Technological Choices: Ceramic Manufacture and Use at the Antrex Site (AjGv-38)

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This paper examines technological characteristics of the pottery recovered from Antrex (AjGv-38), a Middle Ontario Iroquoian village site located in present-day Mississauga, west of Toronto, which dates to the mid-thirteenth century AD. Four different vessel types were identified at the Antrex site, each with a distinct set of manufacturing characteristics and patterns of use alteration. They include: small and medium-sized pots that were used for boiling stews, porridges or soups by placing them on stone supports directly over a small, hot fire; large pots, used in conjunction with hot rocks or "boiling stones," ideal for the extraction of fats and oils; and juvenile vessels, which were not used for food processing but appear to have been carefully curated. Overall, the choices made by Antrex site potters indicate a technologically sophisticated knowledge of ceramic manufacture. They also suggest that the practice of this technology was informed by both functional and social concerns.

Introduction

The majority of analyses performed on pre-contact ceramic assemblages in Ontario examine only decoration and surface treatment, in order to develop chronologies and identify ethnicity. By excluding other pottery characteristics from these analyses, we close many potentially rewarding avenues of inquiry: how these pots were made, used and discarded is certainly as important as how they looked.

The technological choices a potter makes during manufacture are not wholly material in nature–they are also socially meaningful. Characteristics such as temper size and vessel shape are determined through the negotiation of various constraints such as tradition, social relationships and organization, intended function, or the availability of raw materials. A finished pot therefore contains within it embedded information about this negotiation, represented by its technological characteristics (Dobres 2000: 108-109). Examinations of ceramic technology need not be isolated, "scientific" studies whose results are decontextualized and severed from the social: they may also help to answer questions that are anthropological in nature. This approach to technology echoes contemporary discussions related to archaeological theory and practice (Jones 2002: 42-44).

In this paper I contribute to the continuing research into the Late Woodland Iroquoian people of south-central Ontario by examining several ceramic characteristics whose values are easily observed yet rarely discussed within this province. Based on my examination of the ceramic assemblage recovered from the Antrex site (AjGv-38), I describe the main stages of ceramic manufacture and subsequent use and briefly discuss patterns of discard, paying special attention to evidence of decision-making during these activities and highlighting the fact that the technological choices of Iroquoian potters reflected both material and social concerns.

Background

During the early 1990s, a series of excavations were undertaken at the Antrex site, an early Middle Ontario Iroquoian (MOI) village situated close to the intersection of Britannia Road and Hurontario Street in Mississauga, Ontario (Robertson 2010b). The majority of this site was located within a woodlot whose soils remained undisturbed by agricultural activities, resulting in excellent ceramic preservation. Within this woodlot, CRM excavations conducted by Archaeological Services Inc. documented a settlement that measured approximately 0.25 hectares in size and consisted of six longhouses or portions thereof, two large middens, and several exterior activity areas (Figure 1); the ceramics recovered from these excavations are the focus of this paper. Radiocarbon dates from this site suggest that Antrex was occupied during the mid-thirteenth century, earlier than most MOI sites (Robertson and Williamson 2002).

The Antrex site is located on a wide ridge bounded by two small tributaries of Cooksville Creek. The upland area in the immediate vicinity of the village consisted of a mixed deciduous-coniferous forest, providing food resources such as nuts and mammals such as rabbit and deer; a wetland area adjacent to the site would have provided other foods such as tubers, grasses and fish. The strategic position of this settlement, between different ecological zones, would have allowed access to a wide variety of wild food resources (Robertson and MacDonald 2010).

The fertility of the soil plains surrounding the Antrex site can sustain continued cultivation, with a climate typified by warm summers, a five-month growing season, and dependable rainfall (Allen and Zubrow 1989:89-92). Although the full environmental data for Antrex is not yet available, a preliminary comparison with other MOI sites suggests that the cultivation of maize, beans and squash made a significant contribution toward subsistence requirements. Overall, the material culture and settlement patterns at Antrex indicate a year-round occupation (Robertson 2010a).

The Antrex site falls within the Peel Plain physiographic region. The Peel Plain consists of bevelled till plains that contain large quantities of shale and limestone underlying a veneer of clay (Chapman and Putnam 1984:174-175). These deposits also contain a wide variety of igneous clasts, primarily felsic rocks such as granite, syenite, monzonite, granodiorite, and diorite. These are typically found as sand, pebbles or cobbles and can frequently be seen eroding out of riverbanks (Hoffman and Richards 1953: 14-15).

The Ceramic Sample

Over 14,000 ceramic objects were recovered from the Antrex site. A sample of two-thousand nine-hundred and seventeen sherds, representing approximately 21% of the total assemblage, was selected for this analysis. My aim during the sample selection process was to obtain a sample of the largest pottery fragments from each area of the site, and in order to do so several criteria were used. First, pains were taken to include ceramics recovered from both topsoil horizons and subsurface features, and from all areas of the site. Thus, areas of the site that yielded greater amounts of pottery form a larger proportion of this sample. Second, sherds found in the topsoil horizon that measured under 5 cm in diameter were not considered, since I felt that they would not provide enough suitable information for this study. And lastly, all rim fragments with a preserved neck circumference of greater than 10% were included.

Clay Fabrics

The characterization of clay fabrics was first accomplished by visual examination of the entire sample. Each sherd or vessel fragment was carefully examined under 10-40x magnification using a binocular microscope and assigned to a fabric group based on the shape, size, density, and apparent mineralogy of its clay fabric inclusions. Where possible, an existing fresh break was examined; otherwise, a small portion approximately 2 cm long was removed from the edge of the sherd in a location where the preserved profile, neck circumference, and decoration would not be impacted. After the entire assemblage was examined in this way and sorted by their clay fabrics, petrographic analysis was undertaken in order to provide 'ground truth' by evaluating the initial visual observations, and also in order to provide more highly resolved and quantitative data. Samples from each fabric group were thin-sectioned and subjected to petrographic analysis; these samples were chosen so that each fabric group was adequately represented.

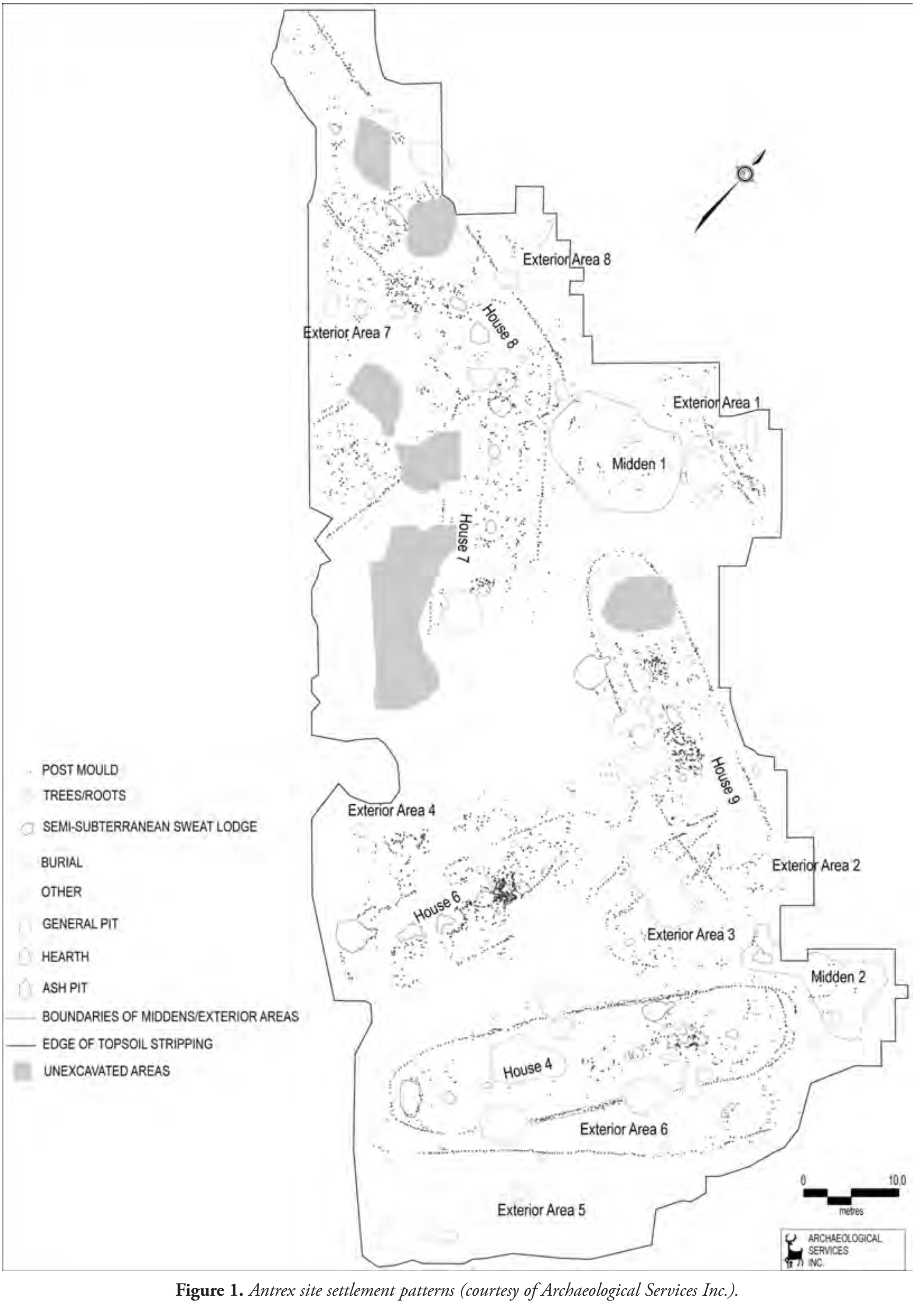


Figure 1. *Antrex site settlement patterns (courtesy of Archaeological Services Inc.).*

The Antrex site is overlying what is essentially a single continuous clay deposit. This clay would have been accessible in nearby eroded riverbanks but could also have been exploited by digging into subsoil deposits located within and around the site. Although clays can be found in several discrete locations, they could not be differentiated based on clast mineralogy using petrographic techniques. Some research suggests that chemical/elemental analyses may be useful in this regard (Trigger et al. 1980). A definitive answer as to whether these analyses can be used to facilitate intra- and inter-site comparisons must await further research.

All clays used to manufacture pottery contained clasts of glacial origin. Petrographic examination of untempered clays (represented by fired clay lumps and raw, unprocessed clays found in the vicinity of Antrex) shows that approximately 99% of the clastic grains measured less than 0.5 mm in diameter; the majority of these were quartz grains that were rounded or sub-rounded in shape due to hydroturbation in a glacial or post-glacial environment (Figure 2). Quartz is likely present in such high proportions due to its hardness and resistance to mechanical alteration (Gribble and Hall 1992: 140). Grains composed of feldspars and mafic minerals are found in lower proportions because they are softer and less resistant to frost cracking, tumbling and other types of mechanical alteration, that commonly occur during exposure to the elements.

