lacking in the archaeological record. Comparison of these vessels to their food contents can only further our understanding of cultural interactions during the time of Besant and Sonota.

Chapter 8: Paleodietary Interpretations

Carbonized residues from 22 Besant-Sonota sites were examined to identify what foods were prepared within early northern Great Plains pottery vessels. Locally available plants predominantly represented identified foods in this study with evidence of maize confined to the Stelzer and Arpan Mound sites. First, the interpretation of the consumption of maize by Besant-Sonota era peoples is discussed.

8.1. Evidence of Maize at the Stelzer and Arpan Mound Sites

Identification of maize at the Stelzer and Arpan Mound sites adds a fascinating chapter to the already complex story reflected in the Besant-Sonota era. Multiple lines of plant microfossil evidence at the Arpan Mound and Stelzer sites reveal that pottery vessels were used to boil maize. At the Stelzer site, 15 of the 30 samples yielded diagnostic maize plant microfossils (refer to Table 6.1). At the Arpan Mound site, each round of samples from the Arpan Mound vessel contained multiple forms of diagnostic maize plant microfossils. These findings mark the earliest confirmed evidence of maize phytoliths and starch grains on the northern Great Plains.

Evidence of maize at the Stelzer and Arpan Mound sites indicates that maize was consumed earlier than anticipated, just before the onset of the Avonlea phase and during a time when the Hopewell Interaction Sphere was still thriving. With the Stelzer site dating between 1646 and 1575 cal BP and Arpan Mound dating between 1710 and 1538 cal BP, these two sites provide additional support for an early arrival of maize onto the northern Great Plains.

In each region discussed in Chapter 2, there is a precedent for earlier identification of maize through microfossil techniques rather than macrobotanicals. I hypothesize that the earlier results gained by microfossil studies are an indication of an infrequent consumption of maize acquired through trade whereas macrobotanical evidence may suggest the possibility of everyday use or even horticulture.

For this hypothesis to be accepted, it is necessary to estimate the quantity of maize consumed at these sites and assess whether this was an unusual or standard practice. All sites examined in this study, and previously by Boyd et al. (2019) and Lints (2012), appear well before the ca. 1050 BP threshold for regular maize consumption suggested by Simon (2017). If horticulture was not practiced by northern Great Plains groups until after ca. 1050 BP, maize could have been present at sites in small amounts but would have been acquired through trade. Long-distance trade was likely facilitated by sending kernels between locations rather than entire cobs. Once dried, maize kernels can be stored for quite some time and would take up considerably less space than entire cobs (Wilson 1917). In 1793, La Verendrye observed fur traders from Manitoba trading for kernels of maize produced by the Mandan and Hidatsa (Schneider 2002; Smith 1980:39, 53). The exchange of perishable goods was commonplace at centres along the Missouri where horticultural groups traded maize, beans, squash, and tobacco with hunter-gatherers for dried bison meat, the hides from bison and other large game, clothing, and moccasins (Abel 1921:173-174; Larocque 1910:22; Lewis and Clark 1987:161, 401-403; Thompson 2015:215). Such transactions extended to the regular trade of wild rice and medicinal plants within and outside northern Great Plains cultures (Scribe 1997). Further, Gregg (1983), Reeves (1983), and Syms (1977) had already suggested that Besant-Sonota peoples may have had the opportunity to acquire domesticated plant foods from Hopewell cultures (Scribe 1997:157). With the data identified in this study, there is now confirmation that these interactions did occur.

The acquisition and use of maize kernels present a problem for archaeologists when basing research on macrobotanicals. Unless carbonized, plant remains do not preserve in most archaeological contexts. If cobs were not present at these sites and kernels were boiled, it is unlikely that plant macrofossils would be preserved at any site where maize was acquired through trade and restricted to occasional, or ritual, use.

Arrival through trade provides a strong rationale for the identification of maize within some of the first pottery vessels used by hunter-gatherers in North America. This is a common theme in the earliest pottery of the northern Great Plains, Central Plains (Adair 2019; Adair et al. 2022), and Canadian boreal forest (Boyd and Surette 2010)—that the spread of maize is connected to the spread of pottery. Pottery would have facilitated the boiling of kernels while also leaving behind little macrobotanical evidence. Additionally, if meals containing maize were limited to special events, these large vessels may have provided an effective means to display this relatively novel food item to all spectators.

While it is difficult to trace the origin of where this maize was grown, there are two possible sources: 1) Hopewell cultures experimenting with maize horticulture to the south and east; and 2) mobile horticulturalists of the American Southwest. In either case, the individuals responsible for the Stelzer and Arpan Mound sites were connected to cross-continental trade networks spanning much of North America. The Hopewell Interaction Sphere facilitated the movement of copper from the Great Lakes, obsidian from Wyoming, and oceanic shells across vast distances. Given that maize has been identified from rock shelters predating the Besant-Sonota era, it is also possible that mobile horticulturalists of the American Southwest supplied maize to nearby Hopewell related cultures such as Valley. There is nevertheless little in the way of other artifactual evidence to support this idea. The durable trade items that made their way into the Stelzer and Arpan Mound sites are connected with societies to the east or south, making it most likely that maize came from these directions.

As several of the pottery samples (specifically the cord-roughened variants) resemble Valley designs, it is not unrealistic to connect the maize found in these vessels to the Valley phase. This connection is strengthened by the identification of maize within Valley phase residues (Adair 2016). The Besant-Sonota and Valley phases have been connected by Scribe (1997), Reeves (1983), and Syms (1977) in terms of pottery and interaction with Hopewell, so this is a highly plausible pathway for the arrival of maize on the northern Great Plains.

Maize consumption at the Stelzer and Arpan Mound sites creates another compelling case for the connection between Besant-Sonota era peoples and emerging trends occurring elsewhere in North America. At this time, artistic motifs, ideology, and religious ideas (Caldwell 1964) were shared among cultures and this research suggests this also extended to perishable foods.

8.2. Consumption of Goosefoot at the Stelzer and Arpan Mound sites

While an emphasis has been placed thus far on maize, this plant was only observed at two sites whereas locally available plants were commonly observed in all food residues. Another plant, goosefoot, was also found at multiple sites. Identified by some researchers as an "Indigenous cultigen" that was semi-domesticated, goosefoot was an important food source to hunter-gathering societies (Halwas 2017; Smith 2006; Smith and Cowan 2003). In this study, goosefoot was represented by starch grains and pollen identified in carbonized food residues obtained from the Stelzer and Arpan Mound sites. This matches descriptions by Haberman and Travis (1995:74) of archaeological features containing charred and uncharred goosefoot seeds found within pit features at the Stelzer site in 1988.

This plant offered hunter-gatherers many culinary options as almost the entire plant is edible, palatable, and can be consumed during all portions of the plant's life cycle (De Bry 1966). Known uses of goosefoot during ethnohistorical times include the preparation of a thick broth using the seeds or direct consumption of the leaves themselves (De Bry 1966:14). Within pottery vessels, goosefoot was likely used as a thickener for stews or as the main ingredient for porridges.

Since the Arpan vessel was used sparingly, residues offer a chance to identify the ingredients used by people at this time to cook meals for important occasions. Within the Arpan Mound vessel, starch grains produced by saskatoon and chokecherry berries were identified. In addition, a series of large unknown tuber starch grains reminiscent of white pond lily and prairie turnip varieties were also observed. The use of berries such as chokecherry and saskatoon is not surprising given the location of the Sonota mounds. During Neuman's initial visits to the Stelzer site in 1962, he noted an abundance of chokecherry along the Missouri river terrace (Neuman 1975). In ethnobotanical literature, berries were traditionally used by Blackfoot communities in many meals, some of which were prepared during important events such as sun dances and renewal ceremonies (Hellson 1974; Johnston 1987). More specifically, saskatoon berries would be mixed with bison fat to produce a dessert served at Blackfoot feasts (Johnston 1987). Given the context of the Arpan Mound vessel, and those found at the Stelzer site, one can easily imagine these meals being an important part of the feasting that occurred.

The inclusion of berries and wild plant tubers alongside maize and goosefoot provides a list of plant foods that may have been prepared together. Although exact recipes have yet to be discovered for ancient meals cooked on the northern Great Plains, ethnographic literature points to a diverse collection of meals prepared by Indigenous peoples. Within horticultural areas, "Three Sisters" soup was a staple food item composed of squash, beans, maize, wild onions, and various herbs consumed during the winter months (Wilson 1917). The use of berries is noted by contemporary Indigenous chefs such as Sean Sherman, to provide texture and flavoring to bison pot roasts and stews (Sherman and Dooley 2017). Within areas of the Great Lakes, the Anishinaabe continue to prepare wild rice meals with dried berries (Sherman and Dooley 2017). Among the Ohlone of California, goosefoot seeds were commonly prepared alongside berries and amaranth to produce a silky breakfast meal (Sherman and Dooley 2017).

Perhaps the most notable recipe is found in the Hopi description of how goosefoot (*sis-wa*) was prepared. Nequatewa (1943:19) outlined that goosefoot seeds were collected in the spring and boiled for one hour. Next, the water would be removed and replaced with fresh water, and this would be boiled for another half hour (Nequatewa 1943:19). This meal would then be served with maize dumplings. The combination of maize and wild plants is also noted in meals the Hopi called *Sy-vif-si*, which is a mixture of boiled berries and cornmeal. Turning attention back to the Arpan Mound vessel, the identification of maize, goosefoot, berries, and large tubers within residues of this vessel provides a glimpse into a meal that is not so dissimilar from those still produced by Indigenous groups today.

8.3. Beyond the Stelzer and Arpan Mound Sites

Although the Stelzer and Arpan Mound sites yielded an abundance of identifiable plant microfossils, particularly maize, all other sites examined contained only locally available plants. Identification of saskatoon, chokecherry, and white pond lily was expected as these plants are often mentioned in both ethnographic accounts and edible plant summaries of the northern Great Plains (Lints 2012). However, the low number of identifiable starch grains observed across this study was surprising. There are two possible scenarios to account for the lack of plant identifications: 1) starch grains were prone to gelatinization within Besant-Sonota vessels; and 2) plant foods were cooked via roasting or eaten raw and pottery was reserved mainly for boiling meat.

Ethnographic literature shows that locally available plants represented a core component of diet across the northern Great Plains, even in societies practicing horticulture. For example, Buffalo-Bird Woman recalled that seasonal activities were based on the ripening of berries found near their gardens (Wilson 1917). Within the Besant-Sonota era, charred macrobotanicals found at sites examined in this study reflect this contribution to past diet. While charred prickly pear and goosefoot seeds were uncovered at the Butler-Rissler site (Miller et al. 1986), no microfossils were identified in carbonized residues.

Since starch grains are organic, intense heat causes these grains to swell beyond the point of recognition (Gott et al. 2009). Within this study, gelatinized starch grains were noted in high abundance, which severely impacted the ability to identify locally available plants that were consumed at these sites. This was notable in larger starch grains produced by tubers where gelatinized types outnumbered identifiable ones 381 to 28 (Table 8.1). Within this study 530 starch grains were identified, but this number is inflated by the 464 smaller starch grains from berries and goosefoot that were found in large clusters. Even at sites where preservation was high, such as the Stelzer and Arpan sites, gelatinized grains were also observed.

Table 8.1 Starch grains separated by plant type and physical condition.

Plant Type	**Maize**	**Berry**	**Goosefoot**	**Tuber**	**Identifiable**	**Gelatinized**
Starch Grain Frequency	63	282	182	28	530	381

Vessel performance may offer clues to explain this trend. Thicker walled vessels are stronger and more resistant to mechanical stress but are less useful for cooking foods (Braun 2010:77; Rice 1987:227). Consequently, thicker vessels unintentionally insulate food contents causing them to cool down at a slower rate and become gelatinized. Besant-Sonota vessels are noted for their size and thickness compared to later pottery traditions. Owing to their ability to insulate liquids, it is likely that these thick vessels would have taken a long time to reach a boil but cooled slowly after reaching this temperature. Cooking plant foods in this manner would eventually lead to an increased gelatinization of starch grains. It should be noted that we do not know what the desired outcome was for the meals being prepared within these vessels. It is possible that a softer texture was desired within Besant-Sonota era cuisine.

It is also possible that locally available plants were cooked by alternative means, eaten raw, or were dried and prepared in pemmican. Excavation reports by Neuman (1975) and Miller et al. (1986) revealed that identifiable plants were uncovered from hearth features at the Stelzer and Butler-Rissler sites, suggesting that these foods were consumed near fires, and potentially prepared without the use of boiling. While this explanation has merit, there is no way to test the validity of this hypothesis as this relies on the presence of negative data alone.

Lastly, the context of these sites must be considered. It is worth mentioning again that the Stelzer, Arpan Mound, and Grover Hand sites were related to highly symbolic activities. Of these three sites, only the Grover Hand site yielded a low number of identifiable plant microfossils. Perhaps the context of these sites played more of a factor in what foods were consumed and their visibility in the carbonized food residues. At Stelzer and Arpan Mound both local and exotic foods were prepared within these vessels and preservation was relatively high. If activities around these sites required feasting and celebration, it is also possible that both local and exotic foods would be available in larger quantities, thereby increasing their chances of survival.

8.3.A. Grass Consumption at the Walter Felt Site, SK

There were some locally available plants identified that were unexpected. Grass phytoliths are often found in small quantities within carbonized food residues. While these are typically attributed to accidental inclusion or airborne dispersal, the Walter Felt specimens exhibited an unusually high number of common grass phytoliths (see Chapter 6). Initially viewed as an anomaly, repeated tests continually showcased an abundance of needle-and-thread, fowl blue, slough, and meadow fescue grasses. Blackfoot communities used the first of these grasses to mark the best timing to hunt bison (Johnston 1987) while the seeds were used as darts or arrows by children of the Navajo and Okanagan-Colville Indigenous communities (Turner et al. 1980:53; Vestal 1952:15). In contrast, the seeds of slough grass have been reported to have been consumed by Indigenous groups of Montana and Oregon (Blankinship 1905:8; Coville 1897:91). While slough grass has been reported as a food source, the others have not. These high numbers present in the carbonized food residues at this site may represent deliberate grass consumption, but we should also explore two alternative scenarios: 1) these grass phytoliths were deposited in vessels when digestive organs (stomachs and intestines) or their contents, also called chyme, were boiled; or 2) these phytoliths were deposited via wind during food preparation activities.

The consumption of rumen or chyme (or stomach contents) is not an unfamiliar practice when considering ethnographic literature. For instance, Blackfoot (Lee and Daly 2004), Cree (Corrigan 1946), and Lakota (Lame Deer and Erdoes 1972) peoples consumed stomach contents from bison, deer, and other large ungulates. During winter months, when vitamin C-rich plants and fruits were unavailable, the scarcity of this vitamin could lead to nutritional stress if not replenished via alternatives. While muscle tissues in large ungulates have no vitamin C (Speth 2019), the internal organs and stomach contents (Hediger 2002:445) contain sufficient amounts of this vitamin to circumvent nutritional stress during times when plants providing these nutritional benefits were unavailable (Buck and Stringer 2014; Price 1939:75).

In many of these cases, chyme was consumed directly from recently killed animals, but cooking digestive organs was often completed through boiling. Individuals would have inadvertently released any undigested plant microfossils by boiling these organs in pottery vessels. These grasses are common forage for large ungulates and therefore phytoliths would likely be abundant within the stomachs of these animals. This would provide a sound explanation for the high number of these phytoliths reported from the Walter Felt site.

The second scenario lies outside of human agency. Piperno (2006) acknowledged that windblown phytoliths can be deposited across sites, potentially impacting phytolith assemblages. These grasses are local to the area and therefore, it is plausible that these phytoliths were being dispersed through the wind when these vessels were used. If the wind was supplying carbonized residues with plant microfossils, one would expect these to be found in insignificant quantities and not an overall dominance of the total phytolith assemblages. In addition, one might also expect to see this high number of common grass phytoliths in nearby sites such as the Ratigan and Crane sites, yet several of those vessels did not share the results observed in residues from the Walter Felt site.

These two scenarios would be driven by past cultural practices or environmental conditions at the Walter Felt site. Given the available ethnographic evidence, associated faunal remains, and the common practice of boiling stomach meat, the consumption of chyme or stomach meat is a more suitable explanation.

8.4. Comparing C_3 to C_4 Grass Phytolith Ratios

Looking further into phytolith assemblages, it is also possible to interpret general environmental trends of plant foods boiled within these vessels. For this section, residues in this study are organized into two groups: 1) the Sonota mound sites; and 2) all other specimens examined in this study.

8.4.A. The Sonota Mound Sites

Residues from the Sonota sites studied here represented the bulk of archaeological data for this dissertation. Calculating the phytolith values at the Stelzer and Arpan Mound sites provided the ability to assess the contributions of maize to identified phytolith assemblages. As mentioned in Chapter 3, the climate index (*Ic*) and *Iph* indexes were applied to phytolith assemblages identified in this study. The *Ic* index provides the percentage of pooid short cell phytoliths (C_3) relative to the sum of pooid, chloridoid, and panicoid grasses within a given sample (Bremond et al. 2008). The presence of C_3 grasses should provide high *Ic* values (above 50 percent) whereas a low *Ic* index (below 50 percent) is indicative of C_4 plant communities (Alexandre et al. 1997; Bremond et al. 2008). Additional insights into the type of C_4 plants present in the phytolith assemblages were inferred through the application of the *Iph* index. This index has been used to identify C_4 short grasses (higher than 60 percent) versus C_4 tall grasses (below 40 to 45 percent) (Alexandre et al. 1997; Bremond et al. 2005; Fredlund and Tiezsen 1997).

Starting with the *Ic* values, the Arpan Mound vessel ranges between 30 to 52 percent with an average of 40.75 percent. This percentage reveals that C_4 food products (panicoid and chloridoid phytoliths) were responsible for the majority of phytoliths recovered from the vessel. The *Iph* value of 53 to 60 percent is also low, also suggesting that tall C_4 grasses contributed to the overall phytolith assemblage within carbonized residues from this vessel. Of course, the Arpan Mound vessel yielded the highest number of diagnostic maize phytoliths and starch grains observed in this study (Figure 8.1).

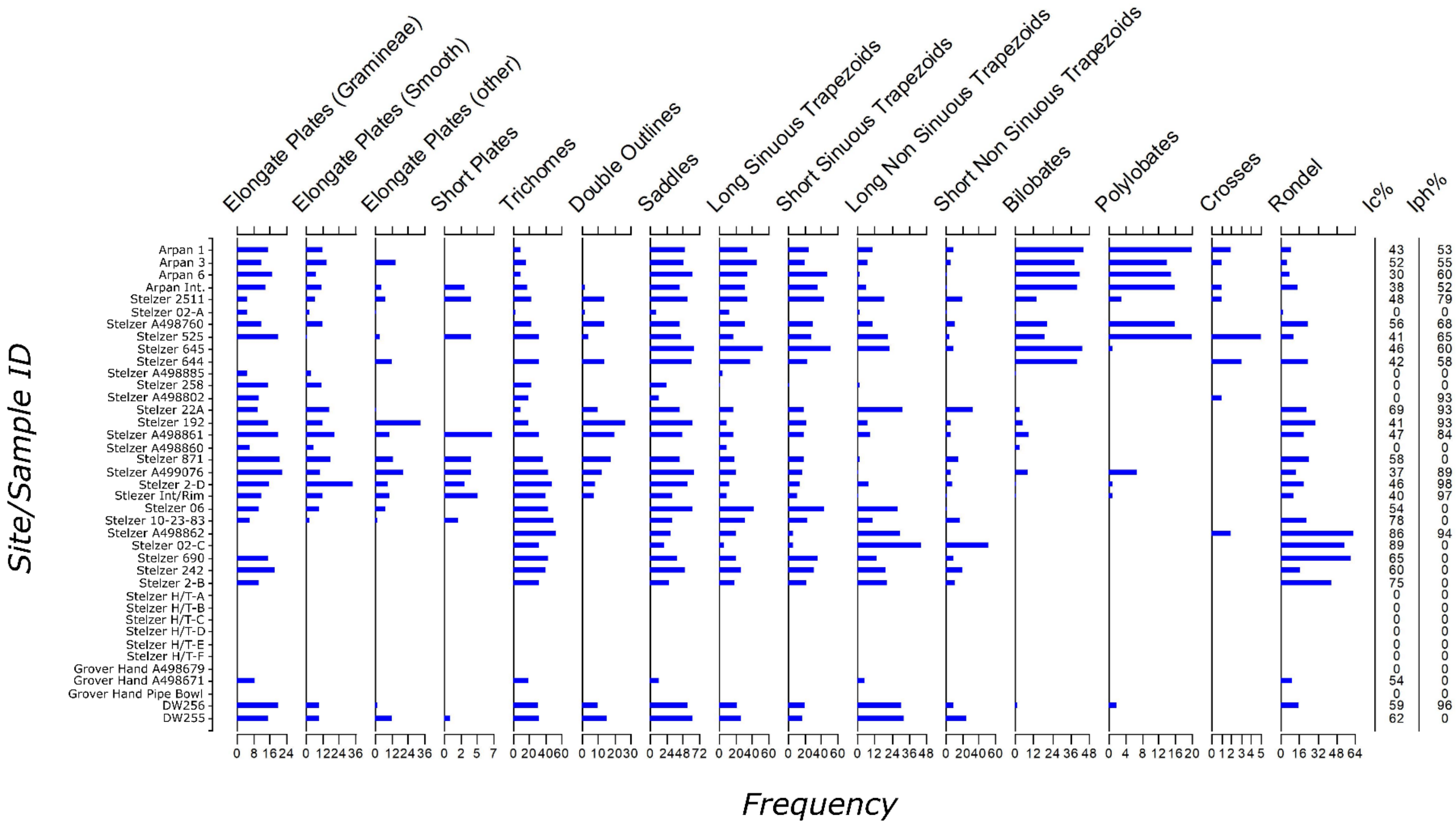


Figure 8.1 Phytolith frequencies observed within carbonized food residues of South Dakota pottery vessels.

Unlike the Arpan Mound site, the *Ic* values from the Stelzer site ranged from as low as 37 percent to as high as 89 percent, with an average of 64 percent. In other words, some specimens from the Stelzer site were primarily composed of C_3 plant phytoliths (pooid grasses) while others were dominated by C_4 types. From these values, the Stelzer site residues contained a variety of plants typical of both C_3 and C_4 environments.

The variety of C_3 and C_4 grasses observed in the residues mirrors the pottery found at this site. Pottery at the Stelzer site was also variable, with different surface textures and decorations observed. These phytolith values work in concert with the pottery identifications to further support the narrative that the Stelzer site was a location where multiple groups, each from different environments, gathered. Polyethnic populations were not uncommon in the past, especially at sites where significant events were occurring. Different communities with their favorite dishes local to their homeland would present a varied phytolith assemblage among pottery residues.

8.4.B. Sites Outside of the Sonota Mounds

Plant microfossil results for those sites outside of the Sonota mound area were limited, with many revealing negative data. Owing to the number of sites, this data has been separated between sites found in the United States (Figure 8.2) and sites found in the Canada (Figure 8.3). Very few sites outside of the Sonota mounds produced *Ic* values around or less than 50 percent with an average of 60 percent, with the lowest value being 29 percent from a single specimen from the Cedar Gap site, WY (see Figure 8.2). These higher numbers suggest that C_4 plant types were present in smaller amounts and were dominated by varieties more likely to be found in C_3 environments. This is also reflected in the identifiable plants noted earlier in this chapter, with local plant types contributing many specimens, particularly at the Butler-Rissler, Cedar Gap, and 39JK63 sites (see Figure 8.2).

