

Intraregional Social Interaction in Late Prehistory: Paste Compositional Analysis of Oneota Pottery Vessels in the Lake Koshkonong Region

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Abstract: At least six large Oneota sites are distributed along the northwestern shore of Lake Koshkonong, which is more than 50 kilometers from other known Oneota settlements. Temporal and material cultural relationships among these sites have been unclear. Pottery production and acquisition of raw materials are significant unresolved questions. Did the occupants of Oneota sites on Lake Koshkonong utilize the same raw material resources? Did they follow the same paste recipes in pottery production? The close proximity of sites suggests strong social interaction and sharing of knowledge, but these connections have yet to be demonstrated. Paste compositional analysis of 226 pottery sherds from three sites—the Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village—using ceramic petrography and energy dispersive x-ray fluorescence (ED-XRF) methods is conducted to determine the degree of connection and autonomy among occupants of Oneota sites in the region.

Key words: Oneota Tradition, Lake Koshkonong, social interaction, ceramic compositional analysis

Introduction

The investigation of micro- and macro-regional interactions between Late Prehistoric social groups has rarely included the use of compositional analysis of Oneota ceramics. Such analyses, when conducted in Wisconsin, have included techniques of ceramic petrography, neutron activation analysis, and energy dispersive x-ray fluorescence (Ahlrichs and Schneider 2011; Naunapper 2007; Rodell 1997; Schneider and Jeske 2010; Schneider and Richards 2012, Stimmel 1978). Compositional analysis can provide information about manufacture, technology, and raw material sources to elucidate cultural interaction at the intra- and interregional levels by identifying different source materials within artifact assemblages (Boszhardt 2008:199; Stimmel 1978; Stoltman 2001). This study represents one of the first compositional analyses focused on Oneota ceramics in the Lake Koshkonong region (see also Ahlrichs and Schneider 2011). Based on data gleaned from our compositional analysis of Oneota ceramics and clays (n=226), we examine the role of acquisition of raw materials and subsequent pottery production to determine the scale and density of social interaction between social groups at the micro-regional level. The micro-regional area is approximately three kilometer by three kilometer along the northwest shore of Lake Koshkonong (Figure 1).

The tight cluster of Oneota sites dating between A.D. 1050–1400 on the northwest shore of Lake Koshkonong suggests strong social interaction (Figure 1). Despite the dense clustering, these connections have yet to be demonstrated. As the basis for our research, we ask the following questions: Were potters from different groups using locally available clays that were distinct chemically and mineralogically? If not, how much variation is there between clays being used by different groups? Did potters utilize the same raw material resources and paste recipes in the region? We conducted a paste compositional analysis of pottery sherds from the Crescent

Bay Hunt Club (47Je904), Schmeling (47Je833), and Koshkonong Creek Village (47Je379) sites, to address these questions regarding the interaction between Oneota sites in the region. The compositional data collected on prehistoric pottery from these three sites through the use of energy dispersive x-ray fluorescence (ED-XRF) and ceramic petrography provide a foundation for establishing models for future research in the region. In addition, modern clay collection was incorporated as comparative clay source data.

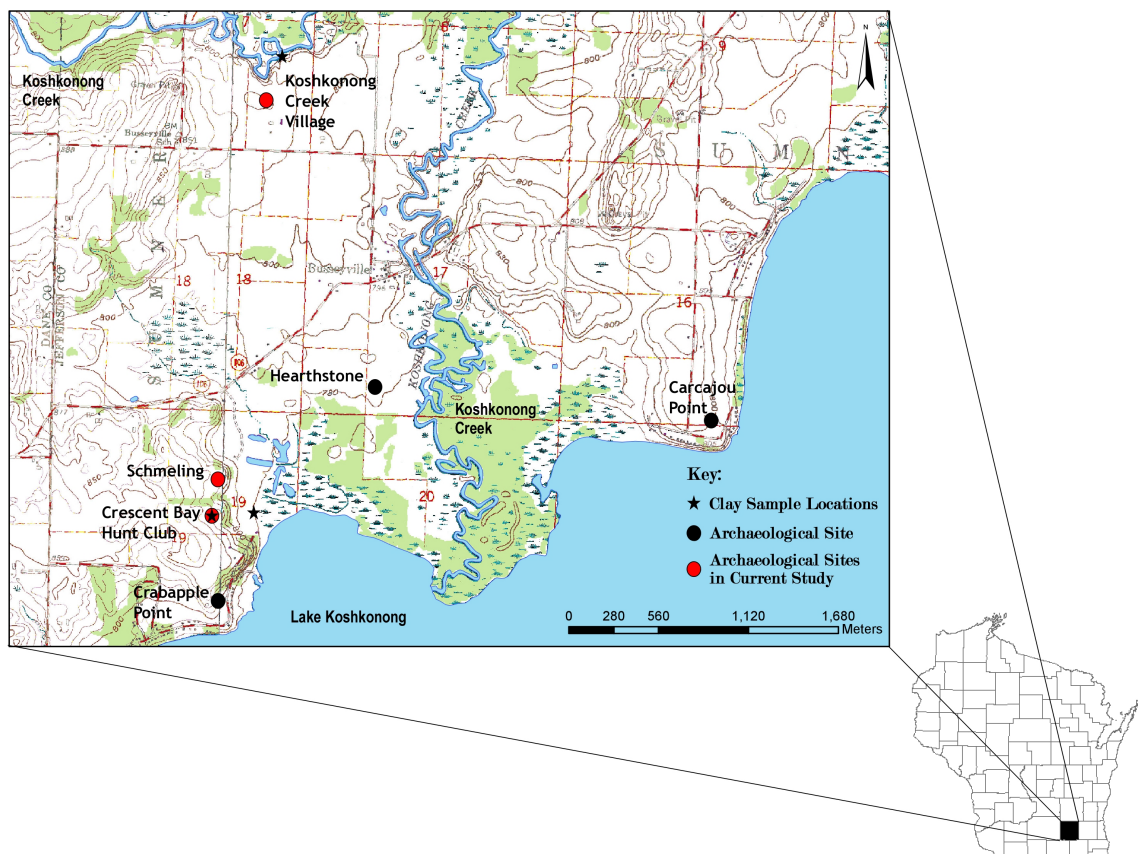


Figure 1. Location of six Oneota sites and clay sources on the northwest shore of Lake Koshkonong.

The Oneota Tradition and The Lake Koshkonong Region

The Oneota Tradition spans from A.D. 1000 to historic times and geographically extends from Indiana to Nebraska and Missouri to Ontario and Manitoba in Canada (Henning 1998:15–19; Hollinger and Benn 1998; Overstreet 1995:33). Material culture of the Oneota Tradition consists of shell-tempered, smoothed-surface globular pottery jars with flared to everted rims as well as curvilinear and rectilinear decorative patterns on the body of some vessels that increase in frequency over time (Boszhardt 1994; James Griffin 1946; Hall 1962; McKern 1945; Overstreet 1997). Triangular points and end scrapers dominate the lithic technology (Hall 1962; Jeske 2001). Maize horticulture was practiced, and in Wisconsin, a variety of nuts, chenopodium, and wild rice were harvested from both upland and aquatic environments (Arzigian 1989; Egan-Bruhy 2001; Hunter 2002; Olsen 2003). The faunal remains demonstrate a reliance on shell, fish, and deer (Edwards and Pater 2011; Gallagher and Stevenson 1982; Hunter 2002; Overstreet

1981). House structures are mat and pole style wigwams and long houses (Hall 1962; Gibbon 1972; Hollinger 1995; Jeske 2001; Moss 2010; O’Gorman 1995).

