THE FONGER SITE: A CASE STUDY OF NEUTRAL CERAMIC TECHNOLOGY

SO MANY DECISIONS!

THE FONGER SITE: A CASE STUDY OF NEUTRAL IROQUOIAN CERAMIC TECHNOLOGY

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Abstract

This thesis investigates how potters from the Fonger site, a Neutral Iroquoian village near Brantford, made their ceramic vessels. My goal is to understand how a given environment, raw material properties, vessel function and a particular social context all came together to influence the potters' choices. I do this by identifying the choices potters made throughout the manufacture of ceramic pots, from the raw materials selection and preparation, to vessel formation and finish, decoration, firing and use, through the combination of a raw materials survey and experimental projects with macroscopic, petrographic and x-ray diffraction analyses and re-firing tests.

Each step in the operational sequence exhibited a different number of choices. The reasons why Fonger potters do things one way and not another seem to be more a reflection of social guidelines, of how a vessel should be made, rather than a reflection of distinct functional or mechanical requirements of their vessels.

There are several interesting conclusions from this research, including the identification of the raw materials from which shell-tempered vessels were made as well as the steps in the operational sequence that were socially directed and those that allowed potters more freedom of choice. I demonstrate that more micro-scale studies of ceramic manufacture at the village level give us a more nuanced understanding of how potters and ceramics fit into the daily lives of the Neutral people.

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Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction, Literature Review and Theoretical Framework

Introduction

The purpose of this thesis is to investigate how potters from a Neutral Iroquoian village, the Fonger site, manufactured their vessels, in order to understand how function, mechanics, environment and social norms influenced their choices. When craftspeople manufacture an object, they often follow 'traditional' or socially guided ways to do things, which results in limited variation. However, craftspeople can choose not to follow social 'rules', thus displaying their individual preferences, which results in a wider range of techniques. By investigating the options that were available to potters, the actual choices that potters made while creating a vessel (the operational sequence), and the range of variation at each step in the operational sequence, this study reveals how communal and individual knowledge and preferences were negotiated in the context of making pots at a protohistoric Neutral site.

Literature Review

To contextualize this investigation within a broader scope of Iroquoian research and provide the necessary background, in this section I summarize Iroquoian ceramic research relevant to this study. This includes studies on style, raw materials, form and function, firing, ceramic production and organization.

Ontario Ceramic Research

In Ontario, the majority of ceramic research has focused on building chronological sequences, examining cultural affiliation, and/or group movement issues (Curtis and Latta 2000; Donaldson 1958; Emerson 1956, 1968; Lennox and Kenyon

1984; MacNeish 1952; Ramsden 1977; Smith 1983; Wright 1968). In these broad, large-scale studies, archaeologists have examined primarily formal attributes of rim sherds and have implemented comprehensive decorative design analysis.

Based on formal and decorative attributes, MacNeish (1952) and Emerson (1968) investigated the development of the 'Iroquoian tradition' in Ontario by developing Iroquoian ceramic types. Wright (1966) also studied the development of the 'Iroquoian tradition' but, instead of ceramic types, he advocated the use of ceramic attributes. While, the debate over the use of types or attributes continued (Engelbrecht 1980; Lennox and Kenyon 1984; Wright 1980), questions of chronology, group affiliation and movement remained the same. By looking at material culture, and ceramics in particular, only as static objects, which reflect the shared ideas of clearly defined cultural groups, rather than as the end result of dynamic activities that involve engaged human decision-making, all of these studies viewed ceramics as only markers of the passage of time and the movements of people.

There have been studies that have challenged the focus on superficial decorative elements and the assumptions of their one-to-one correspondence with ethnic groups. For example, Hawkins (2001) employed petrographic and neutron activation analyses to show that Genoa Frilled vessels, a ceramic style associated with New York Iroquoian groups, had been imitated locally in Huronia. Similarly, Trigger et al. (1984) used x-ray diffraction analyses to show that vessels categorized as Algonquian Parker Festooned, had actually been manufactured in the Iroquoian sites in which they had been found. Trigger et al. (1980) also conducted x-ray fluorescence analyses to show the wide regional and intra-site variability in the raw materials of rim sherds, all of which belonged to the same Ontario and St. Lawrence Iroquoian stylistic groups.

Braun (2003) further challenged existing Iroquoian ceramic typologies from a functional point of view. He was able to show variation in the function and use of Middle Iroquoian vessels by studying the non-plastic inclusions and morphology of vessels from the Antrex site.

Allen and Zubrow (1989) provided the first application of a ceramic ecological model for the analysis of Iroquoian ceramic production that reoriented the focus away from the *vessels* as finished objects and on the *activities* and *people* involved in pottery making. Acknowledging the fact that people make pots in a given environment with particular ecological characteristics that may facilitate and/or constrain potting activities, they examined annual rainfall and temperature patterns in New York State to estimate the optimal time of the year for making pots, giving us a sense of the timing of potting activities in New York Iroquoian communities.

Other researchers, such as Kapches (1994), who were greatly influenced by the work of Allen and Zubrow, investigated activities related to the firing of pots in their environmental context. Using ethnoarchaeological information from around the world, in combination with ethnohistorical and archaeological data from Ontario, Kapches suggested that vessel firing could have taken place in longhouses, within the village, but also in special purpose sites during the summer (1994: 100-101), allowing us to picture people moving in space while completing the ceramic manufacturing sequence.

Another influential article by Allen (1992) examined the production of New York Iroquoian ceramics not only as a technical activity affected by the local ecology, but also as an economic activity, influenced by the social relations of its producers. She estimated that a single New York Iroquoian woman would produce only about 5-10 pots per year (Allen 1992: 140), which suggests that pot making was an unspecialized, part-time household activity.

Martelle's recent study (2002) of ceramics from Huronia took this activity and people orientated approach to Iroquoian ceramic production even further. She focused on micro-stylistic variation of ceramics from three Huron sites to examine vessel function, group movement, group affiliation and the organization of production. As a result, Martelle (2002) demonstrated, contrary to traditional belief, that there was a wide range of ceramic functional variability and that, within Huron villages, pot making was more specialized than previously thought.

Chilton (1998), investigating the choices potters made in an Iroquoian and two Algonquian Late Woodland sites in southern New England, also showed that variations in ceramic manufacture were the result of social factors, rather than purely functional or mechanical ones, since all three groups had access to the same technological knowledge.

Theoretical Framework

The present study continues the move beyond the analysis of isolated formal attributes by combining vessel function, raw materials mechanics and the local environment to explore ceramic technology as a socially embedded web of activities and relations. I follow researchers, such as Dobres (1999, 2000), Lemonnier (1990), and Van

Der Leeuw (2002), who argue that by identifying the operational sequence, the choices made and not made by potters and the influences behind these choices, we can gain insight into the conscious and unconscious attitudes Fonger people had towards the community's shared social 'rules' about what is appropriate and what is not. In the process, we can also gain insight into how potters chose to express their individuality.

The operational sequence or 'chaîne opératoire' can be defined as "the technical chain of sequential material operations by which natural resources are acquired and physically transformed into cultural commodities" (Dobres 2000: 154). The steps potters take to create their vessels reflect their choices throughout ceramic manufacture. By studying the operational sequence, I can identify these choices and begin to understand the logic according to which they were made.

Choices potters make are influenced by vessel function, raw material mechanics, the local environment and most importantly by the potters' community. When creating an object, the functional and mechanical properties of the materials craftspeople use and the forms and shapes of the objects they make restrict the choices available. The surrounding environment also has an effect on the materials available as well as where and when craftspeople choose to make objects. However, while function, mechanics, and environment place certain constraints on craft production, there are numerous options available within these constraints (Van Der Leeuw 2002: 239-241). How craftspeople deal with these constraints and the actual choices they make are socially influenced and directed (Van Der Leeuw 2002: 239-241). This means that ultimately, the reasons why people do things one way and not another are social (Van Der Leeuw 2002: 241). For example, when a shell-tempered vessel is fired between 650-900°C, there is a mechanical and functional obstacle. The shell changes into calcium hydroxide, which expands when re-hydrated, eventually resulting in a crumbled, cracked or weakened vessel. Once potters determine how to solve the problem, shell-tempered vessels can be created successfully. How potters overcome this problem is social, since there are a number of ways to eliminate shell expansion, such as firing vessels either below 650°C or above 900°C, adding salt to clay and shell pastes, wetting vessels while they are still hot, or firing vessels in a reducing atmosphere (Bronitsky and Hamer 1986: 97; Feathers 1989: 587; Rice 1987: 98; Rye 1976; Steponaitis 1984; Stimmell, Heinmann and Hancock 1982: 219).

Some choices that potters make would appear very 'logical' from the point of view of materials science, while others may appear to defy our own functional, mechanical or environmental 'common sense'. These are the cases where it becomes most apparent that different communities can have different technological 'logics' and 'common sense' and that ecology, function and mechanics alone are inefficient to explain the nature of technological decision-making (Sillar and Tite 2000; Van Der Leeuw 2002).

Meaning is created and expressed through craft production because people's beliefs and attitudes about the world are physically manifested in unconscious and conscious technological choices (Dobres 2000: 85, 96-97; Lemonnier 1986: 155). The acceptance and perpetuation of social norms and the lack of thinking or acting outside of our social paradigm, a concept coined 'habitus' by Bourdieu (1977), can explain why a group of people do things a certain way. These unconscious choices are social representations of cultural logic, which are shaped by and specific to each society (Mahias 2002: 158). In this way, habitus encourages underlying similarities (Dobres 2000:140). For example, in our own Western society, we find it illogical to put a toilet in the middle of a living room. This is not due to functional or mechanical reasons, but rather due to our social constructs and values about privacy and cleanliness.

However, not everyone within a community shares the same experiences and exact same knowledge (Dobres 2000: 140). Because of this as well as individual choice, there can be differences and variability in craft production even within a community (Dobres 2000: 140). In this way, similarities perpetuated by habitus and tradition as well as variability introduced by individual skill and perception can be investigated through studying the chaîne opératoire (Dobres 2000: 167-168; Sillar and Tite 2000: 10). By identifying community wide shared choices versus more unique, individual ones we can begin, as archaeologists, to approximate community based rules and social structures as well as the individual agency through which they became manifested in material culture.

Chapter 2: The Neutral Iroquois and the Fonger Site

To place the Fonger site within the wider context of the Neutral Iroquois, I will first provide a brief review of Neutral archaeology and what is known about the Neutral. I will then provide detailed information about the Fonger site and its excavation.

Neutral Iroquois

The history of Neutral archaeology has been long, beginning in the late nineteenth century with explorations by Schoolcraft (1847), Boyle (1888a, 1888b), and Waugh (1903). These early investigators documented Neutral site locations and ossuaries, and collected various artifacts. MacNeish's (1952) seminal work on Iroquoian pottery types, which established an argument for the *in situ* development of the Iroquoian tradition, included the analysis of Neutral ceramics. Wright (1966) also included Neutral ceramics in his ceramic attribute analysis of the origin of the Iroquoians. Ridley (1961) and Wright (1963) compiled summaries of the archaeological and ethnohistoric data, respectively, on the Neutral, which provided a basis for further Neutral research.

Noble (1980), Wright (1981), Lennox (1981, 1984a, 1984b), Fitzgerald (1982), and Warrick (1984a, 1984b) undertook a number of excavations of specific large Neutral sites during the 1970's and 1980's. As these were the first systematic investigations of Neutral archaeological sites, they focused primarily on settlement patterns and basic artifact analysis. Ceramic attribute analysis centered on identifying exterior, interior and lip design techniques and motifs, rim profiles, collar heights, surface treatments, temper, and appendages of rim sherds.

Fitzgerald (1990) and Smith (1983) focused on placing Neutral sites within a chronological framework. Fitzgerald (1990) concentrated on European glass beads from Neutral sites to construct a chronology for the Great Lakes region. Smith (1983) used ceramic attribute complexes to seriate several sites near London, Ontario.

While there is a long history of Neutral research, recent interest has been lacking. Other than limited subsistence studies by Stewart (2000) and Stewart and Finlayson (2000), Neutral research has been minimal since 1990. However, based on these past studies, we have a broad understanding of the Neutral Iroquois.

The Iroquoian tradition in northeastern North America is divided into three clusters: the Mohawk-Onondaga-Oneida, Seneca-Cayuga-Susquehannock, and Huron-Petun-Neutral-Erie (Wright 1966: 2). The Huron, Petun, Neutral and Erie comprise the Ontario Iroquois Tradition, which is separated chronologically into early, middle, and late stages (Wright 1966: 2, 13). It is during the middle stage that the Neutral first become visible archaeologically, based on ceramic typology, during what is known as the later stage of the Middleport horizon (circa 1350 A.D.) (MacNeish 1952: 87; Noble 1978: 152; Wright 1966: 100).

The Neutral formed five to ten loosely aligned clusters/tribes (Noble 1978: 156; Noble 1984: 4) located in specific geographic areas (Fitzgerald 1990: 367). During the fifteenth century, the Neutral region spread from the western corner of Lake Ontario to the north shore of Lake Erie in the Niagara Peninsula (Fitzgerald 2001: 38; Noble 1978: 152; Stewart 2000: 92). However, Neutral sites are located as far away as west of the Grand River and east of the Niagara River (Ridley 1961: 61; Stewart 2000: 92). By the end of the sixteenth century, when the Fonger site was occupied, Neutral territory had decreased only to the area west of Lake Ontario around the Niagara escarpment (Fitzgerald 2001: 38). It has been argued that this reduction of territory was likely a response to hostilities with the neighboring Fire Nation (Fitzgerald 1990: 253-254).

The region the Neutral occupied supplied them with abundant floral resources, including deciduous forests of oak, hickory, and cedar along with nut and fruit trees, berries and other edible plants (Stewart 2000: 92). Faunal assemblages from Neutral sites demonstrate a wide variety of exploited animals, including Virginia deer, beaver, bear, moose, raccoon, wapiti, elk, muskrat, woodchuck, fox, wolf, dog, squirrel, rabbit, passenger pigeon and wild turkey (Noble 1978: 159; Stewart and Finlayson 2000: 25; Stewart 2000: 97-102, 104). These floral and faunal resources would affect the manufacture and use of ceramic vessels. Tools made from animal bone could be used for finishing and/or decorating vessels, and deciduous forests could provide ample fuel for vessel firings. Nuts could be roasted, animal meat stewed or plants cooked in vessels.

Neutral villages were generally in defensible, high ground locations near rivers, streams or marshes (Noble 1984: 14-15; Ridley 1961: 61). This type of location would have provided access to freshwater resources such as crayfish, freshwater bivalves, whitefish, sturgeon, pike, suckers, catfish, trout and salmon (Stewart and Finlayson 2000: 25; Stewart 2000: 102-103). Freshwater close to villages would have provided easy access to bivalve shells that could be used as tempering material or tools for scraping excess clay off pots during manufacturing. Like other bone tools, fish bone tools also could have been used to apply vessel decoration.

Palisades surrounded these villages, which was likely for protection from animals, wind, snow or invaders (Lennox and Fitzgerald 1990: 441-442). Within the walls of the palisades were longhouses ranging from 6 to 36.5 meters long (Noble 1978: 156; Noble 1984: 12). The interiors of these houses, organized around central hearths, contained storage, repository and slash pits, and living, sleeping and food preparation areas (Noble 1978: 156; Noble 1984: 7, 10). Slash pits are oval depressions with straight sides and flat bases. Archaeologically, linear end stains are present within houses, which are likely remnants of long, thin partitions located at the end of houses. Both slash pits and linear end stains are typical of Neutral longhouses (Warrick 1984b: 29). By looking at the size and location of hearths and storage pits in relation to evidence of vessel manufacture, we may be able to obtain clues into the organization and scale of vessel production. Storage pits may have housed ceramic manufacturing materials such as clay, temper and tools. Central hearths could have been used to fire a few vessels at a time, depending on the size of the hearth, and could have been areas of vessel use.

Beyond the palisades, outside of the village, large plots of land were cleared for horticultural practices. Like other Iroquoian groups, the Neutral combined corn, beans and squash cultivation with the collection of local freshwater resources along with hunting and gathering. Other crops, such as tobacco and sunflower were also grown, but these were used more as trade items than for everyday consumption (Noble 1978: 159; Stewart and Finlayson 2000: 26). It is quite possible that potters may have discovered and collected their raw materials while working their fields, hunting or gathering. All of these activities would have also given them access to material they could use as fuel, such as cornhusks or stalks from their fields.

The Neutral had contact with several groups including the Fire Nation, Huron, Erie, Wenro, Seneca, Mohawk, and the French. They were active traders of tobacco and corn for steatite, wampum and marine whelk shells with the Huron, Erie and Wenro (Noble 1978: 160). It is possible that raw materials, ceramic vessels or goods in ceramic vessels were also traded. As Latta (1991: 377) summarizes, there has been no support for pottery being traded but possibly what was being traded was the vessel contents. This assumption is based on ethnohistoric documents on the Huron (Thwaites 1986-1901: 13: 249). The trade connections, which were present prior to European contact, facilitated European goods entering Neutralia before actual contact with Europeans. Relations with the Seneca and Mohawk of the Five Nation Iroquois were not as friendly. Attacks by the Seneca and Mohawk from 1650 to 1651 are thought to have caused the fall of the Neutral confederacy. After this time, surviving Neutrals lived among the Seneca, Onondaga, and Wyandots (Noble 1978: 161).

Neutral village sites provide a wide range of artifacts, including ceramics, lithics, bone tools and European goods. A wide range of vessel types has been recovered including flat-bottomed vessels, open bowls, double-mouthed vessels and traditional globular vessels (Kenyon 1982; Lennox and Fitzgerald 1990: 418). Other recovered ceramic artifacts include juvenile vessels, ceramic gaming pieces, and smoking pipes that depict animals and humans (Lennox and Fitzgerald 1990: 421).

Stone tools, that could be used for scraping or finishing vessels, include utilized flakes, retouched scrapers, unifacial snubnose endscrapers, serrated endscrapers, and side-notched points, which are made mainly of Onondaga chert, although Ancaster chert and Kettle chert are also present (Lennox and Fitzgerald 1990: 421, 423; Noble 1978: 157). Ground stone tools include celts, hammerstones, anvilstones, whetstones, shaft abraders, mortars, pestles, manos, smoothing stones, and gaming stones (Warrick 1984b:102-107). These tools could also have been used to process ceramic raw materials. The Neutral tool kit also incorporated awls, punches, needles, and spoons made of bone, antler, or shell (Noble 1978: 157). Other Neutral artifacts include worked bone, antler, and bone beads embedded with shell, bead waste, modified deer phalanges, modified beaver incisors, shell beads, and modified freshwater mussels (Warrick 1984b:126-133).

European goods appeared in the Neutral region around A.D. 1540 and included copper kettles, iron axes, iron bar celts, knives, copper bracelets, copper beads and glass beads (Lennox and Fitzgerald 1990: 439; Warrick 1984b: 134-142). As these goods became introduced, they could have replaced manufacturing tools or become incorporated into potters' tool kits. In addition, copper kettles may have replaced ceramic vessels.

A Case Study: The Fonger Site

The Fonger site (AhHb-8), a 0.8 ha proto-historic Neutral Iroquoian village located on Lot 50, Concession II in Brant County, was excavated by Gary Warrick from 1978 to 1979 (Warrick 1984b: 1) (Figure 1). The location of the site, known since the 1880s, is above a tributary of Fairchild's Creek on the back edge of an agricultural field, on defensible, high ground, next to a water source, a typical Neutral site location. Based on the assemblage of European trade items recovered at the site, the occupation of Fonger was initially dated to the period A.D. 1600-1615 (Warrick 1984b: ii, 144), but the dates were refined to the period A.D. 1580-1600 (Fitzgerald 1990: 305, 578), which precedes direct contact between Europeans and Neutrals. Being a single component site, with an occupation of less than 20 years, it is an excellent case study for investigating Iroquoian ceramic technology, because while more than one generation of potters may have been manufacturing ceramics together, the majority of potters would have been from no more than two generations.