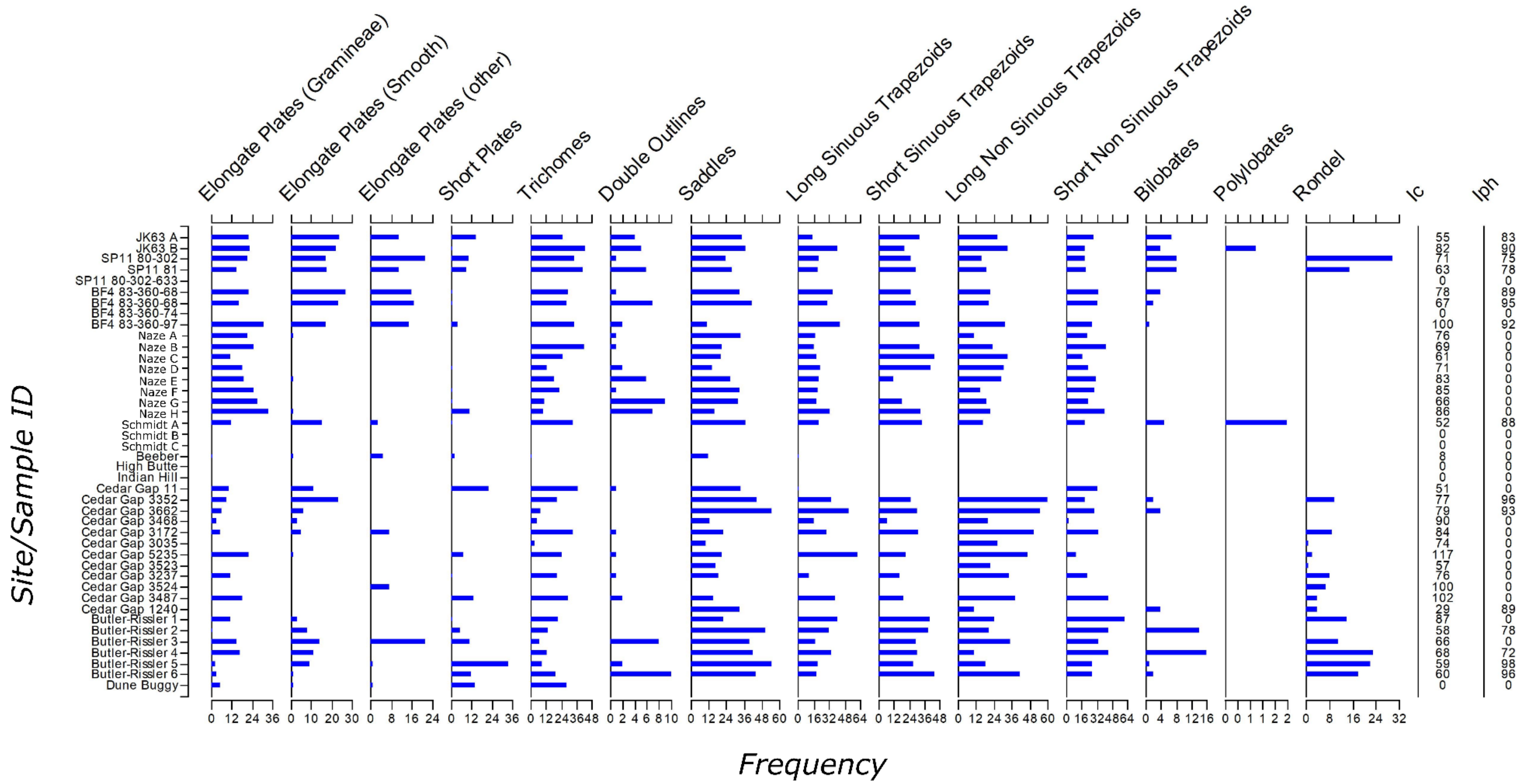


Figure 8.2 Phytolith frequencies observed within carbonized food residues of pottery vessels found in North Dakota, Montana, and Wyoming.

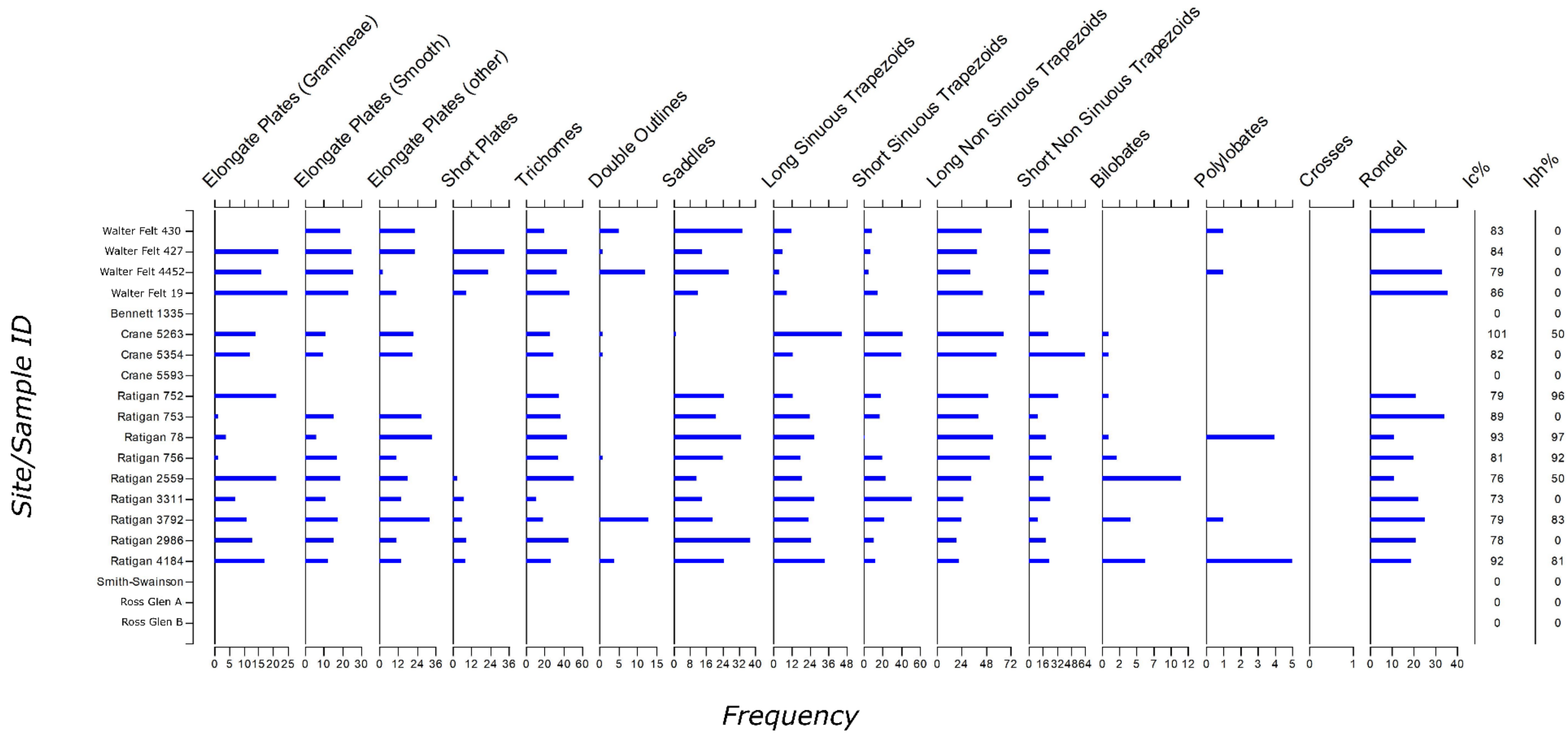


Figure 8.3 Phytolith frequencies observed within carbonized food residues of pottery vessels found within Saskatchewan and Alberta.

The dominance of C_3 phytolith assemblages is also found within the Canadian sites examined throughout this study (see Figure 8.3). *Ic* percentages ranged from 73 to 100 percent for specimens from the Walter Felt, Crane, and Ratigan sites of Saskatchewan. These values mirror the identifiable phytoliths outlined earlier in this chapter as common C_3 grasses that were dominant within the Walter Felt specimens, and local plant foods commonly found in C_3 environments were identified in the other vessels.

8.5. Summary of Plant Microfossil Evidence

Analyses of carbonized food residues for plant microfossils yielded both the expected and unexpected. At the Stelzer and Arpan Mound sites, maize microfossils were found alongside those produced by locally available plants such as goosefoot, chokecherry, and saskatoon. Identification of maize at these two contemporary sites adds further depth to this captivating period on the northern Great Plains. This consumption of maize by Besant-Sonota era peoples provides subtle evidence of larger cultural interactions that occurred between people of the northern Great Plains and those in adjacent areas that were more accustomed to participating in the Hopewell Interaction Sphere. The Sonota mounds were locations where technology, materials, and cultural practices were being shared among different communities.

8.6. Interpretation of $\delta^{13}C$ and $\delta^{15}N$ Isotope Values

A total of 31 residues were sent for isotopic analyses, the results of which can be viewed in Chapter 6. In this study, isotopic evidence was collected to ascertain whether the values of $\delta^{13}C$ would present independent confirmation of maize. As not all samples examined in this study yielded sufficient residues for isotopic analyses, more research is needed to base the interpretation of food consumption through $\delta^{13}C$ and $\delta^{15}N$ values alone.

8.6.A. Geography or Food Choices?

Plant microfossils are the primary focus of this research, but bison were of paramount importance in Besant-Sonota era subsistence strategies (e.g., Frison 1978:223). It is important to consider this with respect to carbonized food residues as there is a strong likelihood that meat products, especially bison, was prepared in these vessels. Recalling Chapter 4, issues may arise when interpreting isotopic signatures collected from carbonized food residues (see Hart et al. 2007, 2009, 2012). Bone collagen and animal tissues from bison living in traditionally C_3 rich environments tend to express lower $\delta^{13}C$ values than those in areas where C_4 grasses are present in higher numbers, such as Wyoming and South Dakota (Metcalfe et al. 2021). This change in isotopic signatures has been used by some (see Hart et al. 2007, 2009, 2012; Boyd et al. 2008) to argue against the identification of maize via isotopic signatures without alternative lines of evidence. For this study, the interpretation of isotopic signatures was challenging owing to the location of the Sonota Mound sites near environments dominated by C_4 grasses. For sites located outside of South Dakota and Wyoming, local grasslands likely contained a higher number of C_3 grasses. Therefore, bison products prepared within the Stelzer and Arpan Mound vessels may have been from animals whose seasonal or regular forage involved high proportions of C_4 grasses. This may explain the higher $\delta^{13}C$ isotopic values of the Stelzer and Arpan Mound residues compared to those outside of South Dakota.

Further complicating this explanation is that these two Sonota sites were the only sites to yield plant microfossil evidence of maize. Therefore, some exploratory research to provide insight into how bison products would have swayed the $\delta^{13}C$ isotopic values of the Stelzer and Arpan Mound residues is desirable. A potential means to distinguish the effect of these bison products on residues is the comparison between isotopic values of bison bone collagen and tissue.

Although bone collagen from bison remains uncovered from the Stelzer site were not analyzed in this study, AMS radiocarbon analyses by Graham (2014) did provide $\delta^{13}C$ and $\delta^{15}N$ isotopic values. Further research is needed to determine if AMS radiocarbon isotopic values can be directly compared to values obtained through conventional isotopic methods. This is worth some preliminary exploration. While it is possible that the bison that were consumed at the Stelzer site spent part of their lifespan in environments with different mixtures of C_3 and C_4 plants, the $\delta^{13}C$ values of bison bone collagen vary by just 4‰ (Figure 8.4). Bone collagen of bison remains from the Stelzer site revealed $\delta^{13}C$ values ranging from -14.4 to -18.1‰ (Graham 2014). During analyses by Metcalfe et al. (2021), $\delta^{13}C$ values from bone collagen were approximately 5‰ higher than meat. Lowering the bone collagen $\delta^{13}C$ values by 5‰ would result in values overlapping those of the Stelzer carbonized food residues. Likewise, Metcalfe et al. (2021) reported similar ranges in $\delta^{15}N$ values for bison which are mirrored by the Stelzer carbonized food residues. While more research is necessary to compare these datasets further, this does provide some indication that meat from bison was boiled within these vessels alongside local and acquired plants. Simultaneously, if these animals were consuming a C_4 grass diet, this may explain the relatively higher $\delta^{13}C$ values than other samples in this study.

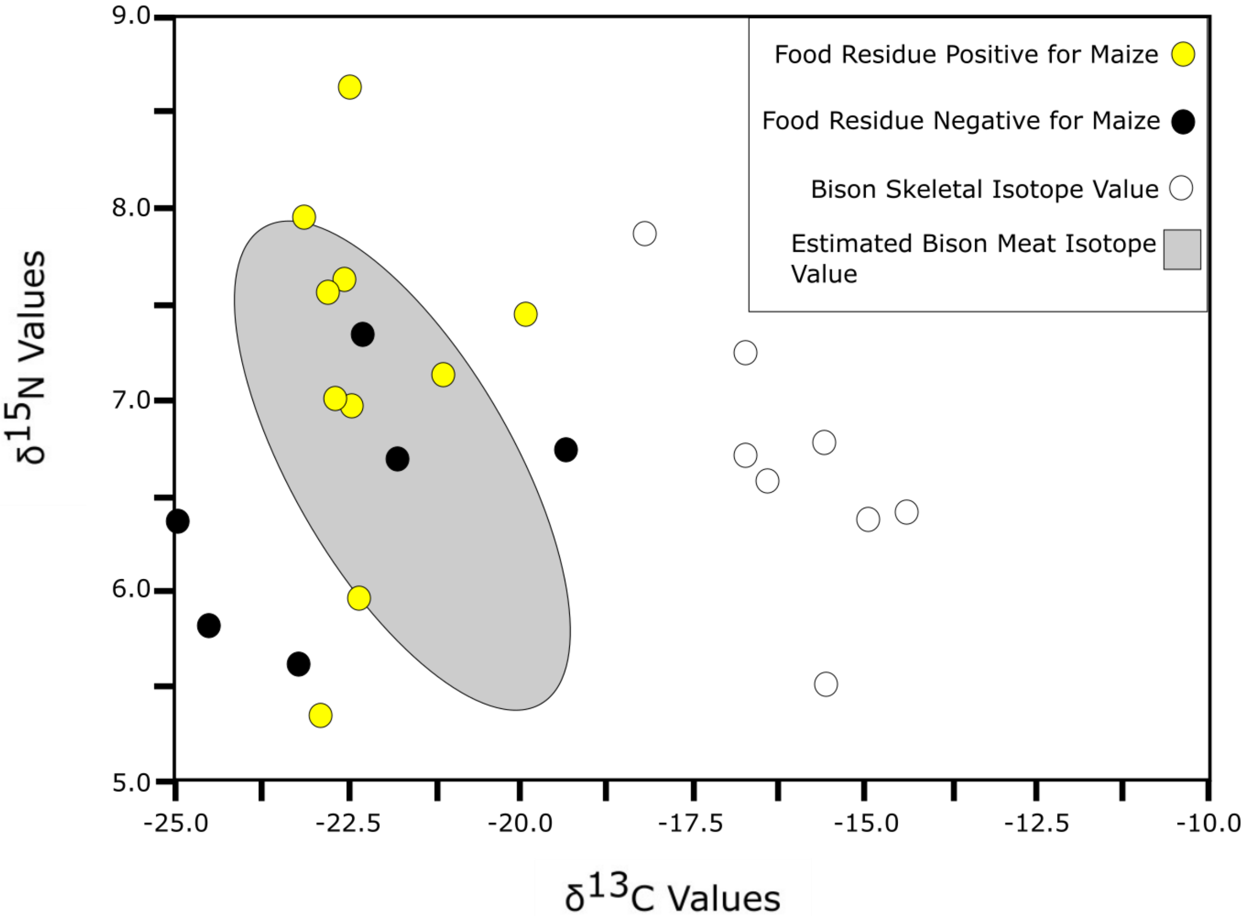


Figure 8.4 Comparison of $\delta^{13}C$ and $\delta^{15}N$ isotopic values between carbonized residues and bison bone collagen collected from the Stelzer site.

It is worth revisiting the Stelzer and Arpan Mound $\delta^{13}C$ values and the identification of maize. Hart et al. (2009, 2012) noted that environmental factors and other foods cooked within vessels prevented the use of higher $\delta^{13}C$ values as supporting evidence for maize consumption. That being acknowledged, the phytolith evidence gathered in this study indicates that C_4 plants were abundant within some of these vessels leaving behind multiple diagnostic microfossils and suggesting a strong signature for maize as the food product involved. In addition, Szpak et al. (2013) identified that goosefoot varieties have a $\delta^{13}C$ value of around -25.6‰ and a $\delta^{15}N$ value of 7.9‰, values which are not too far removed from those reported at the Stelzer and Arpan

Mound site. If maize kernels were present in significant quantities, this would also have impacted $\delta^{13}C$ values, which are higher than those reported for goosefoot also identified in these vessels. Identifying the abundance of a food item prepared in a vessel is difficult to determine but comparing the results of this study to others completed within the northern Great Plains may provide another perspective.

The isotopic results from the Stelzer and Arpan Mound sites express higher, or comparable, $\delta^{13}C$ values to Late Woodland horticultural sites (Figure 8.5) (Boyd et al. 2006, 2008). The Lockport site (EaLf-1) had relatively low $\delta^{13}C$ values for pottery residues compared to the Arpan Mound and Stelzer sites. This was surprising as the Lockport site, located 30 km north of Winnipeg (MB), produced numerous bell-shaped storage pits (Flynn 1993) and at least 12 bison scapula hoes (Roberts 1991). Further confirmation was provided by Flynn (1993) and Deck and Shay (1992) with their identification of carbonized maize kernels and cob fragments. These charred fragments were identified as Northern Flint or eastern eight-row variants of maize (Deck and Shay 1992; Flynn 1993). It is important to note that DNA analysis of these macrobotanicals has yet to be conducted.

Nevertheless, the storage pits and horticultural implements recovered by Flynn (1993) and Roberts (1991) combined with maize phytoliths and starch grains from carbonized food residues (Boyd et al. 2006), can be used to infer that maize horticulture was practiced at this site. While these locations differ significantly in terms of geography, maize consumption at a site where horticulture was taking place (such as the Lockport site) would presumably lead to higher values than that at the Arpan Mound and Stelzer sites. At the Stelzer and Arpan Mound sites, the presence of maize would have been something "new," or at least difficult to acquire. Combined with the cultural activities performed at the Stelzer and Arpan Mound sites, it is possible that maize consumption within vessels at these locations was done at a high enough level to sway isotopic values.

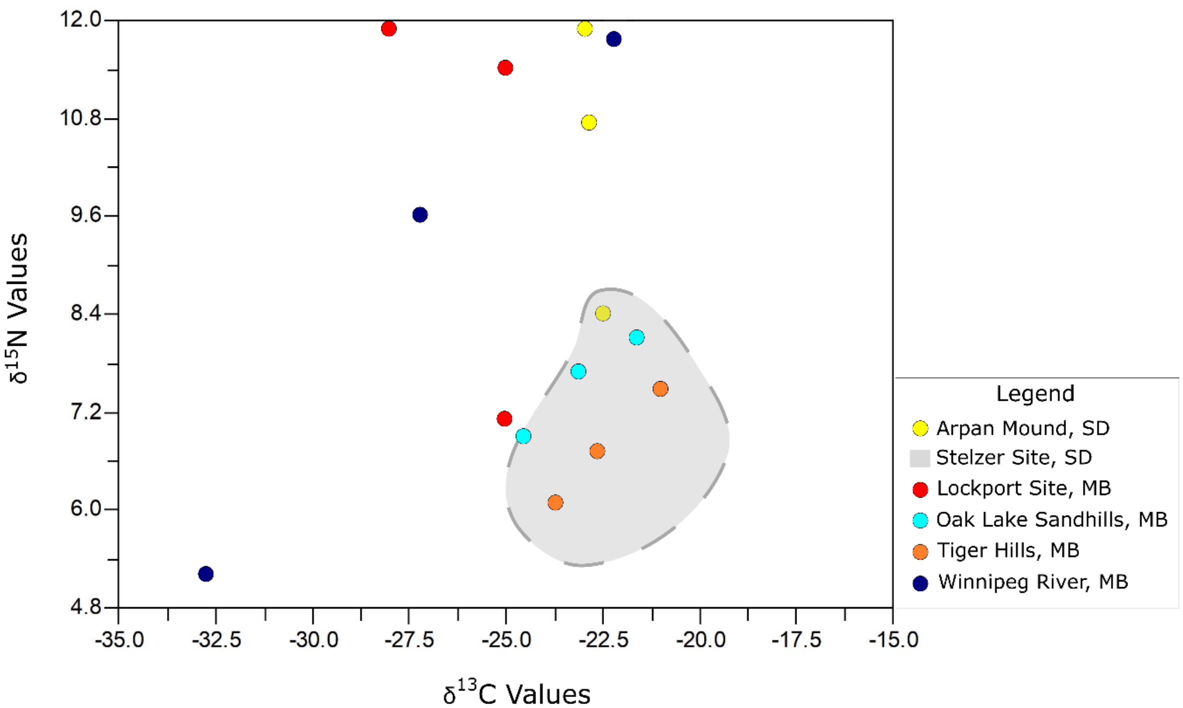


Figure 8.5 Food residue carbon and nitrogen isotopic values from the Lockport site and Winnipeg River, Tiger Hills, and Oak Lake Sandhills areas (Boyd et al. 2008) compared to values from the Stelzer site and Arpan Mound pottery (this study). The Stelzer site isotopic values (n=16) have been simplified to a single gray shaded area. For a complete breakdown of the Stelzer site isotopic values, refer to Table 6.5 of Chapter 6.

Comparing the Lockport, Stelzer, and Arpan Mound sites also provides additional perspective on the quantity of maize present. Since maize likely arrived at the Stelzer and Arpan Mound sites via trade, this would presumably have taken place in the form of kernels. In contrast, maize gardening at the Lockport site would have yielded entire cobs. The roasting of cobs rather than boiling kernels is a possible explanation for the lower isotopic values from within pottery vessels. If roasting was favoured over boiling, individuals may have avoided using pottery to prepare maize and lowered the likelihood of maize isotope values being added to carbonized food residues. It is also a possibility that the meals prepared at the Stelzer and Arpan Mound sites were extraordinary compared to the everyday meals at the Lockport site. During such significant meals, food items outside of normal cuisine were shared with others and in higher quantities (H.Y. Hind in 1860; account by S.G. Wright mentioned in Yarrow 1881). For these particular circumstances, we could infer that maize could have been present in significant quantities, given its position as an 'exotic' item. At the Stelzer and Arpan Mound sites, where kernels likely were the only form available and specifically prepared for an important event, microfossils from maize would have been present in higher amounts within pottery residues. Therefore, differences in how maize was prepared require attention when identifying maize consumption through isotopes from pottery residues.

For the majority of the Besant-Sonota pottery vessels, isotopic values are consistent with locally available food products expected for the environment. This is also supported by the dominance of locally available plant microfossils observed within these residues. But when looking at the Stelzer and Arpan Mound sites, where it appears maize was brought in for consumption, the higher C_4 values may very well represent food choices for meals of unusual significance.

8.6.B. Isotope Variations Between Interior and Exterior Carbonized Food Residues

Another intriguing result was observed when comparing the internal and external carbonized residues from the Arpan Mound vessel. Although $\delta^{13}C$ values were similar, $\delta^{15}N$ values from the interior produced lower values than their exterior counterpart.

Yoneda et al. (2018) found that interior Jomon pottery residues reflected the composition of foods recently cooked within a vessel, while residues found on the exterior were less meaningful because they were more prone to alteration from thermal effects, contamination from soot, or a combination of both. When using this rationale for the Arpan Mound vessel, perhaps the placement of the vessel directly beside the fire—as suggested by visual analyses conducted in this study—exposed food residues to contamination from the heat source. This exposure to soot and heat is consistent with other studies, such as by Teetaert et al. (2017), who reported differences in isotopic values from interior and exterior residues.

Other cultural explanations should be considered. In both archaeological and ethnographic literature, there is evidence that animal fats or grease were applied to the interior and exterior of surfaces before and after cooking to maintain a watertight seal (Reid 1990). Dunbar (1880), referred to the application of animal fats during firing and cooking activities by Pawnee potters. If fats from animals at a higher trophic level were applied to the exterior of the Arpan Mound vessel, this may also explain the heightened $\delta^{15}N$ values compared to the interior residues. The application of grease has already been suspected based upon the glossy surface of Variant 1 and 2 of the Stelzer site, whose appearance also mirrors that of the Arpan Mound vessel. Although residues from Variant 1 and 2 of the Stelzer site were not examined for isotopic values, this specimen provides supporting visual evidence for the application of animal grease or fats on the exterior of pottery vessels.