On the other hand, when tempered clays (represented by pottery sherds) were examined, 14% of inclusions were larger than 0.5 mm in diameter. These included quartz, feldspar, and mafic grains that were angular or sub-angular in shape. The high angularity of even the softer minerals least resistant to rounding from hydroturbation, such as amphiboles, micas and pyroxenes, suggests that they were not present as naturally occurring clasts in the clays, but had been at least partially crushed and added to the clay as temper (Figure 3). Based on this information, inclusions below 0.5 mm were considered to be naturally occurring, and those above 0.5 mm were considered to be added as temper. Although this distinction is somewhat arbitrary and some overlap does occur, the size of an inclusion appears to be a fairly reliable indicator of its origin. In addition, this distinction has proven very useful for the study of tempered glacial clays (Stoltman 1991: 109). Overall, it appears as though naturally occurring clasts are composed mainly of quartz grains that measure less than 0.5 mm in diameter and are rounded due to hydroturbation. Added

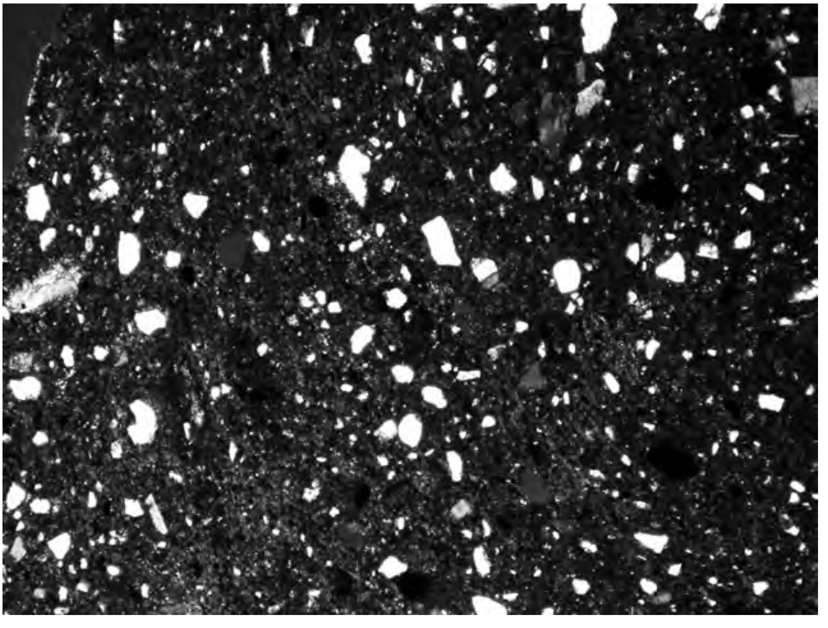
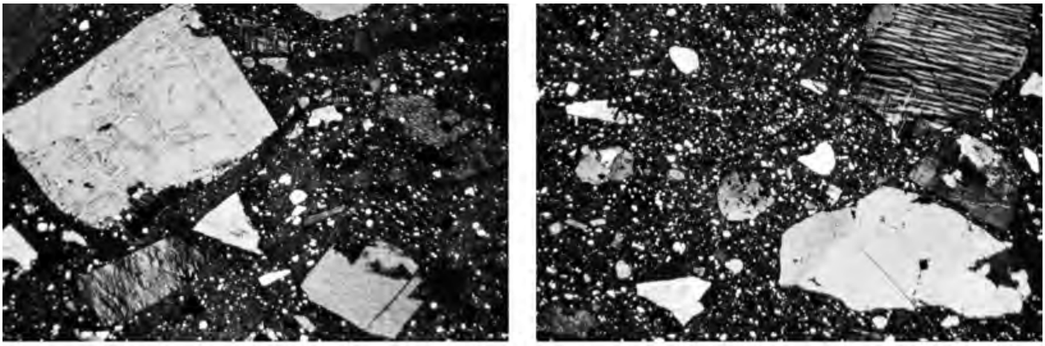


Figure 2. *Photomicrograph of untempered clay. The white and grey particles are mineral grains, mainly quartz and feldspar, while the dark background is the clay matrix. The well-rounded edges of the mineral grains are typical of naturally occurring clasts in a clay matrix. Cross-polarized light, 40x. Frame width: 6.8 mm.*



a b

Figure 3a. *Photomicrograph of pottery fabric tempered with alkali feldspar syenite (group B3). The larger inclusions are of orthoclase feldspar and hornblende: note their very high angularity compared with the smaller glacial inclusions. Cross-polarized light, 40x. Frame width: 6.8 mm.*

Figure 3b. *Photomicrograph of pottery fabric tempered with alkali feldspar granite (group G3). The larger inclusions are of orthoclase feldspar and quartz: note their rounded or sub-rounded shape when compared with Figure 3a. Cross-polarized light, 40x. Frame width: 6.8 mm.*

temper grains are typically larger than 0.5 mm, show considerable variation in mineralogy, and consist of grains that were at least partially crushed before they were added, as indicated by their angular or sub-angular shape.

Sixteen clay fabric types were identified in the Antrex sample, testifying to the great variability in raw materials used during manufacture. These types were organized into seven discrete groups (Table 1). These fabric groups can be seen as technologically distinct, based on their texture and mineralogy; that is, the vessels in a particular group share the same functional characteristics (which will be discussed later). The types found in each group can be seen as expressions of technological style; although the 'recipes' vary within a group, the outcome (with respect to function/performance) is the same (van der Leeuw 1993). This apparent contradiction between variation in recipes and shared end-results can be likened to the way in which various recipes for grandma's home-made apple pie use slightly different ingredients and methods of preparation to create more or less the same product. We are taught how to bake from our family members, and we adopt (at least initially) the family recipes. This isochrestic variation reflects essentially arbitrary choices between functionally equivalent ways of doing things (Sackett 1985). These so-called "arbitrary" choices, made during each stage of the production process, are/were influenced by tradition and other social factors, for both apple pies and Iroquoian pottery. Since it seems plausible that Iroquoian learning strategies and craft production were organized at the household level (Allen 1992; Kapches and Vincenzini 1995; Warrick 1984), a study of the patterned variation in raw material selection within fabric groups at Iroquoian sites might provide interesting information about these social factors. Although beyond the scope of this paper, this topic deserves further investigation.

A summary of these clay fabric groups is given below.

Group UT: untempered clay. Clasts present in the local clay are typically rounded and measured less than 0.5 mm. They consist mainly of quartz, probably due to its hardness and high resistance to alteration. Feldspars and micas were also present in small amounts. Sedimentary grains were

Table 1. *Frequency of clay fabric groups.*

Fabric Group	N	%
G3	985	33.8
B2	832	28.5
G2	404	13.8
B3	320	11.0
G1	258	8.8
C2	77	2.6
UT	41	1.4
Total	2917	100.0

also present and include shelly limestone, clay pellets, siltstone and fine sandstone; although these sedimentary clasts appeared in sizes larger than 0.5 mm, I also considered them to be natural inclusions due to their low sphericity and ubiquitous roundness. Chemical alteration as indicated by the presence of sericitic feldspars suggests a general weathering of parent materials has occurred, a process that is typical of clay formation in a post-glacial environment (Gribble and Hall 1992: 87).

Group G1: fine-textured granite temper. Two types belong to this group, both of which contain alkali feldspar granite inclusions. The majority of these inclusions range between 1-2 mm and are clear, off-white or light pink in colour. All inclusions (including drift) form 38% of the fabric volume.

Group G2: Medium-textured granite temper. This group contains three types with inclusions composed of alkali feldspar granite. Limestone fragments are common in some examples. Few inclusions measure above 4 mm. Most are clear, light pink or dark pink in colour. The average inclusion density is 31%.

Group G3: Coarse-textured granite temper. This group contains two types with alkali feldspar granite inclusions. Limestone fragments are common in some examples. Most inclusions measure 6 mm or less but some are occasionally found up to 10 mm; most are clear or light pink in colour. The average inclusion density is 41%.

Group B2: Medium-textured intermediate rock temper. This group contains three fabric types, each tempered with granodiorite, syenite or quartz syenite. The majority of these temper grains are below 4 mm, are usually off-white, grey or black, and are often shiny or reflective. They are present at an average density of 41% in the clay fabric.

Group B3: Coarse-textured intermediate rock temper. This group contains four fabric types that are tempered with diorite, granodiorite, or alkali feldspar syenite inclusions. The majority of these inclusions measure below 6 mm, with some as large as 10 mm. They range in colour from silver-grey to black and are highly reflective. Inclusion density is high, comprising an average 55% of the clay fabric.

Group C2: Medium-textured calcite temper. There is only one member of this group; it is tempered with calcite (crystalline limestone) fragments, the majority of which measure less than 4 mm. Colour ranges from white to yellowish-white. These inclusions are very angular, and comprise 40% of the clay fabric.

Each fabric group contains temper particles in a range of sizes; however it is possible to differentiate them by texture based on the average size of these particles. Most temper inclusions are granitic and measure less than 2 mm in diameter; with some up to 8 mm (Figure 4): these results are similar to those from the Wiacek site, another Middle Iroquoian settlement found in the Barrie region with radiocarbon dates of A.D. 1320±50 (Lennox et al. 1986:42; Robertson, et al. 1995: 40). Holly Martelle has described the clay fabrics from three seventeenth-century Huron sites: Ball, Auger, and Thomson-Walker (2003: 760). Additionally, Carrie Holterman has employed petrographic analysis in her study of Neutral pottery from the sixteenth-century A.D. Fonger site (Braun 2006). This research suggests that although the range of inclusion sizes is similar, clay fabrics from Ball, Auger and Thomson-Walker contain significantly fewer varieties of rock and mineral temper types than those from Antrex and Fonger. Further petrographic work is needed to document the relationship between manufacturing practices at Antrex and these later sites, and determine whether these differences are due to temporal or regional differences.

In general, the igneous rock temper in these groups would provide vessels with good resistance to high temperatures or thermal shock during

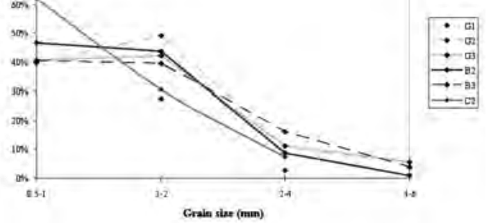


Figure 4. *Frequency of inclusions by size category for each tempered fabric group.*

both their initial firing and actual use. This is because most feldspars and mafic minerals have expansion rates very close to those of low-fired clay (Rye 1976: 116-117). Granite tempers also contain large amounts of quartz, a mineral with an expansion rate much higher than clay; however, due to their low firing temperature and the way in which they were used, vessels made with quartz tempered clay would also have a good thermal shock resistance (see Firing techniques, below).