In 1906 Arlow B. Stout and Halvor L. Skavlem (1908) conducted the first archaeological survey of the Lake Koshkonong region in Jefferson County, Wisconsin. At least 18 prehistoric campsites and villages were identified and possibly associated with the Oneota Tradition based on the presence of shell-tempered pottery. Survey and excavations conducted by the University of Wisconsin–Madison and the University of Wisconsin–Milwaukee (UWM) from the late 1960s to the present have confirmed the presence of at least six large Oneota sites in the region (Hall 1962; Hanson 1996; Gibbon n. d.; Gaff 1998; Jeske 2001, 2003; Musil 1987; Peske n. d.) (Figure 1). The Carcajou Point (47Je2), Crabapple Point (47Je93), Crescent Bay Hunt Club, Hearthstone (47Je89), Schmeling, and Koshkonong Creek Village sites are distributed along the northwest shore of Lake Koshkonong, which is more than 50 kilometers from other known Oneota settlements in Eastern Wisconsin. Three of the six identified sites were included in the study: Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village. At the present, these three sites were chosen because of accessibility to the pottery assemblages. A model of interaction can be presented based on the outcome of this preliminary study, which can be tested by conducting additional compositional analysis on pottery from the three remaining sites in the region: Carcajou Point, Crabapple Point, and Hearthstone (see Figure 1).

The social and economic relationships between these Oneota sites on Lake Koshkonong, including how such relationships changed (or not) over time, have been unclear. Over 20 radiocarbon assays from the sites suggest approximately 350 years (A.D. 1050 to 1400) of prehistoric occupation of people associated with the Oneota Tradition in the region (Birmingham 2006; Boszhardt et al. 1995; Hall 1962; Jeske 2001, 2003; Overstreet 1997). Radiocarbon assays from the sites of Crescent Bay Hunt Club, Schmeling, and Carcajou Point indicate that at least these sites overlap in time around A.D. 1200–1400 (Birmingham 2006; Jeske 2001, 2003, 2008). The contemporaneity and how much interaction is occurring between these sites in the Koshkonong region remain debatable.

Environmental and Site Descriptions

Oneota village sites in Eastern Wisconsin are generally situated on high ground and in proximity to aquatic resources (e.g., fish, shell, and wild rice) (Hanson 1996; Gaff 1998; Hall 1962; Rodell 1984; Jeske 2001; Richards et al. 1998). The Crescent Bay Hunt Club site is located on a limestone ridge rising eight meters above the lowlands and is approximately 300 meters east of Lake Koshkonong (Gibbon n.d.; Jeske 2001). The Schmeling site is located 200 meters to the north of the Crescent Bay Hunt Club site along the limestone ridge (Foley Winkler 2006, 2009). The Koshkonong Creek Village site is approximately three kilometers north of Lake Koshkonong and the other two sites. The Koshkonong Creek Village site is situated roughly 40 meters south of and approximately ten meters above Koshkonong Creek. The spacing of these sites allowed people to take full advantage of both wetland and upland resources (Edwards 2010; Hunter 2002; Jeske 2001, 2003; Olsen 2003).

Soils with high clay content in the Lake Koshkonong region have been identified for the present study. An examination of the U.S. Department of Agriculture's Web Soil Survey indicates that soils with clay percentages greater than 20 percent are available in both the low wetland and upland environments around the sites (Soil Service Staff <http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>), and Figure 1 shows the locations where samples were collected. Ethnographic documentation has suggested that potters will travel between one to seven kilometers in a day to acquire raw clay for pottery production (Arnold 1985:38-42), we assume that local Oneota potters may have adhered to similar geographic distances and procurement strategies, and a wider catchment area is necessary to capture more potential clay sources in the region.

General Description of Oneota Pottery Assemblage in the Lake Koshkonong Region

The pottery assemblages from all three sites in this study have been reported and, to varying degrees, analyzed (Nelson 2001:61–83; Cowell et al. 2008; Gibbon n. d.; Schneider and Clauter 2006, 2007; Schneider et al. 2006). A total of 585 vessels are present in the ceramic assemblages from the three sites: 418 from the Crescent Bay Hunt Club site, 118 from the Schmeling site, and 49 from the Koshkonong Creek Village site. Grand River pottery types dominate the assemblages, followed by Carcajou pottery types, then Busseyville Grooved Paddle vessels, and other pottery types occurring with less frequency. Table 1 shows the frequency of pottery types between sites.

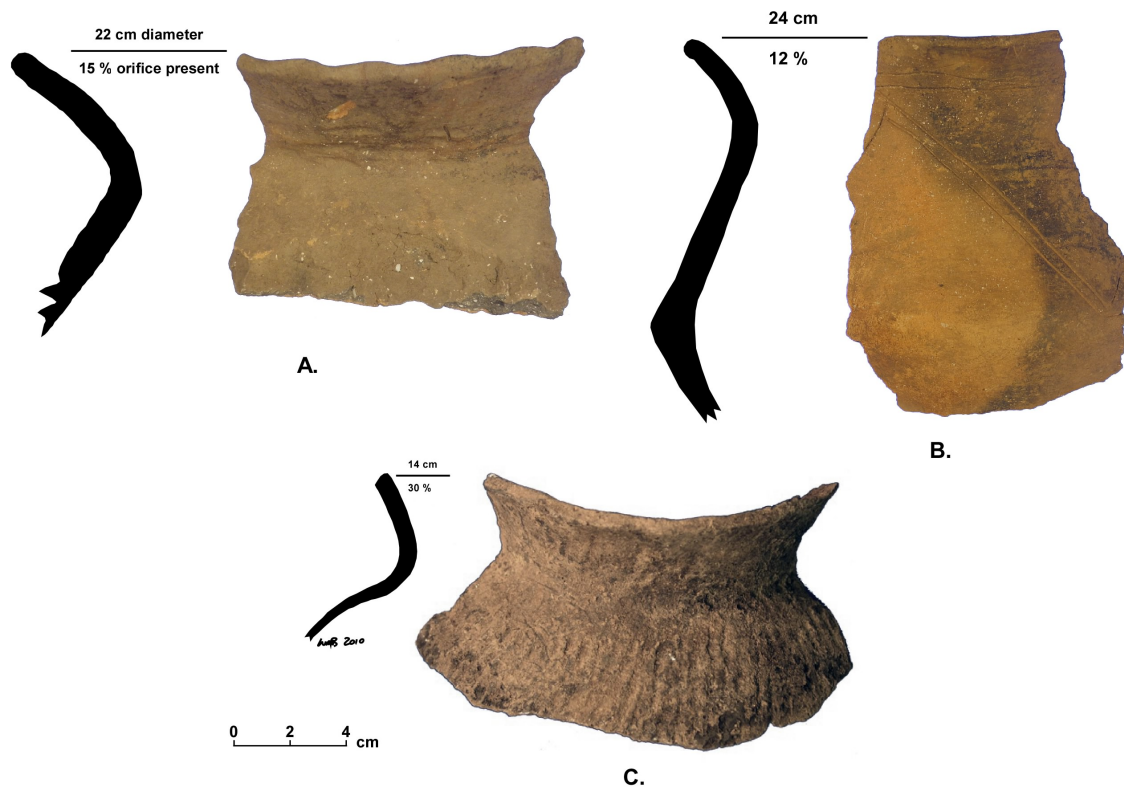


Figure 2. A) Carcajou Plain, B) Grand River Trailed, and C) Busseyville Grooved Paddle pottery types from the Crescent Bay Hunt Club site.