The environment surrounding the Fonger site provided a number of floral and faunal resources. Based on carbonized wood analysis, the site was set amid a hardwood forest consisting of hickory, elm, beech, sugar maple, red maple, red oak, black walnut and black ash (Warrick 1984b: 11-12). Carbonized floral analysis indicated that the Fonger occupants gathered wild plum and raspberries and cultivated beans, squash and eight and ten-row corn (Warrick 1984b: 12-13). Faunal analysis concluded that the Fonger inhabitants exploited mammals, birds, fish, reptiles and amphibians. White-tailed deer, elk, beaver and bear dominate the mammal assemblage, but raccoon, squirrel, canids, woodchuck, chipmunk, American marten, weasel, and muskrat are also present (Warrick 1984b: 14-15). Birds are found in limited amounts, but include passenger pigeon, Canada goose, wild turkey, grouse, hawk, swan, pintail duck, teal, falcon and crane (Warrick 1984b: 16-17). Catfish and sucker make up the majority of fish remains, followed by sturgeon and freshwater drum (Warrick 1984b: 17-18). Also contributing to the faunal assemblage are both turtle and frog (Warrick 1984b: 18).

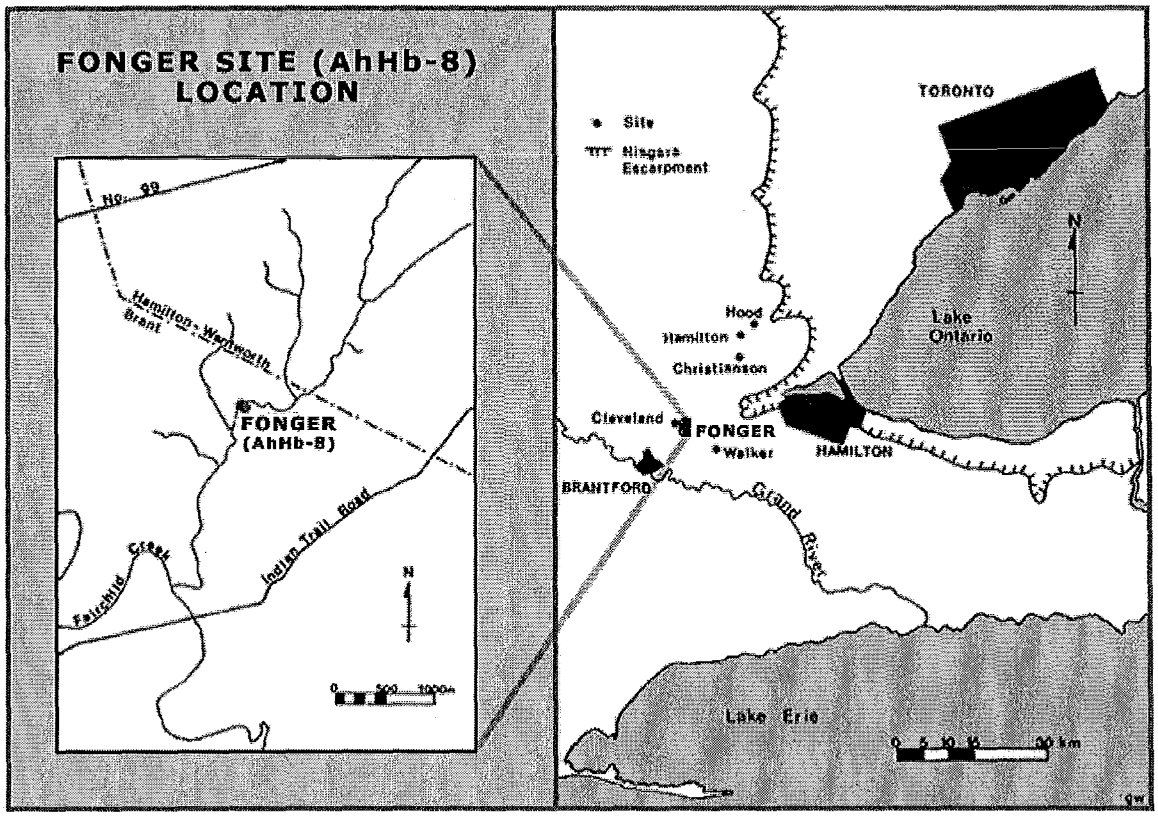


Figure 1. Location of the Fonger Site in Southern Ontario (Warrick 1984a: 81).

In total, six middens and 18 longhouses, surrounded by three or four palisades, make up the site (Warrick 1984b: 19) (Figures 2 and 3). However, only twelve houses existed at a single time. A fire destroyed houses 8, 11, 14 and possibly 17. Subsequently, half of the site required rebuilding (Warrick 1984b: 19).

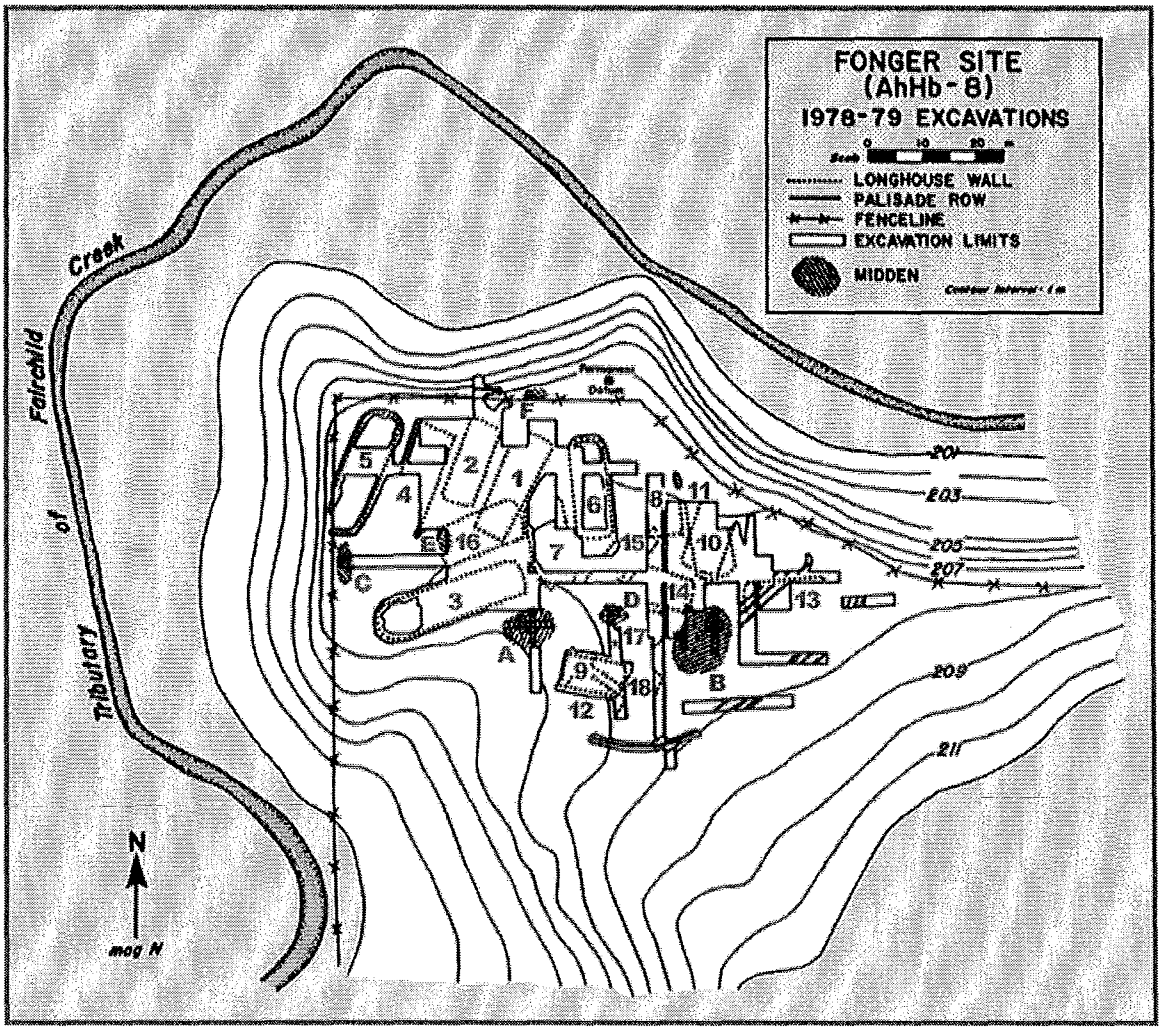


Figure 2. Layout of the longhouses and middens at the Fonger Site in the surrounding landscape (Warrick 1984a: 85).

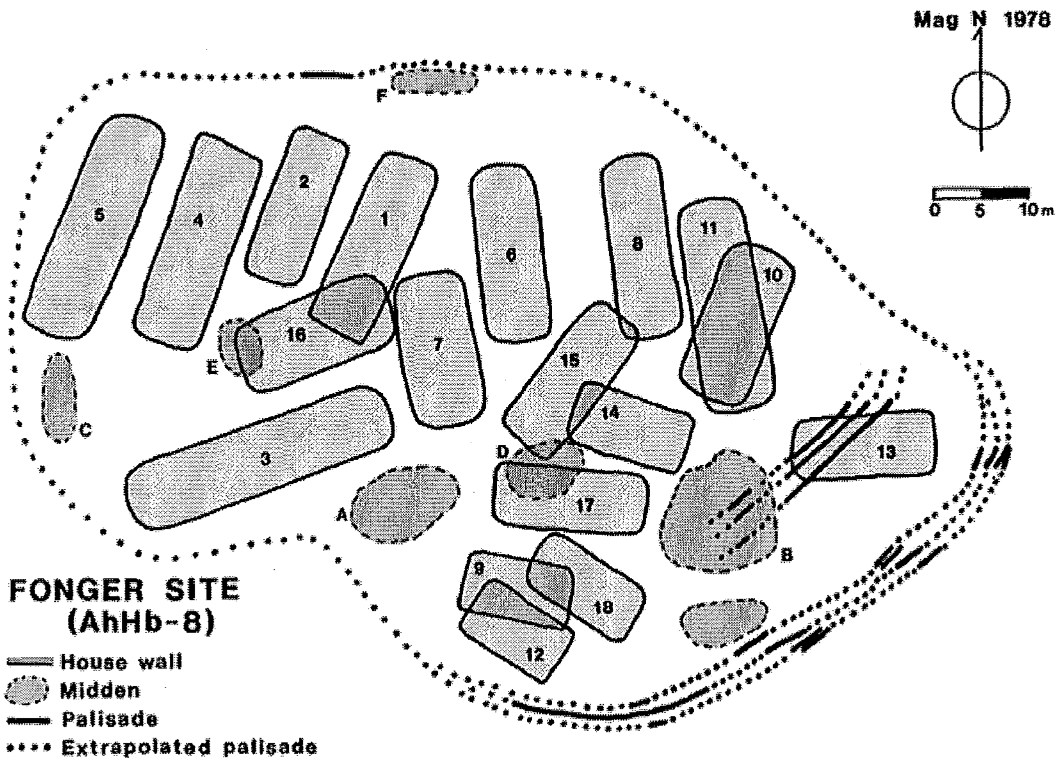


Figure 3. Specific locations of the longhouses and middens in relation to each other (Warrick 1984a: 87).

Compared to other Neutral sites, Fonger longhouses were relatively short, with a mean length of only 17.5 metres (Warrick 1984b: 148). The internal organization of the longhouses focused around central hearths running the length of the houses and containing various storage and slash pits and linear end stains (Warrick 1984b: 29, 149), which are characteristically Neutral.

Besides ceramics, which will be discussed in detail later, Fonger community members made use of several types of utilitarian tools, including chipped lithics, ground and roughstone tools as well as those made out of worked bone and antler. The majority of the chipped lithics found on the site were either debitage or cores. The chipped stone tool kit consisted of retouched flakes, projectile points, endscrapers, bifaces and drills (Warrick 1984b: 74). Recovered ground and roughstone tools include ground stone celts, hammerstones, anvilstones, whetstones, shaft abraders, pestle and mortars, manos, metates, pigment palettes, and smoothing stones (Warrick 1984b: 102). Worked bone and antler utilitarian tools include bone awls, antler pressure flakers, modified beaver incisors, needles, antler harpoons, and antler scrapers (Warrick 1984b: 128-131). Non-utilitarian artifacts found on the site include gaming pebbles, ceramic pipes, bone beads, modified deer phalanges, and shell beads (Warrick 1984b: 102, 124, 126, 129, 132). The site contained a limited diversity of European iron, copper, brass and bronze artifacts (Warrick 1984b: 136). These materials were used to make chisels, bar celts, knives, awls, beads, tubes, earrings, and bracelets (Warrick 1984b: 136, 139-142).

Excavation: Ceramic Recovery

The objective of the 1978 and 1979 excavations was to investigate village organization. This included identifying village size, location and size of structures and major features, and collecting artifacts that represented the various sections of the site (Warrick 1984b: 1). Four houses were completely excavated (houses 1, 2, 9, and 16), while the remaining houses and all the middens were partially excavated (Figure 2 and Table 1).

Table 1. Proportions of excavated middens and houses (Warrick 1984b: 21, 30-31).

	Estimated Area (m^2)	Area (m^2) Excavated	% Excavated	Volume Sampled(l)
Midden A	70	18	25.71	4800
Midden B	105	16	15.24	1650
Midden C	30	2	6.67	145
Midden D	20	3	15.00	45
Midden E	15	2	13.33	260
Midden F	20	1	5.00	300
	Length (m)	**Width (m)**	**Area (m^2)**	**Portion Excavated**
House 1	19.2	7.8	149.76	complete
House 2	16.2	7.2	116.64	complete
House 3	26.5	7.5	198.75	partial (>50%)
House 4	>20	7.0	>140	partial (<50%)
House 5	23.0	6.8	156.40	partial (<50%)
House 6	17.5	7.5	131.25	partial (<50%)
House 7	>16	7.5	>120	minimal
House 8	>11	6.7	>73.7	partial (<50%)
House 9	12.5	6.9	86.25	complete
House 10	>12	7.0	>84	partial (>50%)
House 11	>17	7.0	>119	partial (>50%)
House 12	13.0	6.5	84.50	partial (<50%)
House 13	13.5	7.0	94.50	partial (>50%)
House 14	11.0	7.2	79.20	partial (>50%)
House 15	>16	6.5	>104	minimal
House 16	21.5	7.0	150.50	complete
House 17	>11	7.5	>82.5	minimal
House 18	18.5	6.5	120.25	partial (<50%)

Because of disturbance from agricultural practices, the excavation began with the removal of the ploughzone by shovels (Warrick 1984b: 4). When the site was exposed, the longhouses were excavated in five meter square units, and the middens in one meter units (Warrick 1984b: 4). In 1978 the midden material was screened through 0.5 inch (12 mm) mesh, but in 1979 was screened through 0.25 inch (6 mm) mesh (Warrick 1984b: 4). This inconsistency could have affected the amounts of material recovered from 1978 and 1979 but Warrick (1984b: 6) determined that the screen sizes did not significantly alter the number of recovered ceramics. The recovery techniques of the houses, features and middens were also different. The middens were screened, but the houses and features were not. Artifacts from the houses and features were hand-picked (Warrick 1984b: 5). As a result, the recovery rates in the houses and middens are different. This is also due to the variation in artifact content and condition between the middens and houses. I would expect broken pots to have been discarded in middens, which would accumulate refuse from multiple households and result in a greater number of sherds being recovered. Whole vessels were probably taken away when the Fonger people moved to another location, minimizing ceramic remains within longhouses. Ultimately, the excavations resulted in the recovery of 5285 ceramic sherds, 4884 of which came from the middens and 401 of which came from the houses (Table 2).

Table 2. Number of sherds from the houses and middens for the entire Fonger collection held at McMaster University.

	Body	**Neck/Shoulder**	**Rim**	**Juvenile/Waste/Pipe**	**TOTAL**
House 1	176	12	9	1	198
House 2	82	2	5	1	90
House 3	8	1			9
House 4	6			1	7
House 5	2				2
House 6	10				10
House 7	14				14
House 8	7				7
House 9	21		1		22
House 10	3	1	1		5
House 11	1	1			2
House 12	3				3
House 13	10	1	1		12
House 14	26	3			29
House 15	5		1	1	7
House 16	14	3	1	1	19
House 17	11		2		13

Table 2. Continued

	Body	Neck/Shoulder	Rim	Juvenile/Waste/Pipe	TOTAL
House 18	2				2
Midden A	2418	60	155	87	2720
Midden B	1916	20	126	46	2108
Midden C	46	1			47
Midden D	334		2	2	338
Midden E					0
Midden F	170	8	8	2	188
TOTAL	5285	113	312	142	5852

Analysis and Results

Based on inferences about "village demography, sequence of house construction and occupation and the proximity and geometrical patterning of houses, middens and open areas" (Warrick 1984a: 98-99), Warrick believes the Fonger site was divided into two residential wards, where each group was composed of "an aggregate of closely interacting households" (Warrick 1984a: 98). The west segment was comprised of houses 1 through 7, house 16 and middens A, C, E, and F, while the east segment was comprised of houses 8 through 15, house 17, house 18, and middens B and D (Warrick 1984a: 100). The east and west segments of the site were most likely contemporaneous, based on the construction sequence of the houses (Warrick 1984a: 99).

Warrick provided a general description of the ceramics by recording attributes from 1930 ceramic fragments, including rim, neck, shoulder, and body sherds, castellations, appliqués, juvenile ceramics, ceramic waste, and pipe fragments (Warrick 1984b: 108). Body sherd examination included observations on temper type, thickness, and surface treatment (Warrick 1984b: 109). Temper types were recorded as either grit or shell (Warrick 1984b: 109). Surface treatment on the body sherds included the categories:

plain smoothed, plain polished, ribbed paddle, smoothed-over ribbed, cord impressed, smoothed-over cord, and decorated (Warrick 1984b: 109). Warrick disregarded body thickness because he believed that "such a measure is a function of several factors, including vessel size (i.e. assuming body sherd thickness varies directly with pot size), vessel breakage rates (i.e. different use-lives for different size pots), and site longevity" (Warrick 1984b: 109-110). Rim sherd analysis evaluated temper type, surface treatment, decorative motif, exterior and interior profile, lip profile, presence/absence of a collar, and collar height (Warrick 1984b: 110). Neck sherd analysis included temper type and decorative motif, while shoulder sherd analysis examined form and decorative motif (Warrick 1984b: 116-119).

To see if his interpretation of two distinct site wards was also reflected in the ceramics, Warrick examined 70 rims with impressed designs, primarily from middens A and B (Warrick 1984a: 108, 118). The attributes, subjected to nonparametric statistical tests, included exterior, interior, and lip decorative motif, rim form (collared or uncollared), collar base shape (angled or rounded), collar height, lip width, maximum temper size, the presence or absence of interior carbon encrustations, estimated pot mouth width, and spacing between impressed motif elements on rim exterior and interior (Warrick 1984a: 124-125). The only spatially statistically different attributes included the interior motif and exterior design technique (Warrick 1984a: 125). Based on this, as well as the settlement patterns, Warrick argued for the existence of two closely associated and interacting groups within a single village at the same point in time.

Comments on the Ceramic Analysis

The purpose of Warrick's investigation was to study village organization and not to examine how the Fonger villagers made and used ceramics. To achieve his goal, Warrick used formal rim attributes to see if ceramics reflected the spatially separated wards identified through the settlement patterns. Although he did use ceramics to study village organization, his analysis did not include a detailed reconstruction of ceramic operational sequences. Because the choices potters make while creating a vessel are socially influenced, by investigating Fonger ceramic operational sequences we may be able to see choices and techniques that reflect more community based ways of doing things and steps that are less structured. In this way, steps other than those suggested by rim sherd attributes, such are raw materials preparation or firing, may also be indicative of community groups. Steps in the ceramic operational sequence from the west ward can be compared to the east ward to see if the two groups of potters had distinctly different ways of making a vessel, which would suggest that there were at least two separate groups of potters.

Chapter 3: Methodology and Methods

To understand how functional, mechanical, environmental and social factors influenced the ways potters manufactured their vessels, I investigated the options available to potters, the actual choices potters made while creating a vessel and the range of variation within each step of the ceramic operational sequence. I also examined the Fonger ceramics to test Warrick's (1984a, 1984b) division of the site into two social groups. In order to see people expressing their attitudes and constructs about the world by following or not following social 'rules' and to demonstrate how tangible cultural products carry social meaning, I needed to observe every step within the ceramic operational sequence, which includes the following major stages: raw materials collection and preparation, forming, finishing, decorating, firing, use and discard. To do this, I used a methodology that combined macroscopic, petrographic, x-ray diffraction (XRD) and re-firing analyses, as well as a raw materials survey and experimental archaeology.