It is challenging to identify which explanation best fits the variation of $\delta^{15}N$ values from the exterior and interior of the Arpan Mound vessel, as there is sound logic behind both scenarios. Recent research into the isotopic values of pottery from two Jomon sites in central Japan revealed that exterior residues were less reliable owing to the thermal effect of fires and soot (Yoneda et al. 2017). Nevertheless, archaeological and ethnographic evidence offers an alternative explanation via the application of animal fats to the exterior of some pottery vessels

(Dunbar 1880; Reid 1990). Although insufficient residues permitted examination of Variant 1 and 2 of the Stelzer for $\delta^{15}N$ isotopic values, their similarity in appearance opens the door for the possibility that similar higher values would be identified and provide additional evidence connecting these two sites.

8.7. Timing of the Stelzer and Arpan Mound Site Occupations

Connections between the Stelzer site and Arpan Mound site have already been drawn based upon pottery attributes: namely the two smooth exterior vessels (Variant 1 and 2) from the Stelzer site, with punctates and rounded rims that closely resemble the Arpan Mound vessel. These Stelzer variants (which were found within 10 feet of each other) had the same, irregularly shaped punctates. This irregularly shaped punctate design was only observed on these three vessels and was placed in a similar orientation with irregular designs pointing towards the orifice of the vessel (see Figure 7.6). These similarities raise the possibility that just one or a few artisans had used the same tool to create the punctates. This connection in pottery making is made stronger when viewed alongside recent AMS radiocarbon analyses on these two Sonota Mound sites.

Radiocarbon dating of three residue samples from the Arpan Mound vessel provided an opportunity to address the timing of the Arpan Mound site in relation to the nearby Stelzer site. Neuman (1975) originally thought the Stelzer and Arpan Mound sites were created over several hundred years, but this idea has been refined by recent radiocarbon analyses by Graham (2014). By obtaining 12 ultrafiltered bone collagen dates and using Bayesian analyses, Graham (2014:263) revealed that the Stelzer site was occupied over approximately 80 radiocarbon years, or from 1696 to 1615 ^{14}C yrs BP.

Central to this dissertation is the question of whether these two sites were contemporaneous. To test the temporal relationship between these two sites, Bayesian statistical analysis can be helpful. Bayesian analyses make use of Baye's Theorem, which examines radiocarbon values and calibration curves to determine the probability of time for which an archaeological event occurred (Ramsey 2009). Obviously, the Arpan Mound and Stelzer sites are two separate sites, but the recent overlapping AMS radiocarbon dates imply contemporaneity. Therefore, if these two sites are viewed as connected phases, it may be possible to use Bayesian analyses to explore the amount of time that elapsed between the occupation of these two Sonota Mound sites (Ramsey 2009).

Radiocarbon dates collected by Graham (2014) from the Stelzer site and those obtained in this study from the Arpan Mound site were entered into OxCal 4.4.4 as two separate phases that were placed in a sequence, in the first case identifying the Stelzer site as earlier than Arpan Mound. A second version of this data was entered into OxCal 4.4.4 with the Stelzer site appearing later than the Arpan Mound. As the Stelzer and Arpan Mound sites overlap chronologically, it was important to run both scenarios to allow for either site to predate the other. By treating the radiocarbon dates from the Arpan Mound and Stelzer sites as separate phases, it is possible with Bayesian analysis in OxCal 4.4.4 to explore the temporal relationship between each of these sites. After plotting the dates in OxCal 4.4, an interval command was added to estimate the time existing between these two phases. In the first scenario, the elapsed time between occupations of the two sites ranged from zero to 105 years (Figure 8.6). If the Stelzer site was occupied first, Bayesian calculations suggest that the highest probability of time that elapsed until the Arpan Mound site was created was approximately five years (Figure 8.6).

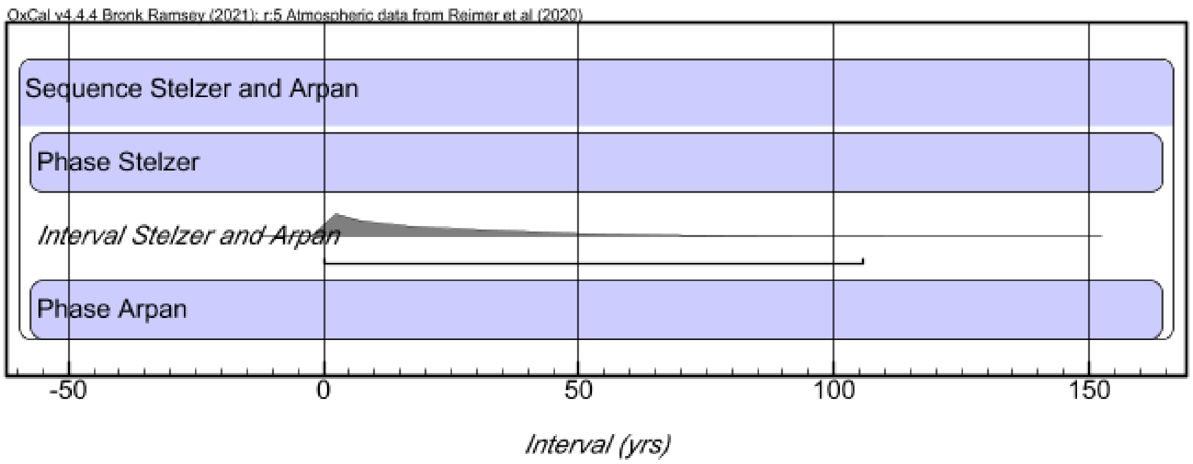


Figure 8.6 Interval calculation based on calibrated radiocarbon dates assuming an earlier start time for the Stelzer site.

The second scenario, where the Arpan Mound site predates the Stelzer site, resulted in an elapsed time between zero and 65 years, with the highest probability of occurring within four to eight years (Figure 8.7). In either case, the highest probability of time separating both sites is within a decade. Key and Jantz (1990) and Neuman (1975) regarded Stelzer as a campsite related to the nearby Sonota mounds. The narrow range of radiocarbon dates and these Bayesian analyses very strongly suggests that Stelzer and Arpan Mound were occupied contemporaneously or within a narrow window of time. This length of time may be explained by revisiting previous examinations of the skeletal remains recovered from the Sonota burials and northern Great Plains burial customs.

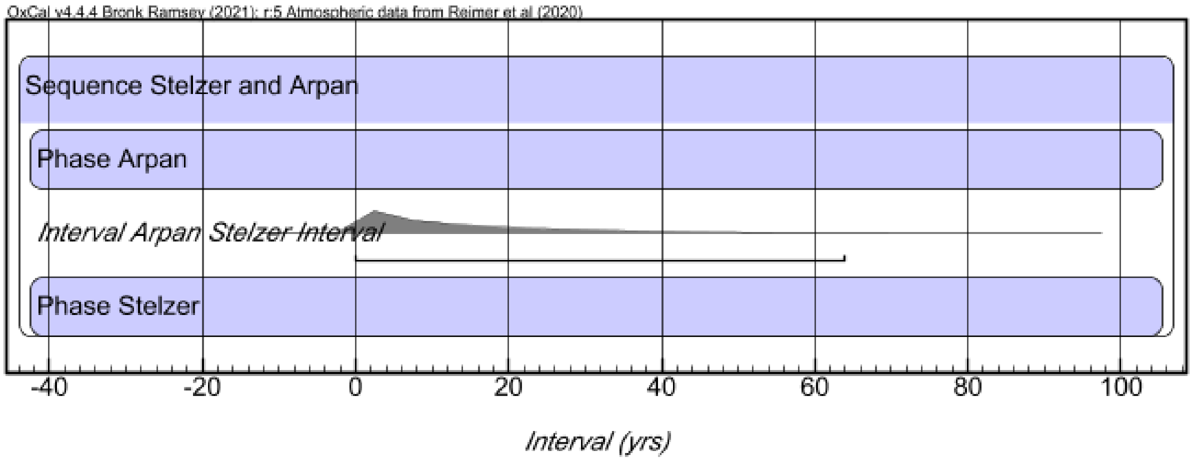


Figure 8.7 Interval calculations for the time elapsed between the end of the Arpan Mound and the start of the Stelzer site.

Recalling Chapter 2, 48 individuals were buried at the Arpan Mound site, representing a variety of age ranges and no clear separation based on status. Northern Great Plains burial customs often involved the placement of individuals on scaffolding with later collection and deposition in bundles occurring (Key and Janz 1990). If these individuals were solely from one endogamous group, this would represent perhaps decades of accumulation. Therefore, the placement of so many individuals within burial mounds would have been considerable events, including important inaugural ceremonies when a mound was created. The gathering of those interred in the burial mounds may have required extensive time and energy by a single group intermittently over years, or even decades, or the participation of multiple contributing groups over less time. According to Buikstra et al. (1998), Hopewell burials required staging areas to be established for all participants to occupy before, during, and after burial activities. The Stelzer site certainly fits several criteria for a campsite that served as a "staging area" created by those participating in the construction of nearby mounds. If a practice such as the Cree custom of

Wikokeo was followed (Skinner 1914), it is possible that this staging area was not used just for the burial, but for subsequent activities that transpired a year, or multiple years, later.

These burial mounds were not constructed and left open until sufficient burials were present, as little evidence of re-opening or re-burial was noted during Neuman's (1975) excavation. The peoples responsible for these mounds were likely smaller band aggregates, and the accumulation of bundle burials may have taken years or even decades to complete. Nevertheless, this is a foreshortened window of time within the Besant-Sonota era and this coincided with the peak of the Hopewell Interaction Sphere (Charles and Buikstra 2006). At the same time, the Valley phase of Nebraska was moving northwards along the Missouri River, bringing maize into the northern Great Plains (Adair 2016, 2019). The Stelzer site was the staging area for not just the Arpan Mound site, but also for Swift Bird and Grover Hand (which is located on the edge of the Stelzer site) during a time of pronounced interregional interactions.

8.8. Summary of Paleodietary and Radiocarbon Information

Within the Besant-Sonota era, pottery was used for the first time to prepare foods for both everyday and extraordinary meals. Although much of the plant microfossil and isotopic evidence reflects the consumption of locally available foods, the Stelzer and Arpan Mound sites are anomalies. At the Stelzer site, four separate specimens produced multiple lines of evidence for maize consumption (multiple types of phytoliths and starch grains), and this is mirrored in all specimens examined from the Arpan Mound vessel. Vessels at the Stelzer and Arpan Mound sites were used to boil a combination of wild plant foods such as goosefoot, chokecherry, and saskatoon with maize serving as an extra ingredient for some meals. Given the significance of these two sites, it is likely that maize was acquired via trade or brought by visitors to the site and was consumed during important meals. Direct evidence of cross-continental trade through many interactions has already been identified within the Stelzer and Arpan Mound sites as shells from the Gulf Coast and copper from the Great Lakes were found suggesting a connection to much of North America. Within Hopewell contexts, the appearance of items originating great distances away is not uncommon as Yellowstone obsidian, KRF, galena, copper, and depictions of exotic animals such as alligators and bighorn sheep have been identified (DeBoer 2004). Evidence of maize consumption fits with this narrative, but this was limited to sites of great significance.

The remaining sites examined in this study yielded very little in terms of plant microfossil evidence for food consumption. One site that yielded an abundance of identified wild plants was the Walter Felt site where needle-and-thread, fowl blue, slough, and meadow fescue grasses were identified in high frequencies. Given this high abundance of these non-traditionally consumed plants, ethnographic literature about boiling stomach tissue or stomach contents provided a plausible explanation for these values. As stomach tissues and their contents from herbivores would be rich in local grasses, one would expect to see this reflected within plant microfossil assemblages obtained from pottery vessels. This appears to be the case at the Walter Felt site as plants local to the area, and common large herbivore forage was present in high numbers in pottery residues. At the same time, we cannot assume these phytoliths were not a by-product of a cooking activity that has been lost to time.

For the majority of residues examined in this study for carbon and nitrogen isotopes, local environments played a considerable role in the values observed. This was not quite so straightforward for the Stelzer and Arpan Mound sites, which are situated within C_4 landscapes. This presented a potential problem when identifying maize consumption via isotopes. Animals spending most of their lifespan within these areas would yield higher $\delta^{13}C$ values, which may have skewed isotopic results for residues. To the extent that carbonized residues reflect the last meals cooked within a vessel, it is just as possible that maize could have also played a role in determining these isotope values, particularly given the microfossil indicators also present.

The new insights from AMS dates collected from the Arpan Mound vessel further strengthen the ties between the Stelzer and Arpan Mound sites. AMS dates from the Arpan Mound vessel suggest a high likelihood that the Stelzer site and Arpan Mound were used within a short period of time from one another with the Stelzer site serving as a campsite, or staging area, for those responsible for constructing nearby burial mounds. It is plausible that all of these mounds were created within a timeframe as narrow as a few decades allowing sufficient time to accumulate the deceased and conduct the necessary pre- and post-burial rituals.

The paleodietary results of this chapter, combined with the use-alteration results of this study provide a new perspective on how early northern Great Plains pottery vessels were made, decorated, modified, and used. While low in frequency, their placement within significant archaeological sites and their use to prepare "exotic" foods highlight their unique role. In the next chapter, these interpretations will be brought together to provide an overview of Besant-Sonota pottery.

Chapter 9: Discussion

The Besant-Sonota era ushered in ‘new’ ideas, materials, and traditions occurring in adjacent areas to the north, east, and south. Some of these practices and ideas were adopted by northern Great Plains peoples, while others were not. Pottery represented one of these changes and appeared alongside the consumption of maize and the creation of burial mounds. The diverse group of people that lived across the Besant-Sonota geographic range adopted pottery for use during certain activities that involved one or more communities.

This study represents a re-examination of Besant-Sonota pottery that was guided by ethnographic accounts and enhanced by archaeological data. This focus has led to a better understanding of the manufacture, use, repair, and modification of these rather rare instances of pottery. After reviewing ethnographic accounts of pottery making, many parallels were drawn between vessels that were made almost 2,000 years ago and those made (or described) in the late 1800s and early 1900s. Knowledge of manufacturing and uses directly addresses the role these vessels played within Besant-Sonota era communities and how peoples interacted with their neighbours.

9.1. Limited but Significant Use

Close to 1,500 Besant-Era sites have been documented on the northern Great Plains, yet less than 100 of these contain pottery. Simultaneously, the relatively few pottery vessels at that smaller number of sites were well-maintained and repaired while also being found at sites of significance. Evidence of modifications and repairs was noted at the 39JK63, Butler-Rissler, Cedar Gap, and Stelzer sites largely in the form of drilling or addition of clays. Modifications and repairs suggest that efforts were made to extend the lifespan of these vessels and adapt them for a mobile lifestyle. For example, the addition of drilled holes to apply a carrying strap would aid in the transportation of these vessels while the addition of clays may have represented an individual trying to save a vessel from breakage. Both actions are also supported by accounts from Mandan and Hidatsa potters (Wilson 1910). It appears that individuals predating Mandan and Hidatsa by over 1,000 years also treated vessels with similar care.

Further evidence of their importance can be inferred from the size of these vessels and their uses. Vessels of larger size are indicative of community-shared food preparation (Blitz 1993; Mills 1999). Standing upright beside a fire, these vessels were at least 30 to 40 cm in height and were marked with designs capable of expressing community identity. Pottery vessels within the Besant-Sonota era provided a means of social expression during food preparation activities not possible through stone boiling or roasting. Not only could these vessels be used to prepare a large quantity of food for special occasions, but they could also be decorated in a manner that reflected the hosts of such occasions. In addition, vessels that were made for everyday meals were placed alongside individuals within burials. Comparisons between the Arpan Mound vessel and Variants 1 and 2 of the Stelzer site in this study revealed a shared surface exterior, decoration, rim design, and overall shape. Combined with the synchronicity of these two nearby sites, it is likely that the peoples who made these vessels were connected and that this vessel type was used for both everyday meals and as the center point of a burial ritual.

Further connections to visual display and the overall significance of the vessels were observed when comparing the Grover Hand conical pipe bowl to vessels at the nearby Stelzer and Arpan Mound sites. The placement of punctates and the overall shape are remarkably similar (Figure 9.1). Pipes during this time were undoubtedly powerful symbols and reserved for highly regarded individuals (Gehlbach 2006), making the possibility of a conceptual connection between the conical pipe bowl and a vessel used in a mortuary context all the more intriguing. Among Hopewell cultures, pipes were deliberately broken and left with individuals of higher status during funeral preparations. Gehlbach (2006) believes that this ritual breaking represented some level of social hierarchy. In Hopewell regions, some individuals were perhaps considered "first amongst equals" and these pipes marked this distinction (Gehlbach 2006; Krause 1995:136). Perhaps there were occasions when pottery was elevated to represent something more, which is a common theme when interpreting items found in low frequencies (Smith 2017).

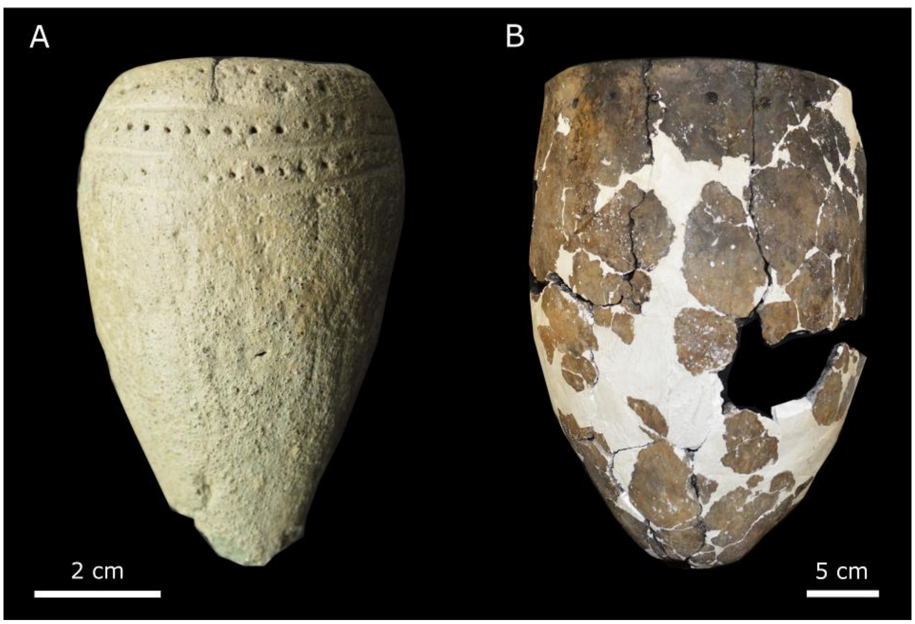


Figure 9.1 Comparison between the Grover Hand pipe bowl (A) and the Arpan Mound vessel (B). A and B have been resized for comparison (see scales in white). Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

In this case, the elevated significance appears to have extended between the living and non-living worlds. Within the Sonota mounds, pottery vessels were placed alongside persons who had left one world for another. In addition, an estimated 15 to 20 vessels were used at the nearby Stelzer campsite. This estimate was developed by Neuman (1979) based on his excavations of the Stelzer site. Although this is an estimate, the 11 separate variants indicate that an unusually high number of pottery vessels were present at this site compared to others from this time frame. In addition, only approximately 0.5 percent of the 220,000 m^2 Stelzer site was excavated. It is possible that this number represents only a small portion of the total number of vessels that the occupants of the site used. Thus, evaluating the context in which we find the pottery vessels is important.

For the Arpan Mound vessel, one cannot escape its intimate connection with a mortuary ceremony, with the pot a focal point around which the bundle burials were arrayed. Amongst many hunter-gatherer societies across the world, and within the northern Great Plains, burials involved community engagement with the deceased as if they were still present and had not yet left for another world (Buikstra et al. 1998; Hulkrantz 1981, 1990; Yarrow 1880). Feasting and celebration, intermixed with mourning, were common (Buikstra et al. 1998; Hulkrantz 1981, 1990; Yarrow 1880).

Carbonized food residues representing the last meals prepared within a pottery vessel reveal that maize played a role during Besant-Sonota era gatherings. The inclusion of maize is not unprecedented for sites where celebrations, feasting, and other community events were happening. Besides maize, locally available plants such as chokecherry, goosefoot, and saskatoon were prepared within these vessels. Outside of the Sonota mounds, only locally available plants were prepared within pottery vessels. It appears that away from the Sonota mounds, pottery vessels were used as an alternative means of preparing everyday dishes.

Based on what has been discussed so far in this chapter, the adoption of pottery by northern Great Plains cultures appears better related to a form of social expression rather than for a functional improvement in cooking practices. Although Rice (1999) and others (e.g., Arnold 1985; Reid 1989, 1990) correctly believe there is a nutritional advantage that led to pottery adoption, the Besant-Sonota era falls more in line with the earliest pottery producing cultures in China, Russia, and Japan where vessels were used for normal dietary activities but also reserved for occasional special use (Shoda et al. 2019). Except for the Sonota mounds, it would appear these vessels were used to prepare meals otherwise made through stone boiling. At the Stelzer and Arpan Mound sites, maize that was grown perhaps by individuals from Hopewell areas or the American Southwest was acquired by northern Great Plains cultures at a similar time as pottery. To further explore the adoption of pottery, and its importance, we must question how these interactions took place.

9.2. Long-Distance Interactions During the Besant-Sonota Era

The movement of materials and ideas during the Besant-Sonota era represents a single entry in a long sequence of interactions that occurred between northern Great Plains and Eastern Woodland cultures. The earliest recorded interaction is marked by the presence of KRF in areas of Alberta and the Eastern Woodlands during the Paleoindian period (Ives 2015). From an Alberta perspective, a projectile point from the Clovis tradition is the beginning of a long line of interactions involving KRF that increases remarkably in frequency during the Cody Complex of the Late Paleoindian period and the Besant-Sonota era (Ives 2015). Other notable moments of long-distance interactions can be interpreted from the movement of northern Great Plains bison hunters from the Rocky Mountains to the Great Sand Hills in southwestern Saskatchewan (Oetelaar 2021), the presence of a copper crescent in east-central Alberta (Steinbring 1975:77), and the Old Copper complex that emerged approximately 3,200 years before present and resulted in long-distance trade of native copper within and outside of the Great Lakes (Ehrhardt 2009). It appears that long-distance interactions occurred throughout much of the Holocene on the northern Great Plains and that cultures were not unfamiliar with new materials or technologies appearing in other areas. The frequencies of such interactions may have experienced ebbs and flows based on the arrival of new technologies and ideas. Ultimately, there was a long history of gatherings that occurred before and long after the emergence of the Besant-Sonota era on the northern Great Plains. The Besant-Sonota era represents one period in time when interregional interactions appear more frequently in the archaeological record.

The Sonota mounds were built in a time frame when Charles (2012:474-475) modelled Hopewell at its maximal extent (1750 to 1650 cal BP), presumably when the Hopewell Interaction Sphere also had its broadest reach. Thereafter, the Hopewell Interaction Sphere entered a period of decline, as earthwork construction was discontinued and long-distance artifacts were no longer obtained. Abrams (2009:186) placed this decline at an estimated 1800 BP in the lower Illinois River Valley while Dancey (2005:131) saw this at approximately 1650 to 1600 BP in the Scioto River Valley of Ohio. In the Eastern Woodlands, cross-continental trade was marked by the circulation of exotic materials such as obsidian, copper, galena, mica, spoonbill remains, and oceanic shells by communities connected to the Hopewell Interaction Sphere (Carr 2005; DeBoer 2004; Griffin 1969; Sarich 2010; Wright and Loveland 2015). This movement of goods transpired during a time of visible, and sometimes pronounced, status changes.