The vessels in the assemblages are primarily shell-tempered globular jars with flared to everted rims. A small number of bowls are also present in the assemblages. Vessels exhibiting decorations along the lip proper and exterior lip margins are diagnostic of Carcajou Plain and Curvilinear pottery types, which make up twenty percent of vessels within all assemblages (Hall 1962:60–65) (Figure 2, A). Vessels without lip decorations are considered Grand River Plain and Trailed pottery types and make up almost forty percent of vessels within the three assemblages (Hall 1962:65–70) (Figure 2, B). Curvilinear decorations are seen on Carcajou Curvilinear vessels and rectilinear decorations are associated with Grand River Trailed vessels, consisting primarily of trailed motifs in shapes of chevrons and nested chevrons. As the name implies, Carcajou Plain and Grand River Plain pottery types do not exhibit any decoration on the body of the vessel. The majority of the vessels have smooth surfaces, but a small number of vessels, four percent of all vessels in the assemblages, have roughened surfaces from a grooved paddle finishing technique that Bob Hall defined as Busseyville Grooved Paddle pottery type (1962:70–72) (Figure 2, C). Besides the grooved paddle surface treatment on vessels, no lip or body decorations are present in this pottery type.



Figure 3. A) Crescent Bay Curvilinear and B) Crescent Bay Punctate pottery types from the Crescent Bay Hunt Club site.

Table 1. Frequency of vessel types between the Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village sites.

	Crescent Bay Hunt Club	Schmeling	Koshkonong Creek Village	Total	
Oneota Pottery Types	#	#	#	#	%
Carcajou Types	61	40	17	118	20.17%
Grand River Types	147	56	26	229	39.15%
Busseyville Grooved Paddle	10	10	4	24	4.10%
Crescent Bay Curvilinear	1	0	0	1	0.17%
Crescent Bay Punctate	1	1	0	2	0.34%
Carcajou/Grand River Hybrid	2	2	0	4	0.68%
Carcajou/Busseyville Hybrid	1	0	0	1	0.17%
Miniature	10	7	1	18	3.08%
Unknown Oneota Vessels	179	2	0	181	30.94%
Exotic Vessel Types	#	#	#	#	%
Fisher Types	3	0	0	3	0.51%
Allamakee Trailed Like	3	0	1	4	0.68%
Overall Total	418	118	49	585	100%

Two provisional pottery types are present in the Crescent Bay Hunt Club assemblage: Crescent Bay Curvilinear and Crescent Bay Punctate (Schneider et al. 2006). The Crescent Bay Curvilinear pottery is a variant of the Carcajou Curvilinear pottery type incorporating lip notching and an interlocking scroll motif. The Crescent Bay Curvilinear motif differs in that it incorporates a grooved paddle surface treatment rather than a smooth surface (Figure 3, A). The Crescent Bay Punctate pottery type appears to be an Eastern Wisconsin variant of the Perrot Punctate pottery type in Western Wisconsin and Iowa (Figure 3, B). Narrow tool notches are evident along the lip of the vessel, as well as trailed lines on the shoulder in a nested chevron motif and vertical trailed beneath. Annular punctates border the interior of chevrons and encircle the neck of the vessel. No other pottery types have been identified, but it is clear that a blending or hybridization of types is present. Vessels with lip notching and rectilinear trailed lines demonstrate characteristics of both Carcajou and Grand River pottery types. Vessels with grooved paddle surface treatment and lip notching represent a blending of Busseyville Grooved Paddle and Carcajou types (Table 1).

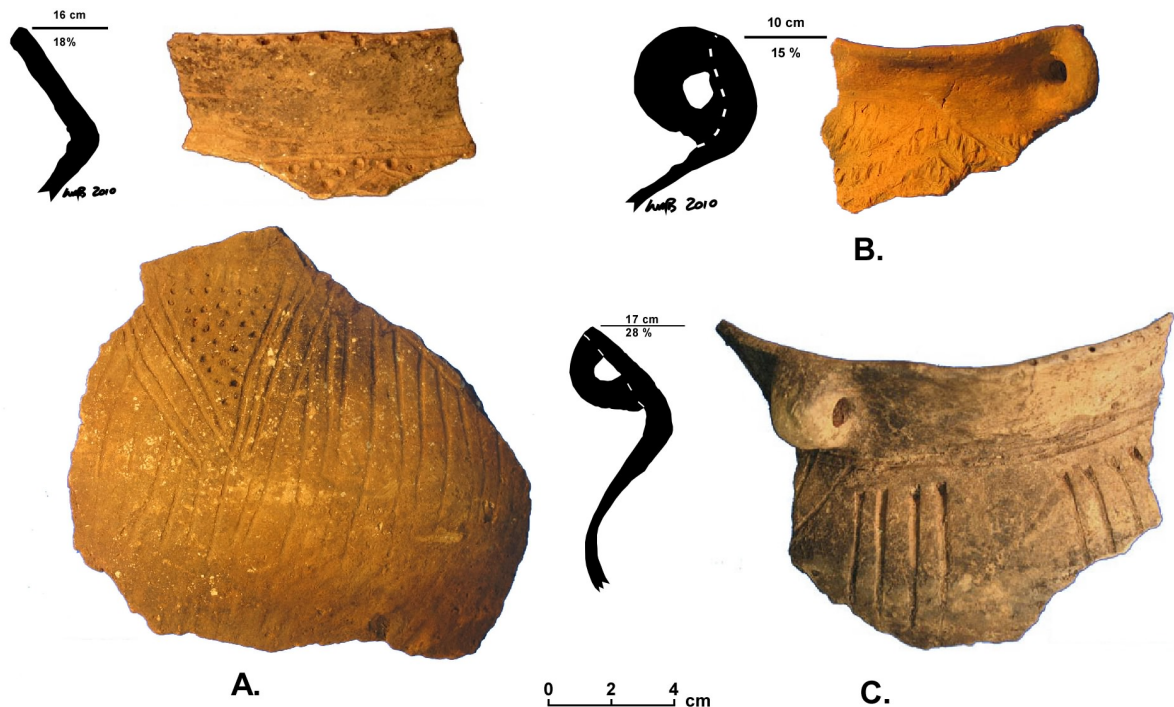


Figure 4. A) Allamakee Trailed, B) Fisher Trailed, and C) Bold Counselor pottery types from the Crescent Bay Hunt Club site.