Group C2 is the only fabric with a non-igneous mineral added as temper. The high angularity of calcite grains, visible as perfect rhombs, indicates that they were deliberately crushed before they were added to the clay. The thermal expansion of calcite is very similar to that of low-fired clay; therefore vessels in this group would also have a high thermal shock resistance. However, several studies suggest that clay fabrics with calcareous inclusions such as calcite and shell may require specialized firing procedures to prevent the finished pots from slowly crumbling (Rye 1976: Woods 1986: 164). Due to their manufacturing difficulties and relative scarcity at the Antrex site, vessels tempered with calcite may have been produced as a potter was experimenting with different tempering agents.

Experimental research with low-fired ceramics indicates that there is a relationship between durability and temper size (Skibo et al. 1989: 123-124; Tite et al. 2001). These studies demonstrate that clay briquettes tempered with coarse sand (1-2 mm grain size) and fired for 30 minutes at 750°C are less durable than those tempered with fine sand (0.5-1 mm grain size). When fired to 650°C however, coarsely tempered briquettes are *more* durable than finely tempered ones. Although it is possible that firing temperatures of vessels at the Antrex site did approach 750°C (see Firing Techniques, below), non-kiln firings rarely maintain their peak temperature for more than a couple minutes; this length of time would not be long enough to cause the structural changes that increase durability (Rice 1987: 156-157). I therefore suggest that the Antrex pottery would more closely resemble the briquettes fired at 650°C in terms of its durability: that is, the more coarsely tempered groups such as G3 and B3 would be more durable than the medium-textured groups. The differences between fine, medium, and coarse-textured clay fabrics can be seen unaided: it seems highly probable that Iroquoian potters were aware of these subtle differences in particle size and how they would affect the manufacture and use of pottery. It seems likely that the production of vessels that were low-fired and coarsely tempered was a deliberate technological choice made by Antrex potters in order to improve thermal shock resistance, a phenomenon seen in many other archaeological assemblages (Tite et al. 2001). This is supported by evidence of use, presented below.

The variation evident in the shape of temper particles found in Antrex pottery may relate to how temper was acquired. The majority of inclusions in granite-tempered fabrics were sub-rounded or rounded, with lesser amounts of angular or sub-angular grains. Since granite is relatively hard and resistant to weathering, the sub-rounded or rounded shape of these particles suggests that, before being used as temper, they were tumbled and had their edges abraded over a long period of time. This is typical of gravels and pebbles found in glacial till. The erosion of these till deposits by post-glacial watercourses would have exposed and further weathered these granite pebbles, which would have been deposited in and around the river in lenses gradated by size and weight. A good example of this phenomenon is the separation of different-sized rocks on a typical beach, with sand found closest to the water and pebbles or cobbles further inland. The presence of angular or sub-angular particles in these pebble lenses is due cracking during weathering processes, such as freeze-thaw cycles: this is typical of the gradual reduction and breakdown of igneous rocks. An Antrex potter could easily have selected temper material of the appropriate size by exploiting various pebble lenses present in the nearby watercourse.

I suggest that different motivations led to potters' acquisition of intermediate and calcite rock temper. Intermediate rocks contain a high proportion of mafic minerals such as amphiboles, pyroxenes, and micas. Both these minerals and calcite are much less durable than granite, whose primary constituent, quartz, is highly resistant to mechanical alteration. In a pebble lens from a glacial till deposit, where even quartz grains are usually rounded, one would expect mafic and calcite inclusions to be rounded or well-rounded, if they are present at all. In fact, the opposite is true: the inclusions present in intermediate rock and calcite-tempered fabrics are angular or very angular in shape and are unaltered by abrasion or weathering, suggesting that these tempers were being produced by crushing or grinding a larger piece of the appropriate rock until the desired inclusion size was reached.

Why would potters spend extra time and effort to pulverize these rocks when granite temper materials of the appropriate size were already available in the riverbanks? Since extra time and effort were being expended to produce these tempers, it is unlikely that their use was accidental. Technological function does not appear to have been a factor, since the performance characteristics of granite and intermediate tempers are so similar that few differences would have been noted by Iroquoian potters or cooks. Perhaps the use of various tempers was socially significant. When crushed, these rocks appear dark and reflective: when used as tempering agents, they often gave the fabric a distinct "glittering" appearance that was visible from a distance of several meters. It is possible that the use of "glittery" temper had some symbolic meaning, for example differentiating social groups by their pottery, or indicating that a particular vessel had a specific function. In his review of early seventeenth-century ethno-historical literature, Hamell suggests that for Iroquoian people, shiny or reflective minerals held symbolic value (1983); this phenomenon has also been documented in other parts of the world (Saunders 1999). In a similar way, certain reflective or strongly coloured minerals may have been used as temper for their symbolic value, and our understanding of these symbols may provide the key to understanding the pots themselves (Robb 1998: 341-342). Although the nature and significance of the role reflective tempers played at Antrex cannot be evaluated here, this subject deserves future research.

Firing Techniques

Several observations made during visual examination and petrographic analysis are relevant to this discussion of firing methods and temperatures used to produce the Antrex pots.

The atmosphere during firing was highly variable. The exterior surfaces of almost all the Antrex pots were fire-clouded. This mottled appearance is caused by oxidation and partial oxidation of the clay during firing, indicating a poorly-controlled firing atmosphere. In cross-section, most sherds exhibited moderately thin bands of oxidized clay along their margins, with thick, unoxidized black or grey cores that occasionally extended to the interior or exterior surfaces. These characteristics suggest that firing took place in an open fire and was short in duration (Rice 1987: 82; Rye 1981: 96). Although ethnographic evidence demonstrates that it is possible to partially control the atmosphere in open firings (Rice 1987: 158), it appears that this was of little concern to the Antrex potters.

The range of firing temperatures used during vessel manufacture was determined using petrographic techniques. Many thin-sections contained limestone or calcite inclusions that had not begun to disassociate during firing, indicating that a maximum sustained firing temperature of around 750°C was achieved (Woods 1986:168; Rice 1987:103). Many materials readily available and commonly used by Iroquoians, such as resinous pine wood, could have been used by Antrex potters to increase the maximum firing temperature to at least 900°C (Rice 1987: 157). Their choice to limit the firing temperature to below 750°C prevented several undesirable chemical and physical changes, such as calcium rehydration and beta-quartz inversions, that may cause spalling and flaking of the finished pot or affect its performance. In addition, as noted above, a lower firing temperature may increase a vessel's resistance to thermal shock.

Wall Thickness

Although examinations of collar and lip thickness are commonly performed (e.g., Robertson et al. 1995:55; Williamson and Powis 1998:54-55), wall thickness below the neck is rarely measured. One exception is in Lennox's examination of the Wiacek assemblage, where body sherd thickness was measured and compared with exterior surface treatment (Lennox et al. 1986: 42). In general, studies of Iroquoian pottery have related collar and lip thickness only to rim morphology and decorative attributes.

Vessel wall thickness is related to the manufacturing process. In general, as the size of a pot increases, its wall thickness must increase in order to provide structural support to the wet clay and prevent sagging during manufacture (Rice 1987: 227). For these reasons, wall thickness may be used as an approximation of vessel size.

Wall thickness can also be related to vessel function. A pot with thin walls is less durable and more easily affected by mechanical strain than a pot with thicker walls. Heat is transferred to and from a vessel's contents more rapidly and efficiently if its walls are thin. Thin-walled vessels have a higher thermal shock resistance, because the thermal gradient inside the vessel wall is reduced (Braun 1983: 118-119). Thin walls also result in lower vessel weight, allowing them to be more easily moved or manipulated during use. These qualities make thin-walled vessels good cooking pots. On the other hand, thick-walled vessels are stronger and more resistant to mechanical strain, either accidental or deliberate; these pots would be more suitable for grinding or pounding applications (Hendrickson and McDonald 1983: 631,636-37). Due to the insulating properties of clay, their contents cool at a slower rate, but these pots are more likely to fail due to the increased thermal gradient and resulting thermal shock. These vessels are more suited to storage or transport functions, and less suited to cooking (Rice 1987: 227). Since thickness is an attribute that affects vessel performance and can be consciously chosen by the potter, I suspect that it can also be used to infer function for Iroquoian vessels.

In this sample, 2504 sherds could be measured for thickness; the averaged results are presented in Figure 5. Sherd thickness has a normal, unimodal distribution, ranging between 3 and 19 mm with a median thickness class of 7-9 mm. These figures are similar to those for the Wiacek site (Lennox et al. 1986: 42).

A different pattern is evident when the thickness of sherds from different vessel areas are examined (Figure 6). Base sherds are thicker than those from other vessel areas, and are the only type whose thickness has a bimodal distribution, with peaks at 5-9 mm and 11-15 mm. Although relatively fewer base fragments were identified (probably due to the difficulty in differentiating body sherds from base sherds in a round-bottomed vessel) this distribution may describe two distinct vessel types. The lower peak must represent vessels that are relatively smaller, since a base this thin could not support a large, heavy vessel body. These bases would be more suitable than thicker ones for use directly over a fire, since the thermal gradient would be less pronounced. The thicker bases, however, would allow a larger and more mechanically durable vessel. In addition, the average thickness variation for the thin bases is 2 mm, versus 4 mm for the thicker bases. This is important because thermal shock resistance decreases as thickness variation increases; pots with walls of a more uneven thickness suffer from varying expansion rates in different areas of the vessel when directly heated and so are more likely to shatter or crack (Braun 1983: 125). This would be especially true of cooking pot bases, since they are more likely to be exposed to higher temperatures and greater thermal gradients. These observations suggest that two distinct vessel types were present in the Antrex assemblage: those with thin bases, poor durability and good resistance to thermal shock, and those with thick bases, good durability and poor resistance to thermal shock.

Vessel Size

Variation in Iroquoian vessel size has been recognized for some time. Several researchers have suggested, based on ethno-historical and anecdotal accounts, that at least two size classes exist, a small pot used by a single person and a large pot for communal use (Engelbrecht 2003: 84; Snow 1996: 107). Evidence for the existence of culturally recognized size categories of Iroquoian pottery

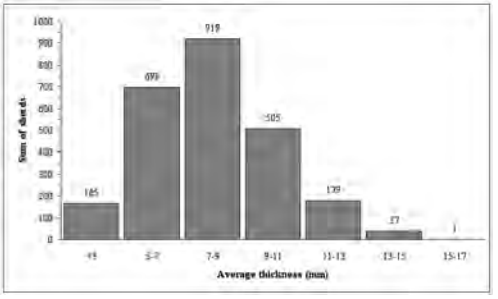


Figure 5. *Bar chart depicting the distribution of average thickness for all sherds in the sample. Note that this distribution is unimodal. N=2504.*

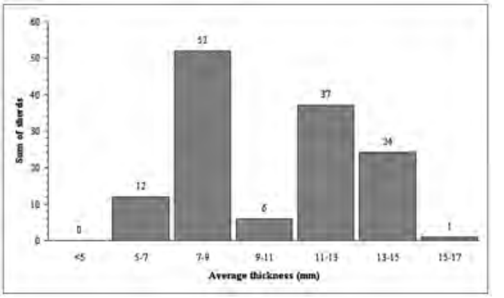


Figure 6. *Bar chart depicting the distribution of average sherd thickness for base sherds only. Note that this distribution is bimodal. N=132.*

vessels is suggested by Allen, who states that some historic Iroquoian groups used different nouns to describe small and large vessels (Allen 1992: 139). The applicability of this information to pre-contact groups is difficult to assess, however considering that pots range in diameter from 5cm to over 30cm, I think it is reasonable to assume that the inhabitants of Antrex recognized a range of vessel sizes, and that an 'ideal' vessel considered suitable for a particular task might fall within a certain part of this range.