To deconstruct the Hopewell Interaction Sphere, Carr (2005:576) chose to describe the interregional and regional trade—that is so pronounced within Hopewell—from the perspective of the actors that would have facilitated these interactions (Table 9.1). Acknowledging that the exact circumstances of these interactions will never be fully revealed, Carr (2005:575, 580) outlined potential "mechanisms" that could be used to explain the movement of peoples and materials throughout the Eastern Woodlands during the time of Hopewell. These mechanisms included vision and power quests, pilgrimages to a place of power or centre of learning (Gill 1982; Helms 1976, 1988, 1993), travels of healers or medicine persons, long-distance buying and selling, travels for learning ceremonial rites (Penney 1989), spirit adoption between individuals or communities (Hall 1987, 1997), intermarriage, exchange of highly sought after of valuable items (e.g., Flannery 1967), and elite-orchestrated transference of religious cults (Wiessner and Tumu 1999). Of these explanations, some are more difficult to show archaeologically. Natural landmarks such as the Obsidian Cliffs of Wyoming or the Great Lakes would have drawn people that were in search of spectacle for their own beliefs, participating in a rite of passage, or building their position within their society while also gaining exotic resources such as obsidian and copper (Carr 2005). Travels to locations where "the Creator's heart beats more strongly" were a common practice by historic Indigenous peoples and should not be ruled out as explanations for long-distance interactions during the time of Hopewell (Gill 1982:97; Swan 1988:152). Yet, while artifacts obtained from these locations at sites situated vast distances away indicate the movement of peoples to these landmarks, how this occurred is less straightforward. Nevertheless, all possible mechanisms need to be addressed when viewing interactions between cultures separated by great distances.

Table 9.1 Explanations for interregional and regional trade summarized from Carr (2005:581).

Possible Mechanism	Suggested Example
Vision or power quest	Gathering of obsidian from Yellowstone region (Carr 2005:585).
Pilgrimage to a place in nature	Travels to Lake Superior (Carr 2005:585).

Travels of medicine persons or patients for healing	Travelling to the patient or the patient travelling to a medicine person and giving a token for services (Mails 1979:186-189).
Elite valuables exchange	Exchange of 'rare' items over long distances (Carr 2005; Carr and Komorowski 1995).
Pilgrimage to a ceremonial centre	Travel to places thought to be powerful to perform sacred rights (Romain 2000:29).
Travel to a centre of learning	Travels of individuals to gain ceremonial knowledge and to make new paraphernalia (Penney 1989:159-229).
Buying of religious items	Acquisition of meteoric iron by travellers to conduct ritual ceremonies (Carr 2005).
Spirit adoption	Releasing the soul of a deceased community member to a prominent member of another society (Hall 1987, 1997:42-47, 155-157).
Intermarriage	Marriage between neighboring communities in the Eastern Woodlands who shared or competed for resources or valued goods (Callender 1979:256).

Aside from examining the potential rationales for interregional interactions, Carr (2005:579) hypothesized the nature of the relationships between different cultures. Hopewell people, and any other culture during this time, may have viewed those that were not part of their community as either normal, as close strangers, or as outsiders. Language and cultural barriers may have impacted trade between cultures (Carr 2005:579). Mark Seeman (1995) also shared this idea and viewed the movement of items within Hopewell as the result of different means of communication being used among ordinary people, close strangers, and outsiders. Given the expanse of the Hopewell Interaction Sphere, covering most of the Eastern Woodlands and spreading into the Canadian Subarctic and northern Great Plains, this was a multidimensional and composite phenomenon that overcame barriers between different cultures (Carr 2005).

The Sonota mound sites occurred precisely during a time when Hopewell was actively "reaching out" onto the northern Great Plains. These sites contained the highest number of pottery vessels on record for the Besant-Sonota era, various cross-continental trade items, and the first northern Great Plains instances of burial mounds. While this speaks to a connection with the Hopewell world, this visible expression is relatively muted. Evidence of Hopewell practices and artifacts appear on a significantly smaller scale and there remains a strong northern Great Plains component represented by the practice of bundle burials and the presence of northern Great Plains material culture. This blending of cultures is further emphasized by the variation of pottery styles observed at the Stelzer site and the consumption of both maize and locally available plants.

Outside of the Sonota mounds, the signs of Hopewellian influence diminish dramatically. Pottery was adapted for a mobile lifestyle, restricted to a limited number of vessels per community, and the foods cooked within them were locally available. Items collected from long-distance trade also appear less frequent, although northern Great Plains materials such as KRF, obsidian, and bighorn sheep remains or representations were transported long distances into Hopewell affiliated areas to the east (DeBoer 2004; Griffin et al. 1969). Stone tools made of northern Great Plains materials such as KRF and Yellowstone obsidian have been recovered in Illinois and Ohio (DeBoer 2004; Griffin et al. 1969), providing direct evidence that materials were being moved between Hopewell affiliated and northern Great Plains adapted communities. The Sonota mound sites may have acted as a gateway for these interactions. Individuals may have participated in the Sonota mound building while travelling onto the northern Great Plains as part of vision quests or pilgrimages. Although this may be difficult to prove empirically, the location of the Sonota mounds along the Missouri River would have facilitated travel for individuals seeking access to the northern Great Plains and powerful locations farther west such as the KRF quarries and Obsidian Cliffs. During such journeys, Hopewell outsiders would potentially have encountered massive herds of bison, in what would be a spectacle for someone unaccustomed to the northern Great Plains.

Coinciding with these long-distance interactions are the marked increase in large, community-driven bison kills and notable increases in tipi sizes that occurred on the northern Great Plains (Frison 1971; Neuman 1975; Reilly 2015; Walde 2006a). These changes to Besant-Sonota communal activities may have been a reaction to trends that were occurring elsewhere in Hopewell centres. Practices such as mound building, extensive trade, and elaborate burials were creating status distinctions within Eastern Woodland societies (Hall 1997:156). As status distinctions became more elaborate for individuals and corporate kin groups in Hopewell settings, some parallels may have arisen in Besant-Sonota societies. Large communal bison kills became a regular feature of northern Great Plains archaeological records during Pelican Lake phase times; that trend continued into the Besant time frame with an increasing tempo of large communal kills (Frison 1971; Reilly 2015; Walde 2006a).

The Besant phase can also be distinguished from preceding and succeeding pre-contact archaeological phases by the presence of notably larger tipi ring diameters (Brumley and Dau 1988:119; Kehoe 1960:462; Quigg 1986; Reilly 2015). Both of these distinguishing features reflect important social dimensions: large communal bison kills required considerable planning and coordination among multiple communities. Similarly, large numbers of people were needed to effectively process the meat and hide products generated from a kill. If successful, this communal activity would have provided an immense quantity of bison products that would have sustained these communities and fueled trade with neighboring societies (Brink 2008:244). The increase in the frequency of communal bison hunting activities may suggest that northern Great Plains peoples were invested in the Hopewell Interaction Sphere, but unlike other notable trade items during this period (e.g., lithics and shells), the perishable evidence (e.g., dried meat products and bison robes) of this interaction could have been lost with time. While such fruits of this labour were not preserved in many archaeological contexts, the entire bison skeletal remains placed within the Sonota mounds (see Figure 2.12) indicate that bison were profoundly important to the peoples during this time. Furthermore, larger tipi ring sizes imply larger co-resident groups lived within these structures, and therefore, that there were somewhat different demographic and social arrangements from other time periods.

These factors raise interesting questions when interpreting the Sonota mound sites. It is legitimate to wonder to what extent the increasing tempo of substantial communal bison kills, coupled with larger domestic groups, could have to do with participation in the Hopewell Interaction Sphere—an area where many economic and societal changes were occurring. Durable items, such as obsidian, KRF, and relatively rare instances of pottery link the northern Great Plains and Hopewell affiliated regions, but we know comparatively little about the extent to which perishable items (e.g., bison robes) might have been involved. It is possible that an elevated demand for northern Great Plains bison products increased the tempo of communal hunting and production of pemmican (Oetelaar 2014; Reeves 1990a; Zedeño et al. 2014). Items that were rare to Hopewell centres were highly sought after during this time (Carr 2005:583), and it is plausible that items made from bison would have been valued similarly. Future research could profitably focus on the possibility that tangible changes in northern Great Plains communal hunting and social organization in the Besant-Sonota time frame might have been stimulated by Hopewell elites reaching out for exotic goods and products affirming their status. This involved not only trade and exchange mechanisms but also profoundly important mortuary rites very likely to have been undertaken and witnessed by groups gathering from considerable distances.

Associated cultural activities, celebrations, and ceremonies conducted alongside communal bison hunting may also need to be considered when viewing interregional interactions through the explanations presented by Carr (2005:581). For Hopewell centres, it has been hypothesized that ceremonial or spiritual knowledge would have been a means to display status to others (Carr 2005:581). Ceremonial activities aimed at securing the successful kill of many animals in a single, spectacular hunt might have garnered interest from Hopewell peoples. Therefore, attendance at communal hunting activities would have yielded both bison products and intangible ceremonial or spiritual knowledge for Hopewell peoples. This exchange of tangible and intangible products would not have been one-sided as it is possible that northern Great Plains peoples also gained knowledge about Hopewell ceremonies in return.

Such interaction with Hopewell centres may have been more pronounced in sites that were marked by a rise in ritual or ceremonial performances. The Stelzer site, and the surrounding burial mound sites, represent such a case where visible signs of Hopewell are found within a northern Great Plains setting. While sites such as Stelzer are anomalous, this does not signify that northern Great Plains cultures were unwilling to participate in the Hopewell Interaction Sphere. Northern Great Plains peoples were not passive actors throughout the Hopewell Interaction Sphere, but owing to a long history of such interactions, had developed their own manner of dealing with outside cultures asserting their influence across great distances. Rather than fully adopt new ideas, items, or technologies such as pottery making, mound building, and domesticated plants, northern Great Plains communities adapted their use in the context of forms of social organization that had been successful for thousands of years. These interactions with outside cultures exerting influences may have been met with force as Walde (2006a) asserted, yet do the Sonota mounds not tell another story?

The Sonota mounds can be better considered to represent a visible expression of "competitive emulation" by a northern Great Plains community attempting to share (or adopt) specific traditions but through different means (Braun 1986). If a wholesale adoption of Hopewellian ideas was completed, entire bison remains, fossil ammonites that would later be called *iniskim* by the Blackfoot, and other traditional northern Great Plains materials would not have been so prominent in the burial mounds. This emulation is observed at the Stelzer site, but may also be involved in the enhancements made to traditional northern Great Plains cultures, such as increased community-driven activities. The expansive nature of the Hopewell Interaction Sphere would not have gone unnoticed on the northern Great Plains despite the vast distance from Hopewell centres. Taking into consideration potential expeditions onto the northern Great Plains by Hopewell peoples of varying status, we cannot view these two regions as isolated entities that were closed off from one another. Increases to tipi ring sizes and bison kills, limited use of pottery as symbolic items, use of maize at ceremonial sites, and the placement of deceased individuals in burial mounds suggest that while northern Great Plains cultures were interacting with Hopewell, many of the ideas and traditions were selectively adopted and modified for a Plains lifestyle.

9.2.A. Imagining the Spread of Pottery onto the Northern Great Plains

Previous studies have reported difficulties in assigning cultural influences upon pottery designs found on vessels made during the Middle Woodland Period (Adair 2016; Scribe 1997; Tiffany 1978). There is no consensus for terminology applied to Besant-Sonota pottery and there has been no clear ancestral origin for this "new" form of material culture. The variety of pottery found at the Stelzer site provides the opportunity to address this taxonomic conundrum.

Caldwell (1964), DeBoer (2004), Gregg (1983), Neuman (1975), Reeves (1983), Scribe (1997), and Syms (1977) have all attempted to trace interactions between northern Great Plains cultures and those located outside the borders of this region. Other studies have approached the movement of pottery among Hopewell centres (Fie 2000; Penney 1989; Ruby and Shriner 2005; Stoltman 2000). These interpretations have been based on the presence or absence of similar artifacts between adjacent cultures or source analyses between pottery production zones. More recently, Graham (2014:266) adapted three theoretical models used by Clark (1984) to assess the movement of KRF among Besant-Sonota and other sites. Such models were based upon Renfrew's (1972) down-the-line trade, directional trade, and prestige chain models. For the movement of pottery, these three exchange models may reveal why there is so much variation in pottery during the Middle Woodland Period. Unlike lithic materials, finding the area where pottery was made is more challenging.

Sourcing of pottery vessels has been completed for Hopewell centres, yet most studies have confirmed that direct trade of vessels was rare (Fie 2000; Ruby and Shriner 2005; Stoltman 2000). For example, during a comparison of pottery vessel compositions, Ruby and Shriner (2005) found that only eight percent of pottery from the Mann site (12PO2) of Indiana, was made of nonlocal clays and temper. Sourcing analyses have yet to be completed on Besant-Sonota vessels and owing to their rarity in the archaeological record, it is difficult to identify whether pots were manufactured or acquired by northern Great Plains peoples. Given this uncertainty and the rare appearances of pottery within Besant-Sonota sites, it is likely that pottery was seldom or never made by northern Great Plains peoples, but was acquired instead.

Earlier in this dissertation, I hypothesized that the origins of Besant-Sonota pottery were connected to pottery producing regions such as those yielding Valley phase and Rowe ware vessels.

Valley and Rowe vessels of Nebraska and Iowa share a strong resemblance to Besant-Sonota cord roughened wares including the overall shape, exteriors, temper, paddle and anvil construction, and application of limited decorations predominantly near the rims (Adair 2016; Gregg and Picha 1989:62; Neuman 1975:86; Scribe 1997). Further connections are seen in the presence of Besant atlatl points within Valley phase sites and similar dwellings found in the northern Great Plains (Epp and Dyck 1983:113; Wettlaufer 1955). Additionally, Reeves (1983), Neuman (1975), and others have postulated that Besant-Sonota pottery was spatially and temporally connected to the Valley phase. Recent evidence of maize within Valley pottery vessels also provides another link for how this exotic food was brought to the Sonota mounds (Adair et al. 2022). The similarity in vessel designs and the northern expansion of the Valley phase from approximately 1750 to 1550 BP points to this pottery-producing culture as a legitimate, potential starting point for these exchange models (Ludwickson and Bozell 1994).

Down-the-line trade involves the transferring of materials from group to group from a source area with a decrease in quality and abundance with distance (Renfrew 1972). In the case of pottery, vessels may break along this journey and the methods to make these vessels may begin to differ from the original designs used in the source area. Directional trade works similarly to down-the-line trade but large population centres may exert an influence on the frequency of a trade item in its surrounding area. Rather than a gradual decrease, there may be locations with increased abundance after an initial decline. For pottery, this would require the accumulation of wares within a location for an extended period before redistribution. The final model, the prestige chain, involves items of high value being moved across great distances such that they only appear in archaeological records in small frequencies. Since these are valued items, these prestigious artifacts would only enter the archaeological record either by accident or through ritual offerings (Clark 1984:185).

As this study has illustrated, pottery is a rare item during this time. It was modified for long-distance travel, was used to cook foods used in ritual meals, and was buried with deceased community members. There is no evidence that pottery was made in one location in abundance away from a source area and then traded from this second location. Owing to these factors, down-the-line trade and prestige chain models best fit the spread of pottery throughout the Besant-Sonota era, and these may have occurred simultaneously (Figure 9.2).

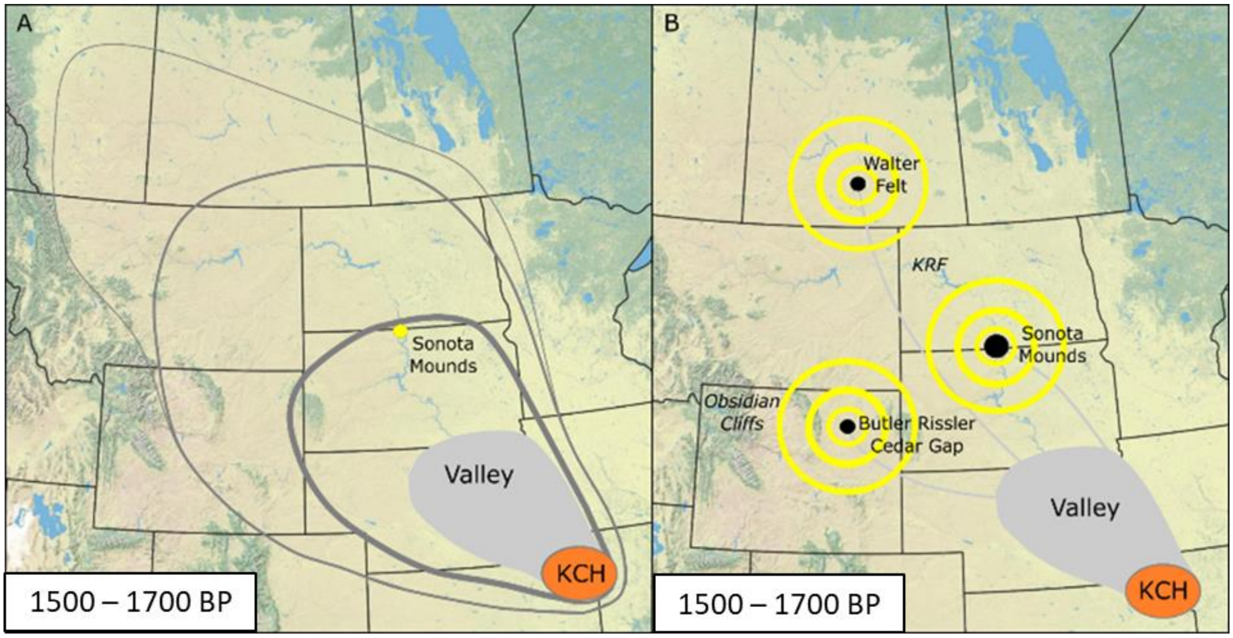


Figure 9.2 Movement of pottery onto the northern Great Plains through trade (A) and isolated gatherings (B).

Starting with down-the-line trade, pottery use within this era occurred more frequently in South Dakota and diminished northwards throughout the northern Great Plains. There is a dramatic fall-off of pottery use outside of South Dakota, as the number of vessels quickly diminishes. If pottery vessels were traded among cultures, this would explain the limited number of vessels in the Canadian Plains (see 9.2 A). It is legitimate to explain the varied decorations and vessel shapes as the result of these wares being acquired through different relationships with pottery producing cultures. The early pottery found on the northern Great Plains appears to have been to manufactured and designed similarly across the entire region. For instance, decorations were almost exclusively placed near the orifice of the vessel, the overall shapes of the vessels were conoidal, and paddle and anvil and other hand forming techniques were used to manufacture vessels. Still, at a finer scale, some variations appear among and within sites. This was most notable at the Stelzer site, where 11 variants were recovered. A considerable variation in decorations and vessel shapes is also expressed in the Valley phase (Adair 2016) and Rowe (Tiffany 1978) pottery types. Because these instances have their own variation between sites, this may explain why pottery vessels on the northern Great Plains share specific resemblances to more than one source area and appear varied at a finer scale.

The placement of pottery in sites of significance also shares characteristics expected for the end of a prestige chain. I have proposed that the small number of pottery vessels within the Besant-Sonota era may in part be explained by their use as community vessels. Their size, the amount of modification, and placement in burials appear to suggest importance, which is also supported by Indigenous viewpoints on pottery outlined in Chapter 2. If pottery was held for important occasions and decorated specifically for each community, it is also feasible that sites with a gathering of people such as the Stelzer site would present an opportunity for several vessels with differing appearances to be in the same location. It is unknown if these vessels were made at the Stelzer site and the variants represent some form of hybridization of styles, or if different communities brought their wares with them. Interestingly, for an item as infrequently found within Besant-Sonota sites, there is an unprecedented number of pottery vessels at the Stelzer site. The people visiting the Stelzer site may have acquired Valley, Rowe, Laurel, or Malmo wares, but pottery would not be actively produced on a routine basis until the Avonlea phase 400 years later. Even in those instances, pottery is considered a relatively minor component of Avonlea material culture (Meyer and Walde 2009).

Pottery use may have been restricted during this time and it is possible that communities brought pots on their journeys to events of significance such as mortuary rites. Pots may have been exchanged during associated activities such as alliance building and marriage. Great Lakes copper, dentalium shells from the Pacific Ocean, large shells from the Gulf of Mexico, and maize (as indicated in this study) were brought to the Sonota mounds and blended with traditional northern Great Plains ritual items such as fossil ammonite (Neuman 1975). Visits by pottery producing cultures to distant locations are also not out of the realm of possibility as DeBoer (2004) viewed the presence of obsidian and bighorn sheep within Ohio Hopewell mounds as markers of long-distance travel and exchange.

This process of travel and interaction would present an opportunity for outside cultures to share ideas, and gain lithic materials such as obsidian and KRF, all while sharing pottery and items more familiar to Hopewell centres before various parties returned to respective homelands. Pottery would be used by groups leaving the Sonota area, but would not likely be replenished unless pottery makers from the Hopewell-affiliated society joined the non-pottery making community through marriage. Perhaps the addition of carrying straps and the repairs noted on vessels outside of the Stelzer site are direct indications that northern Great Plains peoples were not actively producing pottery, but using vessels given to them and extending their lifespan rather than creating new ones. Additionally, this scenario would provide a rationale for the lack of maize outside of the Sonota mounds. During this time, maize was not yet a dominant crop even in the Hopewell world so the amount of this exotic food item leaving these centres would have been nominal (Adair et al. 2022). Therefore, any maize that was brought by visitors as gifts or to be used in special meals or beverages would have been in small quantities (cf. Coltrain and Leavitt 2002 regarding maize beverages in Fremont contexts). Despite the limited amount of pottery and maize present during the Besant-Sonota era, their presence at sites of importance suggests that peoples separated by great distances were interacting or reaching out onto the northern Great Plains near the end of the Hopewell Interaction Sphere. These interactions are additional factors to consider when using taxonomy to trace the origins of Besant-Sonota pottery.

9.2.B. Pottery from a Besant-Sonota Era Demographic Perspective

Examining Besant-Sonota pottery solely through the lens of taxonomy is a difficult endeavour owing to the variability of pottery found on the northern and central Great Plains. In surveys of pottery in this study and others conducted on Valley phase designs, some forms appeared more like Hopewell wares than others (e.g., Adair 2016, 2019; Tiffany 1978). Moore (1994) and Paquin (1995) argued that taxonomies with significant variability can be explained by contemplating the ethnogenetic forces responsible for these traditions.

From demographic studies of intermarriage among North American Plains communities, Moore (1994) observed that many northern Great Plains cultures could be viewed as polyethnic and connected to other ethnic groups. He used the analogy of a braided river system, in which ideas, traditions, and material culture could flow together, separate, and be made anew before repeating this process (Moore 1994:930). These ideas were connected by Paquin (1995) to explain similarities and differences in pottery designs based on the movement of peoples between societies in northern Saskatchewan, as did Yanicki (2019) for the taxonomic variability typical of Promontory phase pottery in Utah (known as the "Promontory problem").

Indeed, marriages between societies separated by great distances in North America (Carr 2005:580) may have been rare, but so too was pottery during the Besant-Sonota era. Recalling the frequency of Besant sites bearing pottery in Chapter 7, I would note that for every site that contained pottery, almost forty-five did not.

It is plausible that pre-contact hunter-gatherer communities within the Central Plains were as demographically diverse as those living on the northern Great Plains historically. In a multicultural setting at the Stelzer site, it is conceivable that potters from different backgrounds developed hybrid forms of pottery. Away from this setting, pottery making may have been limited or non-existent for groups that did not practice pottery making. Without identifying where these vessels were made, this hypothesis is difficult to test. To date, there is no direct evidence of pottery making at Besant-Sonota era sites (e.g., paddles) and no sourcing has been done on vessels from this time period.

Furthermore, the arrival of these varied vessels onto the northern Great Plains, either through many trade interactions or direct visitations, quests, or pilgrimages to important sites, such as Stelzer, leads to a problematic taxonomy only when viewed through the lens of decorations alone. Vehik (1983:211) found that while there were some similarities among the Sonota mounds, Laurel mounds of Minnesota, and Illinois Hopewell mounds, there were also significant differences. Some of these differences, such as mound construction, were visible in the archaeological record while others required viewing these mounds from a demographic perspective. Mounds built in Illinois areas were positioned on bluffs overlooking river valleys, contained one or more central tombs covered with log, slab, or earth walls, and were left open for a time while remains of the dead were processed by individuals with the spiritual knowledge to do so (Tainter 1975:66; Vehik 1983:214). Intrusive burial was also a common practice as new individuals were added to the mound and the last individuals were given more elaborate, or artifact-rich, burials. It has been suggested that the concluding burial was reserved for someone of importance (Braun 1979:68; Vehik 1983:214). The individuals most often placed within Illinois mounds were adults, but not elderly adults, followed by children, as adolescents and women were underrepresented (Vehik 1983:215). According to Braun (1979:79), Illinois Hopewell societies were hierarchically arranged. Access to prestige positions was not hereditary but was conditioned by sex and personal ability. Another trait observed at Illinois mounds involved clear symbols of office that were more or less similar in the materials present and arrangement of burials (Vehik 1983).