Some non-local/exotic pottery types from Western Wisconsin and Iowa, as well as Northern Illinois and the Central Illinois River Valley, are present in the assemblage and comprise just over one percent within the assemblages. Lip decoration and narrow trailed lines in chevron and nested chevron patterns bordered beneath sometimes with vertical trailed lines as well as punctates that in-fill the V-portion of the chevron characterize the Allamakee Trailed pottery type (Figure 4, A). This pottery type, like the Perrot Punctate type, is commonly seen in Western Wisconsin and Iowa.

Two Fisher Trailed vessels and a Bold Counselor vessel are present in the Crescent Bay Hunt Club pottery assemblage. The Fisher pottery types from Northern Illinois are shell-tempered and have similar decorative motifs seen on Oneota pottery, but differ in that the exterior surfaces are also cordmarked and smoothed-over cordmarked besides being smooth (Faulkner 1972; John Griffin 1946) (Figure 4, B). One of the Fisher Trailed vessels has a smooth exterior surface along the rim and the body is roughened with a cord-wrapped stick, or cordmarked. Trailed lines in a nested chevron motif over the cordmarked surface of the body are present. The Bold Counselor pottery type is evident in the Central Illinois River Valley (Figure 4, C). Two horizontal lines encircle the neck with oblique trailed lines underneath the handle. Two sets of four stab and drag vertical lines are also seen on the shoulder beneath the horizontal lines. It is the “stab and drag” vertical decorations that stand out among the decorated vessels at the site. Esarey and Conrad (1998:40) describe Bold Counselor jars as “high rimmed, globular vessels with shoulders bearing typical Oneota trailed lines with punctate borders and ‘stab and drag’ vertical decorations.” Esarey and Conrad’s description fits this vessel very well.

Ceramic Compositional Analyses

Two complementary methods, energy dispersive x-ray fluorescence (ED-XRF) and ceramic petrography, were utilized in this study to obtain chemical and mineralogical compositional data (e. g., Stoltman et al. 1992). Energy dispersive x-ray fluorescence (ED-XRF) is a form of chemical analysis that obtains elemental data, while mineralogical data was collected through ceramic petrography. The ED-XRF data provides identification of clay sources for pottery as well as data on the variation in paste composition between sites and regions (Boor 2009; Morgenstein and Redmont 2005; Padilla et al. 2006; Liritzis and Zacharias 2011:125; Richards and Clauter 2009:169–170). Ceramic petrographic analysis assists in defining pottery classification, production, function, and exchange of pottery (Stoltman 2001:307–322).

Clay samples were collected from clay rich soil strata at the Crescent Bay Hunt Club site and from alluvial deposits near Lake Koshkonong and along Koshkonong Creek. These modern clay collections provide a third set of data that was incorporated into the paste compositional study. Such samples provide a comparative data set for the ED-XRF elemental interpretations of clay sources. Although limited clay samples were examined, these samples strengthen the model in development for future research.

Energy Dispersive X-ray Fluorescence

Two hundred twenty-six samples of pottery sherds, burnt clay, and raw clay samples were included in the elemental analysis (Tables 2 and 3). A Bruker Tracer III-V+ portable ED-XRF instrument with S1PXRF software was used to obtain elemental signatures provided in a spectra diagram (Figure 5). Each sample was placed over the aperture of the instrument and readings of 180 seconds were taken on the exterior and interior surfaces. The green filter of 12 mil of aluminum (Al), one mil of titanium (Ti), and six mil of copper (Cu) provided and recommended by Bruker for analyzing pottery was used to control the amount of excitation given off by the radiation of instrument (Tagle and Gross 2010). The spectra diagram readouts

indicated energy peaks for 13 elements: Arsenic (As), Calcium (Ca), Iron (Fe), Potassium (K), Manganese (Mn), Nickel (Ni), Rubidium (Rb), Strontium (Sr), Titanium (Ti), Vanadium (V), Zinc (Zn), and Zirconium (Zr). ARTAX software provided by Bruker was used to convert the spectra readings into numerical net intensity readings (Table 4) (Ragle and Gross 2010). The net intensity readings were used to generate bivariate plots to compare elements to one another and to determine whether pottery from the sites would cluster together or if separate clusters would be identifiable. Calcium was omitted from the list because shell is composed primarily of calcium carbonate. Shell is a human additive, temper, incorporated during pottery production. The expectations were that the Ca readings obtained from the XRF instrument would be heightened by the presence of shell temper, which would skew readings of natural amounts in the clay samples.

Table 2. Oneota and Exotic pottery types selected for ED-XRF analysis.

	Crescent Bay Hunt Club	Schmeling	Koshkonong Creek Village	Total	
Oneota Pottery Types	#	#	#	#	%
Carcajou Types	24	35	17	76	34.70%
Grand River Types	36	39	26	101	46.10%
Busseyville Grooved Paddle	5	10	4	19	8.68%
Crescent Bay Curvilinear	1	0	0	1	0.46%
Crescent Bay Punctate	1	1	0	2	0.91%
Carcajou/Busseyville Hybrid	1	0	0	1	0.46%
Unknown Oneota Vessels	11	2	0	13	5.94%
Exotic Vessel Types	#	#	#	#	%
Fisher Types	2	0	0	2	0.91%
Allamakee Trailed Like	3	0	1	4	1.83%
Overall Total	84	87	48	219	100%

Table 3. Raw clay and burnt clay/daub selected in the Lake Koshkonong region (Figure 1).

Clay Samples	Crescent Bay Hunt Club		Koshkonong Creek Village		Total
	#	#	#	#	
Raw Clay	4	0	1	5	75%
Burnt Clay/Daub	2	0	0	2	25%
Overall Total	6	0	1	7	100%