Raw Materials

It is important to understand how potters selected and prepared their raw materials. By examining the range of locally available raw materials in relation to the materials the potters actually used, we can begin to understand the potters' actions. Did they use local materials? Did they target specific clays and/or temper? Did they prepare specific clay recipes, controlling the kind, amount, shape or size of the inclusions? Did such manipulations have an apparent effect on the mechanics (e.g. strength, toughness, workability) or the function of vessels?

Macroscopic Analysis

To investigate the types of raw materials exploited and the raw materials preparation techniques used by Fonger potters, I used a stereoscopic microscope at 20x magnification to observe in a fresh break of each sherd the types and shapes of inclusions, temper amounts and sizes, as well as the degree of temper sorting. For every sherd, the data were recorded on a data sheet (Appendix 1). Once the data were collected, they were entered into a database for analysis.

I selected a sample for macroscopic analysis based on the following criteria:
1) that all sherds would be large enough to allow samples removed for petrographic and x-ray diffraction analysis and
2) that all steps of the operational sequence would be observable (e.g. no sherds with a spalled surface were included, even when they were large in size to allow microscopic analyses).
I selected sherds larger than 2 cm x 2 cm with both original surfaces preserved. Any sherd that contained a label that covered over 75% of either surface was excluded in order to accurately observe all steps of the operational sequence including forming, finishing, firing, and use. Any sherd whose provenience was unknown was also excluded. Based on these criteria, the macroscopic sample included 876 sherds. Sherds from juvenile vessels were excluded from the sample because they did not fit the size criteria and because the focus of this study is on household vessels. Table 3 shows the type and number of sherds selected for the macroscopic sample from the houses and middens.

The majority of the sample is derived from middens A and B, because few sherds larger than 2 cm x 2 cm were recovered from the houses. The small number of large recovered sherds in houses and the lack of recovered whole vessels limit the conclusions that can be drawn about individual household variation in ceramic manufacture. The entire sample, including middens and houses, is a better representation of the range of variability of the choices made by Fonger potters.

Table 3. Number of sherds selected for the macroscopic sample from each midden and house.

	Body	**Rim/Neck/Shoulder**	**Rim**	**Total**
house 1	14	12	2	28
house 2	32	3		35
house 3	5			5
house 4	6			6
house 5	2			2
house 6	3	1		4
house 7	1			1
house 8				0
house 9	2			2
house 10	2	1		3
house 11		1		1
house 12	1			1
house 13	3	1		4
house 14	13	2		15
house 15	1	1	1	3
house 16	4	1		5
house 17	2	1	1	4
house 18				0
midden A	312	100	29	440
midden B	142	71	26	239
midden C	8			8
midden D	12		1	13
midden E				0
midden F	39	16	1	56
Total	604	211	61	876

The sample from the west side of the site is larger than that from the east side, because the west segment was excavated more thoroughly. Accordingly, more variation in ceramic manufacture could be expected from the west side of the site, because more sherds were recovered and thus more data were collected. Because houses 1, 2, 9, and 16 were completely excavated, they could be used in the analysis of variation within households. However, because of the very small number of sherds recovered from these houses (n=70) (Table 3), household variation cannot be accurately studied, so my focus will be on the overall variation within the village.

By identifying the types of inclusions present in the Fonger ceramics, whether naturally occurring in the clays or culturally added by potters as temper, I can investigate if potters were specifically targeting raw materials. This is because a narrow range of inclusions in the Fonger sherds may suggest potters were targeting specific inclusion types. Inclusion shape can provide information about the raw materials potters selected, as well as preparation techniques. Naturally rounded or weathered inclusions suggest that either the inclusions were found naturally within the clay or that potters added sediments with naturally rounded particles in them. Angular inclusions suggest potters spent time crushing temper, added naturally angular temper, or angular inclusions were naturally occurring in the clay, as in the case of primary clays. By documenting the temper size and degree of temper sorting, I can investigate if potters separated out and/or targeted specific inclusion sizes. For example, I would conclude that potters took care to sort and target a specific size if all the inclusions within a sherd were about 4 mm in diameter. If potters did not target a specific size of inclusion, I would expect a range of inclusion sizes. The amount of inclusions present within the sherds can suggest whether or not potters were intentionally opting to add specific amounts. (See Appendix 2 for a summary of how the macroscopic observations relate to the operational sequence and human behaviour). Appendix 2 provides the definitions and methods for measuring each variable.

Petrography

To test my macroscopic observations of the raw materials selected and the raw material preparation techniques used by potters, and to obtain details not observable macroscopically, I subjected a sample of Fonger sherds to petrographic analysis, which provides a more accurate assessment of the kind, size, shape, orientation and amount of inclusions within the clay paste.

A sample of sherds from each macroscopically defined fabric group was selected. The sample included sherds from:

1) the four macroscopically observed temper types

(a) majority quartz/feldspar,

(b) majority black and shiny particles,

(c) equal amounts of quartz/feldspar and black and shiny particles, and

(d) shell,

2) the full range of inclusion percentages (between 3-35%),

3) the full range of inclusion sorting categories (from very poor to good),

4) the full range of inclusion orientation categories (chance, medium or clear),

5) the full range of inclusion shapes (from angular to rounded), and

6) the full range of inclusion sizes (from 0.5-5mm) (Table 4).

Table 4. Petrographic sample and the variables that were considered when selecting the sample.

Sherd#	Midden	Inclusion Type	% Inclusions	Inclusion Orientation	Inclusion Shape	Inclusion Sorting	Inclusion Size (mm)
1039	A	Quartz/ feldspar	25	Chance	Sub-angular	Poor	0.5-3.0
1285(9)b	A	Equal black and shiny particles to quartz/ feldspar	15	Medium	Angular	Fair	0.5-2.0
1334	A	Equal black and shiny particles to quartz/ feldspar	25	Chance	Angular	Fair	0.5-2.0
1525(3)	A	Quartz/ feldspar	7	Medium	Angular	Fair	0.5-1.0
1687(9)b	A	Shell	15	Medium	Angular	Poor	0.5-4.0
1711(5)	A	Black and shiny particles	7	Chance	Sub-angular	Fair	0.5-1.0
1752(7)	A	Equal black and shiny particles to quartz/ feldspar	7	Chance	Angular	Very poor	0.5-2.0
2079(1)b	A	Black and shiny particles	25	Medium	Angular	Very poor	0.5-2.0
2395(1)c	A	Black and shiny particles	20	Chance	Angular	Good	< 0.5
3679(1)	A	Quartz/ feldspar	20	Chance	Sub-rounded	Very poor	0.5-2.0
1250f	B	Quartz/ feldspar	25	Chance	Angular	Poor	0.5-4.0
1260(8)	B	Equal black and shiny particles to quartz/ feldspar	7	Chance	Sub-angular	Poor	0.5-1.0

Table 4. Continued.

Sherd#	Midden	Inclusion Type	% Inclusions	Inclusion Orientation	Inclusion Shape	Inclusion Sorting	Inclusion Size (mm)
1277(12)	B	Quartz/ feldspar	3	Medium	Angular	Fair	0.5-2.0
1719g	B	Black and shiny particles	15	Chance	Angular	Fair	0.5-1.0
1719(14)	B	Equal black and shiny particles to quartz/ feldspar	25	Medium	Angular	Poor	0.5-3.0
2030(10)e	B	Shell	15	Clear	Angular	Good	0.5-1.0
2030(12)	B	Black and shiny particles	5	Chance	Angular	Very poor	0.5-3.0
2074(1)	B	Equal black and shiny particles to quartz/ feldspar	15	Chance	Angular	Good	< 0.5
2405(2)	B	Quartz/ feldspar	20	Chance	Sub-angular	Good	0.5-1.0
2525a	B	Black and shiny particles	20	Chance	Angular	Poor	0.5-2.0

Twenty sherds, 10 from midden A and 10 from midden B, were subjected to petrographic analysis. By selecting sherds from different areas of the site, microscopic differences that may reflect spatial differences can be investigated. From each midden, three sherds from each different temper type, other than shell, were selected. Out of the three sherds selected per temper type, I tried to select one sherd with 3-7% temper, another with 10-20% temper, and the last with 20-35% temper. This represents the various temper amounts within the assemblage. Also out of the three sherds per temper type, I selected sherds that contained differently sorted temper (very poor, poor, fair, or good), different temper shapes (angular, sub-angular, sub-rounded, or rounded), and different temper sizes (0.5, 1, 2, 3, or 5mm). Finally, within each temper group sample, there are sherds of medium and chance orientation. Some sherds within the middens did not contain the above specified characteristics. For example, in midden B there are no sherds that contain black and shiny material as temper with a sub-angular or sub-rounded shape. When this was the case, I selected sherds that covered as much of the different characteristics as possible. Table 4 shows the sherds that were sent for petrographic analysis along with the characteristics that the sample was based upon.

The thin-section slides were prepared at the Department of Geology, University of Western Ontario. Once the thin-sections were prepared, the slides were given to Greg Braun from the University of Toronto for analysis. To ensure that the petrographic analysis was conducted without any biases, I did not provide Greg Braun with information about how I chose the sample or any contextual information about the sherds until he had completed the analysis. However, I supplied Mr. Braun with an outline of the information that I was seeking through petrographic analysis (Appendix 3).

Raw Materials Survey

To understand the natural range of locally available raw materials, I conducted a raw materials survey. By comparing the actual choices in raw materials to what was available to potters locally, I could determine if they were targeting specific types of raw materials and if their materials were local.

The raw materials survey was initially conducted within a 7 km radius of the Fonger site (Figure 4), because, as demonstrated by Arnold (1985: 38-50, 227) with ethnoarchaeological evidence from 111 communities, the vast majority of potters (84% in Arnold's example) collect their raw materials locally within a 7 km radius from their living and working area. I consulted geographical soil maps, as well as geological maps, of the 7 km area to identify possible clay and/or temper sources. According to these maps, there were no obvious clay deposits and the overlying soil was clayey sandy loam (Cowan 1972). However, the maps did indicate the presence of sand and gravel deposits that could have provided temper (Cowan 1972; Staff of the Engineering and Terrain Geology Section Ontario Geological Survey: 1980).

With this knowledge of the local landscape, I started at the centre of the survey area, which was the Fonger site, and collected clay samples, approximately 10 litres each, from two different areas around the Fonger site. To see if the material I was collecting was in fact clay, I conducted a standard field test for clay, which includes rubbing clay between two hands to form a coil. If a long coil forms without breaking, the material is likely suitable for pottery making (Rye 1981: 13). Samples 1 and 2 were collected from the immediate vicinity of the Fonger site. The remaining clay samples were collected further away from the Fonger site. To locate samples, I drove the roads in the 7 km radius of the site looking for river cut banks, road cuts, steep slopes or any other area that could have exposed a clay source. Samples 3, 4, 5 and 6 were collected throughout the survey area (see Table 5 and Figure 4 for exact locations and descriptions).

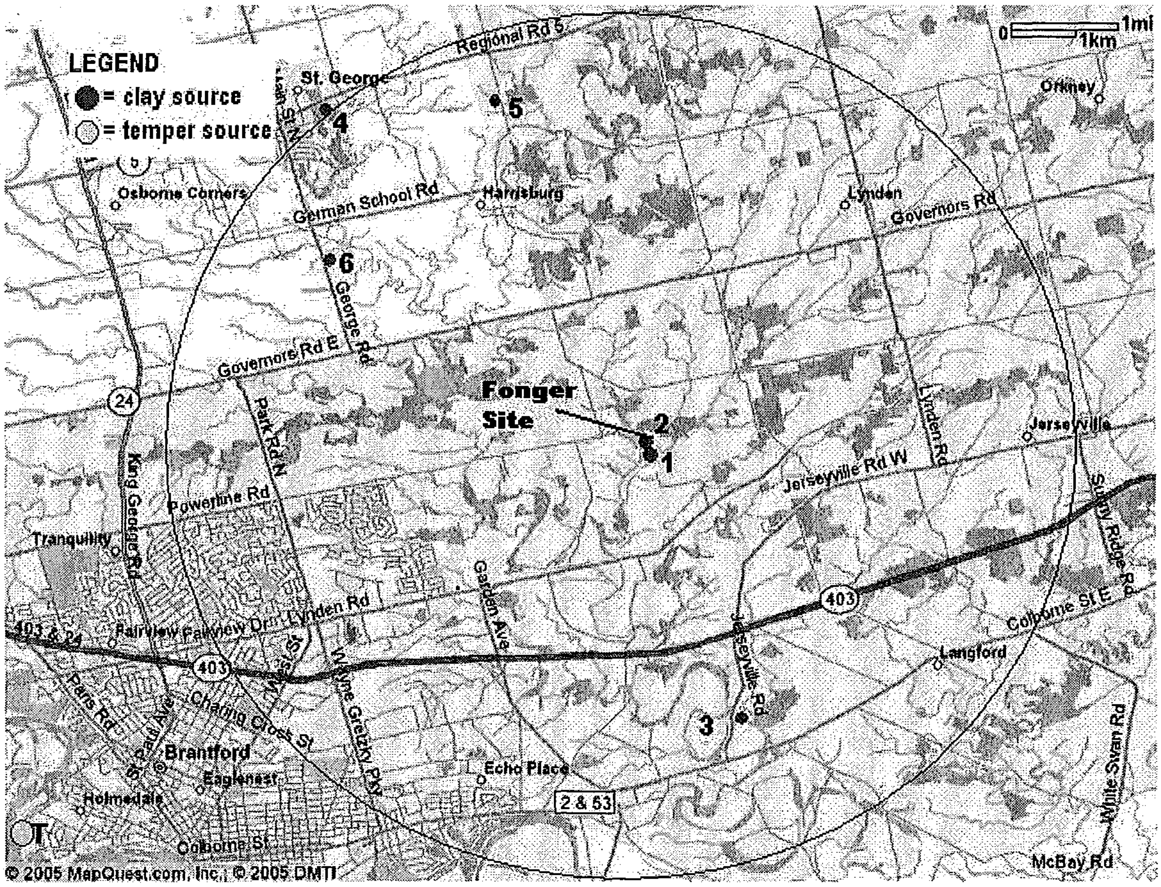


Figure 4. Raw Materials Survey Map identifying the locations of the clay and temper samples.

Table 5. Locations of the clay samples collected in the raw materials survey.

Sample	Location	Collection Details
1	Southwest of the Fonger site on Fairchild Creek bank.	1 meter above the water level, 25 cm below the ground surface.
2	West edge of the Fonger site, on the slope towards Fairchild Creek.	5 meters down the slope, 25-40 cm below slope surface.
3	South of the Fonger site at 45 Jerseyville Road on the steep north bank of the creek.	3 meters above water level, 25 cm below slope surface.
4	Northwest edge of the survey area near St. George, south of Beverly Street East.	7 meters below the road surface on the west bank of the ravine, 15 cm from the surface.
5	Northwest of the Fonger site, north of 407 Harrisburg Road on the west side of road cut.	1 meter below agricultural field surface, 35 cm into cut bank.
6	West of the Fonger site, east road cut bank at 84 St. George Road.	1.5 meters below top of cut bank, 45 cm into the road cut.

Both clay and temper were collected in the raw materials survey. In the macroscopic analysis, I noted the presence of black and shiny material, quartz and feldspar. These minerals are found in granite and there has been a commonly held idea that Iroquoian ceramics were tempered with crushed or disintegrating granite, also known as grit (Cooper 1998: 22; Fitzgerald 1982: 257; Lennox 1984: 75, 212; Schoolcraft 1847: 222). Interestingly, sherds with shell temper are also present at the Fonger site. Because of this, I needed to explore if and where shell and granite or granite-like minerals were locally available.

I could not locate possible tempering materials anywhere in the survey area, even though I searched along the edges of fields, creek banks and beds, and around the Fonger site down to the nearby creek. Reexamining the geographical and geological maps of the Brantford area (Staff of the Engineering and Terrain Geology Section Ontario Geological Survey: 1980), I noticed that, although there were only few sand and gravel deposits within the 7 km radius, several more existed beyond the 7 km range, near the Grand River. When I searched for the sand and gravel deposits within the survey region I did not find them, possibly because they had been depleted over several years or had been destroyed through residential development.

Based on the geological maps I expanded my search 3 km beyond my initial survey radius. Potters could have collected temper beyond 7 km since, according to Arnold (1985: 32-57, 232), potters often travel further to obtain tempering materials. I walked along both the east and west shores of the Grand River looking for rocks and sand that contained minerals similar to the Fonger temper, as well as shell. On the east bank of the Grand River I collected sand, but this material did not look like the granite-based material in the Fonger ceramics. I also collected freshwater clamshells from the shallow waters and east bank of the Grand River. This material was accessible to the Fonger potters and is a possible temper source. However, I could not find enough shells, possibly due to development along the river, pollution, which has decreased the clam population, and the fact that I was only collecting from the bank and not from further into the water. To collect enough shell, I added freshwater mussel shells from the shore of Lake Ontario in Oakville. As I was looking for tempering materials, I also was trying to locate additional clay sources from the Grand River area. However, the riverbanks were composed of mainly sand, gravel, small pebbles and very sandy mud soil. As a result, no clay samples were collected.

Creating Test Tiles

It is important to understand how much shrinkage occurs during drying, when the different types of clays and tempers collected in the raw materials survey are mixed together in various amounts, since too much or rapid shrinkage can cause deformation and cracking (Rice 1987: 70) which can lead to mechanical failure. If a vessel does not survive the initial drying process, then it will not be fired. By examining the difference in the shrinkage of different clay pastes made with local raw materials, I can determine which ones would shrink less and, thus, be better for making pottery, from a materials science point of view.

To assess the shrinkage of the available raw materials, I used the six clay samples and two temper types I collected in the raw materials survey. When I collected the raw materials, I noticed large natural inclusions and organics, which were not present in the Fonger material. This made me suspect that Fonger potters possibly refined their clay in some way. In order to see any differences in unaltered natural clays and refined clays, half of each sample was levigated and slaked. Levigation is a process that separates fine material (like clay) from coarser material by mixing water with the clay and allowing the coarser material to settle to the bottom (Rice 1987:478). Slaking allows clay lumps to disintegrate and the clay to absorb its full capacity of water (Rye 1981:36). With the initial six samples and half of each sample slaked, in total, there were twelve clay samples.

Initially, the clay samples were dried and crushed into sand sized particles using a hammer stone. Approximately half of each clay sample was placed in a 20-litre bucket. Water was added to the buckets until there were several inches of water above the clay. I agitated the water and clay once daily for four days then let the clay soak undisturbed for over a week, allowing the water to penetrate all the clay particles. By allowing the buckets to sit untouched, the clay and water separated out. Heavy particles, such as sand and pebbles, sunk to the bottom of the bucket. Above this, the clay was suspended and covered by a lighter layer of water and organic material. By removing the excess water and organic material, I was able to extract refined clay. The natural raw unslaked clay samples were crushed using a hammer stone into a fine powder and handpicked to remove larger pebbles, gravel, and organics.

To understand the shrinkage that occurs when the clays are mixed with different amounts and types of temper, I created test tiles with 0%, 15% and 25% temper. In the macroscopic analysis, I discovered that potters used 3-35% temper. Thus, I chose to use 15% and 25% temper in the test tiles to be within the range of temper amounts in the Fonger ceramics. Because all shell-tempered ceramics from the Fonger site contained 15% shell temper, I did not make 25% shell-tempered tiles.

To make tiles in the correct proportions of temper to clay, I measured out 15% and 25% temper to 85% and 75% dry unslaked clay by volume. For the slaked clay however, I measured damp clay by volume. After mixing the accurate proportions of clay to temper, water was slowly added and kneaded into the clay paste. This transformed the clay and temper mixture into a plastic mass. I produced four 3 cm by 12 cm by 1 cm tiles for every type of clay and temper combination, thus making 198 tiles, which included 48 types of ceramic pastes. Four tiles of each paste type were formed in order to fire a tile at 500°C, 600°C, 800°C, and 900°C respectively (Figure 5). The reason for these temperatures is explained in the section on 'Firing".

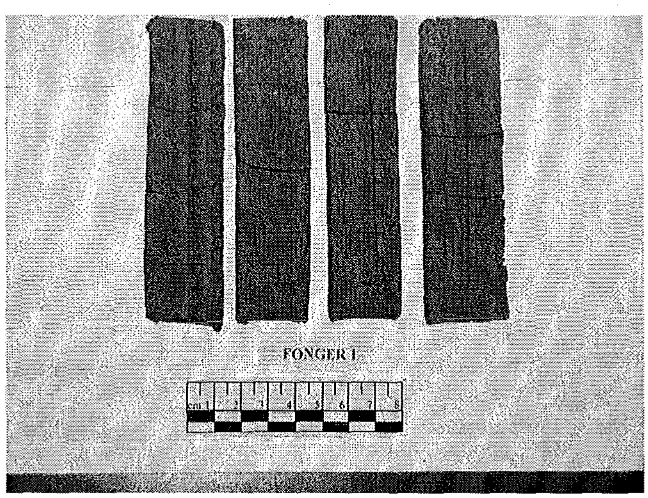


Figure 5. An example of four test tiles with incised shrinkage lines (vertical). The tiles in the picture were made from untempered, unslaked Fonger 1 clay. They have been dried but not fired.