Several aspects of pot morphology are related to vessel function. The size and capacity of a pot limit the ways it can be manipulated during use: due to its increased weight, a large pot is more difficult to lift or position when full. This suggests that larger and heavier vessels are more likely to remain in one position during use (Hally 1986: 280). Access to a pot's contents is controlled by the diameter of its orifice restriction and its interior depth: the contents of a very deep vessel with a restricted orifice would be removed with greater difficulty, suggesting that they were infrequently accessed (Rice 1987: 225). Rim and neck morphology can also affect the way in which a vessel is used and its contents manipulated: a short-necked vessel with an out-flaring rim with a large diameter is ill-suited for pouring, while a longer-necked pot with a more vertical rim and a narrow opening is more ideal for this purpose (Smith 1988: 914). Heat-loss and evaporation are affected by rim diameter: a pot with a smaller opening is easier to cover with a lid, heats its contents more efficiently, and loses less volume through evaporation (Hally 1986: 280-281). Thermal shock resistance is also affected by overall form: more angular vessel bodies are less resistant than rounded bodies to thermal shock since they heat unevenly (Rye 1981: 27).

Although rim diameter is most commonly used in ceramic studies to estimate overall vessel size, the presence of castellations on many Iroquoian vessels as well as their fragmentary nature makes its measurement difficult; for this reason, neck diameter was used instead. Using neck diameter is also preferable in a study of function since it can influence how the interior of a pot is accessed: for example, the contents of a pot with a very narrow neck opening are harder to retrieve than are the contents of a wide-mouthed pot. Neck diameter was measured by placing a vessel in its proper stance and using a contour gauge to create a profile of the neck at its maximum restriction; diameter was then measured by placing the contour gauge on a standard circumference chart. Since these vessels are hand-made and curvature can vary somewhat, values were recorded only for vessels having more than 10% of their neck circumference preserved, as per established guidelines (PCRG 1997).

It appears as though neck diameter exists on a continuum, with no clearly defined categories (Figure 7). For the purposes of this study, three size categories were created: small vessels had neck diameters of less than 10 cm; medium vessels ranged between 10-19 cm; and large vessels were 20 cm or greater. Although arbitrary, these categories are useful as analytical tools. Overall, 111 vessels could be classified by size (Table 2). Medium vessels were most frequent and had a mean neck diameter of ~13 cm; large vessels had a mean of ~24 cm; and small vessels were least frequent, with a mean of ~7 cm.

Very few vessels recovered from the Antrex site were complete enough to measure capacity. However, my examination of the more complete vessel fragments suggests that juvenile vessels had capacities of less than one litre; the non-juvenile small vessels had capacities ranging between 1-2 litres; medium vessels ranged between 3-10 litres; and large vessels from 11-20 litres.

Decorative Types

Several researchers have suggested that traditional Iroquoian decorative types may be associated with vessel function or manufacturing characteristics (e.g., Martelle 2002: 236-250). This would not be surprising, since this phenomenon has been documented archaeologically and ethnographically in many other geographic regions (e.g., DeBoer and Lathrap 1979: 117; Jones 1999: 62; Sterner 1989: 454).

The ceramic sample I used for this study was roughly representative of the entire Antrex assemblage in terms of the frequency of decorative types, and consisted primarily of Middleport Oblique, Ontario Horizontal, and Pound Necked vessels (Table 3). Due to their high levels of fragmentation, Ontario Oblique vessels were under-represented in this sample. Since juvenile vessels were of interest to this study due their technological distinctiveness, they were over-represented in this sample to ensure that their numbers would be adequate for analysis.

The results of this portion of my study suggested that there were few strong relationships between decorative type and manufacturing techniques. The one exception is with clay fabrics: Iroquois Linear and juvenile pots were almost exclusively manufactured using granite tempers, while Middleport Oblique and Pound Necked vessels were more likely to contain intermediate rock tempers (Table 4). In addition, some tendencies with respect to vessel size were observed: Ontario Horizontal vessels tended to be large; Middleport Oblique and Pound Necked vessels were medium or large; Iroquois Linear vessels were small or medium; and unsurprisingly, juvenile vessels were small (Table 5). These relationships with vessel size were not statistically significant, perhaps due to the small numbers of some decorative types. Overall, when decorative type was compared to clusters of manufacturing characteristics that were clearly defined and statistically significant (see below), it appears as though a pot's overall decoration was not related to its technological attributes.

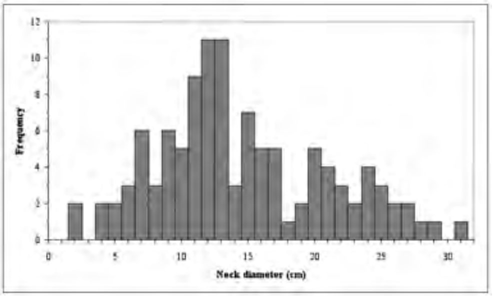


Figure 7. *Histogram of neck diameter. Mean=14.5, standard deviation=6.4, N=111.*

Table 2. *Frequency of vessel size (based on neck diameter).*

Size	N	%
Small (<10 cm)	24	21.6
Medium (10-19 cm)	59	53.2
Large (>20 cm)	28	25.2
Total	111	100.0

Table 3. *Frequency of traditional types included in this sample.*

Type	N	%	Cum. %
Middleport Oblique	154	47.1	47.1
Ontario Horizontal	47	14.4	61.5
Juvenile	46	14.1	75.5
Pound Necked	45	13.8	89.3
Iroquois Linear	15	4.6	93.9
Black Necked	6	1.8	95.7
Middleport Criss-Cross	6	1.8	97.6
Lawson Incised	5	1.5	99.1
Niagara Collared	2	0.6	99.7
Ontario Oblique	1	0.3	100.0
Total	327	100.0	

Table 4. *Contingency table for decorative types by fabric groups. Pearson Chi-Square: value=1.193E2, df=12, asymp. sig. (2-sided)= .000*

Decorative Type	Fabric Group					Total (N)
	G1	G2	B2	G3	B3	
Juvenile	27	2	2	1	0	32
Middleport Oblique	14	28	63	37	9	151
Ontario Horizontal	6	7	10	19	5	47
Pound Necked	5	4	18	9	8	44
Total (N)	52	41	93	66	22	274

Table 5. *Frequencies of vessel size by decorative type.*

Decorative Type	Vessel Size (%)			Total	
	Small	Medium	Large	N	Row %
Iroquois Linear	38	63		8	101
Juvenile	85	15		27	100
Middleport Oblique	7	69	24	91	100
Ontario Horizontal	18	45	36	33	99
Pound Necked	14	59	28	29	101
Total	22	57	21	205	100

Table 6. *Contingency table for fabric texture by vessel size. Pearson Chi-Square: value=30.804, df=4, asymp. sig. (2-sided)= .000*

Vessel Size	Fabric Texture			Total (N)
	Fine	Medium	Coarse	
Small	11	5	2	18
Medium	8	31	20	59
Large	0	14	14	28
Total (N)	19	50	36	105

Table 7. *Contingency table for fabric texture by average sherd thickness. Pearson Chi-Square: value=67.766, df=10, asymp. sig. (2-sided)= .000*

Avg. Sherd Thickness	Fabric Texture			Total (N)
	Fine	Medium	Coarse	
<5 mm	15	34	17	66
5-7 mm	48	142	98	288
7-9 mm	26	194	139	359
9-11 mm	10	101	111	222
11-13 mm	1	32	53	86
13-15 mm	1	10	11	22
Total (N)	101	513	429	1043

Summary of Manufacturing Characteristics

As I completed my analysis of inclusion size, wall thickness and neck diameter, it became apparent that as one variable increased in value, the other two also increased proportionally: pots with small neck diameters had thin walls and were made with finely textured clays, while those with large neck diameters had thick walls and were made with coarsely textured clays. This phenomenon makes sense from a potter's point of view: more coarsely tempered fabrics and thicker walls are needed to prevent larger vessels from sagging and collapsing during manufacture. Larger temper fragments also help prevent vessels with thicker walls from shrinking and cracking as they dry (Rice 1987: 70). The relationship between these three variables proved to be statistically significant (Tables 6, 7). Discriminant function analysis was employed in an attempt to estimate overall vessel size based on wall thickness and temper size, however its success was limited in part due to the variability in wall thickness of rim, neck and shoulder sherds. Nonetheless, based on the correlations between neck diameter, temper size and wall thickness, a total of 643 individual vessel fragments (including those with preserved neck diameters) could be confidently classified by size, including many without preserved rims or decoration.

Based on these manufacturing characteristics, four different vessel types are evident in the Antrex assemblage (Table 8). These types should be regarded as clusters of values selected by the potter during the manufacturing sequence. It is important to note that a pot's technological characteristics may indicate its *suitability* for a particular use, but not how it was *actually* used.

A brief scan of the data presented on Table 4 reveals that some overlap exists between different vessel types; this is to be expected, since the categorical divisions within some attributes, such as thickness, were arbitrarily created and may not represent any categories that were recognized by Iroquoian potters. Instead, these types are analytical tools that represent the general functional differences in pottery present at the Antrex site.

Table 8. *Summary of functional characteristics.*

	Type A	Type B	Type C	Type D
Clay fabric	fine-textured granite (G1) or untempered (UT)	fine-medium textured granite (G1, G2) or intermediate (B2)	medium-textured intermediate (B2)	coarse-textured granite or intermediate (G3, B3)
Wall thickness	variable	<7 mm	5-9 mm	>9 mm
Overall size	small	small	medium	large
Decorative type	Juvenile	Iroquois Linear/Ontario Horizontal	Middleport Oblique/ Pound Necked/Iroquois Linear	Ontario Horizontal/ Pound Necked
Functional Characteristics	–poor thermal shock resistance –variable durability –poor heating efficiency –good heat retention –easy to manipulate	–moderate thermal shock resistance –poor durability –moderate heating efficiency –poor heat retention –easy to manipulate	–good thermal shock resistance –poor durability –good heating efficiency –poor heat retention –easy to manipulate	–poor thermal shock resistance –good durability –poor heating efficiency –good heat retention –difficult to manipulate
Possible Function	storage/serving	cooking	cooking	storage

Type A vessels are comprised solely of juvenile pots. Their fine-textured fabric and the irregular thickness of their walls would make them susceptible to thermal shock, making them unlikely candidates for use as cooking vessels over a direct heat source. Despite the fact that their small size and decreased curvature would increase their mechanical strength (Braun 1983: 118), the great variability in wall thickness would create weak points in the vessel, and I suspect that their overall fragility would be increased. Their dense, fine-textured fabrics would insulate the contents, providing moderately good heat retention. Their small size and capacity would have limited their usefulness, but made them easily transportable. Although these characteristics make Type A vessels poor choices for most utilitarian tasks, their use as serving or storage vessels might be possible.