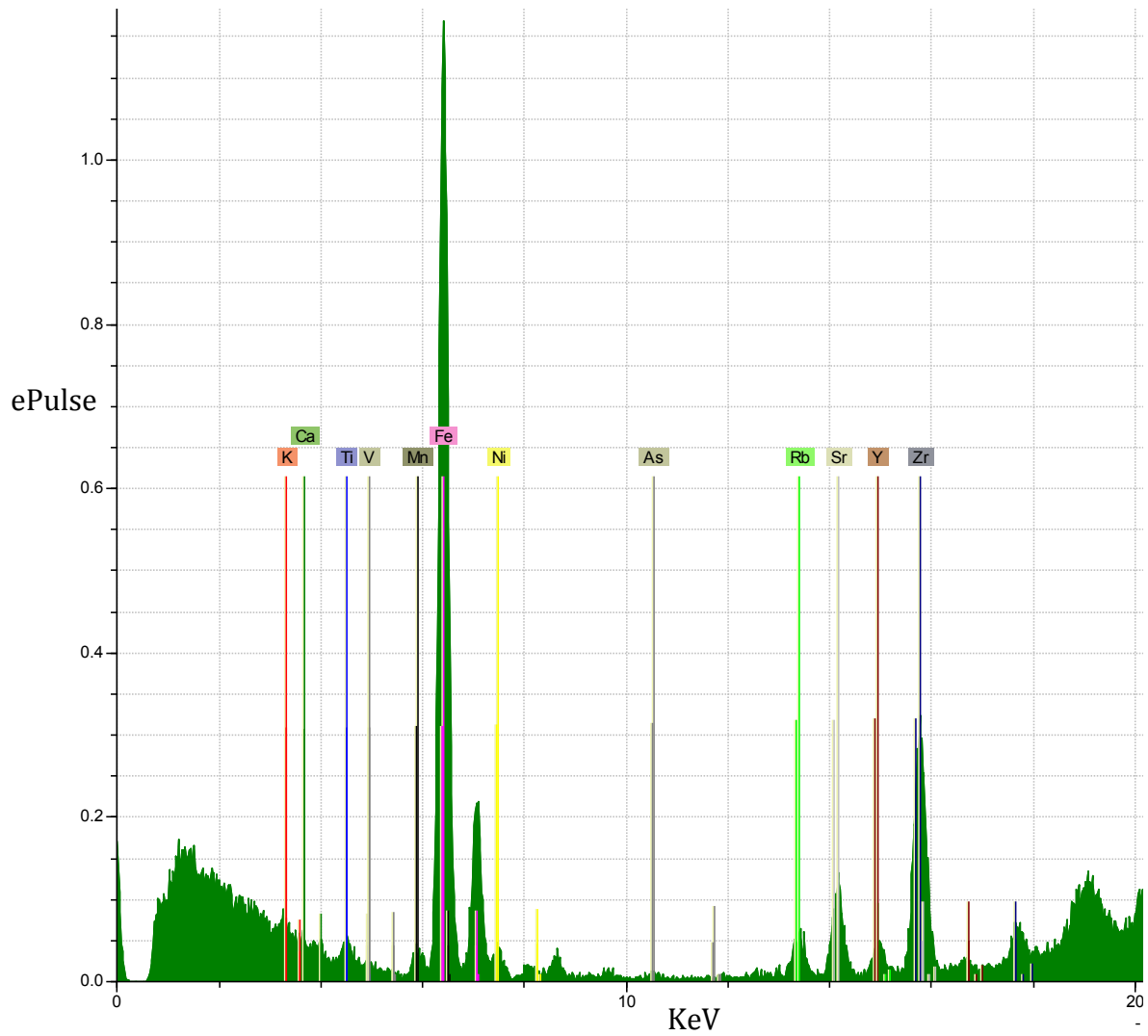


Figure 5. ED-XRF Spectra diagram from SPXRF1 and ARTAX software showing net intensity peaks of the 13 elements identified in the study.

Table 4. Net intensity readings converted from spectra of a sherd from the Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village sites using ARTAX software.

Elements	Sites		
	Crescent Bay Hunt Club	Schmeling	Koshkonong Creek Village
As	175	84	84
Ca	1649	262	125
Fe	15013	13825	12321
K	182	123	174
Mn	127	98	164
Ni	418	391	361
Rb	764	671	795
Sr	2086	1505	1314
Ti	325	310	274
V	22	75	14
Y	311	320	380
Zn	157	170	253
Zr	1952	2997	3792

The results from comparing all combinations of elemental bivariate plots indicate that some potters at the Koshkonong Creek Village site used different clays from potters at the Crescent Bay Hunt Club and Schmeling sites (Figure 6). Bivariate plots of zinc to titanium and zinc to strontium demonstrate that some of the pottery sherds from the Koshkonong Creek Village site cluster some distance from the point cloud of Crescent Bay Hunt Club, Schmeling, and the other Koshkonong Creek Village pottery. In both instances, pottery sherds from the Koshkonong Creek Village site exhibit higher zinc values. There is no clear separation of pottery sherds from the Crescent Bay Hunt Club and Schmeling sites. The co-mingling of sherds from the three sites may indicate: 1) that these potters used clays with the same properties from different sources; 2) the potters from all three sites shared a single clay source; or 3) pottery vessels from the Crescent Bay Hunt Club and Schmeling site were brought to the Koshkonong Creek Village site through either trade or other socio-cultural events. The Koshkonong Creek Village vessels that cluster outside the larger cloud may suggest that potters at the site utilized two different clay sources, or that these vessels are trade items and were not produced from local clays.

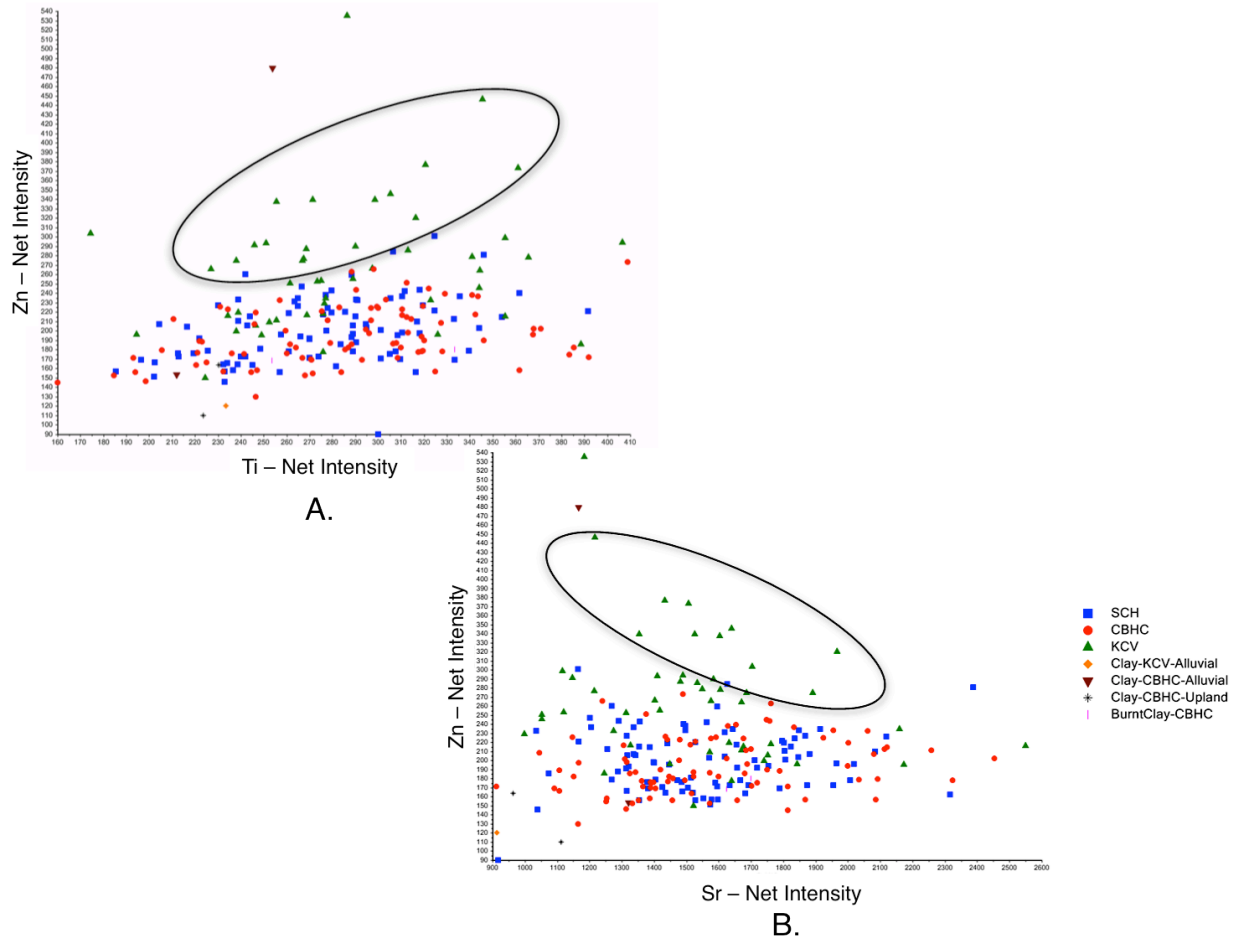


Figure 6. Bivariate plots of titanium-zinc (A) and strontium-zinc (B) ashowing the Koshkonong Creek Village pottery sherds that cluster away from the main point cloud. SHC = Schmeling; CBHC = Crescent Bay Hunt Club; and KCV = Koshkonong Creek Village