Every tile was incised with a 10 cm line while it was wet. This line was used to assess the shrinkage that occurs throughout drying. As the water evaporates between the clay and temper particles, the clay particles are drawn closer together causing shrinkage (Rice 1987: 64). The amount of shrinkage is affected by clay particle size, orientation of clay particles (Rice 1987: 67-69), and the amount of inclusions. With smaller particles there tends to be more shrinkage, because the particles can be pulled closer to each other (Rice 1987: 63-67). Particles that are randomly orientated allow less shrinkage than particles aligned in the same direction, because the randomness prevents them from being packed tightly together (Rice 1987: 68-69). The amount of inclusions also plays a major part in shrinkage, because temper is non-plastic and, thus, not affected by water. Due to this, inclusions restrict the clay particles from drawing as near to each other. Generally then, as the amount of inclusions increases, the amount of shrinkage decreases.

The tiles were dried slowly for several weeks in order for all the water to evaporate. Once the tiles were dry, each tile was measured and the percentage of linear drying shrinkage was calculated, using the following formula (Rice 1987: 71):

$$\text{Linear Drying Shrinkage \%} = \frac{\text{Length wet} - \text{Length dry}}{\text{Length wet}} \times 100$$

X-Ray Diffraction Analysis

In terms of raw materials, x-ray diffraction can provide information regarding the types of inclusions, both naturally present or added, as well as the types of clay minerals present in the clays Fonger potters were using, if the vessels had been low fired. I can then compare locally available clays to the types of raw materials that Fonger potters selected and determine if Fonger ceramics were made from local resources.

Based on the results of the petrographic analysis, a smaller sample that represented the range of inclusion types was selected for x-ray diffraction (Table 6a). I also submitted pieces of the untempered natural clay fired to 500°C from each clay sample collected in the raw materials survey (Table 6b). This analysis was undertaken at the McMaster Analytical X-Ray Diffraction Facility, using a Bruker D8 ADVANCE x-ray diffractometer, Cu (copper) K alpha (K alpha one) radiation, under 40kV voltage, 40mA current and a scan speed of 0.1 degrees per minute.

Table 6a. XRD sample of ceramic sherds from middens A and B and associated inclusions identified petrographically.

Sample	Location	Major Inclusion Types
1039	Midden A	Tempered with alkali feldspar granite
1285(9)b	Midden A	Tempered with quartz monzonite
1687(9)b	Midden A	Tempered with shell
2395(1)c	Midden A	Tempered with hornblende granite
1260(8)	Midden B	Tempered with quartz syenite
2030(10)e	Midden B	Tempered with shell
2074(1)	Midden B	Tempered with alkali feldspar granite

Table 6b. XRD sample of geological clays.

Sample	Location
Fonger 1 fired to 500°C	See table 5
Fonger 2 fired to 500°C	See table 5
Jerseyville 3 fired to 500°C	See table 5
St. George 4 fired to 500°C	See table 5
St. George 5 fired to 500°C	See table 5
St. George 6 fired to 500°C	See table 5

Primary and Secondary Forming

Understanding the forming techniques can answer the following questions: Did potters within a single village use different forming techniques? Were different techniques used to form different parts of the vessel? Did potters use different techniques to form different vessel shapes? How many shapes and sizes of vessels did potters make?

To answer these questions about Fonger potters, I used macroscopic analysis and experimental archaeology.

Macroscopic Analysis

To identify the type of primary and secondary forming techniques used in Fonger vessel manufacture, I documented crack and breakage patterns as well as inclusion orientation. Certain primary methods of forming create distinct fracture patterns. For example, vessels made by coiling break into sherds with irregular meandering edges or more indicatively, into step-like fractures along coil boundaries (Rye 1981: 68). Another line of evidence that reflects the method of forming is finger impressions, which suggests pinching.

Secondary methods of forming also create noticeable patterns. For example, paddle and anvil force the inclusions within the clay matrix to align in specific directions. When the potter hits the vessel with the paddle, the inclusions are pushed parallel to the vessel surface (Rye 1981: 85). Paddle and anvil also leaves characteristic laminar fractures (Rye 1981: 85).

To determine the shapes and sizes of the vessels created by potters, I made several macroscopic quantitative measurements and qualitative observations using the naked eye. Quantitative measurements included body, neck, rim, collar, and lip thickness, collar, neck, and maximum height, and rim and neck diameter and preservation amount. Qualitative observations included rim direction, lip form, and castellation type. These variables are defined in Appendix 2.

Experimental Project

To understand the possible techniques, tools and gestures used in manufacturing Fonger pottery and to assess the workability of each clay sample, I formed vessels using the raw materials collected in my survey according to the methods I identified in the macroscopic analysis. My goal was to compare the workability of the different pastes to each other and follow the operational sequence identified macroscopically to hopefully gain insight into the possible choices potters would have to make when manufacturing a vessel.

After the clay had been prepared and the temper crushed, I started with a lump of clay and added temper by kneading the paste together. I added water as needed to make the paste workable but not sticky. Once the clay, temper and water were mixed well, I created a ball with the paste and used my fingers to make a hole in it. By pinching the sides and pulling slightly outwards, I made the bottom of the vessels. I was careful not to pull the sides out and up too much as to make the bottom too thin and unable to support the addition of coils.

To build up the sides of the vessels, I made and added coils by rubbing both my hands together to create long coils, which were approximately 2 cm in diameter and long enough to surround the pot. I added coils, connected them to the base and smoothed the base of the pot by moving my fingers up and down (vertically) and going around the pot at the coil joint (horizontally). If needed, I added water to the lip of the base before I added the coils and moistened my fingers to make the joining and smoothing easier. However, if too much water was added the walls would slump. Another coil or two was added to build up the sides and form the neck and rim. I used both hands to go over the vessel from the bottom upwards and make a slightly constricted neck and flared out rim. Throughout the whole process, I made sure that the base was not cracking and that it did not become too thin. I also pulled the clay horizontally on the inside to thin the walls and pushed the inner wall outwards to create a globular shape. On the outside base of the vessel, I pushed any sharp edges in and under to make a rounded bottom. During the entire forming process, I noted and compared the workability of each type of ceramic paste. In total, I made 24 vessels with different clays and tempers using the basic operational sequence.

Finishing

I can gain more insight into the choices potters made while finishing their vessels by investigating the following questions: Do potters finish their vessels? If so, how? Do potters smooth vessels in the same direction or do they smooth vessels randomly or not at all? What tools and gestures are associated with vessel finishing? Are there mechanical or functional variations when vessels are finished differently? In an effort to answer these, I employed macroscopic analysis and experimental archaeology.

Macroscopic Analysis

To understand the techniques, tools and gestures that Fonger potters used to finish their vessels and the relative amount of time spent on this activity, I made several qualitative macroscopic observations which included documenting any secondary forming and finishing techniques, including smoothing, burnishing, cord-wrapped stick impressions, ribbed paddle impressions, smoothed-over cord impressions, smoothed-over ribbed impressions, and scarification, as well as the direction or directions of smoothing marks on both the interior and exterior surfaces. Some of these techniques may have taken more time to execute than others. For example, smoothing over cord-wrapped stick impressions could take more time than leaving a cord-wrapped stick impressed vessel as is, unless the smoothing was accidental. These variables are defined and the evaluation criteria are outlined in Appendix 2.

Experimental Project

To understand the techniques, tools and gestures needed to finish vessels, I finished the vessels I formed using techniques identified in the macroscopic analysis of the Fonger material.

The macroscopic analysis showed that all shell-tempered sherds were finished with cord-wrapped stick. Thus, I made the shell-tempered vessels the same way with the formation of a base and the building up of the sides with coils but before the neck and rim were formed, I paddled the outside.

When the vessels were leather hard, I moistened my fingers and smoothed the body surfaces and lip. I also used wet fingers to repair and smooth over any cracking on the base, neck and/or rim. Most of the Fonger material was smoothed. Because of this smoothing, evidence suggesting vessel surfaces were scraped prior to smoothing may have been eliminated. As a result, I scraped then smoothed some vessels, whereas others I strictly smoothed. I used a chert scraper to remove bumps and uneven surfaces, and to thin the walls. The scraper also removed excess clay from the exterior of the base to create a more globular vessel. I also scraped the exterior of the neck to smooth it out and to improve the globular shape. Scraping also thinned the interior walls and increased vessel volume. I also scraped the lips of some vessels to form a flat edge, as observed on some Fonger rims.

Decorating

Potters choose to decorate or not to decorate their vessels. If they do, they must decide where, how and with what tools to apply the decoration. By investigating the decoration on the Fonger ceramics through macroscopic analysis, I am able to observe the range of variation at this step.

Macroscopic Analysis

I observed the location of decoration applied and the type of decoration, either incised, impressed or notched, on the macroscopic sample. I also recorded information that described the shape of the decoration and/or tool, for example pointy, trailed, notched, dentate stamped or punctate, to determine the types of gestures and tools used by potters. A definition of each decoration technique is outlined in Appendix 2.

Firing

To understand the choices potters made when firing their vessels, I wanted to answer some key questions: What conditions did Fonger potters create in order to fire their vessels? To what temperatures were Fonger pots fired? In what types of atmospheres were Fonger vessels fired? Did potters take vessels out of the fire while hot, cooling vessels fast, or did they leave the vessels in the fire to cool slowly? Did potters fire their vessels at specific temperatures? To answer these questions I used: macroscopic analysis, petrography, XRD, re-firing tests, test tile firing and experimental archaeology.

Macroscopic Analysis

By documenting the exterior and interior surfaces and core colours, as well as the boundaries between the surfaces and the core of each sherd in the macroscopic sample, I can identify the firing atmospheres potters created while firing their vessels. There is a relationship between the surface and core colours of fired ceramics and the original firing conditions (Rice 1987: 345). Generally, sherds with brown to light gray surfaces and cores that are similar in colour are fired in oxidizing or incompletely oxidizing atmospheres (Rice 1987: 345). Sherds with gray to dark gray to black surfaces with light gray to black cores are likely fired in incompletely oxidizing or reducing atmospheres (Rice 1987: 345). Before conclusions about the firing atmosphere can be drawn, other valuable information regarding the presence of sooting, carbon deposits and depositional conditions must be gathered because these variables can mask evidence about the original firing atmosphere. Because of this, I not only documented the surface and core colours of the ceramics, but also the presence or absence of sooting and carbonized remains.

Potters opt to remove fired vessels from the fire before the pots cool or they can decide to leave the pots to cool slowly in the fire. To determine what Fonger potters did in terms of cooling, I observed the boundaries between the core and the surface. Diffused cores suggest pots were cooled slowly, whereas sharp boundaries suggest vessels were cooled quickly (Rye 1987: 116-117). These variables are defined and the evaluation criteria are outlined in Appendix 2.

XRD

I used x-ray diffraction (XRD) to aid in discerning the range of temperatures at which Fonger potters fired their vessels. If Fonger ceramics were fired below 900°C, then XRD could identify the clay minerals in the clays potters used. This is because "pottery fired to low temperatures (below 800°C) or for very short durations (or both) may rehydrate during burial and regain its crystalline structure, permitting x-ray identification of the clay mineral constituents, provided the rehydration has produced large enough crystals" (Rice 1987: 385). However, if Fonger potters used illite clays, the clay structure can persist until 900°C, at which temperature spinel appears (Rice 1987: 92). As a result, if XRD identifies clay minerals and no spinel, I can conclude that Fonger pottery was fired below 900°C. If clay minerals are not identified through XRD, I can conclude that there was not enough rehydration of crystals or if spinel is present that Fonger pottery was fired over 900°C.

Re-firing

I determined through macroscopic analysis that the majority of Fonger ceramics were fired in a combination of oxidizing and incompletely oxidizing environment. In order to understand more about the firing conditions and why Fonger sherds exhibit a wide range of surface colours, I re-fired pieces of Fonger ceramics.

The colour of fired clay depends on a number of factors, including the amount, size and distribution of organic materials and impurities, particularly iron, and the temperature, length of time, and atmosphere of firing (Rice 1987:333). Because carbon can be present in fired clay until over 800°C and iron does not display its full colour until

900°C (Rice 1987: 335, 344), I re-fired six sherds, representing a range of colours from orange to brown to gray to black, at 900°C in an oxidizing atmosphere.

The use of ceramic vessels, as well as post-depositional factors, also influences the colour of archaeological ceramics. If vessels are used for cooking over a fire, soot is deposited in a predictable pattern (Hally 1983; Skibo 1992). Since this study deals will ceramic sherds and not whole vessels, I cannot determine the exact pattern of soot deposits on Fonger cooking vessels. Because of use alterations and post-depositional modifications, I do not know exactly what the original firing colours were of the Fonger ceramics. By re-firing Fonger ceramics to 900°C, any post-depositional material influences, sooting from use, fire clouds from the original firing and residual organic material can be burnt off and eliminated from the archaeological material.

After the Munsell colour of the sherd was recorded, a piece was broken off and fired at 900°C in a tube kiln under oxidizing conditions. After re-firing, the Munsell colour was documented again.

Test Tile Firing

To understand specific characteristics, including solubility, colour development and point of calcium carbonate decomposition of the clay pastes I created with the local raw materials, I fired the test tiles in an electric tube kiln in an oxidizing atmosphere at 500°C, 600°C, 800°C and 900°C. It is important to understand these specific characteristics because I can then determine the temperature at which calcium carbonate decomposes, the temperature at which the test tiles are no longer soluble, the colour when fired under oxidizing conditions, and whether the characteristics (solubility, colour and point of calcium carbonate) change with increased firing temperature.

Solubility is an important characteristic, especially for vessels used for cooking and storing liquids. If a vessel dissolves with moisture, it will not hold water, resorting back to the original clay and temper paste. The raw materials, firing temperatures, and atmosphere used influence solubility. Because finer clays and tempers have smaller particles, the paste contents draw closer together during drying and firing. As a result, the number of pores in the ceramic matrix is reduced, limiting the area for water to penetrate, decreasing the rate at which vessels resort back to their initial clay and temper pastes. Another way to reduce solubility is to increase the firing temperature. As the temperature increases, more water is driven off and sintering occurs, which closes the pores (Rye 1981: 108). In addition, at higher firing temperatures, plastic clay minerals are permanently changed to non-plastic substances (Rice 1987: 90). Because increasing temperatures reduce the solubility, the tiles were fired at the four different temperatures in order to see if there were any changes in solubility as the firing temperature increased. The temperature at which sintering occurs can be lowered by firing ceramics in a reducing atmosphere (Rice 1987:354). Thus, ceramics fired in a reducing atmosphere are likely to be less soluble at lower temperatures than ceramics fired in an oxidizing atmosphere. However, the majority Fonger ceramics were fired under oxidizing or incompletely oxidizing conditions.

Impurities other than iron, such as organic material, calcium and other minerals in the clay paste, can also affect ceramic colour (Rice 1987: 333). Organic material can turn the surrounding matrix dark brown, gray, or black, whereas oxidized iron can turn the surrounding matrix red (Rice 1987: 333). If the temperature does not become high enough to totally burn off any organic material, or the duration of firing is not long enough, the organic material has an increased effect on colour (Rice 1987: 334). When the temperature reaches 900°C or hotter, the red colour of oxidized iron is present to its fullest (Rice 1987: 335). This is the reason why I fired some of the tiles at 900°C. In an oxidizing atmosphere, there are ample amounts of oxygen free to combine with any iron present in the clay, giving the clay paste a light colour, typically orange, red or light brown. This is why, I also fired some test tiles at 500°C, 600°C and 800°C under oxidizing conditions so that I could compare the colours of the tiles at different fired temperatures to those of the Fonger sherds.

The final observation of the test tiles is the point of calcium carbonate decomposition. Shell is present as temper in ceramics found at the Fonger site. The use of shell temper poses a particular problem, which warrants a discussion. Shell and other calcium carbonate materials, such as limestone, decompose into calcium oxide and carbon dioxide between 650°C-900°C (Rice 1987:98). When calcium oxide combines with water from the air during cooling it forms calcium hydroxide (Rye 1981: 114). The reaction is as follows:

$$CaCO_3 \rightarrow CaO + CO_2$$
$$CaO + H_2O \rightarrow Ca\,(OH)_2$$

Calcium hydroxide has a larger volume than the original calcium carbonate and thus expands (Rye 1981:114). Within a ceramic vessel, this expansion adds stress to the surrounding matrix and causes fractures, spalling, cracking and/or crumbling (Rice 1987:98; Rye 1981:114).

Shell-tempered sherds from the Fonger site contain shell that is easily identifiable. This does not mean that the vessels were not fired between 650°C-900°C. Potters can work with this physical property in a number of ways. For example, potters in Papua New Guinea add salt water or other forms of salt to their vessels, which prevents calcium carbonate from changing to calcium oxide and eventually to calcium hydroxide (Rye 1976). In another example, Moundville potters from Alabama fired shell before they crushed it and added it as temper to their pots (Steponaitis 1984:92), which also minimizes this chemical reaction (Bronitsky and Hamer 1986: 97-98). Pre-firing shell makes the shell easier to crush and causes the shell to break in platy rather than in blocky shapes (Feathers 2006: 92), which is a pattern that can be easily observed under a petrographic microscope. In addition, pre-firing shell between 300°C and 400°C changes the composition of aragonite in the shell to calcite (Feathers 2006: 92), which will be apparent through x-ray diffraction. Other techniques to reduce the breakdown of shell include wetting vessels with water while they are still hot, a method called docking, and firing vessels in a reducing atmosphere (Rice 1987:98).

The temperature at which calcium carbonate decomposition occurs depends on the types of raw materials and the firing atmosphere. Because the majority of Fonger ceramics were likely fired in an oxidizing atmosphere, I can focus on the types of raw materials. By firing test tiles made with locally available clays and shell temper at a range of temperatures (500°C, 600°C, 800°C and 900°C), I can pinpoint the temperature at which shell expansion occurs.

I fired tiles from each of the different paste types at a range of temperatures (500°C, 600°C, 800°C, and 900°C) rather than one specific temperature for four reasons. First, Ontario ceramic firing temperatures have not been the focus of systematic research. Second, it is believed that calcium carbonate (shell) decomposes between 650°C and 900°C (Rice 1987: 98). The successful shell-tempered Fonger ceramics do not exhibit this chemical change. I wanted to identify the temperature at which this decomposition occurs with the different paste types. For these purposes, I fired tiles below (500°C and 600°C), between (800°C), and at the very end (900°C) of the temperature range for calcium carbonate decomposition. Third, tiles were fired over a 400°C temperature span to observe any colour change and variation in solubility as the temperature increased. Finally, because the full development of iron colour occurs at 900°C, this temperature was specifically selected as the end temperature.

The heating rates, cooling rates and soaking times are also factors that influence the firing conditions. Macroscopically, I observed that the majority of boundaries between the exterior and interior surfaces and the core of Fonger ceramics are diffuse suggesting vessels were cooled slowly. However, because of this limited qualitative observation and the fact that there has not been research on firing conditions of Ontario ceramics, I relied upon ethnoarchaeological studies on heating rates and soaking times from around the world to provide a starting point. Livingstone-Smith (2001: 991-1003) summarizes ethnoarchaeological studies of heating rates and soaking times for different types of firing structures (open, pit, kiln) and types of fuel (wood, bark, palm fronds, leaves, dung). From his study I used the data on open and pit fires that use wood, bark, or leaves as fuel (Livingstone-Smith 2001: 994-995). Only information on open and pit firings was included as relevant to Ontario, because there is no archaeological evidence to date that suggests the Neutral or even the Iroquois used kilns. However, further investigations into domestic activities, ceramic manufacture and production, and a re-evaluation of hearths and features with a focus on firing locations might suggest otherwise. I only use the data on wood, bark and leaves as fuel because these are the kinds of fuel to which Neutral potters would have had access. To get a rough estimate about heating rates and soaking times, I calculated the average from 37 ethnoarchaeological studies, compiled by Livingstone-Smith (2001: 991-1003), on open fires and pit fires with wood, bark and leaf fuel. This calculation suggested an average heating rate of 42°C/min and a soaking time of 5.5 minutes. I am not suggesting that Neutral or other Ontario potters fired their vessels at a heating rate of 42°C/min and a soaking time of 5.5 minutes. This is just an approximation of possible conditions that I can use as a starting point to get a general idea of how locally available materials react when fired under given conditions.