Type B vessels tend to belong to the Iroquois Linear or Ontario Horizontal types. Their thin walls and larger inclusion sizes would give them adequate thermal shock resistance and heating efficiency for use over a direct heat source, but cause them to dissipate heat rapidly, making them a poor choice for serving functions. Due to their thin walls and large temper particles, they would have a poor durability. Their size would make them light and easily manipulated; and the tendency towards a thickened incipient collar would make them more easily gripped and possibly suspended. A cooking function is suggested for these pots, with their small capacity (1-2 litres) suggesting that they were used to prepare a small volume of food.

Type C vessels would have excellent thermal shock resistance and heating efficiency, due to their relatively thin, even walls and the tendency toward medium-textured fabrics tempered with intermediate rock fragments. Although their walls are slightly thicker than Group B's, their increased size and curvature give them a similarly poor durability. As well, their incipient or defined collars would also have made them easier to grip or suspend. Their varying capacity suggests that a wide range of cooking functions would have been possible.

Type D pots are coarse-textured and thick walled, making them poor for heating directly over a fire but giving them good insulation and durability characteristics. Their large size and weight would make them difficult to move or manipulate, especially while full. Based on these qualities, a storage function for these pots seemed most likely.

Use Alteration

Background

Middle Iroquoian pottery has a relatively short post-depositional history when compared with prehistoric pottery found in other parts of the world. This fact, combined with the undisturbed nature of the Antrex site, has resulted in the excellent preservation of ceramic use alteration: 69% of this sample bore evidence of use, providing an excellent opportunity for its examination.

The term "use alteration" refers to the incidental or deliberate modification of a pottery vessel during use, the "wear and tear" of everyday life. An examination of use alteration is especially valuable because it is the only type of evidence that can directly indicate how a pot was actually used: the values for all other attributes are chosen by the potter during the manufacturing process and can indicate the *intended* function of a vessel, but not its *actual* function (Skibo 1992: 33-38). In order to understand the role pottery played in society, we must examine attributes related to both its manufacture and its use.

Systematic studies of use alteration on Iroquoian pottery have rarely been performed. Holly Martelle's doctoral thesis is one rare example: using the presence/absence of carbonized encrustations, sooting, interior pitting, and mid-collar erosion, along with other attributes, she suggests the existence of several functional types within Huron pottery assemblages (2002: 199-200, 686). It is apparent that Martelle made more detailed observations regarding these attributes but did not present them in her dissertation, making comparisons with the Antrex assemblage difficult. Nonetheless, this study represents the one of the first attempts to characterize the use alteration of coarse, low-fired pottery from Ontario.

The process of altering pottery surfaces through use deserves mention. The patterns described below are not created during a single cooking episode: each pattern is the result of a particular behaviour that is repeated over time. What we see when observing surface alteration is the accumulation of typical behaviours associated with a particular pot, represented by additions or deletions to the pottery surface. A vessel that is infrequently used for a particular purpose may not exhibit any distinctive patterning that reflects this purpose; even if wear does accumulate, it may be obscured by other patterns of use more regularly associated with that pot. Therefore, an examination of use alteration may indicate only the primary use of a pot. In addition, not every vessel used for the same purpose will bear identical traces of use: some pots last longer than others, and as the length of time a pot is used increases, so does the clarity of its use patterning.

Attrition: pitting (Figures 8, 9). This form of attrition results from an impact between the pottery surface and a relatively hard implement at a roughly 90° angle (Skibo 1992: 115). This blow crushes the clay matrix and dislodges temper inclusions at the point of impact, resulting in a shallow depression. If these impacts continue, the density of these pits may increase to the point where large proportions of the pottery surface have been removed, with actual pits no longer visible. It is common to find carbonized residue inside these pits, attesting to their presence before the vessel's last use. Examples of behaviours that cause pitting include placing or accidentally bumping the exterior pot surface on a hard object, the vigorous use of hard implements, or jostling of hard objects inside the vessel.

Attrition: scratches (Figure 10). Grooves, gouges or scratches are caused either by a glancing blow with some object, resulting in that object sliding across the pottery surface; or by having a similar object dragged across its surface. Behaviours that may cause this attrition include stirring or accessing the pot with a tool such as a spoon or ladle, or dragging the pot across an abrasive surface (Skibo 1992: 116).

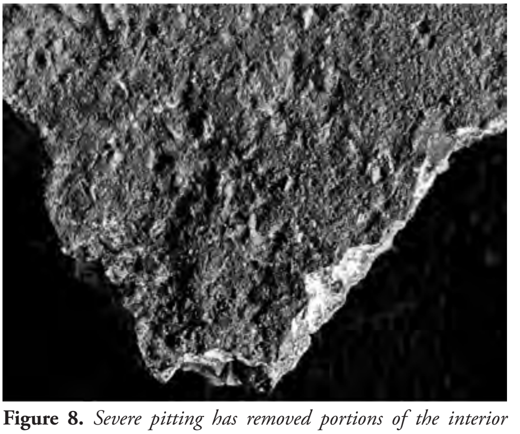


Figure 8. *Severe pitting has removed portions of the interior surface of this sherd. Carbonized food residues are found inside these pits. Frame width: 15 mm.*

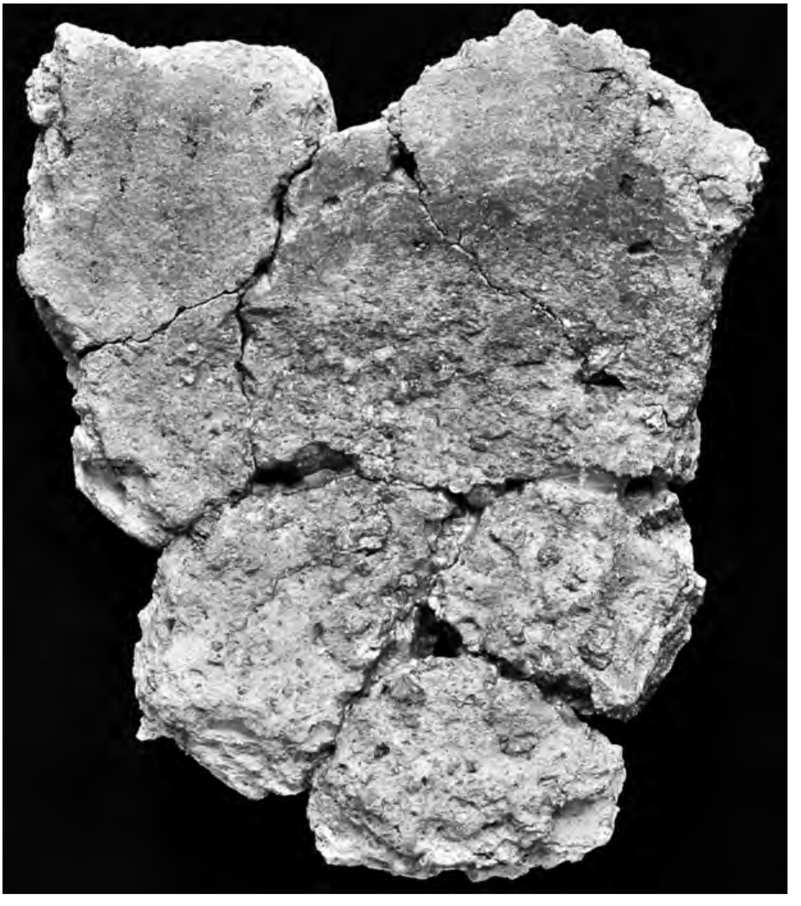


Figure 9. *This vessel fragment shows severe pitting on the interior surface of the body (lower), and a significant decrease in pitting on the interior surface of the shoulder (upper). Frame width: 8 cm.*

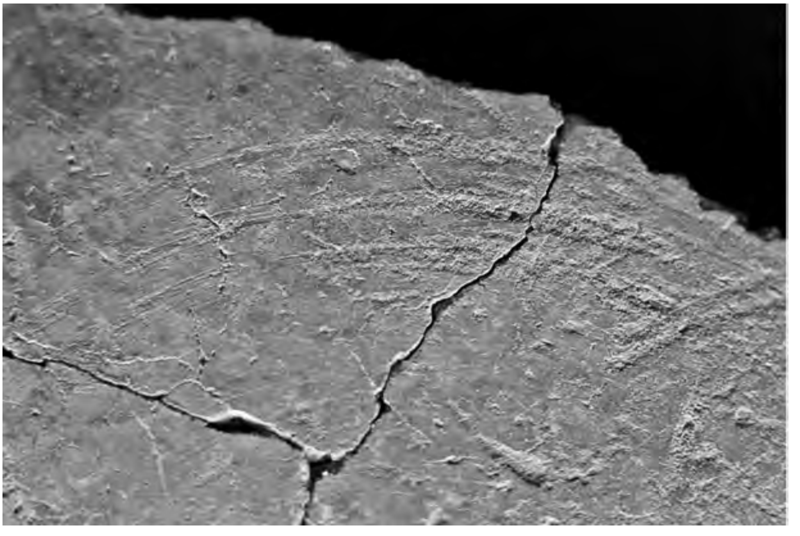


Figure 10. *Curved scratches and grooves on the exterior base of a Type D vessel. Frame width: 7 cm.*

Attrition: pedestaled temper. This attrition appears as a general removal of the surface, resulting in pedestaled temper particles. It results from mild abrasion with a substance whose grains have a smaller diameter than that of the pottery temper, such as fine sand or fibrous organic matter (Skibo 1987: 140).

Carbonized food residues (Figures 11, 12). These residues are the result of the accumulation of small particles of food that adhere to the walls of a pot and burn, eventually permeating the vessel fabric (Skibo 1992: 150-151). This accumulation varies widely in thickness: while some vessels have small amounts, present only in small pores or cracks and visible only under magnification, other examples are several millimetres thick. Typically, carbonized food residues in this sample are dark brown or black and unreflective, with an irregular cracked or crumbly texture. The common assumption that pots with burnt residues were used to cook food seems reasonable. A more detailed analysis of this type of use alteration can also provide insight into the types of food they were used for and how they were cooked. The patterns resulting from simmering a stew, for example, will be different from those caused by frying bread.