Three raw clay samples from alluvial deposits near Lake Koshkonong and Koshkonong Creek, as well as two upland raw clays and two pieces of burnt clay/daub from the Crescent Bay Hunt Club site, were analyzed to determine if local clays were the source material in pottery production at the three sites (Table 3). The same bivariate plots for zinc, strontium, and titanium show that one upland and alluvial clays, as well as the two burnt clay/daub pieces from the Crescent Bay Hunt Club site, fall within or on the edge of the large point cloud of Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village pottery (Figure 7). The second upland and alluvial clays from the Crescent Bay Hunt Club site, as well as the alluvial clay from the Koshkonong Creek Village site, fall well outside the large point cloud and the smaller cluster of Koshkonong Creek Village pottery.

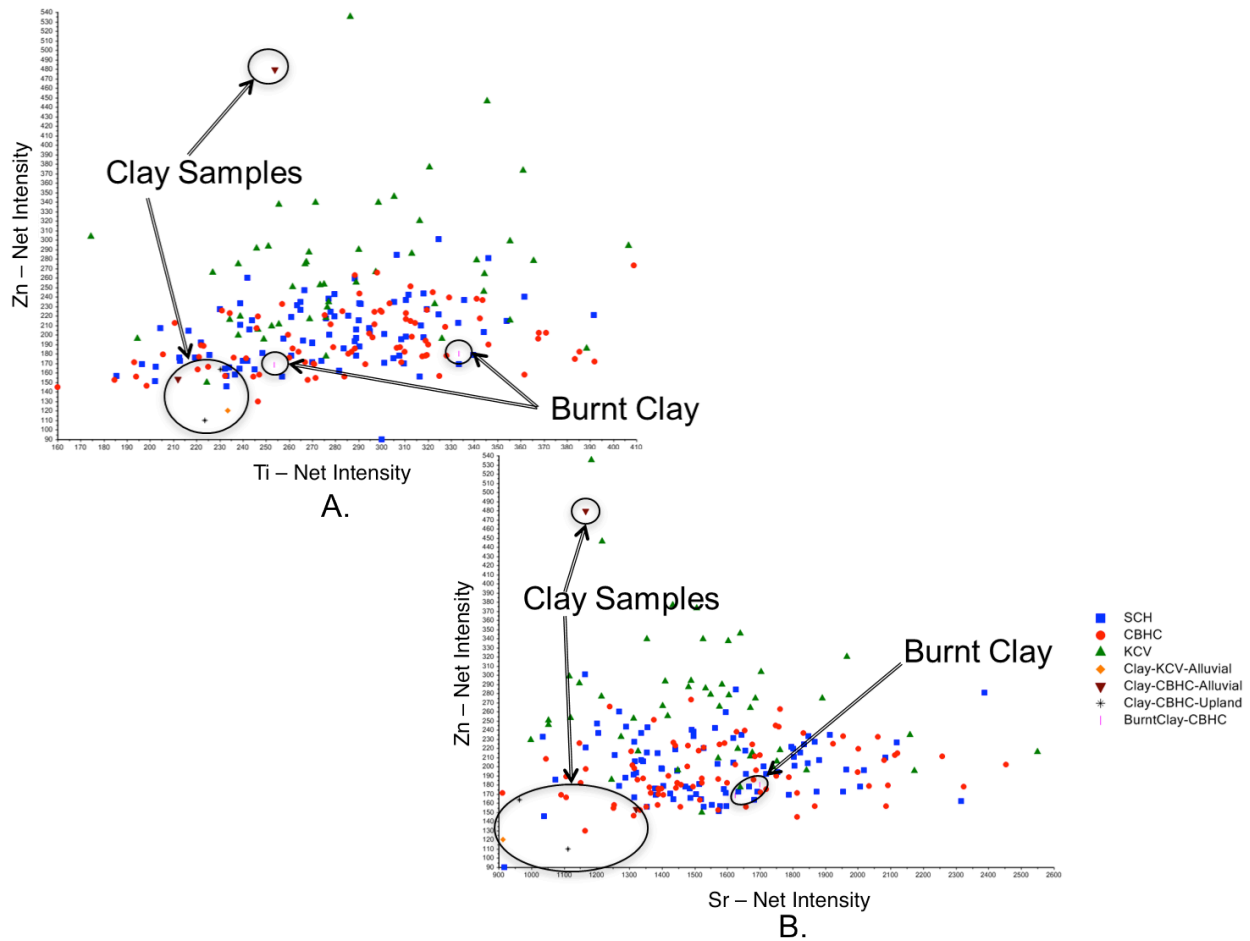


Figure 7. Titanium-zinc and strontium-zinc bivariate plots with clay samples indicated. SCH = Schmeling; CBHC = Crescent Bay Hunt Club; and KCV = Koshkonong Creek Village.

Though this is a small sample of potential raw material sources in the region, and further identification and collection are necessary, the current study does indicate that potters from the Crescent Bay Hunt Club and Schmeling sites utilized clays collected near Lake Koshkonong and the Crescent Bay Hunt Club site. The predominant upland soils at the Crescent Bay Hunt Club site consist of a clay rich soil substrate; alluvial clays are accessible nearby, within a few hundred meters to the east towards Lake Koshkonong. Because of the proximity of the Schmeling site to the Crescent Bay Hunt Club site (a couple of hundred meters to the north) it is assumed that potters at Schmeling would have had access to the same clay sources as those at Crescent Bay Hunt Club. This is one possible interpretation of the elemental data obtained with ED-XRF. The procurement of the upland clays utilized in pottery production may be the byproduct of the large pit features present at the Crescent Bay Hunt Club site; some of these cultural deposits have diameters as large as two meters and maximum depths of up to one and a half meters, which would have gone well into the clay rich substrate present at the site. The two pieces of burnt clay/daub that fall within the large point cloud are likely remnants of clay used in pottery production or in the maintenance of domestic structures at the Crescent Bay Hunt Club site. A clay source, or sources, for Koshkonong Creek Village pottery is indeterminate with the current raw clay samples obtained for this study. The alluvial clay source from along Koshkonong Creek falls outside the large point cloud and smaller cluster of Koshkonong Creek

Village pottery. More samples from potential clay sources from around the Koshkonong Creek Village site will likely demonstrate a source in closer proximity.