Based on the ethnographic data, an electric tube kiln was selected for firing the test tiles (Figure 6a and 6b). The kiln did not have heating or cooling rate control so the tiles were heated between 38.1°C/min and 71.43°C/min. The cooling rates were between 11.95°C/min and 25.93°C/min. By having fast heating and cooling rates I could also see if the tiles survived rapid heating and cooling. When ceramics are heated and/or cooled quickly, if they cannot withstand thermal shock they will crack and weaken. To keep the soaking time (or the length of time at which each temperature was held) consistent with ethnographic studies, I held the temperature for 6 minutes once the maximum temperature was reached before starting cooling. This resulted in an average firing time of 57 minutes.

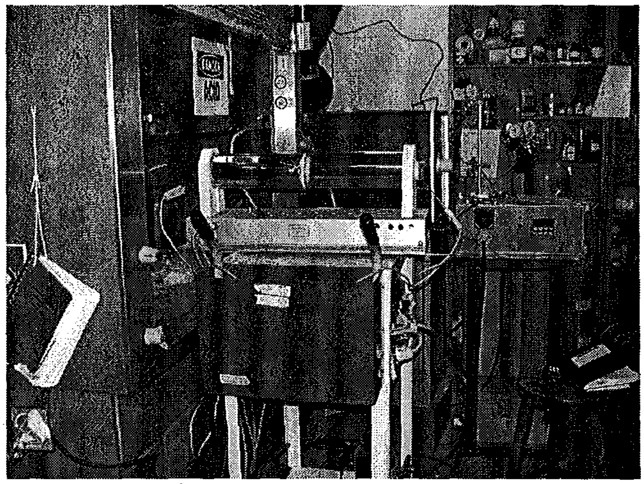


Figure 6a. Tube kiln used for firing test tiles and re-firing Fonger ceramics.

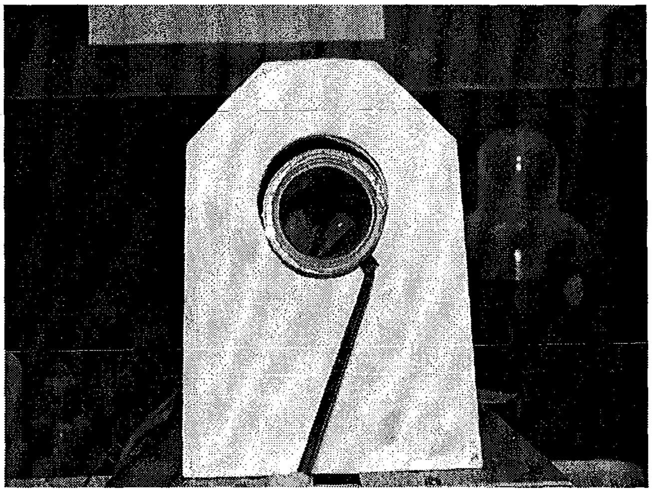


Figure 6b. Electric tube kiln firing tiles.

The tiles were fired in an oxidizing atmosphere, because oxidizing and incompletely oxidizing conditions were identified as the most predominant firing atmospheres in the macroscopic analysis of the Fonger sherds. Also, the atmospheric conditions from bonfires and open pit fires usually produce uneven and alternating environments, which result in incompletely oxidized or fire-clouded vessels.

After the test tiles had cooled and were exposed to the air for five days, I documented whether calcium carbonate decomposition had occurred to any of the shell-tempered tiles. If calcium carbonate decomposition had taken place, I noted the degree of crumbling. I recorded the colour of each tile using a Munsell chart for comparison. I broke off a piece of each fired tile and submerged it in water for 24 hours. After this time, I documented whether the tile had reverted back into the ceramic paste, being soluble, or whether it held its form, being insoluble.

Experimental Project

I fired the vessels created using the raw materials collected in the raw materials survey in an open pit in order to see if I could create a fire that would produce non-soluble vessels and to identify the colours that are associated with open firing. This is important in our understanding of the solubility and fired colours of the locally available raw materials when fired under more realistic, less controlled environments.

Detailed, focused studies into the type, scale, size and locations of Iroquoian pottery firings are still unexplored areas in Ontario ceramic research, but are essential to our understanding of ceramic manufacture. Because of this, I gathered information from the limited studies done in Ontario, research on the Iroquois in New York, and general information about Iroquoian life, to provide a background and basis for firing vessels.

Because there is no archaeological or ethnohistorical evidence for the use of kilns and the only account of ceramic firing suggests pots were fired in hearths (Kapches 1994: 91, 93; Wrong 1939: 109) and because most of the Fonger sherds were fired in oxidizing or incompletely oxidizing atmospheres, I believe that Neutral potters fired their vessels in an open fire (bonfire) or a pit fire. An open fire is prepared by placing fuel on the ground, placing the unfired vessels on top, and building up additional fuel above the vessels (Kapches 1994: 94; Rice 1987: 153). For pit firing, a shallow depression is dug into the ground before the fuel and vessels are added. The duration of open firings is often short and the heating rate rapid and hard to control (Kapches 1994: 94; Rice 1987: 85-86, 109, 153). There is variation in temperature between open fires and even within a single fire, but, in general, temperatures between 600-900°C are reached (Kapches 1994: 96; Livingstone-Smith 2001: 999-1000; Rice 1987: 156). Both open and pit fires have little impact on the surrounding area and leave few remains. Therefore, it makes sense that archaeologically it is not easy to identify firing structures as such.

Fuel type, which affects the type of firing, has an effect on the temperature and the duration of the fire. The Neutral occupied oak and hickory forests, providing twigs, bark and leaves (Stewart 2000: 92) that could have been used as fuel for firing ceramics. Other resources from the horticultural practices, such as cornhusks, could also have been utilized. Because draft animals were not present before the appearance of Europeans in southern Ontario, Fonger potters would not have fueled fires with dung. With the fuel materials available to them, Fonger potters could have created rapid heating due to the fast burning nature of dry thin wood (Rice 1987: 157; Rye 1981:25) or dry corncobs, husks or stalks. This conclusion seems consistent with the evidence from the Fonger material and was taken into consideration when choosing the parameters of the laboratory test-tile firings.

The scale and size of ceramic firing are correlated. Here, scale refers to the number of vessels fired at a single time and size refers to the area the firing takes up. Allen (1992) explored the scale of ceramic production but this research was based in New York. By looking at Iroquoian ceramic production within New York Iroquoian villages and based on the assumption that each Iroquoian woman manufactured ceramic vessels for her own family's needs, Allen (1992: 140) estimated that an Iroquoian woman would only produce 5-10 vessels per year. Depending on village size, approximately 20-30 vessels per longhouse or 500-1080 vessels per village would be produced in a year (Allen 1992: 140; Kapches 1994: 94). If these data and assumptions apply to the Neutral, then the number of vessels produced each year by a single woman is low. However, the scale and size of the firing depends on whether all the vessels were fired at the same time or if smaller firings took place throughout the year. Also, the size of the firing relies upon the vessel sizes. Because of the lack of information on firing scale and size, as well as the limited number and sizes of the vessels I created, I fired the vessels within a single fire.

Firing locations, either in or away from the village, have not been researched in Ontario. However, Kapches (1994) has taken the initial step by investigating one possible ceramic firing location, the Hill site, located north of Toronto, Ontario. Kapches (1994: 100) suggests that Iroquoian vessels could have been fired within longhouses, within the confines of the village, and/or outside the village at special purpose firing sites. If only a few vessels were fired at a single time, then the firing could have been done within the village or even within the longhouses. However, if many vessels were fired at the same time, requiring and producing a large fire, then vessel firing may have been done outside the village at special purpose sites. Firing vessels outside the village would reduce the risk of uncontrollable fires, which was a major fear of the Iroquois. This is a quite rational fear considering longhouses were close together and built of wood, which facilitated the spread of fires. Kapches (1994:101) would also "not argue for large-scale firing events in the villages, near longhouses, or close to any palisades. The Iroquoian fear of fire, coupled with the tinder-dry state of these structures, would render open firing a potentially hazardous procedure. Firing locations away from the village at either agricultural cabins or special purpose firing sites (such as Hill), removed these fire hazard concerns". Evidence of fire is in fact present at the Fonger site where the eastern half of the village burned down.

This background information was incorporated into the choices I made when firing my experimental vessels. Firing the vessels required several steps, including creating the firing structure, preheating, actual firing and cooling. The entire process took approximately eight hours and took place near Arthur, Ontario in an open field.

I prepared an open pit fire, approximately 48 cm by 64 cm, by digging a very shallow depression and placing cinder blocks in a circle around the pit. The blocks were meant to shield the fire from wind and insulate heat. Blocking out the wind was important because the firing location was on the crest of a hill surrounded by farmland, which facilitated windy conditions. On the day of the firing, October 29, 2005, the temperature was –2°C at 8 am. Frost was on the ground but by 9 am the frost had disappeared. Conservation of heat was a concern not only because of the cold temperature of the day, but also because at the time of the firing I did not know the temperatures that could be reached, so I wanted to conserve as much heat as possible for fear that the vessels would not be adequately fired.

Before vessels were placed into the fire, the fire was started using wood chips, bark, newspaper and a butane lighter. After the fire was going, maple and beech twigs and logs fueled the remainder of the firing. Once the fire was lit and burning, the vessels were placed around the fire, but not in it (Figure 7a and 7b). The reason was to preheat the vessels slowly so that they did not crack as a result of too rapid heating. The vessels were rotated and moved around the fire so that there was even heating. Also by burning fuel without vessels in the pit, a bed of hot coals accumulated, lining the pit. After approximately 1 hour and 25 minutes, the coals and remaining logs were pushed to one side of the pit to make room for the vessels. The vessels were positioned on a small bed of coals at the edge of the pit. Again, this was to ensure their heating was not too fast. After two hours had elapsed since the beginning of preheating, the vessels were moved into the heart of the pit. As the fire burned, more fuel was placed over the vessels (Figure 8a and 8b).

Figure 7a. Preheating the vessels around the open fire.

Figure 7b. Further along in the preheating process. The vessels are moved closer to the heart of the fire.

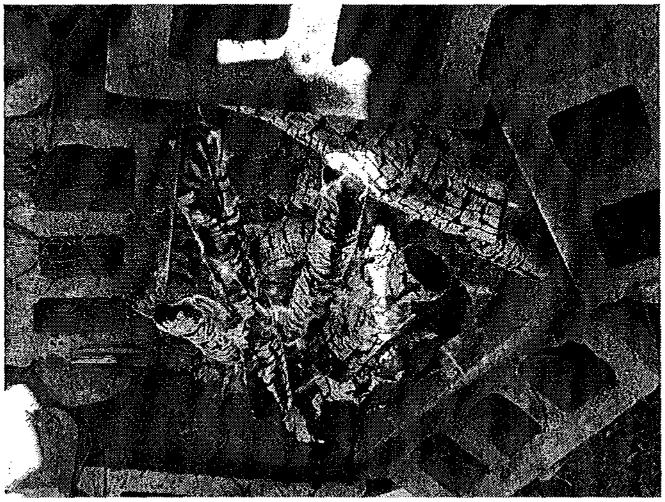


Figure 8a. Vessels are in the heart of the fire and fuel is placed on top.

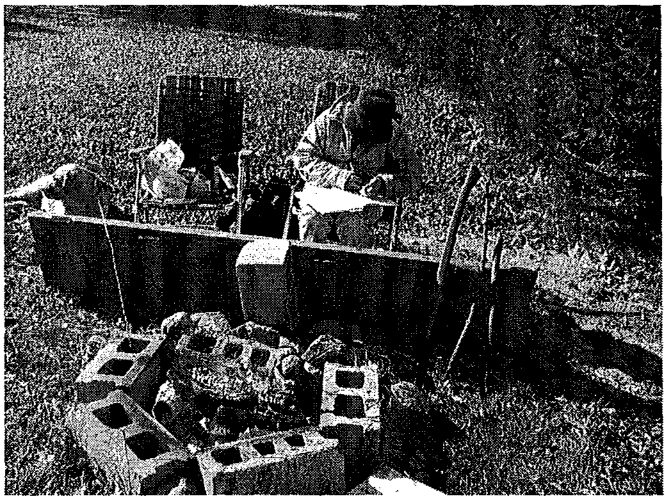


Figure 8b. Vessel firing.

Throughout the preheating and firing, temperature measurements were taken using a thermocouple at specific locations. Temperature readings were taken from the north, east, south and west sides at the outside edge of the burning fuel near the base, the area with the most coals. Temperatures were also recorded from the centre of the fire just above the vessels. More than one temperature reading was taken at the five locations to get an overall idea of the minimum and maximum temperatures of the fire, since temperatures can vary within a single fire. The temperature was recorded every half hour for the preheating stage and every hour from the time the pots were placed in the fire until the pots were removed. After 30 minutes of preheating the temperature in different areas of the fire was between 40°C and 174°C. After one hour and 20 minutes, the temperature ranged from 90°C to 167°C.

To make sure all the vessels were thoroughly fired, because the heating rate of the experimental fire was not as fast as I had expected based on ethnographic data, and to ensure enough temperature readings were taken, the pots were fully immersed in the open pit fire for two hours. After this time, no more fuel was added and the remaining fuel was allowed to burn down to coals. When the pots were placed into the fire, the temperature ranged from 100°C to 206°C. After one hour of the pots being in the fire the temperature ranged from 530°C to 756°C. At this point, the thermocouple I was using malfunctioned and could not be used for the rest of the firing. Over a period of 3 hours and 45 minutes, the vessels were slowly moved away from the heart of the fire to the original preheating locations.

A piece of each vessel was broken off and submerged into water to test the solubility. After the pieces of vessel were left in the water for 24 hours, I recorded whether the sherds reverted back into the unfired ceramic paste. The colours of each vessel were assessed and documented using a Munsell chart. After these analyses, the vessels were placed in cardboard boxes for storage.

Summary

In this chapter, I have outlined my methodology and provided the technical details for each method I employed in this study (macroscopic analysis, petrography, x-ray diffraction, re-firing, raw materials survey and experimental archaeology). I provided the questions I wanted each method to solve along with how the questions will be answered. Macroscopic analysis, petrography and x-ray diffraction contributed to the identification of the choices made by the Fonger potters. The raw materials survey identified the range of locally available raw materials. The creation and firing of test tiles provided information on specific characteristics (shrinkage, solubility, colour and point of calcium carbonate decomposition) of the raw materials collected in the raw materials survey. Making vessels using the colleted raw materials provided me with insight into the techniques, tools and gestures associated with pottery manufacture.

Chapter 4: Results and Analysis

My methodology was constructed to identify and understand the choices that Fonger potters made throughout the ceramic operational sequence. In this chapter I shall present my results following the ceramic operational sequence as it proceeds from the collection of raw materials to the preparation of the clay paste to vessel forming, finishing, decorating, firing and use. I will further test Warrick's (1984a, 1984b) hypothesis that the Fonger site contained two separate but closely interacting groups, which occupied two wards, by comparing the choices and the frequency of choices made by the potters from the east and west wards.

Selection and Preparation of Raw Materials

Macroscopic Analysis

My macroscopic observations of the kind, size, shape and degree of sorting of the inclusions present in the Fonger sherds gave me a general indication of the raw materials Fonger potters were selecting and the ways in which they were preparing them into ceramic pastes.

I identified several inclusions within the Fonger sherds primarily a variety of granite-based minerals, such as quartz, feldspar and black and shiny material, as well as shell in a limited number of sherds. Since quartz and feldspar cannot be confidently distinguished macroscopically, I recorded both under one variable named: quartz/feldspar. Similarly, I could not accurately distinguish hornblende from biotite so I classified all this type of material as black and shiny material.

Most of the sherds, other than those tempered with shell, contained more than one type of inclusion mineral. However, macroscopically some minerals were more prominent than others. The dominant inclusions in the Fonger sample (n=876) were: quartz/feldspar (n=830, 94.7%), black and shiny material (n=35, 4%), shell (n=7, 0.8%), and unknown (n=4, 0.5%) (Table 7). The majority of the sample (n = 719, 82%) contained secondary inclusions. When more than one type of inclusion was present (n=719), black and shiny material was the most common secondary inclusion (n=678, 94.3%), while in a few sherds quartz/feldspar (n=39, 5.4%) was the most common and rarely (n=2, 0.3%) unknown inclusions were secondary (Table 8). When black and shiny material was the predominant inclusion, quartz/feldspar was the typical secondary inclusion. Interestingly, shell-tempered sherds did not contain macroscopically observable secondary inclusions.

Table 7. Macroscopic Analysis: Distribution of primary inclusions within each sherd.

Primary Inclusions	**Sherd Count**	**Sherd %**
Quartz/feldspar	830	94.7
Black and shiny material	35	4.0
Shell	7	0.8
Unknown	4	0.5
Total	876	100

Table 8. Macroscopic Analysis: Distribution of secondary inclusions within each sherd.

Secondary Inclusions	**Sherd Count**	**Sherd %**
Black and shiny material	678	94.3
Quartz/feldspar	39	5.4
Unknown	2	0.3
Total	719	100

Inclusion shape can provide information about whether the inclusions in the sherds occur naturally in clay or if potters added them as temper. If potters added temper, then by investigating inclusion shape I can see if potters prepared temper by crushing it before adding it into the clay. Crushed shell (n=7, 0.8%) breaks into platy shapes, with very angular edges. The granite-based inclusions in the Fonger sherds are primarily angular in shape (n=731, 83.5%), although there are also sub-angular (n=123, 14%) and sub-rounded (n=15, 1.7%) shapes (Table 9).

Table 9. Macroscopic Analysis: Distribution of inclusion shape within each sherd.

Inclusion Shape	**Sherd Count**	**Sherd %**
Platy	7	0.8
Angular	731	83.5
Sub-angular	123	14
Sub-rounded	15	1.7
Total	876	100

How well inclusions are sorted within a sherd can be very informative about the types of raw materials selected and/or the preparation of these materials by potters. Mineral grains within granite are "more or less uniform in size and proportions" within a single rock (Raguin 1965: 1). However, if potters crushed their temper or used weathering granite that contained minerals decomposing at different rates, then several different sizes might be present in their clay fabric. Potters could have targeted specific sizes of inclusions. Inclusions within the Fonger sherds were sorted very poorly (n=204, 23.3%), poorly (n=392, 44.8%), fairly well (n=235, 26.8%), well (n=44, 5%), or very well (n=1, 0.1%) (Table 10).

Table 10. Macroscopic Analysis: Distribution of the types of inclusion sorting within each sherd.

Inclusion Sorting	**Sherd Count**	**Sherd %**
Very poor	204	23.3
Poor	392	44.8
Fair	235	26.8
Good	44	5
Very good	1	0.1
Total	876	100

The size of inclusions also provides information about the types of raw materials potters selected, the inclusion size preferences of potters and possibly the relative amount of time potters spent (if they did) crushing temper. Granite grain sizes are fairly uniform within a single rock but between rocks the grain size can vary from smaller than 5 mm to over 10 mm (Raguin 1965: 16). Within the Fonger sample 693 sherds (79%) included very coarse inclusions (2 mm or larger), 154 (18%) included coarse (1 mm) and 29 (3%) included medium inclusions (0.5 mm or smaller) (Table 11).

Table 11. Macroscopic Analysis: Distribution of inclusion size within each sherd.

Inclusion Size	**Sherd Count**	**Sherd %**
Very coarse (2 mm or larger)	693	79
Coarse (1 mm)	154	18
Medium (0.5 mm or smaller)	29	31
Total	876	100

I identified macroscopically a range of inclusion amounts within the Fonger sherds: from 3% to 40% (Table 12). However, this result is just a rough estimation, because through macroscopic analysis I cannot view small inclusions and the unevenness of the observed surface creates distortion. In addition to this limitation, macroscopically I could not confidently distinguish between quartz and feldspar and between biotite and hornblende. For these reasons, petrographic analysis was needed to refine the macroscopic results.

Table 12. Macroscopic Analysis: Distribution of the amount of inclusions within each sherd (in %).