Sooting (Figure 13). Soot deposits are accumulations of combustion products that are

Figure 11. *Carbonized food residues adhering to a vessel interior. Frame width: 2 cm.*

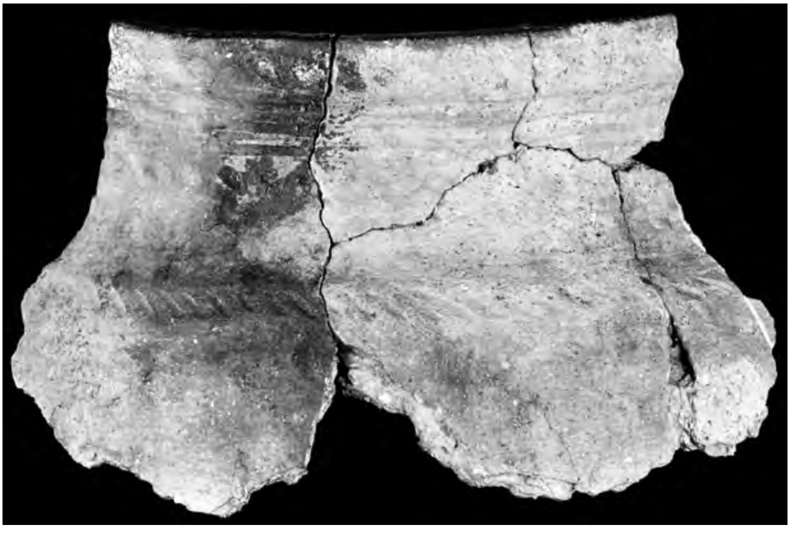


Figure 12. *Carbonized residues on the exterior of this vessel take the form of drips or rivulets, seen as a black discolouration on the left side of the vessel fragment that proceeds vertically down from the rim. Frame width: 12.5 cm.*

produced by a cooking fire. Two kinds of soot are found, usually in combination, on the vessels in this sample: a hard, lustrous coating that ranges in colour from dark grey to black, caused by the accretion of resin vapours produced by the burning fuel; and a dull, black surface that consisting of solid carbon particles produced during the incomplete combustion of these fuels (Hally 1983:7-8). These carbon deposits can resemble burnt food residues; however their pattern of deposition is much more even, with regularly shaped circular or oval patches that have diffuse margins. The presence of soot indicates that a vessel was heated by direct exposure to a combusting heat source; its patterning can suggest how this was accomplished, for example whether the pot was placed directly on a bed of coals or suspended over a fire.

Artifact processing. Attrition also accumulates during excavation or artifact processing, and may obscure traces of use alteration. Fortunately, use-related attrition can be easily distinguished by the rounded edges of pits or scratches, weathered appearance of exposed temper inclusions, and dull colour of any exposed clay matrix. In contrast, attrition caused during excavation or processing is characterised by sharp edges; exposed temper particles appear unblemished, and the colour of the clay matrix in the affected area appears brighter and lighter in colour than that of the surrounding areas – similar to the colour differences between a fresh sherd break and an old one.

Pottery recovered from Antrex was washed during processing using water and toothbrushes, a common practice both in this region and world-wide. Although for the majority of the assemblage this seemed to have little impact on the preservation of use alteration, in some instances this practice completely removed portions of the sherd surface, obliterating any other traces of use alteration and leaving faint striations in the fired clay; often this removal was only visible under magnification. Juvenile vessels seemed to be particularly vulnerable to this sort of damage, perhaps due to the greater friability of their fabrics. Although difficult to assess, it is likely that in some cases this sort of processing has resulted in the removal of surface adhesions such as carbonized residues. This phenomenon suggests that vigorous scrubbing with a hard-bristled brush should be avoided during artifact processing, especially when dealing with poorly fired or friable fabrics.

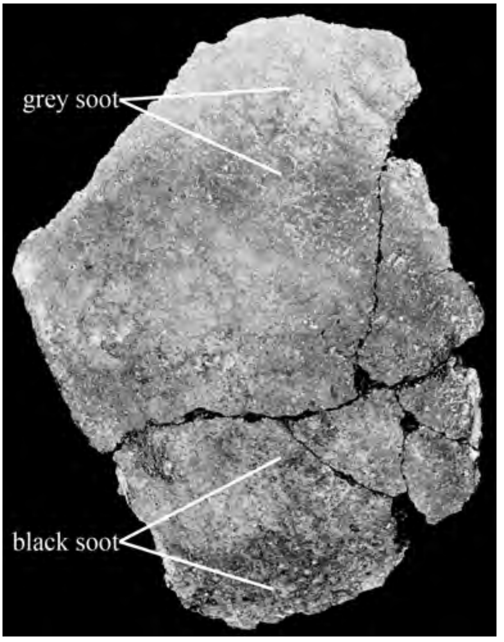


Figure 13. *This base fragment is part of a Type C vessel. The lowest areas of this fragment show black soot deposits, while the upper areas show reflective grey soot deposits with pitting and short scratches or gouges. Frame width: 9 cm.*

Recent research has highlighted the utility of chemical analyses for studies of pottery use. The work of Reber and Hart (2008) suggests that techniques such as gas chromatography/mass spectrometry and stable carbon isotope analysis are effective tools for determining the contents of a vessel. Although beyond the scope of the research presented here, these techniques should be considered for future studies of pottery use.

Results

As my analysis progressed, it became apparent that the each of the vessel types I had identified based on manufacturing characteristics had clear patterns of use alteration. A description of these patterns is described for each group below.

Type A: Juvenile Vessels

Evidence of use was rarely found on the exterior surfaces of these vessels. Only two vessels show any use alteration, one with faint pitting on its rim and another with pedestaled temper on its base.

41% of these vessels showed some evidence of use on their interior surfaces. Faint and relatively sparse pitting without any defined pattern or significant surface removal was observed at the rim and body. A single vessel had a chipped rim expanding towards the vessel interior. Carbonized residues were found on rim, shoulder, and body areas; these residues were barely visible and did not show any clear patterning, and were significantly different in appearance from the thick, easily identifiable deposits found on some other vessels.

The lack of patterned use alteration suggests that juvenile vessels were either rarely used, or used in a way that prevented the accumulation of use alteration, such as for the storage of small amounts of material. These contents must have been dry or they would have adhered to the side of the vessels: no significant traces of tools being used to remove their contents have been found. Alternatively, they could have been used in a symbolic rather than utilitarian manner; while it has been suggested that these pots might have been used for magical or medicinal purposes (Engelbrecht 2003: 51), no supporting evidence has been found to support this interpretation.

At first glance, due to their crudity and lack of patterned use alteration, it seems likely that these vessels were made and used by children: the use alteration that is visible could have been caused by children mimicking the behaviours of adults using their pots, but in a less directed or refined way, resulting in alteration that has no clear patterning. A closer looks suggest that this is not the case. If children were playing with these vessels, I would expect attrition to appear consistently on their exterior surfaces, since child's play would reasonably produce several types of attrition, such as accidental bumps or falls and being placed on an abrasive surface such as the ground. It is possible that these pots were not playthings but served only as tools to develop pottery-making skills, and were discarded after firing, but I find it difficult to accept that after investing considerable time and effort a young child would willingly discard her or his creation. These pots might have embodied some special significance for the children who made them: a child's participation in the transformation of soft, formless clay into a hard and permanent object through fire would have been quite memorable, since low production levels and seasonality meant that pottery might have been manufactured only once or twice a year (Allen 1992:140; Allen and Zubrow 1989: 91-92). Indeed, the presence of attrition or carbonized residues on the interiors of many vessels suggests that at least some of these vessels were not immediately discarded. Therefore, the evidence for use alteration presented here does not support the idea that these pots were used as children's playthings, but does suggest that they were carefully curated and used infrequently for something.

Another explanation is that unskilled adults were in fact making 'juvenile' vessels. Several characteristics typical of these pots indicate that they were made by unskilled individuals; clays are poorly prepared and mixed, frequently causing drying cracks; vessel walls are lumpy, poorly finished and of uneven thickness; and decoration is inconsistently, unevenly, or asymmetrically applied (Braun 2010). These attributes are not restricted to pottery produced by children, but are characteristic of pottery produced by any unskilled individual, regardless of age (Crown 2001; Longacre 1999). The presence of some use alteration, albeit unpatterned, indicates that they were not merely practice pieces that were discarded after manufacture.

Based on this information, I argue that we cannot assume that these vessels were made by children. These vessels were manufactured by unskilled individuals of unknown age, were carefully curated and not subjected to the knocks and bumps of children's play, and were used infrequently. GC/MS analysis of the absorbed residues in these vessels is planned for the future and may provide more information about how these vessels were used.

Type B: Small Boiling Vessels

Over 85% of the records belonging to this group bore traces of use alteration. Carbonized residues were found in similar frequencies on the interiors of rim, neck, shoulder and body sherds; no reliable data are available for base interiors due to low counts. These residues are thickest in the rim and neck areas, often appearing as a clearly defined horizontal band several centimetres wide; below this band, the thickness of this residue decreases somewhat but these deposits continue down into the body. Pitting appears on all areas of the vessel interior, but is most frequent at the neck, body and base; below the shoulder, pitting is so severe that widespread surface removal is common.

On the exterior surfaces, carbonized residues appear on rim, neck and shoulder, and often appeared to have dripped down in thick rivulets from the top of the rim to the body during a single event. Below the shoulder, use alteration becomes much less frequent, with pitting, scratches and soot deposits observed only rarely (possibly due to low numbers of these vessels).

A diagram of typical use alteration for this group is presented in Figure 14. The thickness of the carbonized residues running down the pot exterior from the rim suggests that they must have been deposited as the pot boiled over during its final use, before it failed or was discarded. These residues were not washed off or gradually removed through handling, suggesting that immediately after these pots boiled over, they reached the end of their use-life. This pattern of carbonized residue deposition suggests that the contents of these pots were being heated at a high enough temperature that they would occasionally boil over, spilling down the sides of the vessel.

The observed pattern of interior carbonized residue accumulation suggests that these vessels were used for boiling organic matter. This pattern can be described as a "bubble zone" and is created by the boiling of a liquid or semi-liquid substance (Figure 15). As the liquid bubbles, tiny organic particles splash up and adhere to the vessel wall at and above the liquid's surface; if the pot continues to be heated, these particles will eventually burn, leaving a characteristic ring (Skibo 1992: 151). While most of this residue can be scrubbed off, some of it remains embedded in the surface of the pottery fabric and will accumulate over time, creating this characteristic pattern.

The pattern of attrition seen at the neck is caused by the use of an implement inside the vessel. Since the neck of the pot serves to restrict the implement's movement, it receives numerous blows and scrapes (Skibo 1992: 134). The curvature of the shoulder prevents the implement from regularly striking its surface, resulting in the reduced attrition seen in the shoulder area. The body sees the greatest frequency and severity of attrition because in this region the end of the implement is striking the vessel walls: due to the restriction of the neck, the force applied to the handle of the implement would be amplified inside the pot in a way similar to the operation of a lever or fulcrum, resulting in harder blows.