In contrast to the Illinois Hopewell mounds, the Sonota mounds were completed in short periods of time. No clear symbols of office were present and utilitarian items and bison remains were often placed alongside the bundle burials (Vehik 1983:217). Another distinction was the uniformity in the placement of burial goods as no burial was more elaborate than others. This is most evident at the Arpan Mound site where multiple bundle burials were arranged around a single pottery vessel (Neuman 1975; Vehik 1983), almost as if the individuals responsible for this burial were expressing a collective identity.

Treatment of human remains was also conducted in a similar manner for the individuals that were buried, as remains were processed at another location. For all of the Sonota mounds, 210 of the 227 individuals were completely reduced and none were found fully articulated (Vehik 1983:216). The people buried in these mounds also differed from Illinois examples as a greater number of individuals aged 0 to 5 and 6 to 10 were buried within the Sonota mounds (Vehik 1983:218). Ages 11 to 35 and 41 to 45 were also underrepresented and these numbers suggest that not all individuals received a mound burial. Females and individuals between the ages of 11 and 35 were not given a burial and if children were buried; those individuals were always accompanied by an adult male (Vehik 1983:222). Approximately 85 percent of children that were buried were placed within central pits and 93 percent of these were placed in clusters involving adult males (Vehik 1983:222).

For children living on the northern Great Plains during this time, there would not have been enough time to achieve a greater level of status aside from what was ascribed at birth. Nevertheless, their inclusion within the Sonota mounds suggests that children were of importance even though they had not had the opportunity to achieve status. Perhaps their inclusion in burial mounds alongside adults mirrored how children were viewed as part of the community until reaching adulthood at which point their status may have changed or they may have left their community to join another.

Based on the skeletal evidence at the Sonota mounds, it appears that women were only included in central burials when their death coincided with a particular adult male. Vehik (1983:223) hypothesized that the prominence of males, both young and old, within the mounds could be explained by examining relatedness. If the host community responsible for the mound building practiced female exogamy, this may have resulted in higher numbers of males being interred where inclusion within the mounds would have been directly tied to being part of the community.

Regarding items placed within the mounds, these varied from everyday to exotic items and no burial was given a noticeably higher degree of elaboration over others. Utilitarian items common from the northern Great Plains, pottery vessels reminiscent of Hopewel wares, exotic items such as shells, and bison remains—all of which were recovered from the nearby Stelzer campsite—were also placed within the Sonota mounds (Neuman 1975:62; Vehik 1983:220). This is a substantial deviation from Illinois Hopewell mounds where one individual was given a more enhanced burial and nearby campsites were less abundant (Braun 1979). Indeed, the items included with the bundles further signify the collective nature of this mortuary practice as no single burial was more elaborate than another. Again, the single pottery vessel placed at the centre of a group of bundles within Arpan Mound suggests that this one vessel was shared among community members.

Despite roughly the same number of individuals being interred within the Sonota mounds as the Illinois Hopewell mounds, their periods of use differed. In contrast to the accretional, time transgressive nature of the Illinois Hopewell Mounds, the Sonota mounds involved rapid construction, interment, and closure (Vehik 1983:224). Accordingly, Vehik (1983:224) explained the number of individuals present in the Sonota mounds as either the result of the host population being large enough to collect bundles in a shorter period for burials or a smaller group slowly accumulating bundles over a long period of time that then culminated in a single burial event. As we now know based on AMS radiocarbon evidence, the Stelzer campsite was occupied over a brief window of time and was likely contemporaneous with the Arpan Mound site (Figure 9.3). While more extensive dating would further refine the chronology of the nearby Grover Hand and Swift Bird mounds, existing radiocarbon evidence can be used to infer that these other mounds are at least penecontemporaneous with the Stelzer site. It is possible that these mounds, if not contemporaneous, were constructed periodically over decades or one or two centuries. These data point to a limited period of mound building on the northern Great Plains during the time of Besant and Sonota.

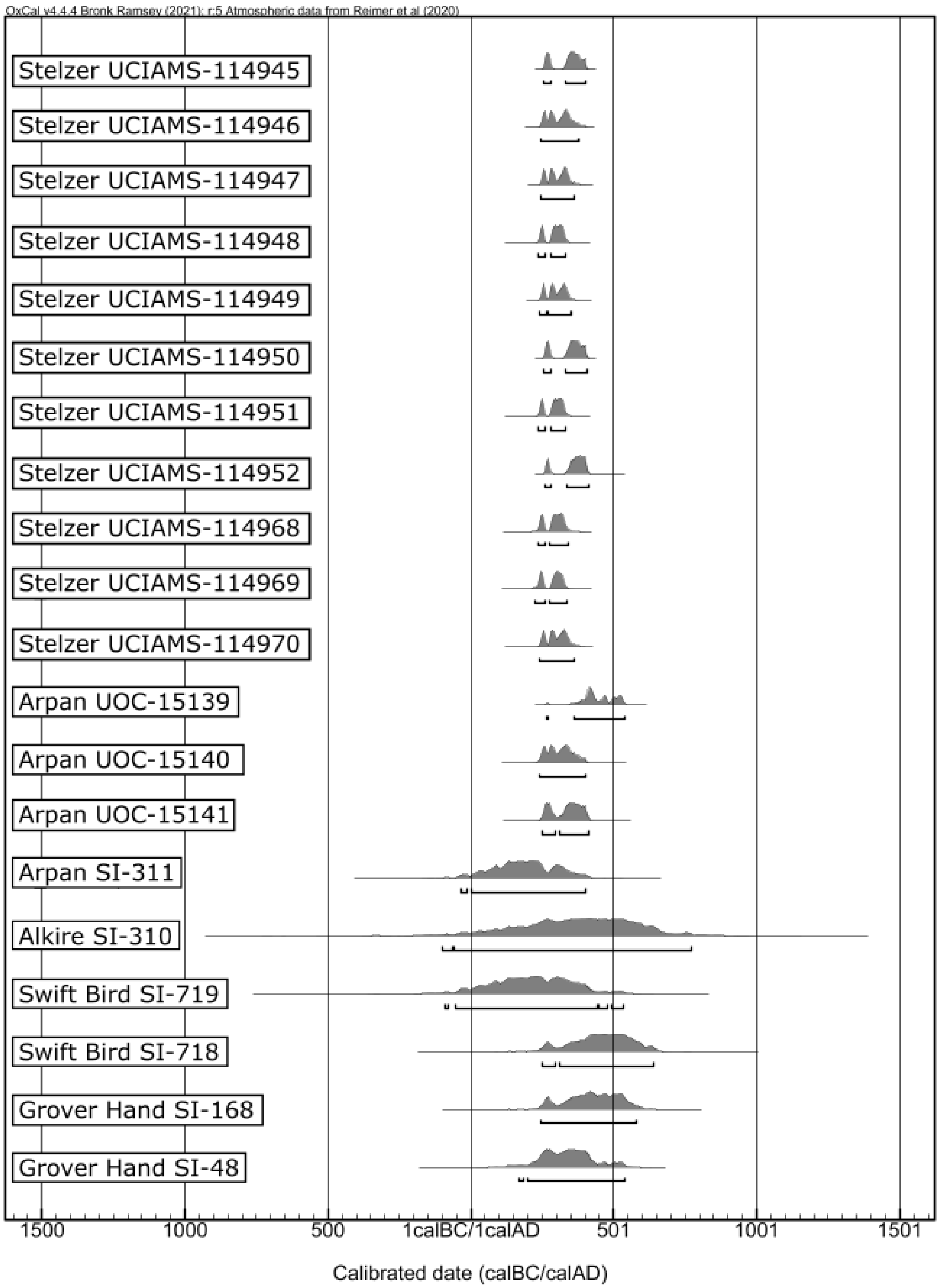


Figure 9.3 Calibrated radiocarbon dates from the Stelzer campsite and surrounding Arpan, Grover Hand, Swift Bird and Alkire burial mounds.

Therefore, there is a third scenario that I propose involving the presence of multiple smaller entities, perhaps kin groups, gathering at the Stelzer site when sufficient time had elapsed to accumulate bundles or when a prominent member of their community passed away. The Stelzer site is the only campsite in the area and given its estimated size of 220,000 m^2, it would have facilitated the gathering of multiple kin groups for all associated burial activities and ceremonies. These kin groups shared in the mound building experience, potentially with groups more closely related to Hopewell centres, who may have influenced the overall design of the mounds.

9.2.C. Middle Woodland Varied Assemblages and Long-Distance Interactions

Hopewell, with its enormous geographic reach, would have presented numerous opportunities for interactions such as this among different ethnic groups across much of North America (Carr 2005). Pottery belonging to Valley, Kansas City Hopewell, Malmo, Laurel, and other traditions linked to Hopewell are potentially difficult for archaeologists to distinguish at sites such as Stelzer where people gathered. Concerning Besant-Sonota, what appears as a taxonomic conundrum could reflect the polyethnic intersection of the northern Great Plains and other societies during a time when items, ideas, and peoples were moving across great distances.

What fueled this movement of ideas and materials may very well be explained by individuals of slightly higher status wanting to amplify their influence with exotic goods acquired through relationships with distant communities. When contemplating the Hopewell burial mounds of Kansas, Krause (1995:136) stated the following:

> "I therefore tend to view them [i.e., burial mounds] as labors of love or markers of voluntary piety that were, for the most part, self-organized and self-directed, albeit guided by tradition and custom as understood and interpreted by authorities having the status of

> first amongst equals—a status validated more by act and deed than by birthright (Krause 1995:136)."

The Hopewell mounds that Krause (1995:137) to which was referring were also variable, as artifacts reminiscent of Central Plains, Plains Woodland, and Hopewell phases were uncovered. This immediately brings to mind the variations observed at the Sonota mound sites. Although Wedel (1986:82) suggested this variety was the result of repeated occupation over time by later traditions, a synchronous gathering of individuals from differing areas makes better sense when thinking about the impact that burial mound construction and the performance of mortuary rituals would have held. Individuals present, including outsiders, were likely connected to others present long after the completion of any ceremonies and likely paid respects or tributes to the individuals hosting the mound building. Through participation in mound building, gift-giving, intermarriage, or even spirit adoption, individuals and communities would be joined together, regardless of the distances that separated them. The Sonota mounds reflect aspects of northern Great Plains culture, but at the same time are reminiscent of larger and more elaborate Hopewell mounds.

Mounds within Hopewell centres were built to offer individuals the chance to prepare and view the deceased for a considerable amount of time within charnel houses; these features are absent from the Sonota mounds (Buikstra et al. 1998; Charles and Buikstra 2006; Neuman 1975). Individuals interred within the Sonota mounds were prepared in bundles—a secondary burial technique that was customary for many northern Great Plains cultures before and after the Besant-Sonota era. These bundles were placed within mounds that could reasonably have been constructed by moderate-sized groups in a period of several days, with every indication that mortuary ceremonies were followed by rapid burial. These mound building ceremonies were the first to be conducted on the northern Great Plains and appear reminiscent of a symbolic gesture involving multiple communities to create or maintain alliances.

On the basis of skeletal analyses, Key and Jantz (1990:467) hypothesized that two or more populations were interred within the Sonota mounds. They based their conclusion upon the variability of crania from 17 individuals from the Arpan, Grover Hand, Alkire, Swift Bird, and Boundary mounds. They reasoned that the Sonota burials resulted from a gradual accumulation of deceased individuals over a considerable amount of time (Key and Jantz 1990:467). The nature of the mortuary ceremonies conducted and the remarkably narrow time span during which Stelzer and Arpan were occupied strongly suggest a different alternative: that a larger host of people from multiple groups participated in the Sonota mound activities over a much shorter period.

Analogously, the variability in the pottery found at the Stelzer site also suggests the presence of multiple communities. The presence of maize within some, but not all of the vessels being used at this site, provides additional support for items arriving at this location from distant sources. The evidence collected in this study combined with the sheer size of the Stelzer site and the potential gathering areas identified by Graham (2014:254), all suggest that multiple groups were present at this location. They participated in the Sonota burials while exchanging materials and ideas and building (or rekindling) relationships. Rather than a longer, ongoing process that is visible at other Hopewell mounds through the presence of charnel houses, the Sonota mounds represent more singular events where individuals from multiple communities gathered and shared ideas.

Besant-Sonota era peoples could selectively borrow Hopewell customs and material culture, and indeed, Hopewell representatives may well have been present. Such interactions would result in an archaeological assemblage that we see as neither simply northern Great Plains nor Hopewell, but with elements of both. Groups that witnessed or participated in the Sonota mound rituals likely camped at the Stelzer site and afterwards left with durable items such as pottery, KRF, or copper. At the same time, some of these items were left behind to be included in the mounds themselves. Items that appear unfamiliar in northern Great Plains contexts, such as the pipe bowl from the Grover Hand site, the Arpan Mound vessel, prepared human tooth rows, and exotic shells, were powerful symbols that no doubt amplified the status of the individuals they were interred with. Participants or witnesses from other cultures joined in recognizing them and left behind pottery wares from their culture. On the surface, we see a varied archaeological assemblage but upon closer inspection, we see that the assemblages that resulted came from moments that marked collective actions and togetherness. Upon the culmination of the mound building and associated ceremonies, northern Great Plains individuals may have returned home with new ideas, and pottery, from multiple regions. Ultimately, pottery use outside of these events remained restricted to moments of significance such as feasts and other community-driven events.

9.3. Final Thoughts

Three findings from this study stand out: 1) Pottery, although infrequently used during this time, played an important symbolic role in northern Great Plains cultures; 2) Although far removed from Hopewell centres, some peoples during this period were active participants in the Hopewell Interaction Sphere; and 3) Just as changes were occurring in the Hopewell world, so too was notable change happening on the northern Great Plains.

The large conoidal vessels, although infrequently represented at Besant-Sonota sites, were left behind at sites with significant collective or ceremonial activity. Decorated in ways that reflected different source communities, they were ‘presentation devices’ capable of expressing a social identity while at the same time bringing individuals together as large quantities of food were prepared, both at the massive Stelzer campsite and as graveside offerings in mounds such as Arpan. These pots were altered, modified, and repaired to fit a mobile hunter-gathering way of life in cases where participants left with them and in other instances were left behind with community members during their final rites of passage. Some of these pots were also marked with designs similar to those placed on pipes, suggestive of yet other ceremonial connections.

At the Stelzer site, an estimated 15 to 20 individual vessels were used, featuring at least 11 different design variants. This ceramic diversity at the Stelzer site suggests the gathering of people from multiple areas for feasting, celebrating, and mourning of those that had passed. The Sonota mounds mark an active involvement with the Hopewell Interaction Sphere, but one in which pottery use itself sharply diminished as participants moved westwards onto the northern Great Plains.

I believe that pottery use was restricted to certain occasions during the Besant-Sonota era. Besant-Sonota pottery was eventually succeeded by Avonlea conoidal pots that were characterized by four regional design styles (Meyer and Walde 2009). These new wares were predominantly decorated with parallel grooving and net impressions and bear little resemblance other than size and shape to Besant-Sonota wares (Meyer and Walde 2009). Later Avonlea vessels continued to play a minor role in the overall material culture, but again were left behind within burials and used to prepare maize that was acquired via long-distance trade (Lints 2012). While Avonlea pottery vessels also play a relatively minor technological role, by now, a northern Plains pottery tradition was persistent, and was the subject of intergenerational transmission. This includes situations in which one variant, Etheridge ware, continues across the Avonlea to

Old Women's phase transition on the northern Great Plains (Fisher 2021; MacDonald 2008; Meyer 1988; Meyer and Walde 2009; Walde 2006b).

Pottery arrived on the northern Great Plains precisely when the Hopewell Interaction Sphere was at its height. The involvement of northern Great Plains cultures within the Hopewell Interaction Sphere may have been a form of competitive emulation. As changes in status developed for individuals and corporate kin groups in the east, so too could shifts in status occur within contemporary northern Great Plains societies. Changes to tipi ring sizes, intensification of large-scale bison hunting activities, and the arrival of pottery potentially fit a narrative in which some degree of status differentiation was also occurring on the northern Great Plains.

9.4. Future Directions

The results of this dissertation provide a starting point for future inquiries into the origins and adoption of pottery in North America. Several additional analytical techniques should be pursued to further expand our knowledge of Besant-Sonota pottery.

Beginning with paleodietary research, future examination of carbonized food residues through additional isotopic and GC-MS analyses may help in characterizing the animal component of foods prepared within these vessels. Isotopic analyses conducted within this dissertation were exploratory rather than the focal point of the research, but did begin to elucidate some interpretative data on animal remains prepared within pottery vessels used during the Besant and Sonota era. Additional isotopic analyses of carbonized residues and butchered skeletal remains left behind at these Besant and Sonota sites will provide more data to interpret food practices of the Middle Woodland Period.

Analyses of organic residues, including lipids, from unglazed pottery fragments have been completed on samples from a diverse temporal and geographic range (Charters et al. 1995;

Eerkens 2002, 2005; Evershed 2008; Horiuchi et al. 2015; Skibo and Deal 1995). Within the northern Great Plains, research and experimentation with modern foods through oven storage simulation led Malainey (2007) to support the use of fatty acid analyses, such as C18:0 and C18:1 isomers, as a valuable technique for identifying general food trends. To further increase the validity of fatty acid analyses, Malainey (2007) suggested that investigators make a careful selection of archaeological samples with well-preserved residues and secure a general understanding of the surrounding vegetation and depositional environments. While this may be true, some caution is warranted when considering the environment from which the foods were collected. Hunter-gatherer populations during the Besant-Sonota era were likely highly mobile, occupying several biomes in the course of seasonal activities. Therefore, combined with the fact that some food resources may have been traded between communities with access to different resources, it may be difficult to predict the source region for foods prepared within these pottery vessels. This study has identified key plants that were boiled within these vessels, but a more holistic interpretation of diet may be reached through GC-MS analyses.

Continuing with paleodiet, this study only focused on carbonized food residues. Although this was critical to understanding how pottery vessels were used, further insight into Besant-Sonota food choices may be identified via similar research into boiling stones and stone tools (for example mortars and pestles). Analyzing stone tools and boiling pits would increase the number of sites available to study while also providing another opportunity to expand our knowledge of what plant foods were consumed by Besant-Sonota era peoples. For instance, although maize was only reported at two sites, further research into these contexts may yield additional traces of this domesticated plant. This may also provide an opportunity to compare food choices made by Besant-Sonota era peoples that used pottery and those that did not.

Ritual food consumption was identified in this study, but further refinement could be pursued to determine whether beverages were included. In a recent study by Adair et al. (2022), the authors presented an explanation for the first uses of maize in the Central Plains in the form of a ritual beverage. The use of starchy grains, like maize, to produce alcohol was practiced by many groups around the world and has been noted to be strongly connected to rituals (Guerra-Doce 2015; Hastorf 2016; Hayden et al. 2013:103). It is possible that ritual beverages played a role alongside meals consumed at the Stelzer site; however, identifying this has been problematic. Adair and colleagues (2022:345) noted that starch grains from Central Plains carbonized food residues were not gelatinized. Yet in this study, gelatinization was widespread. Would this be a potential indication of fermentation occurring or simply the result of different cooking techniques? To answer this question, further experimental research needs to be conducted on the effects of the fermentation process upon maize starch grains. Other important fruits (e.g., saskatoon berry and chokecherry) should also be included as these are noted in ethnobotanical literature as being ritually consumed (Turner et al. 1980). A potential study would be to undertake the fermentation process using replica Besant-Sonota era pottery vessels and examine how the appearance of starch grains changes during this process.

Another future direction is tracing where these pottery vessels were made. This study identified potential sources of influence of these wares in the form of Havana, Rowe, Valley, and Laurel. Examining the trace elements held within the paste and temper of the vessels themselves may further reveal connections to these outside cultures. A comparison of trace elements from within sites where multiple vessels were found, such as Stelzer, may offer the chance to add further evidence to the narrative that multiple groups from different cultures were present at these sites. Along the same line, comparing trace elements between vessels that shared a similar appearance, such as the Arpan Mound vessel and Variants 1 and 2 from the Stelzer site, may provide further specific connections.

Although the most effective way to establish the cultural origins of the Besant-Sonota era burial mounds is the collection of DNA from human remains, this would be a sensitive and complicated process that cannot begin without meaningful engagement with descendant communities that live in the area today. Prior to any consideration of that possibility, efforts must be directed towards healing relations between archaeologists and community members within the vicinity of the Sonota mounds. During archaeological surveys and excavations of the Sonota mounds, local communities were not included. From talking to individuals living near the Sonota mounds recently, these wounds are still fresh. Stories of how the burials were plowed over by bulldozers are still told and to this day, the remaining mounds can still be seen via satellite imagery. Excavation areas appear as visible scars on the mounds. Therefore, any work on human remains should only be completed in partnership with local communities, and only should they wish to see any further study.

Continuing with the theme of working alongside Indigenous communities, the results of this study have been shared with the North American Traditional Indigenous Foods Systems (NATIFS) non-profit of Minnesota. A school and research facility dedicated to training Indigenous peoples in culinary arts, the Indigenous Food Lab strives to bring back local cuisines from the northern Great Plains. The results of this research provide another opportunity to learn about ancient cooking methods as Indigenous culinary experts may also use this information to confirm or explore ancient recipes. This is an exciting opportunity to share knowledge with local communities and contribute to the Indigenous Food Lab’s ongoing research.

Additional knowledge shared with local communities about pottery making would also be beneficial. This study leaned upon ethnographic accounts in addition to archaeological evidence even though the Besant and Sonota phases occurred roughly 1,700 years before these observations were made. Seeking guidance from Indigenous potters would provide an excellent opportunity to learn more about ancient pottery and how cultures in the past may have used it to bring people together.

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Appendix

A.1. Descriptions of the Stelzer Site Variants

The results of the Stelzer site pottery survey summarized in Chapter 5 for Variants 1 to 11 are described here in detail. This summary is organized by surface expression type beginning with smooth exteriors.

Variants 1 to 3: Smooth Exterior Vessels

Variant 1: A498862 (192PI)

The first smooth pottery fragment was the largest recovered from the Stelzer site, measuring 6.3 cm by 7.2 cm and almost 2 cm thick. Rim A98862 (Figure A.1) is notable for both the smooth exterior and the presence of internal oblique punctates, rising from the right to the left. These punctates were made by the same object, likely a stick that contained a protrusion or sharp point and placed in the same orientation for each punctate. This orientation can be viewed by the linear markings extending out from the flat upper section of the interior punctates. On the exterior, these punctates have protruded from the surface to form bosses that have been smoothed over, along with the entirety of the fragment, by an object leaving a faint series of horizontal lines. This treatment is often completed during the final stages of pottery making when the vessel is smoothed to seal any imperfections or gaps. Known objects that were used to complete this task include smooth stones and materials made of wood and bone (Wilson 1910).

Figure A.1 Smooth exterior rim fragment Variant 1. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variant 1 has a rounded rim design that expands at the midsection of this vessel revealing a side profile measuring approximately 1.7 to 2 cm in thickness. Coarse granite temper was noted protruding from the interior of the fragment when viewed from the side.

In terms of use-alteration, although this fragment was of larger size, Variant 1 exhibited no signs of alteration post-firing that would allow for interpretation of use. This smooth exterior vessel is, however, covered by a thin and uneven layer of carbonized food residue exhibiting a polished appearance. Although residue is present on the exterior of the vessel, the interior is barren of any carbon encrustations except for a small portion of carbonized residue from within the interior punctates.

Variant 2: 498766 (55)

Variant 2 is another smooth exterior vessel that shares the design characteristics of Variant 1, including the same light-brown colour of the exterior. Unlike Variant 1, Variant 2 has this on both the interior and exterior (Figure A.2). This fragment is quite small, measuring approximately 3.3 by 3.4 cm, which limits the amount of reporting that can be completed. Of interest is the use of a tool to create punctates that are almost identical to those present on Variant 1, including the orientation of the design. In this case, Vessel 2 exhibits exterior punctates that were created on the vessel when it was in a wet-dry state using a sharp-edged instrument. On the interior, this punctate style is repeated, but the orientation of the sharp edges is opposite of the exterior and those displayed on Vessel 1 (see Figure A.1).