% of inclusions	Sherd Count	Sherd %
3	16	18.31
5	28	3.204
7	79	9.039
10	177	20.252
15	249	28.490
20	200	22.883
25	96	10.984
30	23	2.632
35	5	0.572
40	1	0.114
Total	874	100

Petrography

I submitted 20 sherds, 10 from midden A and 10 from midden B, which represented a range of macroscopically observed inclusion types, shapes, sizes, sorting and amounts for petrographic analysis (Table 4).

Petrographic analysis was used to identify in greater detail the natural and added inclusions in the Fonger sherds. Natural inclusions are typically less than 0.5 mm in diameter, are more rounded due to weathering over time and provide clues as to the parent material of the clay used by potters. Almost all of the inclusions smaller than 0.5 mm in my sample were sub-rounded or rounded quartz and feldspar particles, suggesting that they were naturally occurring in the clays (Braun Petrographic Report: 1) (Appendix 4). There were five sherds where potters added temper larger than 0.5 mm and also added temper less than 0.5 mm in diameter. Three of these sherds contained a notable amount of added amphiboles and the other two were shell-tempered (Braun Petrographic Report: 1). Braun noted that when the added temper smaller than 0.5 mm in these sherds is ignored, "the mineralogy of drift inclusions for all twenty samples is petrographically indistinguishable" (Braun Petrographic Report: 2). This suggests that Fonger potters selected clays that came from similar parent materials.

The sherds submitted for petrographic analysis (n=20) demonstrated that Fonger sherds contain shell (n=2, 10%) or a wide range of granite-based materials (n=18, 90%), such as a variety of quartz and alkali feldspars, biotite and hornblende (Braun Petrographic Report: 2-5) (Appendix 4). This analysis is consistent with my macroscopic observations. However, the petrographic identifications of the granite-based minerals are much more accurate and detailed. Braun distinguished between quartz and feldspar and between biotite and hornblende, but also identified syenite, peralkaline granite, alkali feldspar granite, orthopyroxenes, clinopyroxenes, plagioclase, monzonite, augite, monzodiorite, muscovite, and grandiorite.

Braun also identified the shapes of sherd inclusions within the petrographic sample. Each sherd contains a range of shapes from rounded to angular, except for the shell-tempered sherds, which are all platy. Out of the 18 sherds with granite-based inclusions, 13 (72%) have primarily angular inclusions. The five (28%) remaining sherds have more rounded shaped particles (Table 13).

Table 13. Petrographic Analysis: Distribution of inclusion shape within each sherd.

Inclusion Shape	**Sherd Count**	**Sherd %**
Platy	2	10
Angular	13	65
Rounded	5	25
Total	20	100

Braun documented poorly (n=10, 50%), moderately (n=7, 35%) and well-sorted (n=3, 15%) inclusions in the petrographic sample (Table 14). This distribution is similar to the frequency distribution of the macroscopic analysis.

Table 14. Petrographic Analysis: Distribution of the types of inclusion sorting within each sherd.

Inclusion Sorting	**Sherd Count**	**Sherd %**
Very poor	0	0
Poor	10	50
Fair	7	35
Good	3	15
Very good	0	0
Total	20	100

When it comes to inclusion size, smaller sizes are far more clearly observed under the petrographic microscope than macroscopically. Within each sherd there is a range of inclusion sizes. In 17 (85%) sherds, the majority of the inclusions are between 0.5 mm and 1 mm. In the remaining sherds (n=3, 15%), the majority of the inclusions fall in the 1-2 mm size category (Table 15). Seventeen (85%) sherds contain inclusions with a maximum size of 4 mm; Three (15%) contain inclusions with a maximum size of 6 mm (Table 16).

Table 15. Petrographic Analysis: Distribution of the majority of inclusion sizes within each sherd.

Inclusion Size	**Sherd Count**	**Sherd %**
1-2 mm	17	85
0.5-1 mm	3	15
Total	20	100

Table 16. Petrographic Analysis: Distribution of the maximum of inclusion size within each sherd.

Inclusion Size	Sherd Count	Sherd %
4 mm	17	85
6 mm	3	15
Total	20	100

The amount of inclusions within each sherd that Braun identified is higher than what I identified macroscopically, ranging from 20% to 50% and not correlated to inclusion size (Table 17). In petrographic analysis, the surface observed is flat and smooth, unlike the surface of the fresh break observed macroscopically, providing more accurate observations.

Table17. Petrographic Analysis: Distribution of the amount of inclusions present in each sherd.

Amount of Inclusions (%)	Sherd Count	Sherd %
20	2	10
25	1	5
30	2	10
35	3	15
40	6	30
45	2	10
50	4	20
Total	20	100

In the petrographic analysis, Braun also noted the presence of elongated voids, which are "hollow spaces, usually recognizable without magnification" in the clay paste (Rye 1981: 61-62), within the sherds of the petrographic sample. Voids can be the result of organic material that was burned off during firing, the joining of two pieces of clay together, or inadequate kneading of clay (Rye 1981: 62). Most of the voids run parallel to the sherd surface, except in the case of sherd number 1039 (Braun Petrographic Report: 2) (Appendix 4). Elongated, flattened voids randomly distributed running parallel to the vessel surface are characteristic of inadequately kneaded clay (Rye 1981: 62). The presence of these voids within the Fonger sherds suggests that Fonger potters did not knead their clay well before forming ceramic pots. Sherd number 1039 has less elongated voids than those of the rest of the sample; they are not consistently parallel to the sherd surface (Braun Petrographic Report: 2). Braun suggests that, because of this discrepancy in void shape and patterning, sherd 1039 was manufactured using a different method. The only difference between this and the other sherds is that it was a joined neck and shoulder sherd. All the other sherds were either necks or bodies. It is possible that this difference in void shape could be from the potter joining the neck to the shoulder.

X-Ray Diffraction

In order to better understand the types of clays and incidental minerals in the clay, I submitted seven Fonger sherds for x-ray diffraction analysis. All of the sherds include illite clays and have similar high amounts of quartz, plagioclase, alkali feldspar and trace amounts of amorphous/unidentifiable material (Table 18a and 18b). This suggests that Fonger potters selected basically similar types of clays. However, there are slight differences in the minerals that occur in lesser amounts. For example, four sherds have small amounts of mica, five sherds contain calcite and three sherds have cordierite. One sherd contains dolomite, and another contains chlorite. Each sherd within the XRD sample is slightly different from the next.

Table 18a. XRD results for the Fonger sherds from midden A (Provided by Wen-He Gong from the McMaster University X-Ray Diffraction Facility at the Brockhouse Institute for Materials Research).

Sherd Number	**1039**	**1285-9-b**	**2395-1-c**	**1687-9-b (shell)**
Quartz, SiO2	62%	53%	48%	30%
Plagioclase, NaAlSi3O8 / (Na,Ca)(Al,Si)3O8	17%	20%	~19%	5%
Potassium feldspar, KAlSi3O8	5%	6%	5%	4%
Illite/mica, KAl2(Si,Al)4O10[(OH)2	5%	10%	9%	6%
Mica/biotite, KMg3SiAl3O10[(OH,F)2	~4%	7%	2%	
Calcite, CaCO3	4%		6%	10%
Shell/calcite, CaCO3				40%
Dolomite, CaMg(CO3)2				~1%
Chlorite/clinochlore,(Fe, Mg, Al)6(Si, Al)4O10(OH)8			1%	
Cordierite, Mg2Al4S5iO18	1%	~2%	8%	
Amorphous & others	2%	2%	2%	4%

Table 18b. XRD results for the Fonger sherds from midden B (provided by Wen-He Gong from the McMaster University X-Ray Diffraction Facility at the Brockhouse Institute for Materials Research).

Sherd Number	**2074-1**	**1260 (8)**	**2030-10-e (shell)**
Quartz, SiO2	54%	65%	44%
Plagioclase, NaAlSi3O8 / (Na,Ca)(Al,Si)3O8	16%	15%	15%
Potassium feldspar, KAlSi3O8	9%	6%	7%
Illite/mica, KAl2(Si,Al)4O10[(OH)2	10%	9%	11%
Mica/biotite, KMg3SiAl3O10[(OH,F)2	4%		
Calcite, CaCO3	5%	~3%	
Shell/calcite, CaCO3			~21%
Dolomite, CaMg(CO3)2			
Chlorite/clinochlore,(Fe, Mg, Al)6(Si, Al)4O10(OH)8			
Cordierite, Mg2Al4S5iO18			
Amorphous & others	~2%	2%	2%

In order to see if the shell-tempered sherds were made from local materials and were not traded into the site, two shell-tempered sherds were submitted for XRD analysis. Other than the high percentage of calcite due to the presence of shell, the sherds are not very different from the other sherds in the XRD sample. The shell-tempered sherds both contain illite, quartz, and alkali feldspar in relatively similar amounts to all the other samples. One of the shell-tempered sherds also has very similar amounts of plagioclase and amorphous material. The other shell-tempered sherd, while it does contain plagioclase, has approximately 10% less of this mineral, but 2% more amorphous material and trace amounts of dolomite.

To determine if the slight differences in the composition of the Fonger sherds are a reflection of local raw materials variation, I subjected samples from the geological clays collected in my raw material survey to XRD analysis. I used material from the test tiles I had made and fired them at 500°C to ensure that any differences I might observe between the sherds and the test tiles would not be due to mineralogical transformations during firing. All of the local clay samples have very similar compositions to each other. They all are illite clays, just like the Fonger sherds (Table 19). All the samples contain quartz, plagioclase, alkali feldspar and amorphous material in similar amounts. Of the local clays I collected, Jerseyville 3, St. George 4, St. George 5 and St. George 6 samples contain calcite and dolomite. None of these clays were collected in the immediate vicinity of the Fonger site (Figure 4). Interestingly, the shell-tempered sherd that does not seem to be made from the same raw materials as the others in the XRD sample contains calcite and dolomite. All of the samples, except Fonger 1, have chlorite and all of the samples, except St. George 6, have cordierite. By comparing the XRD results of the Fonger sherds to the test tiles, I can say that it is likely that Fonger potters selected local raw materials to manufacture their vessels.

Table 19. XRD results for clays collected in the raw materials survey (provided by Wen-He Gong from the McMaster University X-Ray Diffraction Facility at the Brockhouse Institute for Materials Research). .

	Fonger 1	**Fonger 2**	**Jerseyville 3**	**St. George 4**	**St. George 5**	**St. George 6**
Quartz, SiO2	72%	68%	49%	50%	~42%	50%
Plagioclase, NaAlSi3O8 / (Na,Ca)(Al,Si)3O8	15%	16%	15%	14%	14%	15%
Potassium feldspar, KAlSi3O8	5%	6%	5%	~4%	6%	5%
Illite/mica, KAl2(Si,Al)4O10[(OH)2	~5%	6%	5%	4%	6%	6%
Mica/biotite, KMg3SiAl3O10[(OH,F)2						
Calcite, CaCO3			17%	18%	22%	~20%
Shell/calcite, CaCO3						
Dolomite, CaMg(CO3)2			~5%	6%	6%	1%
Chlorite/clinochlore,(Fe, Mg, Al)6(Si, Al)4O10(OH)8		~1%	1%	1%	1%	1%
Cordierite, Mg2Al4S5iO18	1%	1%	1%	1%	1%	
Amorphous & others	2%	2%	2%	2%	2%	2%

Raw Materials Survey

In the raw materials survey, I only identified and collected two clays in the immediate vicinity of the site (Fonger 1 and Fonger 2) and four clay samples within a 7 km radius (Jerseyville 3, St. George 4, St. George 5 and St. George 6). I also collected large sand and freshwater mussel shells from the banks of the Grand River, approximately 10 km away from the site. Within the surrounding area of the Fonger site, significant modern residential and commercial development has occurred, which may have eliminated several clay and temper sources. In my raw materials survey, I could not locate sources of granite. This does not mean that granite was not locally available, as granite is very common in Ontario. Prior to modern development, granite may have been accessible and the occupants of the Fonger site would have had a thorough knowledge and a better understanding of their local environment and resources than I do.

Fonger 1, Fonger 2, Jerseyville 3 and St. George 4 samples were directly associated with a water source. All four samples were collected on the banks of running creeks or streams. The other two clays were located within a kilometer of water.

Experiments

Regarding the stage of raw material selection and preparation, the purpose of making vessels was to assess the workability of specific ceramic pastes created with the local raw materials. By workability I mean "the suitability of a plastic clay or body for forming pottery, judged by its feel to the potter" (Rye 1981: 147). Workability is an important clay quality, yet also very difficult to assess, as to a certain extent it can be a matter of personal tactile strength and preference. Accordingly, I compared the workability of the different pastes to each other according to my own judgment and strength.

Before I could assess the workability, I had to prepare the raw materials. When preparing the clay, I found that using a grinding motion to crush up the dried clay with a hammer stone was much quicker and produced finer particles than a pounding motion. I found that when the clay was dry and in finer pieces, I had better control over the amount of water I added. Grinding required me to firmly press the hammer stone into the clay and turn my wrist and arm while moving the hammer stone over the clay. To prepare tempering material, I crushed shells using a hammer stone and removed large bits of sand by swirling it in a bowl repeatedly until the large particles came to the surface and could be easily scooped off the top. Interestingly, I noticed that the difficulty of crushing shell varied depending on the kind of shell used. Thin small shells were easier to crush than thick large shells. In fact, it was almost impossible for me to crush the larger shells but undemanding to crush smaller shells.

When mixing clay, temper and water together, I kneaded the raw materials like I would bread. My knuckles and fingers took turns digging into the mixture, while flipping and rotating the paste every so often. Throughout this process, I noted that slaked clays were more plastic and workable in comparison to unslaked ones. This is because slaking removes larger materials present in the clay and clays with finer particles are more plastic (Rice 1987: 59). I also found it easier to mix temper into and create vessels with slaked clay than with natural clay. Overall, Fonger 1 slaked had the best workability followed by Jerseyville 3, St. George 4, St. George 6, Fonger 2 and finally St. George 5.

Pastes with shell temper were better to work with than those with sand temper. This was because shell-tempered pastes held formed shapes much better. However, because the crushed shell temper was platy in shape and the sand temper was well rounded, the shell temper was rougher and tougher on the hands.

Test Tiles

I created test tiles with the materials I collected on my survey to observe the naturally occurring inclusions of the local clays and to measure the shrinkage of the different clays when mixed with different kinds and amounts of tempers. I fired six of the tiles, one piece from each untempered and unslaked clay sample, to 500°C and then submitted them for XRD analysis, to better understand the composition of local raw materials.

I noted the type and size of inclusions naturally occurring in the clays so that I could compare them to the inclusions found in the Fonger sherds, to determine if and what types of temper Fonger potters added to their ceramic pastes. In all of the clay samples I collected, there were few inclusions. However, the inclusions that were present were large (ranging from 2 to over 4 mm) rounded pebbles that were not quartz, feldspar or mica. In addition, organic material, such as small plant roots, was also naturally present in all the clay samples.

Shrinkage is an important property of ceramic pastes because too much shrinkage can cause cracks and break a vessel. Even minor cracks during drying can lead to breakage during firing. It would be very frustrating to a potter if after the entire vessel was manufactured, it did not survive. After the tiles were dry, I recorded whether they broke during drying (Table 20).

Overall, unslaked clay mixed with any type or amount of temper shrinks less than slaked clay (Table 21). Unslaked natural clay contains more inclusions, which prevents shrinkage, and, as previously stated, increases plasticity. Slaking removes the larger, heavier and organic inclusions, which prevent the clay particles from drawing closer together, causing slaked clays to shrink more.

Table 20. Breakage of test tiles after drying. Breakage was observed over the four tiles made from each clay paste. S=slaked

Breakage	No Inclusions	15% Sand	25% Sand	15% Shell
Yes*	Fonger 1 Fonger 1 (S) Fonger 2 Fonger 2 (S) Jerseyville 3 Jerseyville 3 (S) St. George 4 St. George 5 (S) St. George 6 St. George 6 (S)	Fonger 1 Fonger 1 (S) Fonger 2 Fonger 2 (S) Jerseyville 3 St. George 4 St. George 4 (S) St. George 5 St. George 6 St. George 6 (S)	Fonger 1 Fonger 1 (S) Fonger 2 Jerseyville 3 St .George 6 (S)	
Partial**			St. George 5	St. George 4 St. George 4 (S)
No***	St. George 5	Jerseyville 3 (S) St. George 5 (S)	Fonger 2 (S) Jerseyville 3 (S) St. George 4 St. George 5 (S) St. George 6	Fonger 1 Fonger 1 (S) Fonger 2 Fonger 2 (S) Jerseyville 3 Jerseyville 3 (S) St. George 4 (S) St. George 5
No***				St. George 5 (S) St. George 6 St. George 6 (S)

* Yes = 3 or more of the test tiles were broken
** Partial = 2 of the 4 tiles were broken
*** No = 1 or less of the tiles were broken

In general, regardless of whether clays are slaked or not, as the amount of temper increases the amount of shrinkage decreases. On the whole, shell tempered tiles have less shrinkage and, as a result, no shell-tempered tiles broke. This may be because the ceramic paste was not as saturated with water, compared to the other ceramic pastes, when the tiles were formed, or because the platy shape of crushed shell adds strength to the surrounding clay matrix and stops crack propagation (Tite, Kilikoglou and Vekinis 2001: 310, 319; Steponaitis 1984: 94).

Table 21. Test tile shrinkage measurements. The average shrinkage was calculated from the shrinkage percentage of the four tiles created from each type of clay and temper mix.

Unslaked Clay		**Slaked Clay**	
Clay and Temper Type	**Average shrinkage (%)**	**Clay and Temper Type**	**Average Shrinkage (%)**
Fonger 1	6.5	Fonger 1 slaked	5.125
Fonger 1-15% sand	5.625	Fonger 1 slaked 15% sand	5.0
Fonger 1-25% sand	3.5	Fonger 1 slaked with 25% sand	3.625
Fonger 1-15% shell	3.5	Fonger 1 slaked-15% shell	3.5
Fonger 2	4.25	Fonger 2 slaked	6.5
Fonger 2-15% sand	4.25	Fonger 2 slaked-15% sand	4.875
Fonger 2-25% sand	2.5	Fonger 2 slaked-25% sand	6.25
Fonger 2-15% shell	3.625	Fonger 2 slaked-15% shell	5.5
Jerseyville 3	3.875	Jerseyville 3 slaked	4.25
Jerseyville 3-15% sand	3.75	Jerseyville 3 slaked-15% sand	4.75
Jerseyville 3-25% sand	2.0	Jerseyville 3 slaked-25% sand	3.25
Jerseyville 3-15% shell	3.25	Jerseyville 3 slaked-15% shell	5.25
St.George 4	0.625	St.George 4 slaked	1.875
St.George 4-15% sand	2.5	St.George 4 slaked-15% sand	0.75
St.George 4-25% sand	0.25	St.George 4 slaked-25% sand	2
St.George 4-15% shell	0.875	St.George 4 slaked-15% shell	0.125
St.George 5	5.25	St.George 5 slaked	5.375
St.George 5-15% sand	2.625	St.George 5 slaked-15% sand	4.0
St.George 5-25% sand	3.5	St.George 5 slaked-25% sand	4.0
St.George 5-15% shell	2.875	St.George 5 slaked-5% shell	4.0
St.George 6	3.125	St.George 6 slaked	3.0
St.George 6-15% sand	2.0	St.George 6 slaked-15% sand	1.0
St.George 6-25% sand	3.75	St.George 6 slaked-25% sand	2.5
St.George 6-15% shell	3.125	St.George 6 slaked-15% shell	2.375
Total Average Shrinkage	3.214		3.703

Out of all the natural and slaked clay samples, unslaked St. George 4 had the least shrinkage (no mater how much or what type of temper was added) with 0.125%-2.5% shrinkage. St. George 6 had the next least shrinkage followed by Jerseyville 3, St. George

5, Fonger 1 and finally Fonger 2. It appears then that the clays available today right at the site would need the most care in terms of making sure enough temper was added to compensate for the clay's higher shrinkage.

Summary

The clays that Fonger potters selected and the clays collected in the raw materials survey were very similar, containing comparable types and amounts of microscopic natural inclusions. Thus, I suggest that Fonger potters used locally available clays to make their vessels. The results of the XRD analysis demonstrate that maybe not all but at least some shell-tempered vessels were made using local materials. Without exploring the composition of more shell-tempered sherds and clays from areas further away than 7 km from the Fonger site, I cannot confidently say that all of the shell-tempered sherds found at the Fonger site were made from local materials. The shell-tempered sherd (1687-9-b) with small differences in composition may represent clays from beyond my survey area.