In summary, Type B vessels show signs of being used for cooking or food processing. The soot deposits and attrition on the lower body suggests

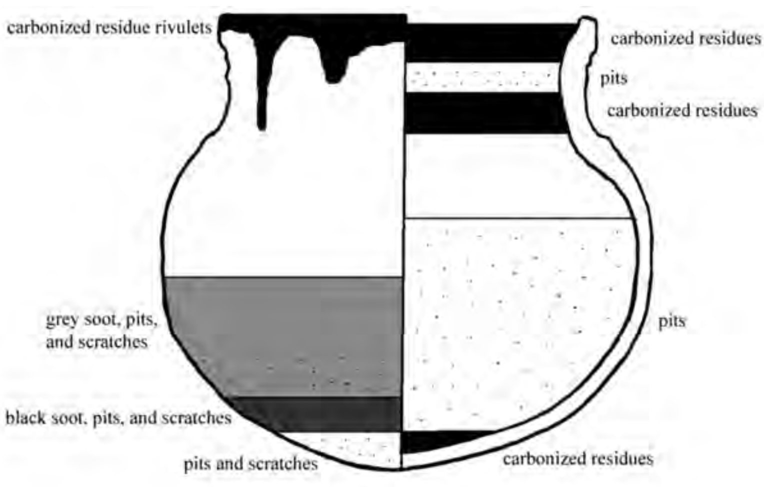


Figure 14. *Section drawing depicting use alteration typical of a Type B/C vessel; exterior to the left, interior to the right. Not to scale.*

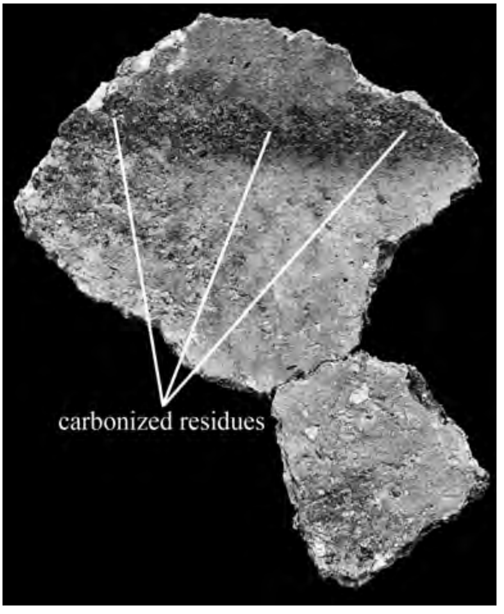


Figure 15. *Interior of vessel with a "bubble zone" of carbonized residues at the lower neck. Frame width: 12 cm.*

that they may have been used directly over a fire. The technological characteristics of this group support the idea that these vessels could have been used directly over a fire: vessel walls were thin, increasing thermal shock resistance and thermal conductivity, but also overall fragility; this trade-off is nonetheless required for vessels used directly over a fire. Several researchers have suggested that during menstruation, Iroquoian women cooked their food separately in small pots with similar capacities to Type B vessels (Engelbrecht 2003: 85; Trigger 1969: 65, Snow 1994: 57). While this idea is intriguing, it cannot be supported using the evidence presented here and must be evaluated using other means.

Type C: Medium-Sized Boiling Pots

Carbonized residues were found throughout the interiors of the majority of these vessels, but most frequently above the neck and at the base. The characteristic bubble zone is noted in the rim or neck regions on almost 60% of these vessels. Some attrition patterns similar to those of Type B are also apparent in these vessels: a horizontal band of more severe pitting is often present at the point of maximum neck constriction, then becoming less severe at the shoulder. On the body surfaces, however, pitting occurs with moderate severity and significantly greater frequency than Group B. All base interiors were moderately to severely pitted with significant surface removal.

On the exteriors of these vessels, drips or rivulets of carbonized residue appear infrequently from the rim to the shoulder, and are almost completely absent elsewhere. Light pitting is rare on the upper portions of the vessel, but is found more frequently on the lower body and on 100% of bases; at the base, it is often associated with short scratches or nicks. Lustrous soot deposits first appear at the shoulder in very low frequencies; as one moves down the body, these soot deposits increase in frequency and often become darker in colour. At the base, most have soot deposits that consist of a dull greyish black ring 2-3 cm in thickness around the centre of the base, surrounded by glossy dark grey deposits; inside this dull black ring, the soot is thinner and greyish.

These patterns of use are similar to those of Type B (Figure 14). Based on the frequent appearance of thick bubble zones of carbonized residue on the rim and neck areas, these vessels were used to boil food. Pitting on the neck interiors suggests that an implement was used inside these pots. The higher frequency and severity of pitting on the body and base suggests that this implement performed its primary function below the surface of the liquid. Sooting on the lower exteriors of these vessels indicates that they were used directly over a heat source. The circular patches of thick carbonized residues on base interiors also demonstrate this: much like the burnt food we find today at the bottom of a sauce-pan, this residue forms on the hottest part of the pot, which is the area closest to the heat source. The lack of significant soot deposits on the upper portions of these vessels show that the heat source was hot and clean, with too little smoke to produce abundant deposits in these areas: a small, well-established fire with a large proportion of coals would meet these criteria. The ring of black carbon deposits around the base, with small amounts of thin, greyish soot inside, indicates that some carbon is being oxidized (Hally 1983:7-8, 10). This means that the pot must have been elevated slightly above the heat source so that some carbon deposits could initially accumulate, but close enough for the pot to eventually reach temperatures high enough that the soot will begin to oxidize and disappear from the centre of the base, which occurs at approximately 400°C (Skibo 1992: 160). Supporting this interpretation are the scratches and pits that appear so frequently on upper areas of the base: I suggest that this attrition was caused by the placement or adjustment of the pot on supports of some sort that hold it in place above the heat source, at a height low enough to create the patterns of soot deposition described above.

The technological characteristics chosen for these vessels support the interpretation that these vessels were positioned directly over a fire during use. The reduced mechanical durability caused by their thin walls was offset by an excellent thermal shock resistance, which would have been needed if this vessel was used over a fire. The large temper inclusions would have allowed heat to conduct quickly through the vessel walls and into its contents, also a favourable characteristic for vessels intending to be positioned directly over a fire, resulting in a decrease in cooking time and increase in efficiency. Their size meant that they could be easily positioned over a fire and removed after cooking was finished, even while full.

Type D: Hot-Stone Cooking Vessels

Carbonized food residues are found throughout the interior, but are relatively thin and sparse compared with Types B and C, and are often only visible in the pores and cracks of the pottery fabric. Again, a thin bubble zone of residue at the rim or neck is common. These residues are rarely found at the base: often, there is a circular patch around the centre of the base that is surrounded by burnt residues but is itself devoid of residues. Pitting was also observed throughout the interior. A horizontal band of pitting was often found at the neck, suggesting that an implement was being used inside these pots. Below the neck, pitting increases in frequency and severity toward the body and base, where substantial surface removal was evident. This is also in contrast to Types B and C, where shoulder pitting was less frequent or severe.

On the exterior surfaces, burnt food residues appear as spills or drips down the sides of these vessels and are frequently found as drips on the shoulder. Pitting is generally restricted to the base, where it appears alongside scratches several centimetres long that take the form of circumferential arcs.

Pots belonging to this type were also used to process food, judging by the burnt encrustations at the rim and neck (Figure 16). The fact that these residues were present at the same frequencies but were relatively thin and sparse compared to other vessel types suggests that these pots were used at lower temperatures, resulting in the lighter deposition of carbonized residues. Burnt residue drips at the shoulder probably occurred during the removal of food from the pot: as a ladle or spoon was removed from the vessel, any drips would most likely fall on the shoulder, since the neck and rim would present a smaller target than the shoulder in terms of surface area. The neck shows attrition patterns associated with the use of a tool. The greater frequency and severity of attrition on the shoulder interior suggests one of two things: either this area was more accessible to this tool, due to the larger neck diameters of this vessel type; or that the vessel contents were somehow causing this attrition. The attrition at the base exterior suggests that these pots were resting on the ground during use, with the curved scratches indicting that they were rotated without being lifted from the ground, perhaps testifying to their great weight. This is not surprising, since when full these vessels could weigh over 20 kilograms, and would be awkward to lift or carry. The lower part of the base remained cooler during cooking, since it was resting on the ground. This prevented food particles from burning and adhering to its interior surface, resulting in a small circular bare patch I describe above.

It is apparent that the manner in which these pots were used differs from that of other vessel types: no direct exposure to heat is indicated. So how were these vessels used to cook food? I believe

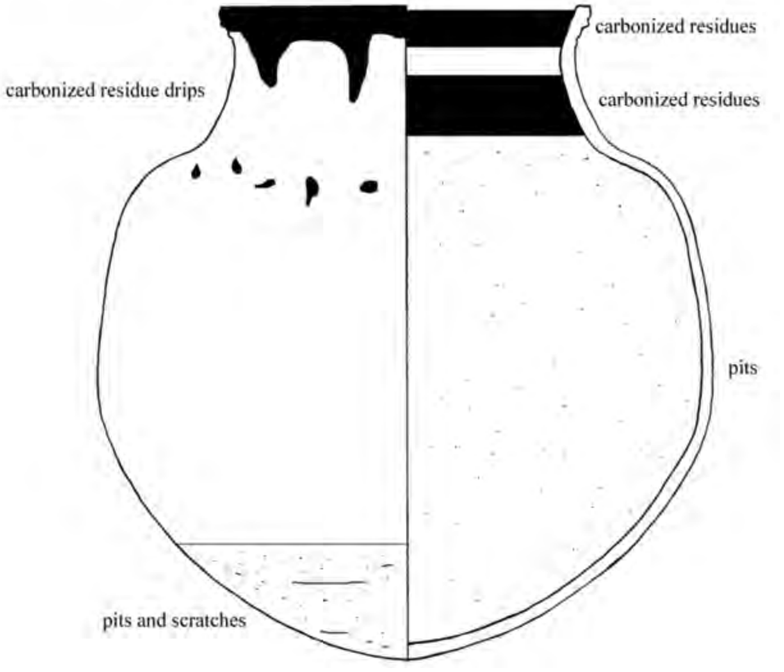


Figure 16. *Section drawing depicting use alteration of a typical Type D vessel; exterior to the left, interior to the right. Not to scale.*

that hot stone technology would create the patterns of use alteration seen in these vessels. The cycle of adding hot stones to the vessel while removing cool ones could result in the patterns of attrition on the interior of these vessels, especially at the shoulder: as a stone is positioned inside the pot so that it can be grasped and removed, the tendency would be to brace it against the side of the vessel so that it could not roll away. Consequently, as this stone is lifted it would follow the vessel wall instead of being removed directly from the centre. This would be more advantageous, since if a stone was positioned at the side of a vessel it would be easier to slip a flat implement underneath and lift it while supporting it from below in a manner that would reduce the likelihood of it accidentally being dropped. During the addition or removal of the cooking stones, dropping or otherwise jostling them increases the likelihood that they will shatter (Robertson 2001: 56 fn 10): it therefore seems likely that Iroquoian cooks would choose methods of stone removal that would reduce this risk.