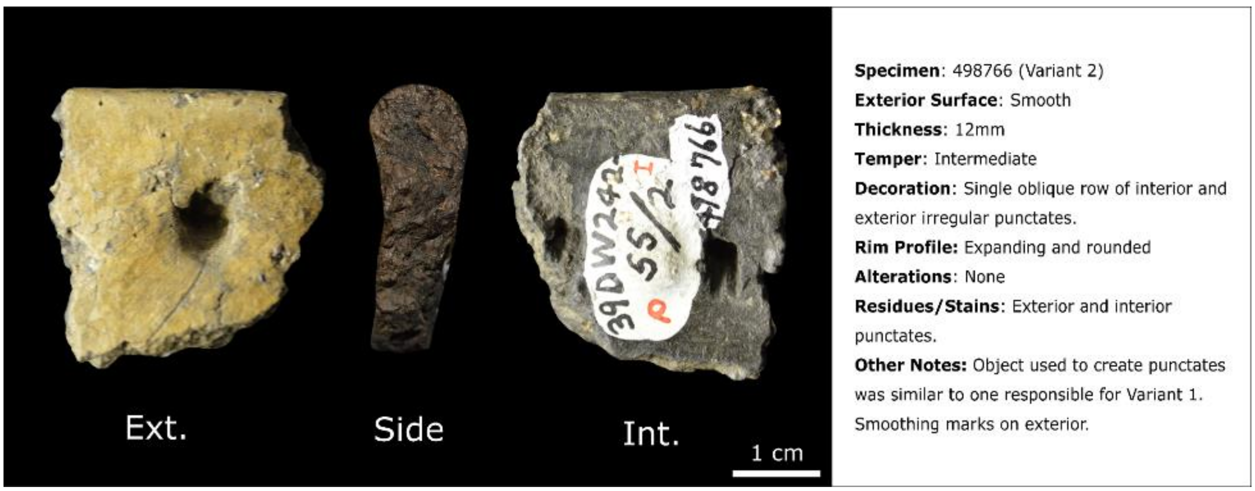


Figure A.2 Smooth rim specimen Variant 2 exhibiting multiple irregularly shaped punctates which resemble Variant 1. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Aside from decoration, another similarity to Variant 1 appears in the presence of linear smoothing marks on the exterior of the vessel. In this instance, smoothing marks on Variant 2 are oriented on a diagonal axis, rising from the left towards the exterior punctate. As with Variant 1, these markings were likely the result of the potter smoothing the vessel with a bone, stone, or wooden instrument prior to firing (see Figure A.2). While this variant shares characteristics with

Variant 1, the decorations on the exterior and interior are in closer proximity (approximately 1.6 cm) to the rim of this vessel and the overall shape of the rim is less rounded and almost square.

The size of this fragment also limits clues about the manufacturing technique, but intermediate sized grit temper was observed protruding along the edges of this fragment. On the interior of Variant 2, we find a thin layering of carbonized residues that are more abundant within the interior punctates. This fragment's size prohibits inferences regarding how this vessel was used to prepare foods. Other than carbonized food residues, this fragment lacks any alterations that were applied to the vessel after it was fired.

Variant 3: 498885 (230)

Of all the pottery examined in this study, Variant 3 has the most complex arrangement of decoration (Figure A.3). Like Variants 1 and 2, Variant 3 also exhibits punctates, but in this instance, these are circular and appear as a single somewhat horizontal row on both the interior and exterior. While these punctates are in a horizontal arrangement, there is some variation on the exterior and interior as these were not placed at the same distance from the top of the vessel.

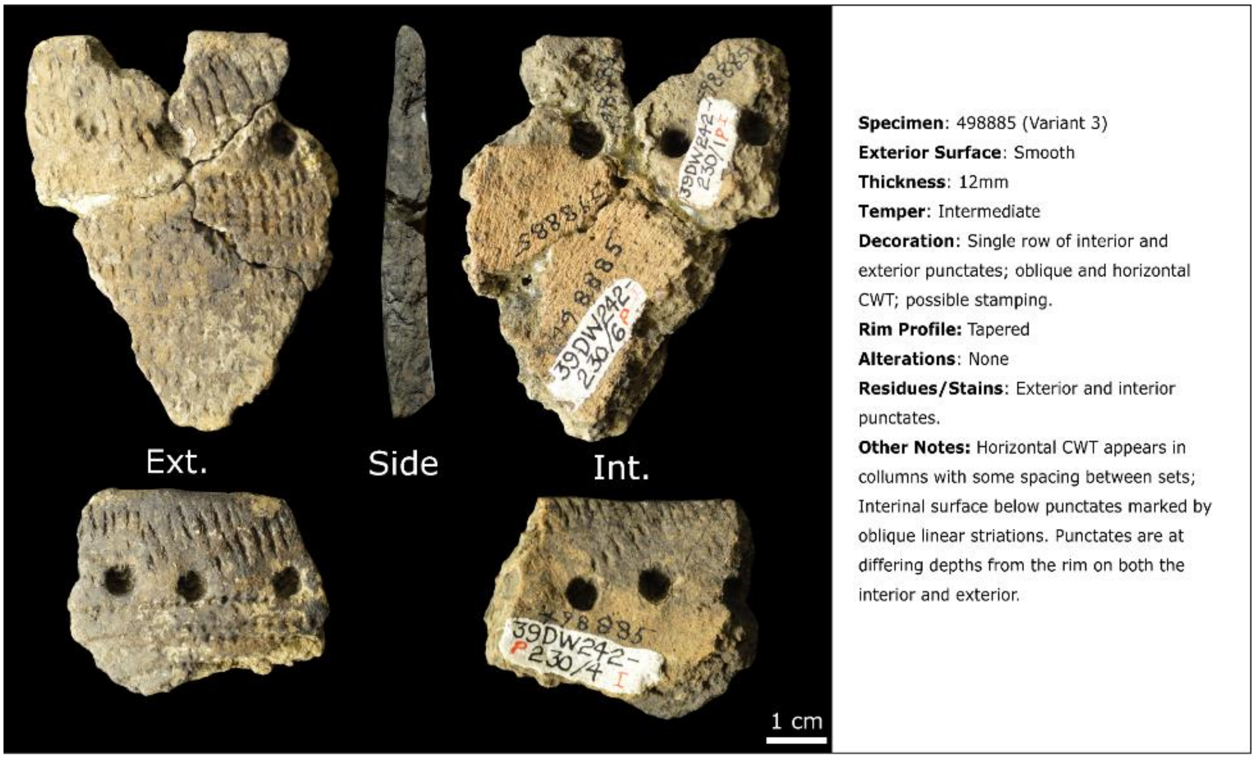


Figure A.3 Smooth exterior rim fragments from Variant 3 exhibiting CWT, punctates, and stamping. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Other than punctates, cord-wrapped-tool (CWT) impressions were placed in differing orientations. Horizontal CWT markings cover many of the fragments of Vessel 3 but are uneven in design as they appear to overlap. In some instances, the horizontal CWT markings end in an abrupt incised line (Figure A.4).

Figure A.4 Variant 3 CWT impressions in a column arrangement with abrupt incised lines marking the end of the tool used by the potter. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Additional decoration techniques were found when examining the exterior punctates. A series of right oblique stamping marks were visible that are reminiscent of the CWT markings but lack the horizontal line connecting each impression as seen with CWT designs. Therefore, it is likely that these stamps were made by an object that was potentially rolled on the vessel in an oblique pattern. In concurrence with the CWT impressions, these stamped marks are also uneven as some appear to overlap with others and the distances between markings are inconsistent (see Figure A.4). On the interior of the vessel, the stamped marks continue in the same orientation as the exterior, but there is a single row of stamping that runs horizontally just below the top of the rim.

Like Variant 1, this vessel also shows evidence of at least three layers of vertical clays placed during the construction of the vessel. Again, this provides evidence of either the practice of layering clays during manufacturing or the use of coils followed by smoothing to fill in any gaps.

Variants 4 to 9: Cord Roughened Exteriors

Variant 4: 499226

Variant 4 represents one of the larger sections of pottery recovered at the Stelzer site with a maximum width of 9 cm (Figure A.5). The distinct cord roughened exterior of which pottery from Besant-Sonota sites is known for is well preserved on this sample. Close inspection of this marking reveals twisted cord impressions that were sewn into clothing, bags, or baskets that have long since decomposed. While it is possible that these marks were created by an instrument with CWT markings, there does not appear to be any overlapping as one would expect to see if an object was repeatedly rolled, or paddled, along wet-dry clays. These consistent markings are found in an oblique orientation pattern rising towards the right.

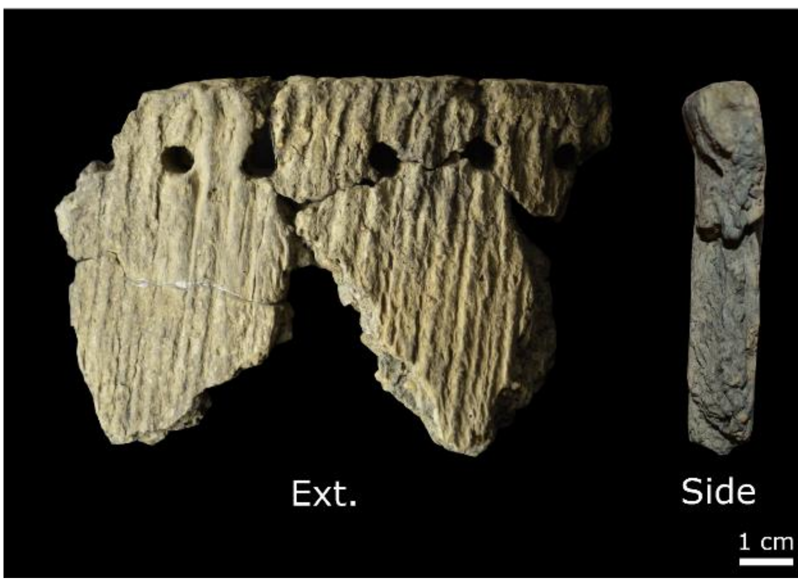


Figure A.5 Cord roughened Variant 4 rim sample exhibiting a single row of exterior punctates. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

The rim of Variant 4 is square on the exterior with more rounding occurring on the interior. Like Variants 1 and 3, there are clues regarding the construction of this vessel. This cord roughened Variant 4 also has coarse grit temper and exhibits a minimum of three vertical layers when examining the side profile. There does not appear to be any indication that coils were used in the construction of this vessel, but rather, clays were placed in layers against a mold or bag.

Although the body fragments could not be refitted to the large rim section of Variant 4, the decoration observed on these specimens is of interest. What is remarkable about these body fragments is the placement of irregular incised lines on the exterior prior to firing (Figure A.6). The exact reason for these marks is unknown as there does not appear to be any patterning and many of these lines overlap.

Figure A.6 Large body section of a cord roughened pottery vessel exhibiting irregularly shaped incised lines. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variant 5: 499084

Variant 5 (Figure A.7) has an overall design that resembles Variant 4 with cord markings and a single row of circular punctates. In this case, the lines of twisted cord impressions are overlapping, however, this rim fragment is rather small measuring only 4.6 cm in width. Therefore, it is possible that the remainder of the vessel did not share these attributes. Another similarity with Variant 4 is the presence of smoothing, but in this case, the smoothing covers the twisted cord impressions but does not obliterate them as in the case of Variant 4. Another distinguishing feature of this rim is the rounded lip compared to the squarish rim exhibited by Variant 4.

Specimen: 499084 (Variant 5)
Exterior Surface: Cord roughened
Thickness: 14mm
Temper: Coarse
Decoration: Single row of exterior punctates.
Rim Profile: Tapered
Alterations: None
Residues/Stains: Exterior punctate and interior.
Other Notes: Cord marking on exterior appear smoothed over. Cord impressions also apear over previous cord impressions. Concave break pattern along bottom of fragment.

Figure A.7 Rim specimen 499084 (Variant 5) exhibiting a concave breakage along the base of the fragment. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variant 6: Haberman and Travis Surface Collection 3B

Variant 6 showcases oblique twisted cord impressions that are placed with greater visible gaps than observed in Variants 4 and 5. These twisted cord impressions are also oblique, but are found in the opposite orientation as the previous vessels (Figure A.8). Further distinction is found while examining the shape of the rim, which exhibits an exterior bevel.

Specimen: Travis Collection 13 (Variant 6)
Exterior Surface: Cord roughened
Thickness: 9mm
Temper: Coarse
Decoration: Single row of interior punctates.
Rim Profile: Slight exterior bevel
Alterations: None
Residues/Stains: Exterior punctate and interior.
Other Notes: Wide spacing between deep cord impressions. Twisting of cord visible.

Figure A.8 Photographs of Variant 6 cord roughened rim specimen with an interior punctate and exterior bevel. Photographed by the author courtesy of the South Dakota State Historical Society.

For this variant, intermediate grit temper was used in the construction of the vessel and only a single layer of clay was used to form the vessel. During the surface collection by Haberman and Travis in 1989, multiple rim fragments were recovered from this vessel and refitted.

Variant 7: 498833

Moving onwards with cord-roughened specimens, Variant 7 is only a small section of a vessel, a mere 4.2 cm in width, but this sample does offer clues regarding vessel design. The overall shape of the rim is more angular than previous variants, exhibiting a sharp lip extending outwards from the top of the fragment that appears folded over (Figure A.9).

Figure A.9 Cord impressed rim fragment Variant 7 having oblique stab-and-drag decorations. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

In terms of decoration, this vessel is also distinct compared to other Stelzer variants as it has two angular stab-and-drag designs. Outside of these stab-and-drag markings another decoration was recorded on the interior of the vessel in the form of a long-incised line on a right oblique angle. As there is only one rim fragment from this vessel, it is not possible to determine if this was part of a repeating pattern.

Variant 8: 499144

Variant 8 from the Stelzer site has left oblique cord markings that abruptly end at the lip of the vessel. While this design is comparable to Variant 5, punctates were placed in multiple horizontal rows. This is unusual for the Stelzer site, as punctates are typically limited to a single horizontal or arching row. In addition to the unique punctate arrangement, this variant provides the best evidence that a cord-wrapped paddle was used to create the exterior surface texture. On Variant 8, the oblique lines of cord markings are irregularly spaced, with wider gaps appearing on the right side of the exterior (Figure A.10). In addition, the imprints appear to be repeated near the middle of this fragment as other more vertical cord markings overlap the deeper oblique markings.

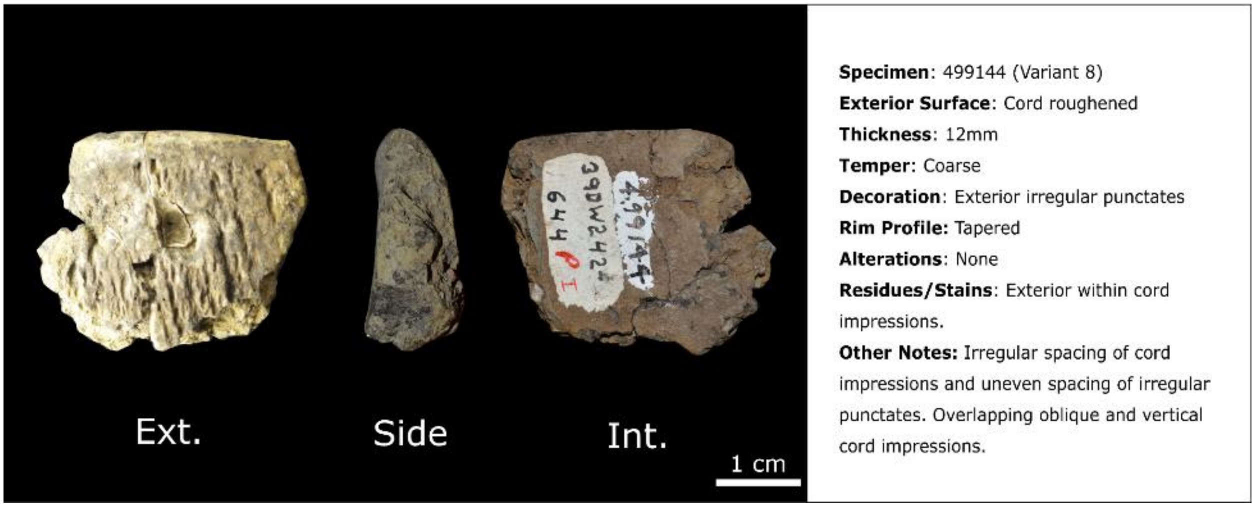


Figure A.10 Variant 8 from the Stelzer site exhibiting irregularly spaced cord markings and exterior punctates. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variant 9: 498766

Although Variant 9 is small (4.3 cm in width), the curvature of the vessel is also quite sharp, indicating that the complete vessel was smaller compared to others found at the site (Figure A.11). It is important to note that Neuman (1975) hypothesized that vessels discarded at this site ranged in size from 473 ml (one pint) to 22 litres (six gallons). Decorations are limited to a single row of angular punctates placed beneath the rim of the vessel. Examination of the profile reveals a rim bevelled toward the exterior and intermediate grit temper used in the construction of the vessel.

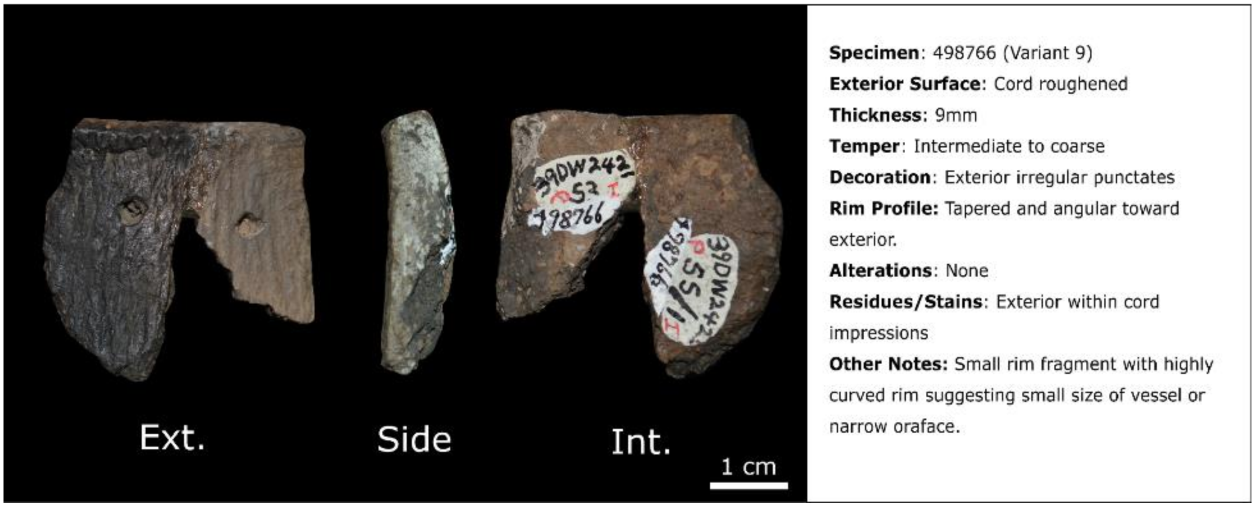


Figure A.11 Variant from the Stelzer site exhibiting irregularly shaped punctates. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variants 10 and 11: Fabric Impressed Vessels

The Stelzer vessels described so far were smooth or cord roughened. In addition to these exterior surfaces, I observed a third style that is defined by fabric impressions. The two rim specimens with this surface expression will be discussed here.

Variant 10: 499145

Variant 10 from the Stelzer site is the first example thus far of a vessel with no decorations other than surface treatment (Figure A.12). This vessel bears an uneven and rough exterior that is often the hallmark of fabric impressed vessels. These fabric impressions sharply end prior to the lip of the vessel, which is tapered. This vessel was prepared with a single layer of clays interspersed with coarse and intermediate sized grit temper.

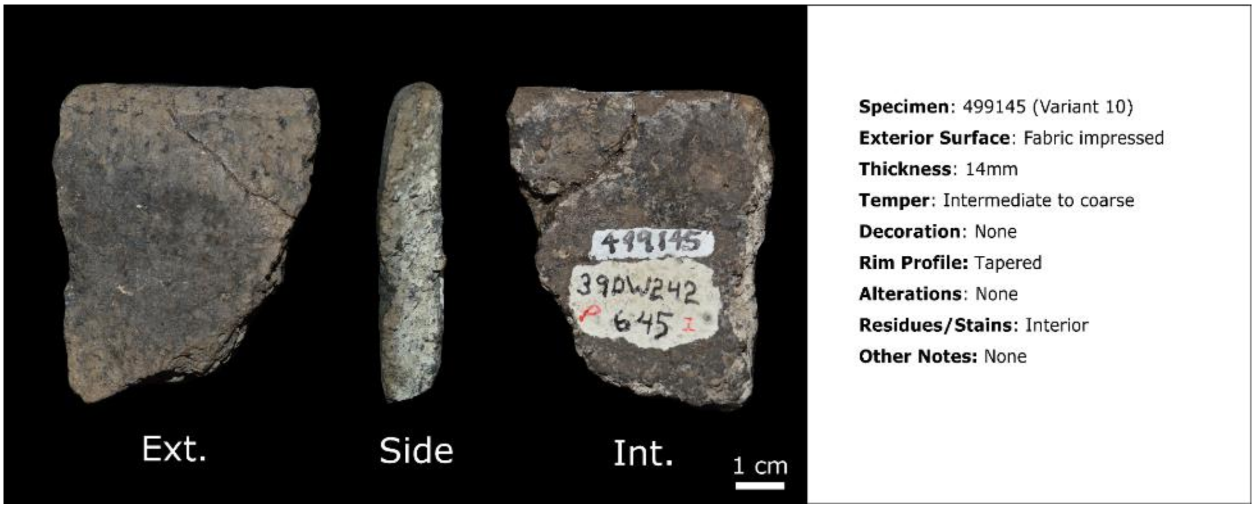


Figure A.12 Undecorated fabric impressed Variant 10 from the Stelzer site. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Variant 11: 498974

Variant 11 from the Stelzer site is the smallest rim section used to describe a variant style. Despite the size of this fragment, multiple clues point to this as a separate vessel type from other variants observed at the site (Figure A.13). Unlike other vessels at the Stelzer site, Variant 11 curves outwards rather than featuring a straight or inward curving rim profile. What distinguishes this vessel is the placement of two rows of incised lines on the uppermost portion of the rim, which is completely flat. These designs were only visible after the removal of carbonized residues, which had completely hidden this pattern. After the removal of residues, these two incised lines appear to run along the top of the rim and were likely produced by dragging a blunt instrument along the top of the vessel.

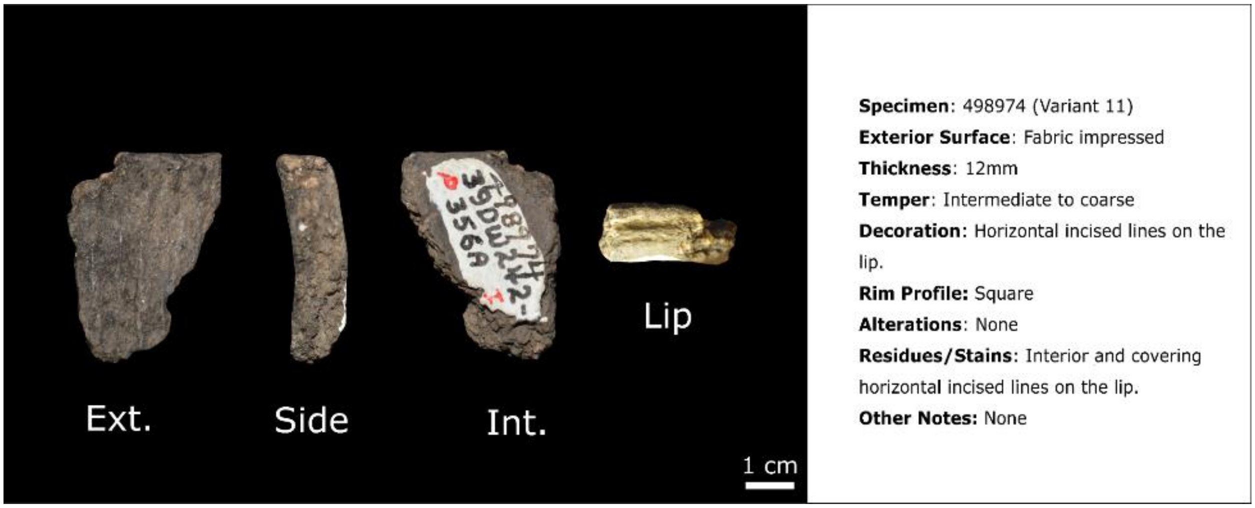


Figure A.13 Fabric impressed Variant 11 exhibiting multiple horizontal incised lines on the lip. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Basal Section: 498767

While not an obvious variant of the Stelzer site, one section of pottery that is worth discussing is a reconstructed basal section (498767). A series of fingernail impressions in a vertical line moving upwards from the base of the specimen can be seen (Figure A.14). The profile of this section also reveals a pattern emerging at the Stelzer site, which is the vertical layering of clays.