Within the naturally occurring clays of the area surrounding the Fonger site, there are macroscopically observable inclusions naturally present. However, these inclusions occur in far fewer amounts, are not the same type (sedimentary-based rocks) and are much larger and more rounded than the inclusions found within the Fonger sherds. Because Fonger potters used local clays and the naturally occurring large inclusions are not present in Fonger sherds, I conclude that Fonger potters likely refined their clay, eliminating these large rounded inclusions.

In addition to shell, the variety of minerals identified petrographically shows that potters selected a broad range of granite-based temper to add to their ceramic paste. By identifying the large number of sherds that contain angular or platy temper, I suggest that most of the time Fonger potters crushed their temper, whether granite based or shell, prior to adding it to their ceramic pastes. Potters usually added temper particles larger than 0.5 mm but sometimes smaller crushed temper, especially shell, was added.

The presence of sub-angular and sub-rounded shapes suggests natural weathering suggesting further that occasionally potters did not crush their temper as much. Weathering of granite over time eventually produces rounded quartz particles and clay (Marshak: 2001: 165). Quartz and feldspar are hard materials that take longer to round than softer materials, such as mica. Because of this, quartz and feldspar are usually not completely rounded if weathered and as a result can account for the sub-angular and sub-rounded shapes of inclusions in the Fonger sherds.

The predominance of very poor and poor sorting of inclusions, a wide range of inclusion sizes, and limited large naturally occurring inclusions suggest that potters did not generally spend much time targeting specific sizes or trying to obtain smaller temper sizes, though occasionally there were instances when potters took some time to sort their temper and target sizes smaller than 2 mm. Specific amounts of temper were not targeted, ranging from 20% to 50%, but generally Fonger potters added a significant amount.

There appears to be only two distinct recipes associated with the types of raw materials selected and how they were prepared (shell or granite-based temper). However, within the sherds tempered with granite there are no distinct sub-recipes. I tried to correlate the kind of raw materials with the amount, shape, size, and sorting but I could not discern a clear pattern. As a result, clay can be combined with a wide range of granite-based material or shell. Temper is crushed and temper smaller than 6 mm is added in amounts that range from 20% to 50%.

What Do These Choices Mean Mechanically/Functionally?

The raw materials selected and preparation techniques used by potters can be influenced by the mechanical and functional properties of the vessel that a potter is creating.

Clays close to the Fonger site, such as Fonger 1 and Jerseyville 3, have a better workability, in my opinion, but Fonger potters may have preferred other clays for their workability. However, because all the clays that I collected could have been used for making pottery, workability may not have been an influencing factor for clay selection. In regards to shrinkage, the most ideal clay would be St. George 4. However, the other clays could be used as well and potters could have combated shrinkage in other ways, such as by adding more temper.

Shell and granite-based minerals, such as quartz, feldspar, mica and hornblende, can affect both the mechanical and functional properties of a vessel. For example, vessels used for cooking are exposed to great amounts of thermal stress and shock from the continuous heating and cooling cycles associated with cooking. Thus, to be functionally successful, cooking vessels must be able to withstand these cycles. One way of coping with thermal stress and reducing the effects of thermal shock is to add inclusions to the ceramic paste that have similar heating and expansion properties as the surrounding clay (Rice 1987: 229). Quartz has a higher thermal expansion than clay, resulting in an increase in stress from thermal shock (Bronitsky and Hamer 1986: 98). Thus, quartz, which is present in Fonger sherds, is not an ideal temper choice for cooking vessels according to materials scientists. However, quartz is one of the most common inclusions and is repeatedly used in cooking pots around the world. More ideal choices would be feldspars and hornblende since they have similar expansion properties to clays (Rice 1987: 229).

The shape of temper can have an effect on the function of a vessel. As temper increases in angularity, the resistance to cracking, strength and toughness increases (Bronitsky and Hamer 1986: 97; Feathers 1989: 586; Tite et al 2001: 313). This is because irregularly shaped particles distribute stress more evenly than rounder particles (Bronitsky and Hamer 1986: 97). Mica and shell, when crushed, have a platy shape, resulting in an increase in strength and toughness and a reduction in crack propagation (Rice 1987: 407). While these mechanical and functional properties are true and the majority (79%) of Fonger sherds have angular temper, there is no evidence suggesting that sherds with angular temper were used differently than sherds with more rounded temper.

In general, as temper size decreases vessel strength increases (Bronitsky and Hamer 1986: 97). Functionally, vessel strength is important because when vessels are moved around they get bumped and jarred (Tani 1994). Even with vessels that are not moved regularly, in longhouses there are many people including children who can run into and knock over vessels (Tani 1994). As a result, vessels with smaller inclusions have a greater hardness and are better suited for storage vessels that are kept in activity areas. However, this does not necessarily mean that Fonger potters added smaller sized temper to storage vessels. Because sooting and carbon encrustations were not found on approximately half of the Fonger sherds with larger sized temper, sherds with larger temper may have come from vessels possibly used for other functions, such as storage or transport vessels.

Forming

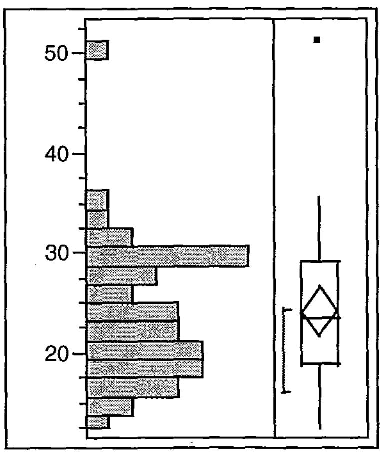
Macroscopic Analysis

At the forming stage, the shape and size of a vessel is established. The aim of the macroscopic analysis was to understand how many sizes and shapes of vessels the Fonger potters produced and what specific methods they utilized to achieve their goals.

It is very difficult and almost impossible to comment on the overall vessel shapes Fonger potters created, because there were no whole vessels recovered. The largest sherd recovered was approximately 2/3rds of a rim and neck. The most detail I have obtained about vessel shape is in regards to the upper part of the vessel (necks, collars, rims, lips and castellations) and from a single possible base sherd. Here, I will describe the shapes of Fonger vessels in parts, starting from the body and working upwards to the rim, rather than in whole vessel shapes.

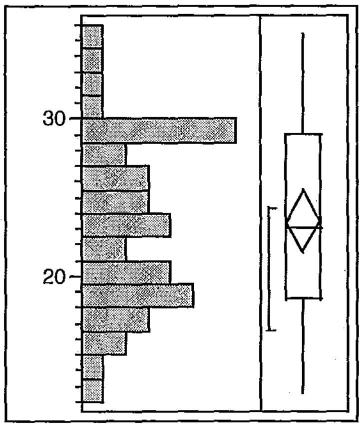
Because I do not have any identifiable base sherds (except for one), I combine my data with known Neutral vessel shapes from other sites to construct an idea of the possible body shapes Fonger potters manufactured. In most cases, Neutral vessel bodies are globular in shape with gently rounding shoulders (Lennox and Fitzgerald 1990: 417). They have no sharp angles around the body and their bases are rounded. Fonger bodies follow this pattern. All Fonger body sherds, except one, are slightly curved, suggesting a globular shape. Any sherd could come from any part of the vessel body or base. One sherd from midden A stands out as an exception. This sherd (number 842) curves at a much sharper angle, creating a less rounded base. This type of vessel shape has been documented at other Neutral sites, in conjunction with "nearly vertical walls decorated with triangular plat motifs" (Lennox and Fitzgerald 1990: 417, Figure 13-4). Similarly, sherd 842 displays incised trailed lines on the walls in a possible triangular pattern. Other than the different shape, sherd 842 conforms to the rest of the Fonger assemblage characteristics.

There appears to be a greater range of variability at the upper portion of the Fonger vessels, including the neck, rim, and lip. The neck sits above the body and shoulder and connects the bottom part of the vessel to the rim. Fonger necks vary in height from 12.6 mm to 51.2 mm (Figure 9a and 9b). There are two main sizes of neck heights. Short necks were about 20 mm in height on average, but there were even smaller ones. Medium sized necks were about 30 mm tall, but taller necks were created as well. I found evidence in a single sherd that necks over 50 mm tall were also made.



Mean	24.1
Std Dev	7.2
Std Err Mean	1.1
upper 95% Mean	26.3
lower 95% Mean	21.9
N	42

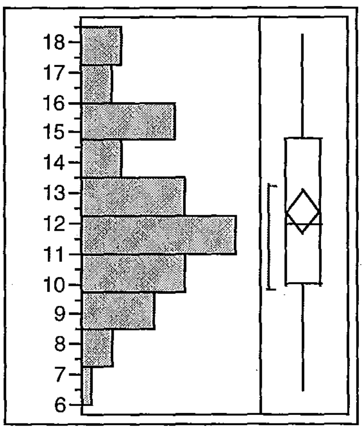
Figure 9a. Distribution of neck heights (mm).



Mean	23.4
Std Dev	5.8
Std Err Mean	0.9
upper 95% Mean	25.3
lower 95% Mean	21.6
N	41

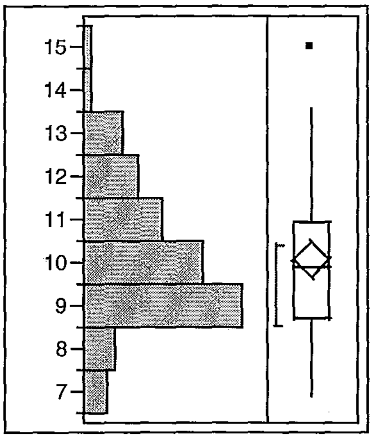
Figure 9b. Distribution of neck heights (mm) when the exceptionally tall neck is removed.

Rims are situated above the neck and can have collars or not. Sixty-five percent (n=66) of Fonger rims have collars of various heights and thicknesses. Collar heights range from 6.5 mm to 18.1 mm and that can be classified into two sizes: short (6.5-13.5 mm) (n=46, 70%) and tall (13.5-18.1 mm) (n=20, 30%) (Figure 10). Collar thicknesses range from 6.9 mm to 15 mm with an average thickness of 10 mm (Figure 11a and 11b). While there is a general pattern that as collar height increases collar thickness increases, this is not always the case (Figure 12). There are sherds that have short, thick collars and sherds with tall, thin collars.



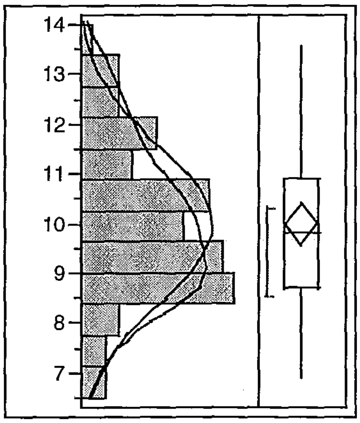
Mean	12.3
Std Dev	2.7
Std Err Mean	0.3
upper 95% Mean	13.0
lower 95% Mean	11.7
N	66

Figure 10. Distribution of collar heights (mm).



Mean	10.0
Std Dev	1.7
Std Err Mean	0.2
upper 95% Mean	10.5
lower 95% Mean	9.6
N	66

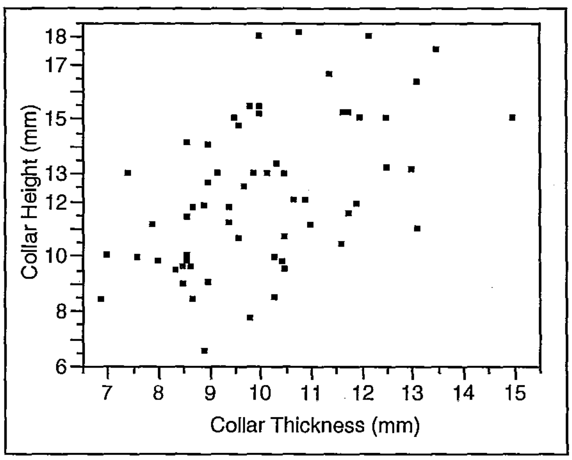
Figure 11a. Distribution of collar thicknesses (mm).



Mean	10.0
Std Dev	1.6
Std Err Mean	0.2
upper 95% Mean	10.4
lower 95% Mean	9.6
N	65

— Smooth Curve()
— Normal(9.97,1.55737)

Figure 11b. Distribution of collar thicknesses (mm) when the exceptionally thick collar (15.0 mm) is removed. There is almost a normal distribution of collar thicknesses ranging from 6.9 mm to 13.5 mm.



p = <0.0001

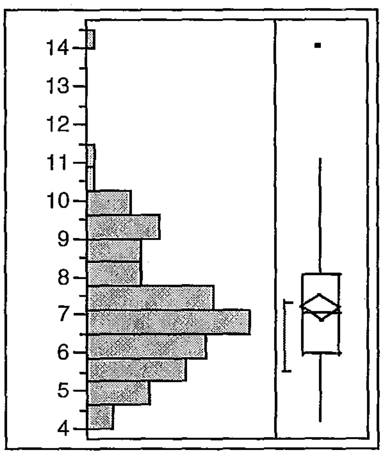
Figure 12. Correlation between collar height (in mm) and collar thickness (in mm).

Rims, whether there is a collar or not, are formed to point in three directions: out, up or in. The majority of the rims, 79% (n=76), flare out from the vessel, whereas 12.5% (n=12) face up and 8.5% (n=8) flare inwards (Table 22).

Table 22. Rim direction based on macroscopic analysis.

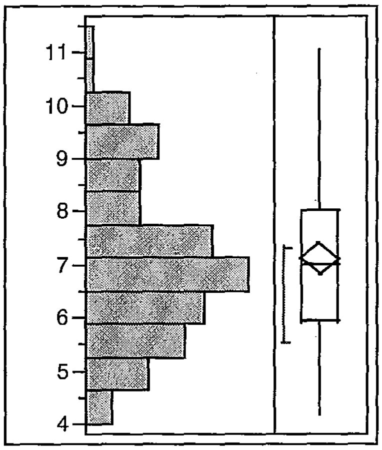
Rim Direction	**Sherd Count**	**Sherd %**
Out	76	79
Up	12	12.5
In	8	8.5
Total	96	100

The edge of the rim is called the lip and can be shaped into different thicknesses and forms. Fonger potters created lips ranging from 4.2 mm to 14 mm that fall into three general categories: thin, medium and thick (Figure 13a and 13b). Thin lips, which were thinner than 8 mm (n=66, 70%) were the most popular, followed by medium lips (n=27, 29%), which measure between 8 and 12 mm. There was one sherd with a thick lip of 14 mm. There is not a clear correlation between lip and rim thickness. This is because, while there are thicker lips attached to thicker rims, there are also thin lips attached to thick rims. In addition, lip thickness is not related to whether a collar was present or not.



Mean	7.2
Std Dev	1.7
Std Err Mean	0.2
upper 95% Mean	7.5
lower 95% Mean	6.8
N	94

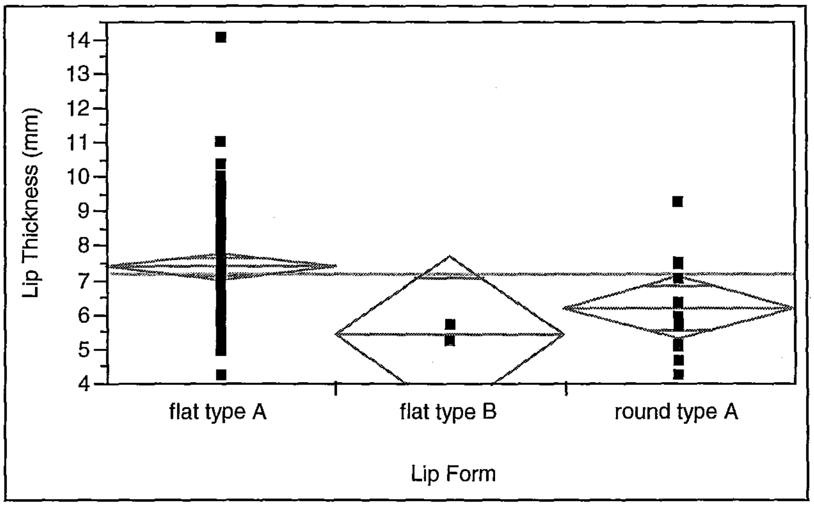
Figure 13a. Distribution of lip thicknesses (mm).



Mean	7.1
Std Dev	1.5
Std Err Mean	0.2
upper 95% Mean	7.4
lower 95% Mean	6.8
N	93

Figure 13b. Distribution of lip thicknesses (mm) when the exceptionally thick lip is eliminated.

Fonger potters chose to form three lip shapes: flat type A, flat type B and round type A (See Appendix 2 for description of lip shape). The most common lip form was flat type A (n=78, 83%) followed by round type A (n=14, 15%) and flat type B (n=2, 2%). I determined that there is relationship between lip thickness and lip form as well as a relationship between rim direction and lip form. Flat type A lips are thicker than round type A lips (Figure 14). All rims that are curved inwards have flat type A lips. Rims that face up or out have flat type A, flat type B or round type A lips. However, rims that have an outward direction have a higher percentage (85%) of flat type A lips compared to rims with an upward direction (58%). In addition, only 1% and 14% of the outward curving rims have flat type B and round type A lips, respectively, whereas, 8% and 33% of up rims have flat type B and round type A lips, respectively (Table 23). While these correlations are true, because there are only two flat type B lips, the existence of a relationship with this lip shape is a hypothesis at best.



Lip Form	N	Mean	Std Error	Lower 95%	Upper 95%
Flat type A	77	7.4	0.2	7.0	7.8
Flat type B	2	5.4	1.2	3.1	7.8
Round type A	13	6.2	0.5	5.3	7.1

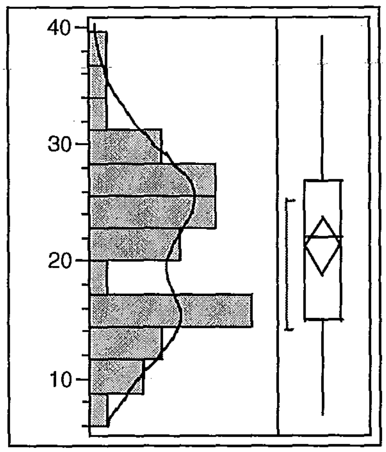
Figure 14. Relationship between lip thickness (in mm) and lip form.

Table 23. Correlation between lip form and rim direction. All inward facing rims have flat type A lips. Outward and upward facing rims can be associated with any lip form.

	Flat type A	Flat type B	Round type A	**Total**
In	8	0	0	8
Out	63	1	10	74
Up	7	1	4	12
Total	78	2	14	94

Castellations, which are defined as "a vertical and sometimes horizontal projection of the rim" (Lennox and Fitzgerald 1990: 417), occur on Fonger vessels, but were not very popular, considering the very few recovered (n=5). If present, there is evidence that more than one castellation can occur on a single Neutral vessel (Lennox and Fitzgerald 1990: 417). However, because my sample does not contain complete vessel rims, I cannot say if Fonger potters added multiple castellations or not. They formed three types of castellations: turret (n=1, 20%), notched (n=1, 20%) and incipient pointed (n=3, 60%) (See Appendix 2 for description of castellation types).

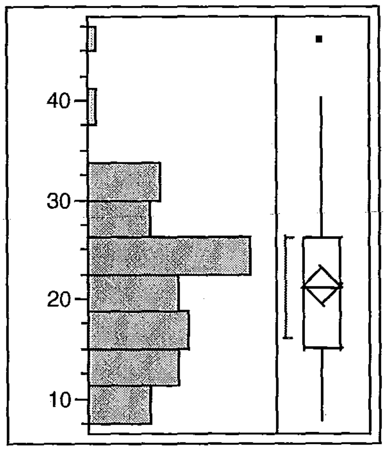
Vessel shape is also determined by the diameter of the rim and neck. Vessels can have very small rim and neck diameters, like a wine bottle, or very large rim and neck diameters, like a wide mouthed vase. When the rim diameter is larger than the neck, the product is a vessel with a constricted neck, which is typical of Iroquoian vessels. The few larger pieces of joined rims and necks from the Fonger site also follow this Iroquoian pattern. When measuring rim and neck diameter, the amount of preservation must be taken into consideration, because if less than 5% of the vessel rim or neck is present, then the measurement is very unreliable. To be as conservative as possible in assessing rim and neck diameter, I eliminated those sherds with less than 5% preservation. Rim diameters at the Fonger site range from 7 cm to 39 cm and can be classified into two categories: narrow and wide (Figure 15). Narrow (n=19, 43%) diameters are between 7 and 20 cm, with a mode at 16 cm, whereas wide (n=25, 57%) diameters are between 21 and 39 cm, with a mode between 26 and 28 cm.