However, based on the current study, some of the pottery from Koshkonong Creek Village was made using clays similar to clays used to make pottery at the Crescent Bay Hunt Club and Schmeling sites. The cluster of pottery from the Koshkonong Creek Village site higher in zinc (indicated in the bivariate plots) likely comes from a currently unidentified local source. Pottery from the three other sites (Carcajou Point, Crabapple Point, and Hearthstone), as well as additional clay sources in the region need to be analyzed to provide a more comprehensive catalog of the compositional variation in the Lake Koshkonong region at the elemental level.

Ceramic Petrography

A total of 14 rim and body sherds were selected to represent different pottery types in each assemblage. The selected sherds were made into thin sections to conduct petrographic microscopy and were examined using a Leitz Orthoplan polarizing microscope (Table 5).

Table 5. Vessel types selected for petrographic analysis.

Vessel Type	Crescent Bay Hunt Club	Koshkonong Creek Village	Schmeling	Total
Grand River Plain	1	2	1	4
Carcajou Plain	1		1	2
Carcajou Type			1	1
Busseyville Grooved Paddle		1	1	2
Crescent Bay Curvilinear	1			1
Crescent Bay Punctate	1			1
Fisher Type	1			1
Unclassified Oneota		2		2
Total	5	5	4	14

The qualitative analysis of overall paste characteristics consists of the visual identification of the minerals present in a given thin-section. Then a point counting methodology proposed by James Stoltman (1989, 1991) was used for the petrographic analysis to obtain quantitative counts for natural inclusions and temper. A one-millimeter by one-millimeter grid was used to obtain the counts with a minimum of 100 counts per sherd. If the first set of transects did not meet this minimum count requirement, the thin-section was rotated 180 degrees and the sherd was subjected to a second point counting. The quantitative method distinguishes sherd composition in terms of body and paste components, as well as a grain size index. Body composition is a combination of matrix (clay and silt), temper, and natural inclusions; paste consists of clay, silt, and sand particles. A size index was employed for natural grains and temper: 1–fine (.0625–.24 mm); 2–medium (.25–.49 mm); 3–coarse (.50–.99 mm); 4–very coarse (1.0–1.9 mm), and 5–gravel (> 2.0 mm).

Ceramic Petrography Results

Table 6. Body composition with means and indices.

Site	Matrix (Mean %)	Temper (Mean %)	Sand (Mean %)	Temper Inclusion Indices (1-5)
Crescent Bay Hunt Club	85	11	3	2.4
Koshkonong Creek Village	84	11	4	2.7
Schmeling	84	12	4	2.3

The overall paste characteristics of the pottery vessels have natural inclusions of very well-sorted to well-sorted silt and sand grains in the clay matrix. The shell temper is well-sorted to moderately well-sorted. The natural inclusions in the clay consisted of common single grained minerals: quartz, micas, plagioclase, and opaque (hematite or magnetite). Very coarse multi-grained quartz grain minerals, one to two millimeters in size, representing sandstone rock fragments were present in a body sherd from the Koshkonong Creek Village site. Multi-grained quartz minerals were also present in the thin-sections from the Crescent Bay Hunt Club and Koshkonong Creek Village sites (Table 6) (Figure 8). In thin-section, the body composition of the pottery has temper size indices ranging from about two to three. This indicates the use of medium to coarse size pieces of shell as aplastic in ceramic production at these sites. Shell temper in pottery from the Koshkonong Creek Village site was slightly larger on average than those from the Crescent Bay Hunt Club and Schmeling sites, with mean temper indices of 2.7, 2.4, and 2.3 (Figure 8). The body composition of sherds from the three sites plotted on the ternary diagram shows five sherds with slightly higher temper percentages than the other vessels in the study (Figure 9, A). The clustering of samples in the ternary diagram and the similar ratios

of clay to temper to sand in Table 6 suggests that a similar recipe was followed by potters at all three sites.

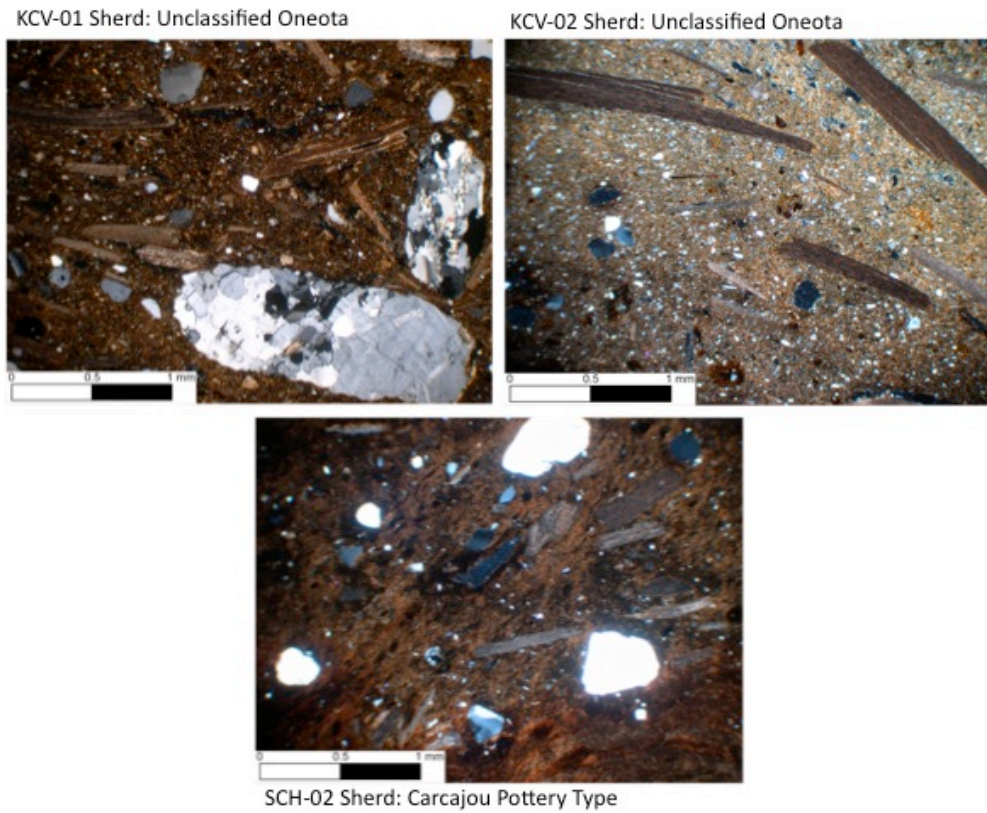


Figure 8. Microscope images of thin sections at 4X from the Koshkonong Creek Village (KCV) and Schmeling (SCH) sites. KCV-01 shows coarse to very coarse multi-grained quartz minerals in the lower right and the KCV-02 thin sections shows a very well-sorted paste with coarse to very coarse shell temper inclusions. SCH02 shows medium grain size single-grained quartz minerals and shell temper.