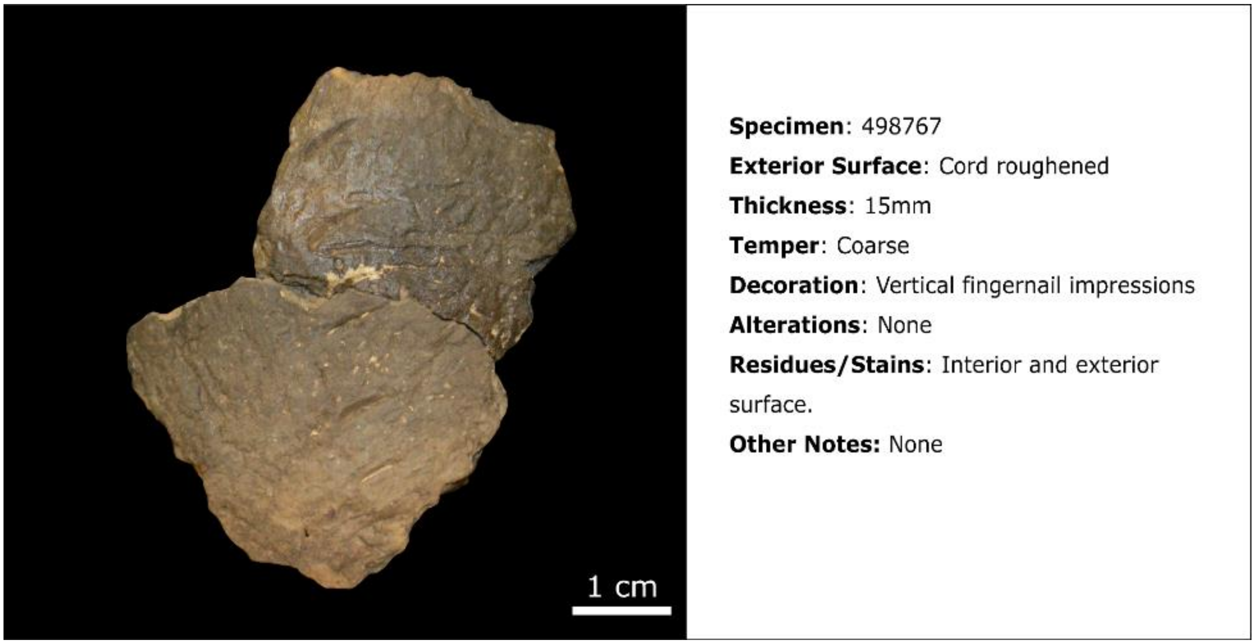


Figure A.14 Reconstructed base fragment from the Stelzer site exhibiting a vertical arrangement of fingernail impressions. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

Fired Clay Object with Fingerprinting

A single, fired clay fingerprint was also identified at the Stelzer site (Figure A.15). Labelled as a 'clay object,' this specimen has been created by an individual pressing clay together between their fingers and then placing the clay fragment in a fire pit, whether purposely or not, transforming this item into fired clay.

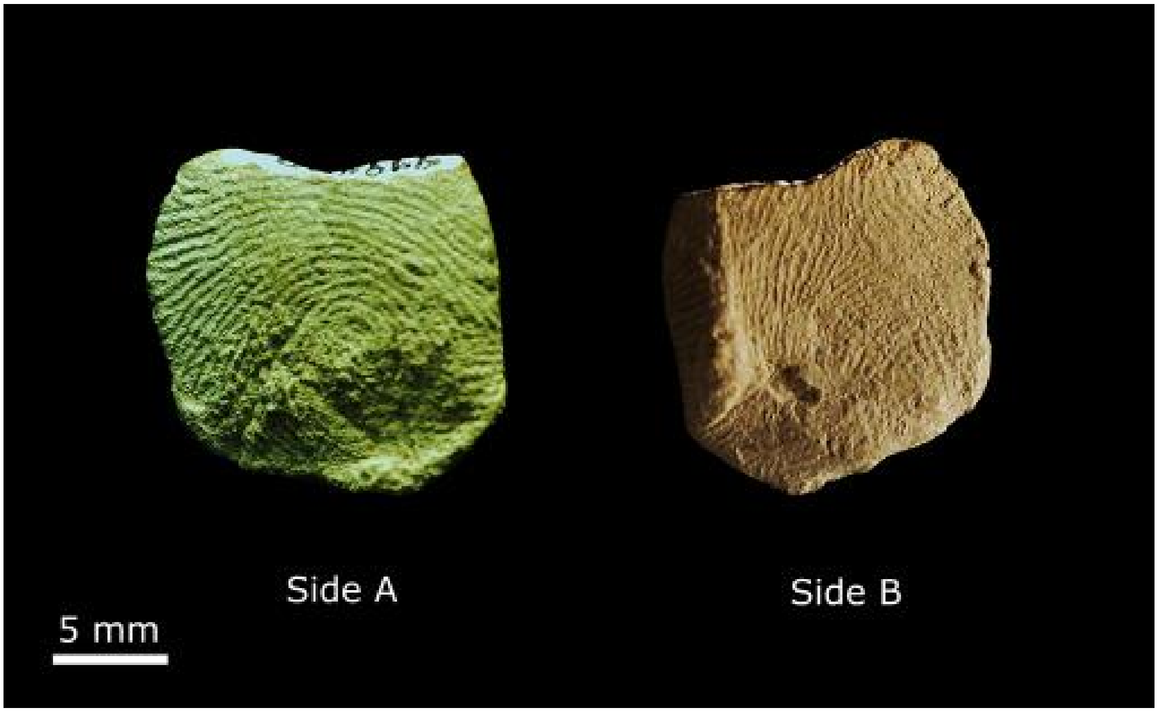


Figure A.15 Photographs of the fired clay fingerprints recovered from the Stelzer site under 45º lighting. Photographed by the author courtesy of the Smithsonian National Museum of Natural History.

As fingerprints can be used to identify the age and sex of an individual, an analysis was conducted to see what information could be extracted from these Stelzer fingerprint molds (Branigan et al. 2002; Sanders 2015). While the fingerprints on each side were remarkably well preserved, Reflectance Transformation Imaging (RTI) was conducted by James Krakker, E. Webb, Yeneneh Terefe, and Gina Watkinson from the Smithsonian Institute to further provide clarity to these finger impressions (Figure A.16). RTI images are obtained through the collection of many digital photographs of a specimen from a stationary camera position. During each photograph, light is projected from a different source and direction. Photographing a specimen in this manner provides a series of images with differing highlights and shadows that are used by RTI software to create a single image that is three dimensional and free of shadows, which significantly improves the clarity of an image.

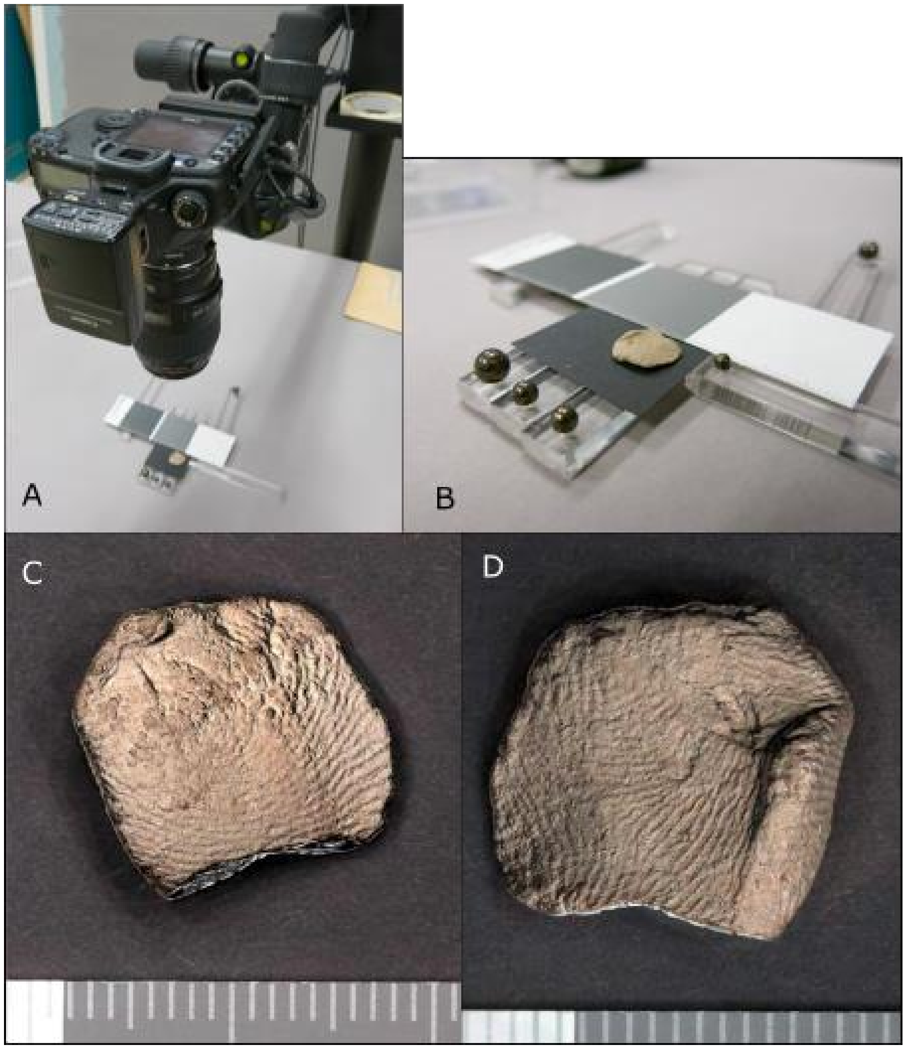


Figure A.16 RTI image setup (A and B) and digital output image for each side of the fingerprint (C and D). Image courtesy of James Krakker (2017) of the Smithsonian National Museum of Natural History.

After more precise RTI images were collected, methods developed by Sanders (2015) to deduce the age and sex of the individual from the Stelzer fingerprints were employed. Sanders (2015) based her research on fingerprint ridge densities examined over a 5mm-by-5mm square. In the study by Sanders (2015), the mean fingerprint ridge densities of males and females recorded on Mesopotamian pottery were compared to mean fingerprint ridge density in populations from around the world (Acree 1999; Gungadin 2007; Kaur and Garg 2011; Nayek et al. 2010). These studies also factored in ‘shrinkage’ that occurs as clays harden and dry. In a study by Fowler et al. (2020) ridge density values were found to increase due to shrinkage and the authors compensated for this by dividing the density values by 6 percent for archaeological samples. Therefore, the comparisons made in this study are taking into consideration that the size of the fingerprints was larger than represented on the clay fragment.

On the first side of the clay object, three separate 5 mm by 5 mm squares could be placed to count finger ridge lines and indents. Within these squares, a maximum of 16 ridgelines was recorded from each square alongside 16 ridge indents (Figure A.17). In comparing these numbers to those reported by Sanders (2015) and others (Acree 1999; Gungadin 2007; Kaur and Garg 2011; Nayek et al. 2010), it becomes evident that the number of ridge lines fall at the upper range of female values or the lower range of males. On the alternate side, another three squares could be placed to count the number of finger ridges and indents. The ridges and indents were less well preserved than on the previous side, but a maximum number of 16 were recorded, matching the results of the previous side.

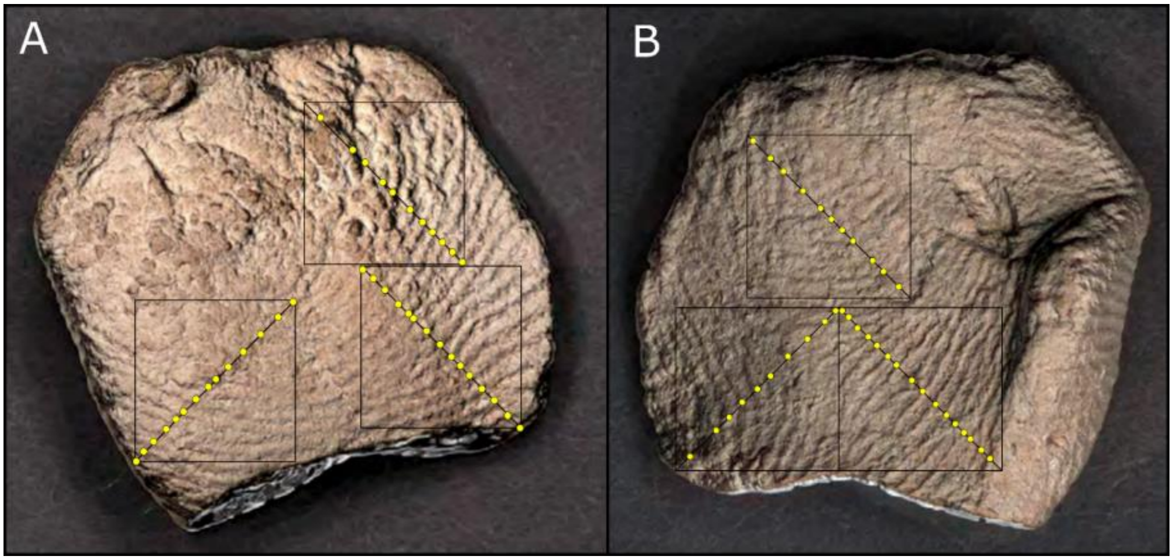


Figure A.17 Ridge counts performed on 5 mm by 5 mm diagonals from the Stelzer 'clay object.' Image courtesy of James Krakker (2017) of the Smithsonian National Museum of Natural History.

While these numbers appear to fit within adult male and female values, Sanders (2015) noted that fingerprints from younger individuals tend to appear within overlapping ranges. The age of an individual in fingerprint analysis can be roughly determined by the amount of wear on a fingerprint. As individuals age, these patterns become less distinct as finger ridges are worn due to activities (Sanders 2015). Returning to the RTI images, the distinct ridgelines may show some subtle evidence that these prints were made by a younger individual. While the values reported by Sanders (2015) did not contain any values for North America, it is possible that the number of ridgelines was different amongst Indigenous peoples.

This information, combined with the amount of pottery at the Stelzer site in comparison to other Besant-Sonota sites, is a fascinating connection. If pottery vessels were being made at the site, it is quite possible that younger individuals would have participated in such an activity. This clay object may provide direct evidence that young individuals played a role in the manufacturing or perhaps patching clay vessels. As this fragment is too small to bear any signs of temper and it is unknown whether pottery making was conducted when this site was occupied, this clay fragment may simply reveal a playful act of squeezing clay between fingers. Nevertheless, the results here remind us that the sites examined in this study contained individuals of all ages that behaved in a manner not so different than people today.

A.2. Pottery Samples and Carbonized Food Residues by Weight

Sample ID	Site	Region	Vessel Portion	Residue Weight (mg)
A498679-97	39DW240	SD	Rim	25
A498671-78	39DW240	SD	Body	25
A498880	Stelzer	SD	Rim	45
A498789	Stelzer	SD	Body	55
A498862	Stelzer	SD	Rim	110
A498802	Stelzer	SD	Body	110
A498903	Stelzer	SD	Body	15
A498910	Stelzer	SD	Body	30
A498886	Stelzer	SD	Body	30
A498885	Stelzer	SD	Rim	30
A498975	Stelzer	SD	Body	30
A499116	Stelzer	SD	Body	20
A499084	Stelzer	SD	Rim	40
A499145	Stelzer	SD	Rim	10
A499144	Stelzer	SD	Rim	50
A499270	Stelzer	SD	Body	15
A499226	Stelzer	SD	Rim	20
A499417	Stelzer	SD	Body	10
A499384	Stelzer	SD	Body	5
A499463	Stelzer	SD	Body	5

A499076	Stelzer	SD	Rim	5
A499472	Stelzer	SD	Body	10
A499515	Arpan	SD	Vessel	150
A494971	Dune Buggy	MT	Body	10
83-360-68	39BF4	SD	Body	5
83-360-68	39BF4	SD	Body	5
83-360-74	39BF4	SD	Rim	5
83-360-97	39BF4	SD	Body	5
83-360-97	39BF4	SD	Body	5
B02-1	39BF4	SD	Body	5
92-82	39BF4	SD	Rim	10
83-361-217	39BF44	SD	Body	15
83-361-114	39BF44	SD	Body	5
B04-9	39BF44	SD	Rim	10
87-263	39BF44	SD	Rim	10
81-48-12	39DW256	SD	Body	10
81-48-8	39DW256	SD	Body	10
10-72 Cat#1	39DW242	SD	Body	50
2	39DW242	SD	Body	55
2	39DW242	SD	Body	20
#1	39DW242	SD	Body	15
#2	39DW242	SD	Body	25
#3	39DW242	SD	Body	22
#5	39DW242	SD	Body	15
#6	39DW242	SD	Body	5

#7	39DW242	SD	Body	5
#8	39DW242	SD	Body	10
#9	39DW242	SD	Rim	40
#12	39DW242	SD	Body	30
#13	39DW242	SD	Body	20
#14	39DW242	SD	Body	20
#15	39DW242	SD	Body	15
#16	39DW242	SD	Body	15
#17	39DW242	SD	Body	15
#18	39DW242	SD	Body	15
#19	39DW242	SD	Body	15
#20	39DW242	SD	Body	15
#21	39DW242	SD	Body	15
#22	39DW242	SD	Body	5
#23	39DW242	SD	Body	10
#24	39DW242	SD	Rim	15
#25	39DW242	SD	Rim	35
#27	39DW242	SD	Base	20
80-24	39JK63	SD	Body	55
80-24	39JK63	SD	Body	45
#1	39SP11	SD	Body	5
80-302 621	39SP11	SD	Body	5
80-302 621	39SP11	SD	Body	5
No ID	39SP11	SD	Body	0
80-301 655-1	39SP11	SD	Body	10

80-301 655-2	39SP11	SD	Body	10
80-302 #1	39SP11	SD	Body	35
80-302 #2	39SP11	SD	Body	35
80-302 #3	39SP11	SD	Body	10
80-302 #4	39SP11	SD	Body	10
#1	39SP11	SD	Body	5
#2	39SP11	SD	Body	5
#3	39SP11	SD	Body	5
#4	39SP11	SD	Body	5
80-302	39SP11	SD	Body	5
80-302	39SP11	SD	Body	5
81	39SP11	SD	Body	5
80-302-633	39SP11	SD	Body	5
Naze Rim	Naze	ND	Rim	10
1062	Naze	ND	Rim	5
1100	Naze	ND	Body	10
1131	Naze	ND	Body	5
1159	Naze	ND	Rim	5
204 -563 WS	Naze	ND	Rim	5
164WS	Naze	ND	Rim	5
245WS	Naze	ND	Body	5
2012A.6.239-C	Schmidt	ND	Body	10
2012A.6.237-A	Schmidt	ND	Body	30
2012A.6.237-	Schmidt	ND	Body	30

B				
1975.003	Beeber	ND	Vessel	20
Surface - A	High Butte	ND	Body	15
9211-92 -A	Indian Hill	ND	Rim	15
9211-2-B	Indian Hill	ND	Body	15
84.101.19-24	32OL270	ND	Body	15
84.101.8-A	32OL270	ND	Body	11
487	Butler-Rissler	WY	Body	15
413, 399	Butler-Rissler	WY	Rim	25
1169	Butler-Rissler	WY	Body	25
495	Butler-Rissler	WY	Body	25
411	Butler-Rissler	WY	Body	25
1660	Butler-Rissler	WY	Body	25
Uncatalogued	Butler-Rissler	WY	Body	25
970	Butler-Rissler	WY	Body	20
1443	Butler-Rissler	WY	Body	15
93	Butler-Rissler	WY	Body	15
694	Butler-Rissler	WY	Body	10
554	Butler-Rissler	WY	Rim	15
242, 243	Butler-Rissler	WY	Body	10
1431	Butler-Rissler	WY	Body	25
164-5991630	Butler-Rissler	WY	Rim	25
4, 89, 90, 843	Butler-Rissler	WY	Rim	25
3662	Cedar Gap	WY	Rim	55
11	Cedar Gap	WY	Body	55

3552	Cedar Gap	WY	Rim	40
3468	Cedar Gap	WY	Rim	35
3556	Cedar Gap	WY	Rim	25
3172	Cedar Gap	WY	Body	35
3035	Cedar Gap	WY	Rim	30
5235	Cedar Gap	WY	Body	15
3523	Cedar Gap	WY	Body	15
3237	Cedar Gap	WY	Body	15
3524	Cedar Gap	WY	Body	20
1335-20377	Bennett	SK	Body	5
2316, 2318	Walter Felt	SK	Rim	25
420	Walter Felt	SK	Body	25
425	Walter Felt	SK	Body	25
427	Walter Felt	SK	Body	25
430	Walter Felt	SK	Body	25
431	Walter Felt	SK	Body	25
432	Walter Felt	SK	Body	30
15 and 16	Walter Felt	SK	Rim	30
17 and 18	Walter Felt	SK	Rim	15
137	Walter Felt	SK	Rim	10
19	Walter Felt	SK	Body	25
Display	Walter Felt	SK	Rim	15
5300	Crane	SK	Body	5
5352	Crane	SK	Body	5
5302	Crane	SK	Body	5

5303	Crane	SK	Body	5
4982	Crane	SK	Body	5
5606	Crane	SK	Body	5
5601	Crane	SK	Body	10
5600	Crane	SK	Body	15
5486	Crane	SK	Body	15
5263	Crane	SK	Body	15
5335	Crane	SK	Body	10
5306	Crane	SK	Body	15
5594	Crane	SK	Body	15
5354	Crane	SK	Body	15
5301	Crane	SK	Body	10
5593	Crane	SK	Body	5
5351	Crane	SK	Body	5
5299	Crane	SK	Body	5
5603	Crane	SK	Body	5
4988	Crane	SK	Body	5
5353	Crane	SK	Body	5
5607	Crane	SK	Body	5
4979	Crane	SK	Body	5
752	Ratigan	SK	Body	0
753	Ratigan	SK	Body	0
3044	Ratigan	SK	Body	0
3447	Ratigan	SK	Body	0
11452	Ratigan	SK	Body	0

11451	Ratigan	SK	Body	5
11595	Ratigan	SK	Body	5
78	Ratigan	SK	Body	5
756	Ratigan	SK	Body	5
2559	Ratigan	SK	Rim	10
3311	Ratigan	SK	Rim	10
3792	Ratigan	SK	Rim	5
2986	Ratigan	SK	Rim	5
4184	Ratigan	SK	Rim	5
3627	Ratigan	SK	Body	10
2564	Ratigan	SK	Body	0
2563	Ratigan	SK	Body	0
2585	Ratigan	SK	Body	0
3481	Ratigan	SK	Body	10
3483	Ratigan	SK	Body	10
1-14	Ross Glenn	AB	Body	15
1	Smith Swainson	AB	Rim	5
5-B	Kane	MB	Body	0
5-C	Kane	MB	Body	0