A comparison of the observed use alteration and functional characteristics of this type of pot indicates that these vessels have all of the qualities required for hot stone cooking. Due to the relatively low temperatures achieved during cooking with stones, thermal shock resistance was not a priority. Instead, durability was stressed: due to their large capacity, these vessels were built with thick walls and bases so that they could better support the weight of their contents, including stones, without breaking. These thick walls also acted as insulation for the pot's contents, since both heating and cooking were accomplished within its interior.

The hot stone cooking method would have been ideal for extracting fats and oils from various food products. Hot stone cooking allows the temperature of a pot's contents to be more carefully controlled: this is important because, if temperatures become too high, the nutritional value of seed or nut oils will be reduced, and fat will coagulate (Benison 1999: 296). In addition, the skimming of fats or oils would require a relatively still surface. This interpretation is supported by ethno-historical evidence suggesting that bear, beaver and deer fat, as well as nut and seed oils, were extracted using pottery vessels (Tooker 1967: 69; Trigger 1969: 27). In addition, Champlain specifically describes the process whereby a spoon was used to skim fat off the surface of a pot's contents (Macklem 1970: 79).

Discard

The vast majority of pottery recovered from Antrex was found in the middens and exterior activity areas. In general, clearly defined patterns of spatial distribution for each vessel type were not observed, making an interpretation of discard patterns difficult. However, based on the patterns that were apparent, some (albeit tentative) conclusions can be drawn.

Three slightly different ceramic spatial distributions for these vessel types are apparent (Table 9, Figure 17). Houses 6 and 9 appear to be using hot stone cooking technology more often than other houses. In addition, these houses show significantly higher densities of post moulds and features, suggesting that they were occupied more intensively compared with the relatively sparse settlement patterns of the other houses. It is possible that certain activities involving these pots, such as the rendering of fats and oils, were restricted to these houses, perhaps representing a division of labour by household. Alternatively, this distribution may be due to a seasonal variation in the occupation and subsistence strategies of this village, since fat and oil-bearing foods were generally acquired during autumn and early winter. Thus, a winter occupation of Houses 6 and 9 may be reflected by their higher proportions of Type D vessels.

Type D vessels were also recovered in high frequencies from Exterior area 1. This area is located on the floodplain below the village proper and is relatively isolated; it consists of several features and a relatively large number of post-moulds that appear to form a series of roughly parallel fence lines. Due to its close proximity to the watercourse, people may have been using this area for industrial activities requiring large amounts of water, such as nut processing. Due to their high tannin levels, some nuts must be boiled in large volumes of an alkali solution and then rinsed several times before they are palatable, a practice that continued into historic times (Fenton 1968: 101). The Type D vessels found so frequently in this area would have been well suited to this sort of activity, due to their high capacity but also because their cooking temperatures were lower and easier to control than those of direct-heat cooking vessels,

Table 9. *Expected and actual frequencies of each vessel type recovered from various areas of the Antrex site.*

Location	Functional Group A	Functional Group B	Functional Group C	Functional Group D	Total	
					N	%
Exterior area 1	2	6	21	71	66	100
Exterior area 2	13	4	69	14	71	100
Exterior area 3	8	12	62	19	26	100
Exterior area 4	7	7	71	14	14	100
Exterior area 5		13	75	13	40	100
Exterior area 6		13	63	25	8	100
Exterior area 7	15	3	73	10	40	100
Exterior area 8	9	14	46	31	35	100
Longhouse 4	9	9	57	25	44	100
Longhouse 6	5	6	42	46	95	100
Longhouse 7		5	95		20	100
Longhouse 8	6	13	56	25	32	100
Longhouse 9	8	10	43	40	40	100
Midden 1	12	7	55	27	75	100
Midden 2	3	5	59	32	37	100
Expected %	7	8	55	31	643	100

resulting in greater nutritional yields. A more detailed examination of the floral and faunal remains from Antrex is necessary to further explore this idea.

Four exterior areas, each associated with a different house, had the highest proportions of pots belonging to Type C, and relatively few vessels of other types. An examination of sherd mend links between areas of the site shows that there were many connections between outdoor areas but very few between outdoor areas and houses. A more detailed study of these mend links and other contextual data may provide the answers that are lacking here: what can be said is that it appears as though type C pots are being used in these exterior areas and, during use or discard, travel to neighbouring exterior areas but not nearby houses.

Conclusions

Four different vessel types were discerned at the Antrex site, each with a distinct set of technological characteristics and patterns of use. Most vessels were manufactured with food processing in mind, and although we cannot know what other purposes these pots might have served, they primarily functioned as cooking pots. Small and medium-sized pots were used for

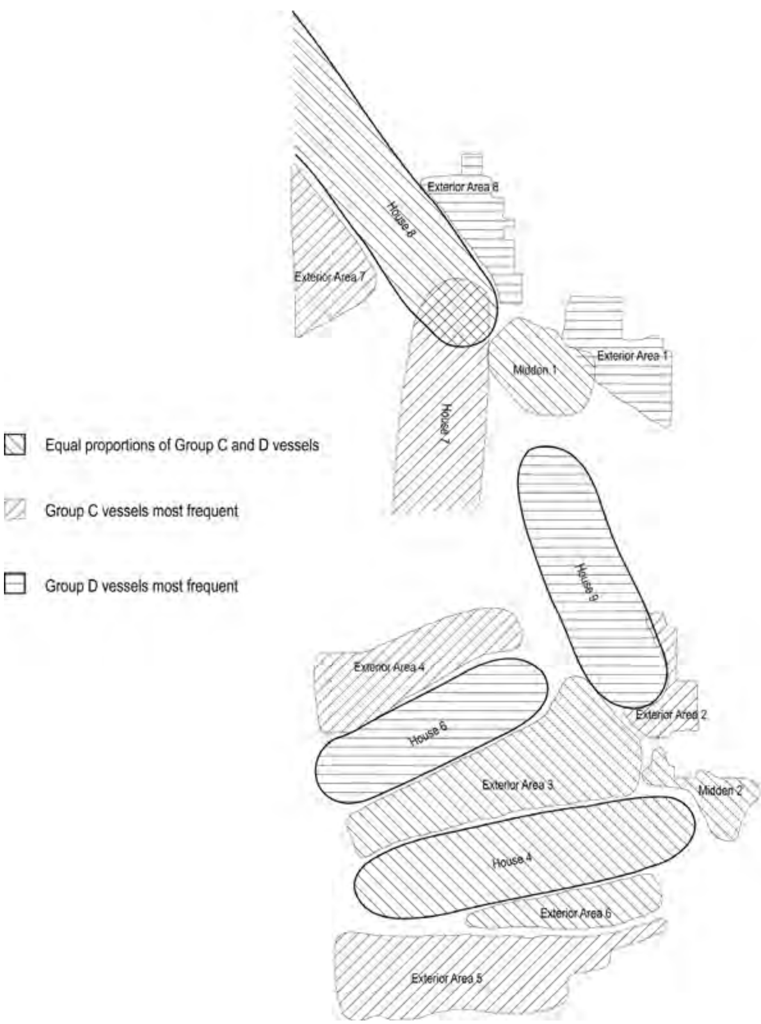


Figure 17. *Schematic diagram depicting the longhouses, middens and exterior areas identified at Antrex. The relative proportion of Group C and D vessels found within each area is represented by shading.*

boiling stews, porridges or soups by placing them on stone supports directly over a small, hot fire. Large pots were used in conjunction with hot rocks or "boiling stones," and would have been ideal for the extraction of fats and oils.

Juvenile vessels are the only vessel type that does not appear to have been consistently used for food processing. Their technological characteristics and general crudity suggest that they are ill-suited for storing, serving, or cooking. They were made by unskilled individuals, but not necessarily children. Evidence for use is scant, but suggests that they were not used as children's toys. The fact that *some* use alteration on their interiors was observed suggests that these pots were not discarded immediately after they were fired. Based on these data, I suggest that the commonly held assumption that juvenile vessels were made and used by children must be re-evaluated.

This study must be viewed as preliminary; the full publication of the Antrex site data will provide an opportunity to re-examine my findings and their significance. However, my work suggests that decoration, while invaluable for answering questions of chronology, bore little relation to how pottery was manufactured and used. In order to make more meaningful observations about the relationship between Iroquoians and their material culture, we must expand our focus and incorporate other attributes, such as those related to technology, into our analyses.

It is apparent from this work that Antrex potters made deliberate choices during manufacture in order to achieve their desired results. Raw materials such as temper were selected to facilitate the manufacturing process but also for the technological characteristics they imparted to the finished product. During firing, temperatures were kept low to prevent pots from failing prematurely. This sophisticated knowledge of ceramic manufacture suggests that, as has been demonstrated elsewhere in the world, these choices were conscious ones based in technological awareness and tradition, and are intrinsically meaningful (e.g., Michelaki et al. 2002:316). Many of the choices the Antrex potters made were influenced by the environment, such as availability of raw materials. Some choices were also influenced by the intended function of the pot they were making, for example the decision to make thin-walled vessels with large temper inclusions so that they could be used to boil food.

Some choices, however, cannot be explained solely by environmental or economic factors – they are also influenced by social concerns. The decision to use dark-coloured igneous rocks such as diorite, granodiorite, or syenite as temper is an example of such an influence. Since they require more effort to prepare, and they provide no greater technological benefits over granite temper, their use must be seen as socially significant. In this way, technological choices are social expressions of engagement with the material world (Dobres 2000: 97-98). For the people who occupied the Antrex site, the practice of ceramic technology was a socially embedded activity.

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Choix technologiques: fabrication et utilisation de la céramique au site Antrex (AjGv-38)

Cet article examine les caractéristiques technologiques de la poterie retrouvée au site Antrex (AjGv-38), un village de la période iroquoienne moyenne de l'Ontario situé à la ville actuelle de Mississauga, à l'ouest de Toronto, et qui date des années 1350 après Jésus-Christ. Ici, quatre différents types de récipients ont été identifiés, chacun ayant des caractéristiques distinctives de fabrication et des modifications au niveau des patrons d'utilisation. Ces récipients incluent des petits et des moyens pots qui étaient placés directement par-dessus un petit feu sur des supports de pierre et qui étaient utilisés pour bouillir des ragoûts, des porridges ou des soupes. Il y avait aussi de gros récipients, utilisés avec des pierres chaudes pour faciliter l'ébullition, qui étaient l'idéal pour l'extraction de matières grasses et d'huile. De plus, il y avait des récipients juvéniles, vases fabriqués par des jeunes apprentis, qui n'étaient pas utilisés pour la transformation des aliments mais qui paraissent avoir été soigneusement entretenus. Dans l'ensemble, les choix des potiers du site Antrex indiquent que ces derniers détenaient une connaissance technologique sophistiquée quant à la fabrication de pièces de céramique. Ces choix indiquent aussi que la pratique de cette technologie était influencée par les préoccupations fonctionnelles et sociales du milieu.

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