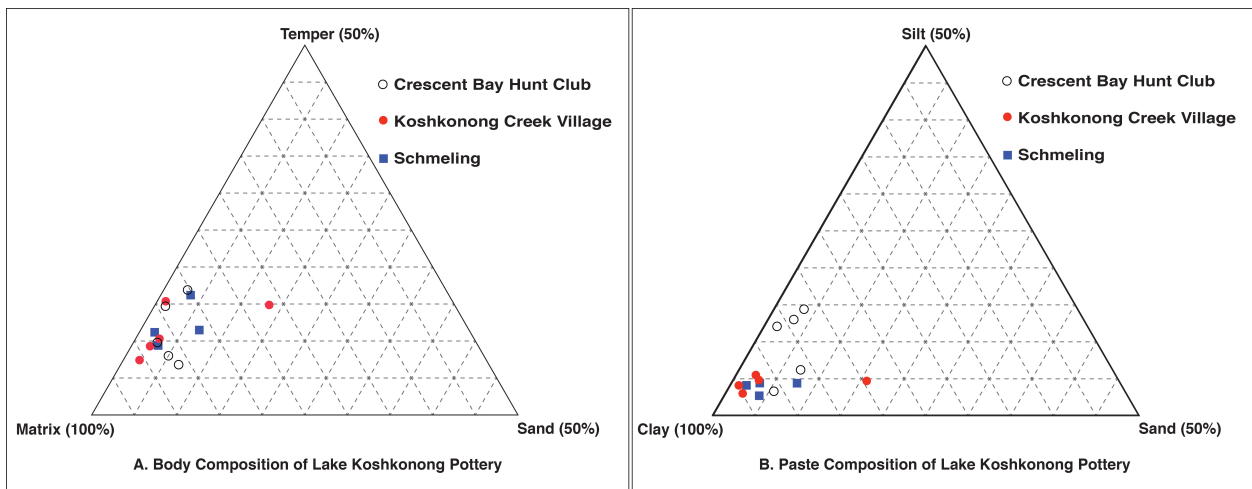


Figure 9. Ternary diagram of body composition (A) and paste compositions (B).

The paste composition showed that natural sand inclusions ranged from fine to medium on the size index (Figure 8, Table 7). Three Crescent Bay Hunt Club sherds are approximately 8.5 percent higher in silt content than are the other two sherds from the site (Figure 9, B). One sherd from the Koshkonong Creek Village site is significantly higher in sand content than the four other sherds analyzed from this site. The separation seen in the Koshkonong Creek Village sherds is similar to that seen in the elemental bivariate plots, with some sherds clustering with Crescent Bay Hunt Club and Schmeling sherds and one sherd plotting outside the cluster. The separation of three Crescent Bay Hunt Club sherds with higher silt content was unexpected and may indicate a different clay source. The separation might reflect the difference in alluvial from Lake Koshkonong and upland clays collected from the Crescent Bay Hunt Club site. If not, it is a completely different clay source. Thin-sections are being made of the clay samples to determine if the difference in paste composition is due to environmental setting, or if a completely different clay source is present.

Table 7. Paste composition with means and indices.

Site	Clay (Mean %)	Silt (Mean %)	Sand (Mean %)	Natural Inclusion Indices (1-5)
Crescent Bay Hunt Club	86	10	4	1.5
Koshkonong Creek Village	91	4	5	1.4
Schmeling	92	4	4	1.0

The ceramic petrography demonstrates that potters in the Lake Koshkonong region used a similar body recipe based on ratios of matrix, natural sand inclusions, and temper observed at the three sites. However, potters did not use the same clay source in their production of all the vessels examined. Potters from all three sites either used the same clay source or clays from different sources with the same properties. Other potters at the Crescent Bay Hunt Club and the Koshkonong Creek Village sites appear to have utilized different clay sources, or different techniques for processing and decanting of clays were employed, or these are vessels from trade/exchange.

Conclusions and Future Research

The two compositional approaches provide complementary and consistent conclusions. Did potters in the Lake Koshkonong region utilize the same raw material resources? Preliminary results from the ED-XRF and ceramic petrography analyses suggest that some potters from the Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village sites utilized either the same clay source or different clay sources with the same properties. If potters from the three sites utilized the same clay source near Lake Koshkonong and the uplands areas around the Crescent Bay Hunt Club, then potters from the Koshkonong Creek Village site would have traveled three

kilometers to acquire clay from the area, falling within the ethnographically documented range of one to seven kilometers travelled by potters to acquire clay (cf. Arnold 1985:38–42). Inter-marriage between villages may have facilitated such an arrangement. Young potters learning the location of raw material resources from their mentors would have taken that knowledge with them when they married into another village and then taken advantage of known resource areas. The clay sample from along Koshkonong Creek did not cluster with any of the Koshkonong Creek Village sherds in the ED-XRF analysis. This may indicate that some vessels were brought to the Koshkonong Creek Village site from the Crescent Bay Hunt Club and Schmeling sites.

Results also suggest that not all potters at the Crescent Bay Hunt Club and Koshkonong Creek Village sites utilized the same clay source. In the ED-XRF analysis, a number of sherds from the Koshkonong Creek Village plot together and away from the other sherds, and three of the Crescent Bay Hunt Club sherds have higher silt content than the other sherds in the petrographic analysis. No specific clay source has been associated with these sherds. However, these sherds may overlap with pottery from and clay sources around the other three sites (Carcajou Point, Crabapple Point, and Hearthstone) not yet analyzed. If the Crescent Bay Hunt Club and Koshkonong Creek Village sherds were found to overlap with any of the other three sites, then it would strengthen the interpretation of social connections between villages in the Lake Koshkonong region.

The use of different clay sources by Crescent Bay Hunt Club and Koshkonong Creek Village potters may also reflect a shift to new raw material sources. The depletion of one clay source might have caused individuals from different villages who at one time used a single source to branch out and locate new sources with different properties, discovering sources closer to their village. It is also possible that these are non-local/exotic vessels, but none of the known vessels in this category separated out during compositional analysis (Ahlrichs and Schneider 2011). The variation we do see at the Crescent Bay Hunt Club and Koshkonong Creek Village sites may suggest variation in practices within these communities, and a study of paste and body composition variation at the household level may be very informative.

Did potters in the Lake Koshkonong region follow the same paste recipes in ceramic production? Oneota potters in the Lake Koshkonong region appear to have shared ceramics manufacturing technology, specifically the mixture ratio of raw clay and shell temper. Several pottery types are evident in the Lake Koshkonong region, but the ceramics examined in this study do not separate out by pottery type or by site based on the petrographic body composition recipes.

Future compositional analyses of Oneota pottery in the Lake Koshkonong region will include petrographic and ED-XRF analysis of additional vessels from the Crescent Bay Hunt Club, Schmeling, and Koshkonong Creek Village sites, as well as pottery from the Carcajou Point, Hearthstone, and the Crabapple Point sites. Statistical tests such as Principle Component Analysis or Correspondence Analysis using ED-XRF net intensity readings will be necessary to determine if the separation identified in the bivariate plots is significant. The statistical significance of the tests will either refute or support the model for social interaction posited in this study. Additional clay sources within the region will also be included to assist in pinpointing raw material sources utilized in pottery production within the Lake Koshkonong region. Ceramic

petrography conducted on the clay samples will provide a mineralogical comparison of the paste composition between the pottery and clay sources. With additional compositional analysis from other pottery assemblages and clay sources in the Lake Koshkonong region, the model for social interactions developed in this study can be tested by future research.

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