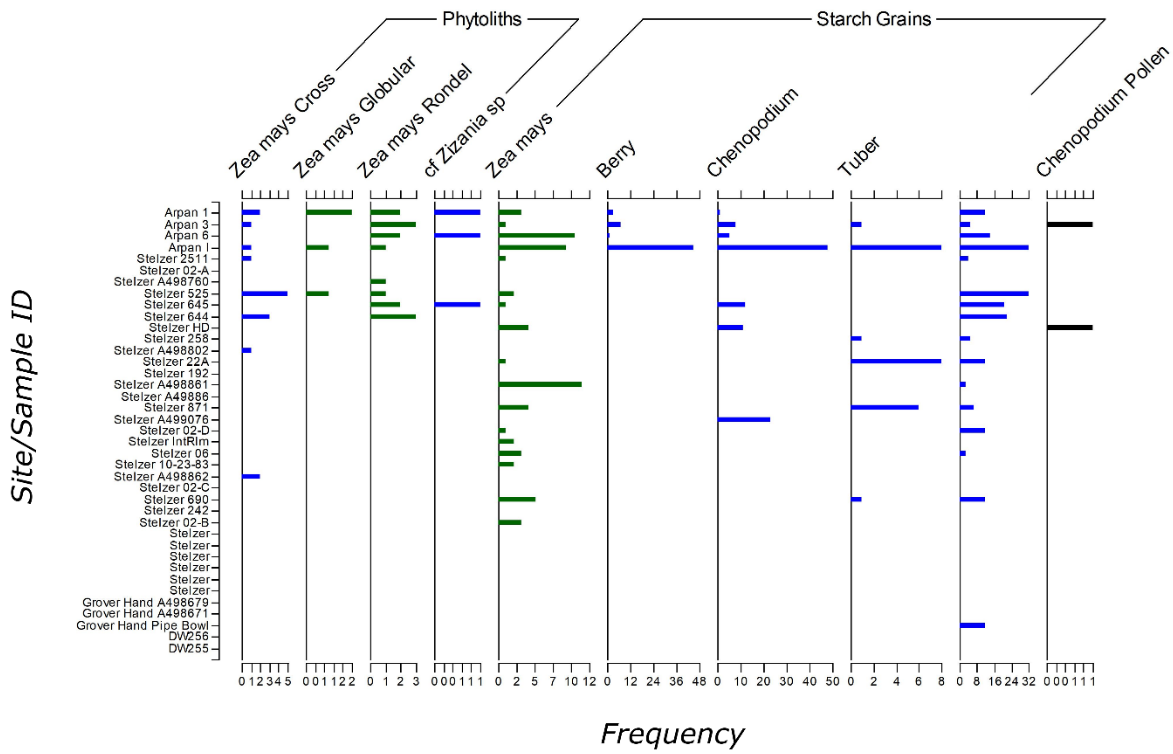
B.1. Comparative Plants Used for Starch Grain Identifications

Scientific Name	Common Name	Portion Sampled	Source
Heuchera richardsonii	Alum root	Roots	This study
Iva annua	Marsh Elder	Seeds	This study
Lathyrus polymorphus	Hoary peavine	Seeds	This study
Opuntia macrorhiza	Prickly pear	Seeds and fruit	This study
Penstemon grandiflorus	Large beardtongue	Roots	This study
***Polygonum* sp.**	Knotweed	Seeds	This study
Proboscidea louisianica	Devil's claw	Seeds	This study
Ribes odoratum	Buffalo current	Seeds	This study
Solanum triflorum	Cut-leaved Nightshade	Roots and fruit	This study
Veronicastrum virginicum	Culver's Root	Roots	This study
Acer negundo	Boxelder maple	Seed	Lints 2012
Heracleum lanatum	Cow parsnip	Rhizome	Lints 2012
Lomatium foeniculaceum	Desert biscuitroot	Root	Lints 2012
Osmorhiza longistylis	Smooth sweet-cicely	Rhizome	Lints 2012
Peltlandra virginica	Green arrow arum	Tuber	Lints 2012
Symplocarpus foetidus	Skunk cabbage	Rhizome	Lints 2012
Corylus americana	American hazlenut	Fruit	Lints 2012
Corylus cornuta	Beaked hazlenut	Fruit	Lints 2012

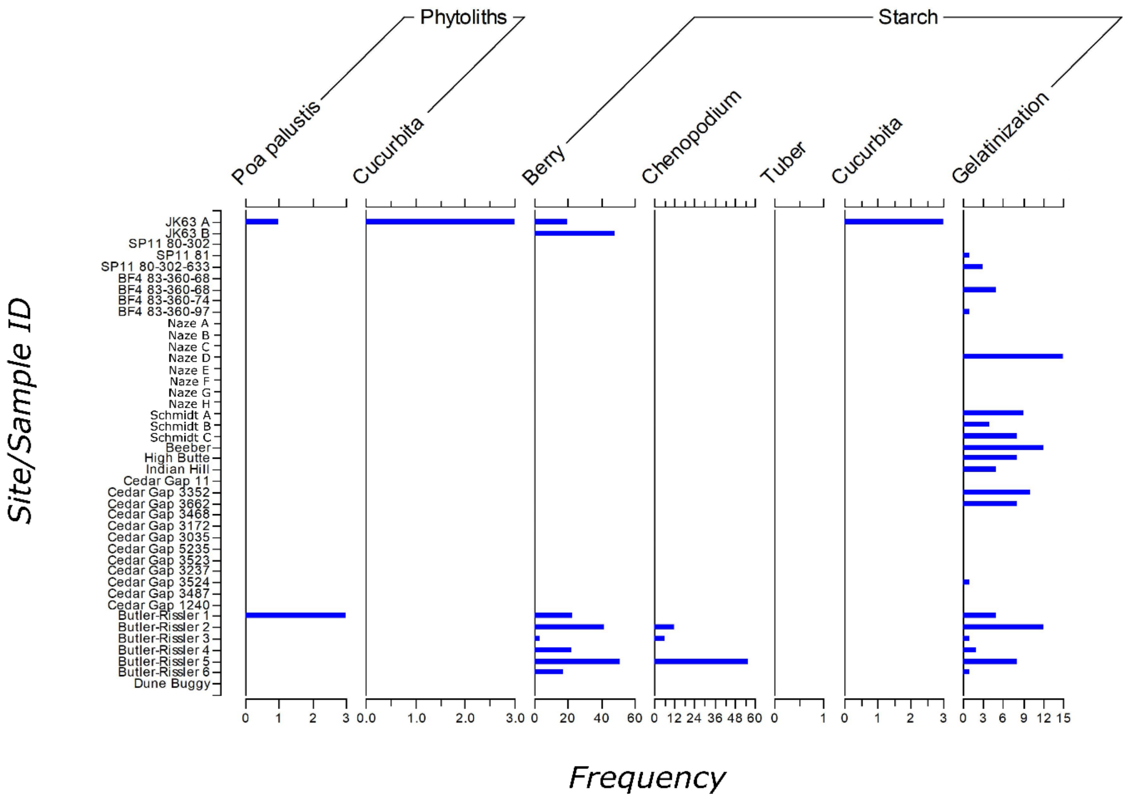
Viburnum opulus	High brush cranberry	Fruit	Lints 2012
Cucurbita pepo	Acorn squash	Fruit and seeds	Lints 2012
Cucurbita maxima	Buttercup squash	Fruit and seeds	Lints 2012
Cucurbita moschata	Butternut squash	Fruit and seeds	Lints 2012
Cucurbita maxima	Hubbard squash	Fruit and seeds	Lints 2012
Cucurbita maxima	Kabosha squash	Fruit and seeds	Lints 2012
Cucurbita pepo	Common pumpkin	Fruit	Lints 2012
Cucurbita pepo	Zucchini squash	Fruit	Lints 2012
***Lagenaria* sp.**	Common gourd	Fruit	Lints 2012
Phaseolus vulgaris	Black turtle bean	Seed	Lints 2012
Phaseolus vulgaris	Green bean	Seed	Lints 2012
Phaseolus lunatum	Lima bean	Seed	Lints 2012
Phaseolus vulgaris	Pinto bean	Seed	Lints 2012
Phaseolus vulgaris	Red kidney bean	Seed	Lints 2012
Phaseolus vulgaris	Romano bean	Seed	Lints 2012
Phaseolus vulgaris	White navy bean	Seed	Lints 2012
Phaseolus vulgaris	Yellow eyed bean	Seed	Lints 2012
Psoralea esculenta	Prairie turnip	Tuber	Lints 2012
Quercus macrocarpa	Bur oak	Seed	Lints 2012
Lilium philidelphicum	Western lily	Tuber	Lints 2012
Maranta arundinacea	Arrowroot	Rhizome	Lints 2012
Nymphaea odorata	White pond lily	Tuber	Lints 2012

Nymphaea odorata* ssp. *tuberosa	White pond lily	Tuber	Lints 2012
Platanthera dilata	Tall white bog-orchid	Rhizome	Lints 2012
Hordeum jubatum	Foxtail barley	Seed	Lints 2012
Claytonia caroliniana	Broad-leaved spring beauty	Tuber	Lints 2012
Caltha palustris	Marsh marigold	Rhizome	Lints 2012
Amelanchier alnifolia	Saskatoon	Fruit	Lints 2012
Prunus nigra	Canada plum	Fruit	Lints 2012
Prunus pensylvanica	Pincherry	Fruit	Lints 2012
Prunus virginiana	Chokecherry	Fruit	Lints 2012
Sparganium eurycarpum	Giant bur reed	Rhizome	Lints 2012
Typha latifolia	Cattail	Inflorescence and rhizome	Lints 2012
Zizania aquatica	Southern wild rice	Seed	Lints 2012
Zizania palustris	Northern wild rice	Seed	Lints 2012

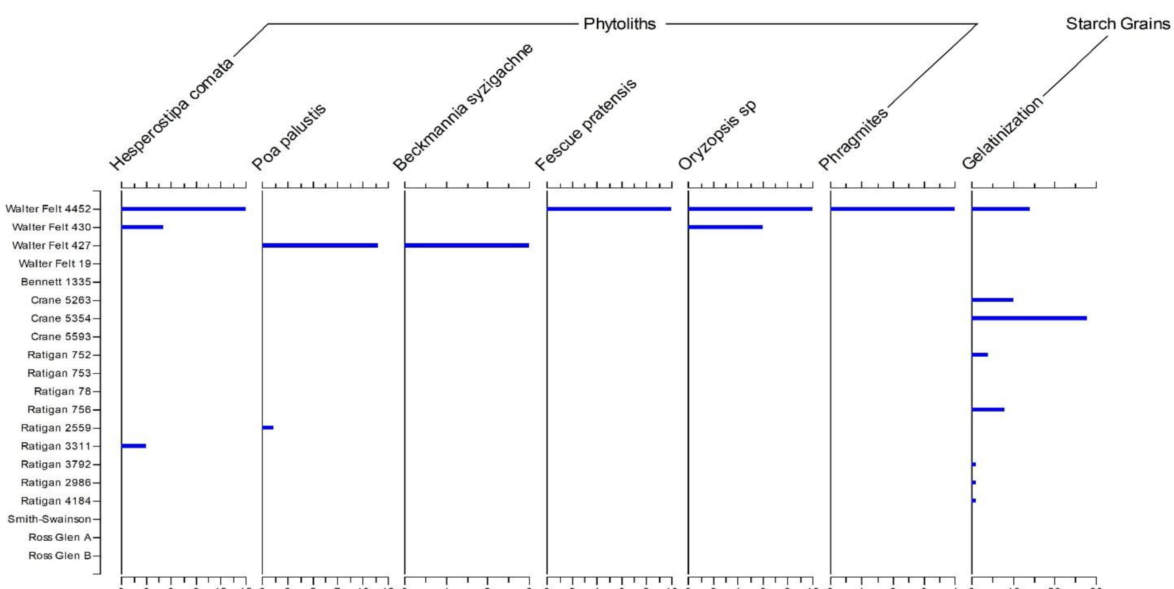
B.2. Identified Plants Per Carbonized Food Residue Sample



B.2.A. Plant identifications by frequency for each carbonized food residue sample from the Sonota Mound sites



B.2.B. Plant identifications by frequency for each carbonized food residue sample from SD, ND, MT, and WY sites.



B.2.C. Plant identifications by frequency for each carbonized food residue sample from Alberta and Saskatchewan sites.

B.3. Airborne Starch Testing Results April 2017 to September 2017

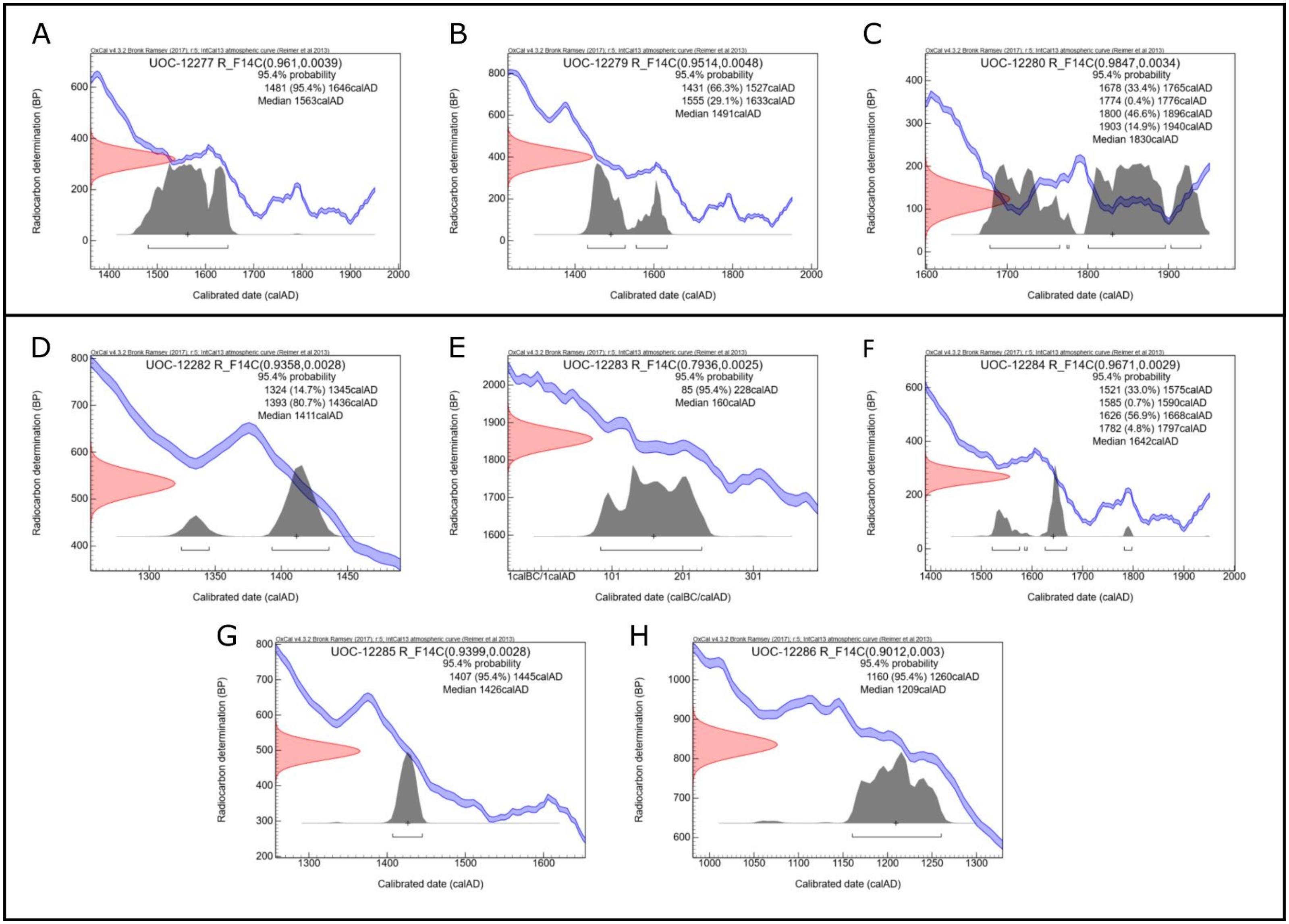
Sampling Week	Contamination Testing Results	Actions Taken
1	No Starch Grains Identified	None
2	No Starch Grains Identified	None
3	4 Starch Grains Identified	Lab cleaned and tested. Samples repeated after a negative test
4	No Starch Grains Identified	None
5	No Starch Grains Identified	None
6	No Starch Grains Identified	None
7	No Starch Grains Identified	None
8	No Starch Grains Identified	None
9	2 Starch Grains Identified	None
10	No Starch Grains Identified	None
11	No Starch Grains Identified	None
12	5 Starch Grains Identified	Lab cleaned and tested. Samples repeated after a negative test
13	No Starch Grains Identified	None
14	No Starch Grains Identified	None
15	1 Starch Grain Identified	Lab cleaned and tested. Samples repeated after negative test
16	No Starch Grains Identified	None
17	No Starch Grains Identified	None

C.1. Isotopic Results from Carbonized Food Residues Obtained from CAIS

			Carbon Isotopes				Nitrogen Isotopes			
Sample ID	Site	Sample Wt.(mg)	Ampl. 44(mV)	Total %C	$\delta^{13}C_{VPDB}$	Atom%^{13}C	Ampl. 28(mV)	Total %N	$\delta^{15}N_{AIR}$	Atom%^{15}N
14-SD-TR13	Stelzer	2.34	3183	7.32	-24.95	1.078	129	0.32	6.35	0.369
7-SD-RIM644	Stelzer	1.94	4799	13.45	-23.19	1.080	416	1.06	5.61	0.369
3-SD-AEX9	Arpan	2.00	13371	41.71	-22.94	1.081	1315	3.09	11.90	0.371
15-SD-TR12	Stelzer	2.57	7421	16.12	-23.13	1.080	835	1.55	7.96	0.369
6-SD-RIM645	Stelzer	1.28	7836	34.54	-22.46	1.081	970	3.65	8.64	0.370
4-SD-STDEN	Stelzer	1.16	3585	16.54	-22.80	1.081	206	0.94	7.55	0.369
5-SD-1292/2	Stelzer	1.54	8898	33.10	-19.32	1.085	2187	6.67	6.73	0.369
2-SD-AINR	Arpan	1.44	10730	44.21	-22.43	1.081	1586	5.18	8.40	0.370
12-SD-252/2	Stelzer	1.57	10662	40.26	-22.26	1.081	1507	4.53	7.33	0.369
11-SD-5512	Stelzer	1.80	6391	19.60	-21.07	1.083	631	1.72	7.15	0.369
9-SD-1579/2	Stelzer	0.40	2925	39.29	-22.55	1.081	381	4.87	7.01	0.369
10-SD-1278/2	Stelzer	2.10	10710	30.73	-21.77	1.082	1542	3.51	6.69	0.369
13-SD-525	Stelzer	1.02	4804	25.50	-22.31	1.081	241	1.25	5.98	0.369
17-SD-R222	Stelzer	2.12	2217	5.43	-22.89	1.081	146	0.39	5.34	0.368

16-SD-TR09	Stelzer	2.08	2358	5.87	-24.51	1.079	136	0.38	5.82	0.369
1-SD-JK63	JK63	1.58	3858	12.99	-22.85	1.081	315	1.03	7.03	0.369
13SRAT09	Ratigan	2.19	19696	43.60	-24.76	1.079	4589	4.34	8.71	0.370
7WBA2NEQ	Cedar Gap	2.28	13398	26.28	-22.79	1.081	4605	4.30	8.52	0.370
6-W-3556	Cedar Gap	2.37	12511	23.28	-23.60	1.080	2995	2.71	8.25	0.369
5WNA1000	Butler Rissler	2.31	9535	17.64	-22.54	1.081	2214	2.08	8.20	0.369
4SA49884	Stelzer	2.15	11747	23.82	-22.57	1.081	1609	1.63	7.62	0.369
3-SA498885	Stelzer	2.29	9620	18.01	-22.41	1.081	1414	1.38	6.98	0.369
2-S-B21073	Stelzer	2.16	14177	29.62	-19.88	1.084	4835	4.74	7.45	0.369
1-A-P2710	Arpan	2.11	16532	36.56	-22.79	1.081	2778	2.80	10.74	0.370

C.2. Calibration Plots from the Walter Felt (A-C) and Ratigan sites (D-H)



C.3. List of Radiocarbon Dates from Selected Besant-Sonota Era Sites

Site	Lab ID	Material	^{14}C yr BP	Source
Stelzer, SD	Beta-38267	Charcoal	1800 ± 50	Haberman and Travis (1995)
Stelzer, SD	Beta-38266	Bone	1600 ± 60	Haberman and Travis (1995)
Stelzer, SD	UCIAMS-114945	Bone	1715 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114946	Bone	1745 ± 20	Graham (2014)
Stelzer, SD	UCIAMS-114947	Bone	1750 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114948	Bone	1775 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114949	Bone	1755 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114950	Bone	1710 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114951	Bone	1775 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-114952	Bone	1700 ± 15	Graham (2014)
Stelzer, SD	UCIAMS-143668	Bone	1775 ± 20	Graham (2014)
Stelzer, SD	UCIAMS-143669	Bone	1785 ± 20	Graham (2014)
Stelzer, SD	UCIAMS-143670	Bone	1755 ± 25	Graham (2014)
Arpan Mound, SD	SI-311	Wood	1850 ± 90	Neuman (1975)
Arpan Mound, SD	UOC-15139	Carbonized food residues	1640 ± 31	This Study
Arpan Mound, SD	UOC-15140	Carbonized food residues	1746 ± 29	This Study
Arpan Mound, SD	UOC-15141	Carbonized food residues	1718 ± 32	This Study
Grover Hand, SD	SI-167	Mound 1 Charcoal	650 ± 200	Neuman (1975)
Grover Hand, SD	SI-168	Mound 2 Wood	1640 ± 80	Neuman (1975)
Grover Hand, SD	SI-48	Mound 3 Wood	1720 ±75	Neuman (1975)
Alkire Mound, SD	SI-310	Wood	1650 ± 200	Neuman (1975)
Swift Bird, SD	II-718	Charcoal	1825 ± 120	Neuman (1975)

Swift Bird, SD	II-719	Wood	1600 ± 100	Neuman (1975)
Boundary Mound, ND	II-499	Wood	1540± 160	Neuman (1975)
Boundary Mound, ND	II-498	Wood	1340± 150	Neuman (1975)
Boundary Mound, ND	II-414	Wood	2200 ± 125	Neuman (1975)
Butler-Rissler	Beta-17830	Carbonized food residues	1660 ± 90	Miller and Waitkus (1989)
Cedar Gap	QL-4725	Charcoal	185 ± 30	Eckles et al. (2012)
Cedar Gap	QL-4724	Charcoal	1960 ± 60	Eckles et al. (2012)
Cedar Gap	Beta-37559	Charcoal	1820 ± 130	Eckles et al. (2012)
Cedar Gap	Beta-62486	Charcoal	2540 ± 130	Eckles et al. (2012)
Greyrocks	RL-704	Charcoal	1750 ± 110	Tibesar (1980)
Greyrocks	RL-955	Charcoal	1890 ± 120	Tibesar (1980)
Walter Felt	UOC-12277	Bone Layer 13	319 ± 33	This Study
Walter Felt	UOC-12278	Bone Layer 13	Failed	This Study
Walter Felt	UOC-12279	Bone Layer 3	400 ± 40	This Study
Walter Felt	UOC-12280	Bone Layer 1	124 ± 27	This Study
Walter Felt	UOC-12281	Bone Layer 3	Failed	This Study
Ratigan	UOC-12282	Bone	533 ± 24	This Study
Ratigan	UOC-12283	Bone	1857 ± 26	This Study
Ratigan	UOC-12284	Bone	268 ± 24	This Study
Ratigan	UOC-12285	Bone	498 ± 24	This Study
Ratigan	UOC-12286	Bone	836 ± 26	This Study
Head-Smashed-In, AB	GX-1253	Bone	1930 ± 80	Reeves (1990b)
Head-Smashed-In, AB	RL-331	Bone	1900 ± 100	Reeves (1990b)
Head-Smashed-In, AB	GX-1220	Bone	1705 ± 90	Reeves (1990b)
Muddy Creek, WY	RL-1338	Wood	1720 ± 120	Craigie (1985:43)
Muddy Creek, WY	RL-394	Bone	1720 ± 120	Frison (1978)
High Butte, ND	N1428	Hearth	1600 ± 150	Wood and Johnson (1973)