Mean	21.2
Std Dev	7.5
Std Err Mean	1.1
upper 95% Mean	23.5
lower 95% Mean	18.9
N	44

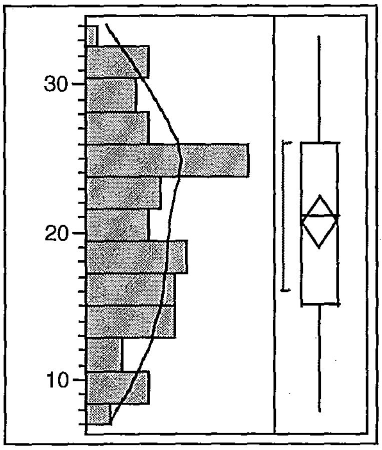
Figure15. Distribution of rim diameters (cm).

Neck diameters at the Fonger site range from 8 cm to 46 cm (Figure 16a and 16b). There seems to be one distinct group of very wide necked vessels (over 35 cm) (n=2, 3%), a group of necks with medium diameters (20-35 cm) (n=40, 55%) and then a group of necks with narrow diameters (less than 20 cm) (n=31, 42%). Without joined rims and necks, I cannot determine the amount of vessel neck constriction. Because of this, I only looked at sherds with more than 5% of both the rim and neck present (n=21) to determine how constricted Fonger potters made their vessels. In 86% (n=18) of the sherds the rim diameter was larger than the neck diameter, demonstrating that Fonger vessels had constricted necks (Figure 17). These sherds had a neck diameter that was from1 cm to 8 cm smaller than the rim diameter, which shows that there was a range of vessel neck constriction. The other 14% (n=3) of sherds have rim diameters as wide as neck diameters. This demonstrates that Fonger potters made vessels without constricted necks or with straight necks, as well.



Mean	21.3
Std Dev	7.8
Std Err Mean	0.9
upper 95% Mean	23.1
lower 95% Mean	19.4
N	73

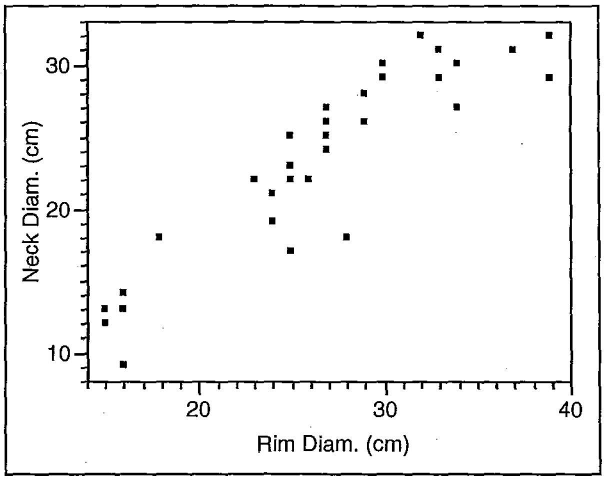
Figure 16a. Distribution of neck diameter (cm).



Mean	20.6
Std Dev	6.92
Std Err Mean	0.8
upper 95% Mean	22.3
lower 95% Mean	19.0
N	71

—— Smooth Curve()

Figure 16b. Distribution of neck diameter (cm). Wide necks are removed.

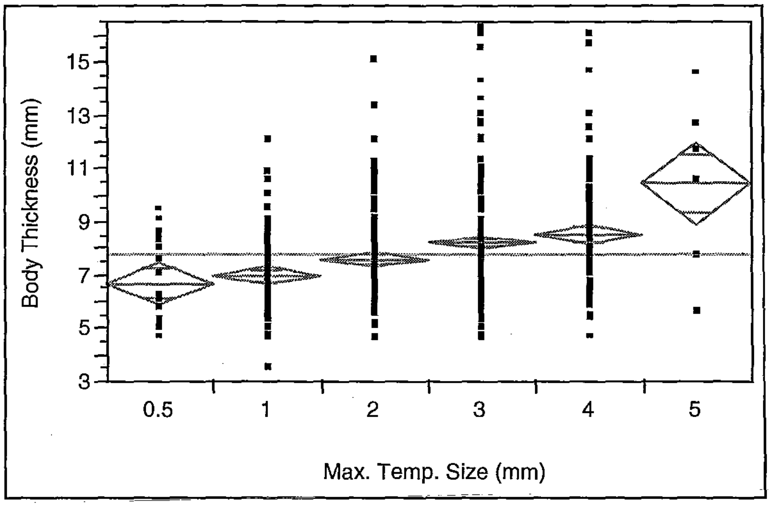


p = <0.0001

Figure 17. Rim diameter (cm) by neck diameter (cm). As the neck diameter increases so does the rim diameter.

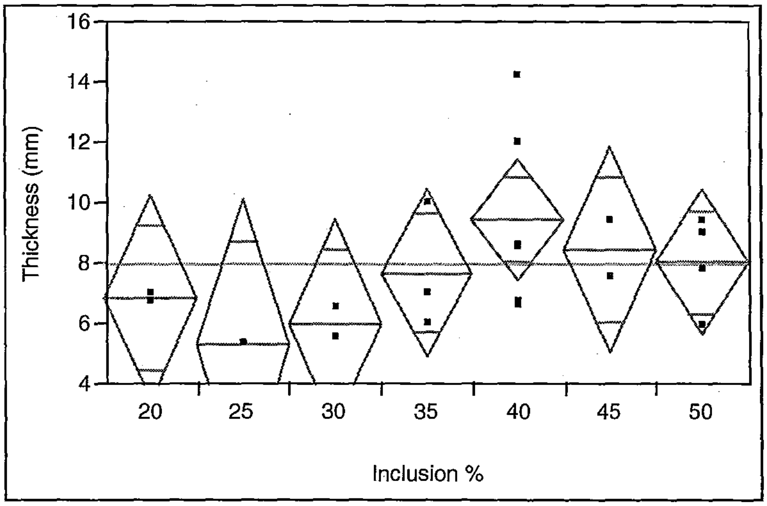
Now that I have established that Fonger potters made vessels the were generally globular in shape with constricted as well as straight necks, but also made flatter more angled bottomed pots, I can discuss vessel size. I cannot provide detailed information regarding actual vessel capacity, because I do not have maximum vessel diameter or maximum vessel height measurements. I can, however, comment on the relative size classes. Vessel size can be estimated using a combination of the amount and size of inclusions within a sherd, wall thickness and rim and neck diameters.

In general, larger vessels require thicker walls to support the weight of the vessel. For thick walls to hold shape and prevent slumping, larger and more temper is needed (Rice 1987: 227). As a general trend, as body thickness increases, on average, larger temper was used (Figures 18). But, this is not always the case because large sized temper is sometimes found in thin walled sherds. Surprisingly, when sherd thickness is compared to the amount of temper there is not a clear pattern. But, there is a very weak tendency for thinner sherds to have less temper than thicker sherds (Figure 19).



Temper Size (mm)	N	Mean	Std Error	Lower 95%	Upper 95%
0.5	25	6.7	0.4	5.9	7.4
1	125	6.9	0.2	6.6	7.3
2	181	7.6	0.1	7.3	7.9
3	222	8.2	0.1	8.0	8.5
4	91	8.5	0.2	8.1	8.9
5	6	10.4	0.8	8.9	12.0

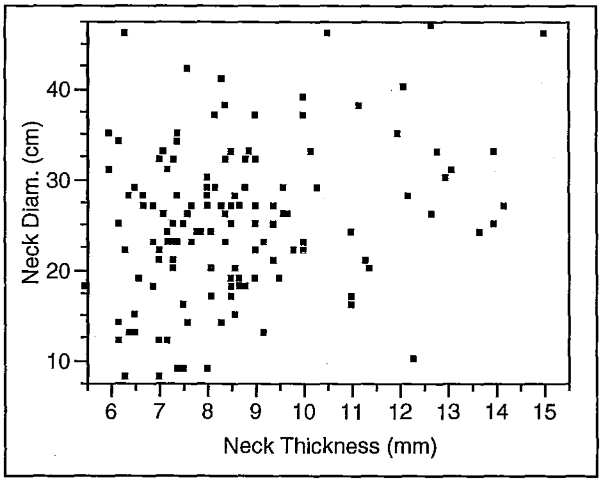
Figure 18. Macroscopic Analysis: Body thickness (in mm) by maximum temper size (in mm). As body thickness increases, the amount of temper present in the sherds increases.



Inclusion %	N	Mean	Std Error	Lower 95%	Upper 95%
20	2	6.9	1.6	3.4	10.3
25	1	5.3	2.2	0.5	10.1
30	2	6.0	1.6	2.6	9.4
35	3	7.7	1.3	4.9	10.4
40	6	9.4	0.9	7.5	11.4
45	2	8.5	1.6	5.0	11.9
50	4	8.0	1.1	5.6	10.4

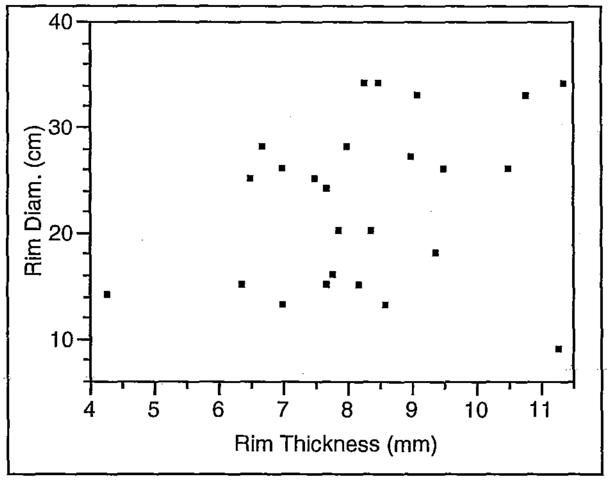
Figure 19. Petrographic Data: Body thickness (in mm) by amount of inclusions (%). As the body thickness increases the amount of inclusions increases.

If vessel shapes were kept consistent, as size increased, rim and neck diameter would increase as well. In order to determine if Fonger potters were creating different sizes of vessels, I must see if these patterns hold true for Fonger vessels. There are no relationships between both neck and rim diameter and neck and rim thickness (Figure 20 and 21). However, there are thick necks with narrow diameters and thin necks with wide diameters, as well as thick rims with narrow diameters.



p = 0.0002

Figure 20. Neck thickness (mm) by neck diameter (cm). There is a relationship between neck thickness and neck diameter.



p = 0.6093

Figure 21. Rim thickness (mm) by rim diameter (cm). There is no correlation between rim thickness and rim diameter.

The data do not demonstrate clear patterns for Fonger potters manufacturing distinct vessel sizes, but show that a range of vessel sizes were created. I cannot comment on the actual vessel sizes or capacities. However, there were tendencies for potters to add larger sized temper to thicker vessels and to make vessels with wider neck diameters and thicker vessel walls.

Even though I cannot demonstrate the vessel shapes and sizes the Fonger potters may have created, I can present the methods potters used to manufacture vessels. I identified three forming techniques: coiling, pinching and paddle and anvil. Coiling and pinching are considered primary forming techniques, whereas paddle and anvil is often considered a secondary technique (Rye 1981: 84). Because the paddle and anvil method is often used after a primary technique, it can mask evidence of the original method of forming. As a result, I will present all three forming techniques together.

In 72.5% (n=636) of the cases there was no evidence of the type of forming technique used. Based on coil and laminated fracture breaks and finger imprints, I identified that 13.5% (n=118) of the sherds had evidence of coiling, 10.5% (n=92) of paddle and anvil and 3.5% (n=30) of pinching (Table 24).

Table 24. Macroscopic Analysis: Forming techniques of the each sherd.

Forming Technique	**Sherd Count**	**Sherd %**
Unknown	636	72.5
Coiling	118	13.5
Paddle and anvil	92	10.5
Pinching	30	3.5
Total	876	100

The orientation of inclusions within a sherd provides information about the forming technique potters used. Paddle and anvil can align particles parallel to the surface, creating a clear orientation, whereas medium and chance orientations are associated with coiling (Rye 1981: 68, 84), unless wiping and burnishing have been used as finishing techniques. The majority (n=706, 80.6%) of Fonger sherds have a chance orientation, whereas 163 (18.6%) have medium orientation and seven (0.8%) are oriented clearly (Table 25 and 26). Of the sherds with a clear orientation, only two are tempered with granite-based materials and the remaining five are shell-tempered sherds. Because it is difficult to assess the orientation of non-platy shaped inclusions, especially macroscopically, I suggest that conclusions based on fracture patterns and finger impressions are more reliable than inclusion orientation.

Table 25. Macroscopic Analysis: Inclusion orientation in each sherd.

Inclusion Orientation	**Sherd Count**	**Sherd %**
Chance	706	80.6
Medium	163	18.6
Clear	7	0.8
Total	876	100

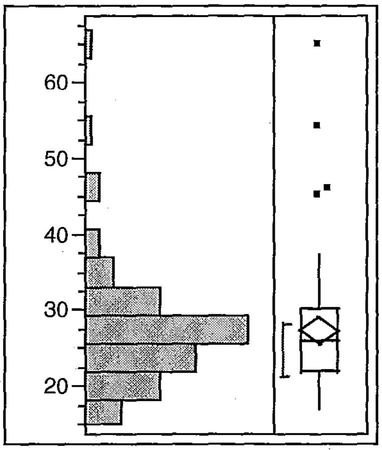
Table 26. Petrographic Analysis: Inclusion orientation in each sherd.

Inclusion Orientation	**Sherd Count**	**Sherd %**
Chance	18	90
Clear	2	10
Total	20	100

Of the shell-tempered sherds, two sherds were formed by coiling and for the remaining sherds the forming method could not be identified. However, because the orientation of the shell within the sherds is medium to clear, this implies that these sherds were paddled. I cannot determine if paddling was a primary or secondary forming technique but the sherds formed by coiling were subsequently paddled. Evidence for shell-tempered sherds being paddled is also supported by the presence of cord roughened paddle impressions on 57% (n=4) of shell-tempered sherds.

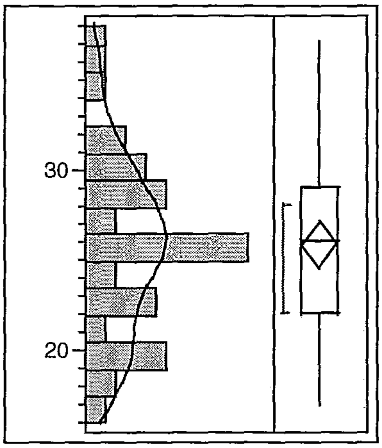
Different parts of a vessel can be formed using different techniques. For example, the body of a vessel could be paddled, whereas the neck and rim could be coiled without paddling. When identified, Fonger body sherds (n=595) were predominantly formed by paddling (n=74, 12%), while some were formed by pinching (n=22, 3.7%) and coiling (n=12, 2%). Because paddling can be a secondary forming technique, it can mask evidence of a primary technique. Thus, while most of the body sherds were paddled, another technique, such as coiling or pinching, may have been used as well. The majority of shoulder sherds (n=31) were created, when the technique could be identified, by coiling (n=5, 16%) or paddling (n=3, 9.7%). In this sample, there were no shoulder sherds with evidence of being formed by pinching. Of the neck sherds (n=125) with evidence of the forming technique used, coiling was the predominant choice (n=46, 36.8%) followed by paddling (n=7, 5.6%) and pinching (n=3, 2.4%). Potters chose to form the vast majority of vessel rims by coiling (n=35, 61.4%) and very few by pinching (n=2, 3.5%) or paddle and anvil (n=1, 1.7%).

Of the sherds that display evidence of coiling, I measured the coil height, based on coil break patterns (Figure 22a and 22b). Coil heights ranged from 17 mm to 65 mm (n=72). There are three possible categories of coil heights: narrow, medium and wide. Narrow coils range from 17 mm to 21 mm (n=15, 21%), whereas medium from 22 mm to 37 mm (n=53, 73%). However, two narrow coils could be joined together to form a single medium coil. The last category could include either wide coils, which ranged from 46 mm to 65 mm (n=4, 6%), or two medium coils joined together.



Mean	27.3
Std Dev	8.1
Std Err Mean	1.0
upper 95% Mean	29.2
lower 95% Mean	25.4
N	72

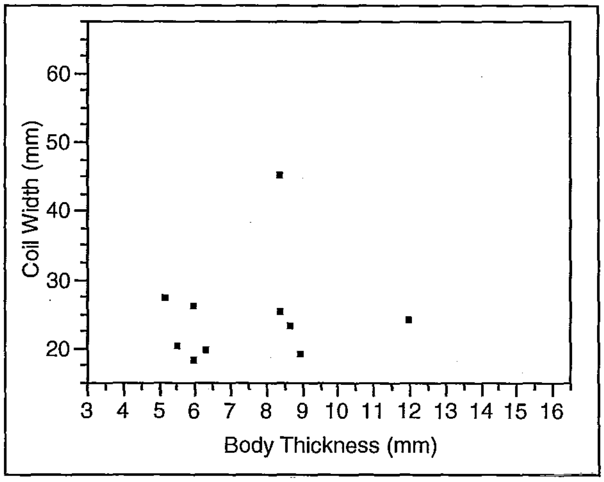
Figure 22a. Coil height distribution (in mm). There are three groups of coil height sizes: narrow, medium and wide.



Mean	27.2
Std Dev	8.1
Std Err Mean	1.0
upper 95% Mean	29.2
lower 95% Mean	25.4
N	72

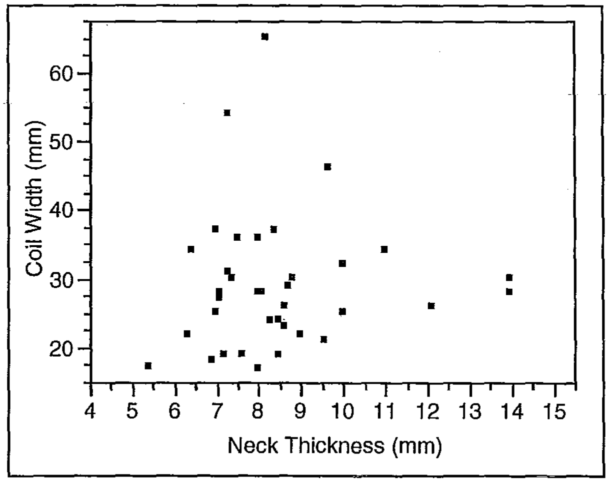
Figure 22b. Coil height distribution (in mm). The four wide coils are removed. When the wide coils are removed, the narrow and medium groups of coils are clear to see.

The height of coils can be a reflection of the habits and preferences of potters, as well as vessel size. Vessels that are made with taller coils are likely to be larger in size. If I assume that vessel wall thickness is a reflection of vessel size and compare coil heights to wall thickness I can determine if coil height is related to vessel size or more a reflection of potter's habits and/or preferences. If coil height is related to vessel size, as wall thickness increases so should coil height. However, this is not the case (Figures 23 and 24). When body and neck thickness are compared to coil height, there is not a clear correlation. There are taller coils with thinner walls. I thought that the tall coils (over 46 mm), which could be more than one coil joined together, might disguise a clear correlation. However, when these possible outliers are removed, there is still absolutely no correlation between coil height and wall thickness.



$p = 0.6748$

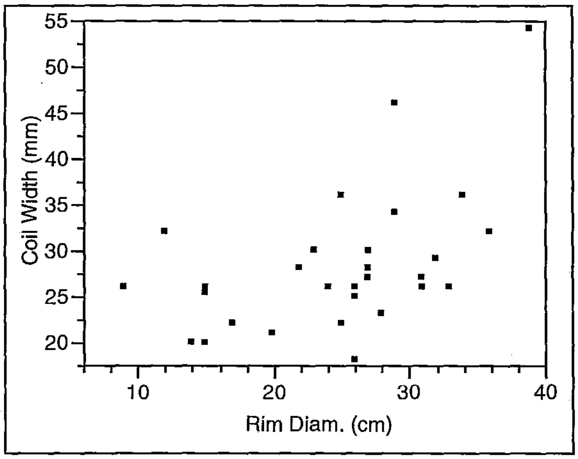
Figure 23. Correlation between coil height (mm) and body thickness (mm). There is no clear pattern that directly associates coil height with body thickness.



$p = 0.6316$

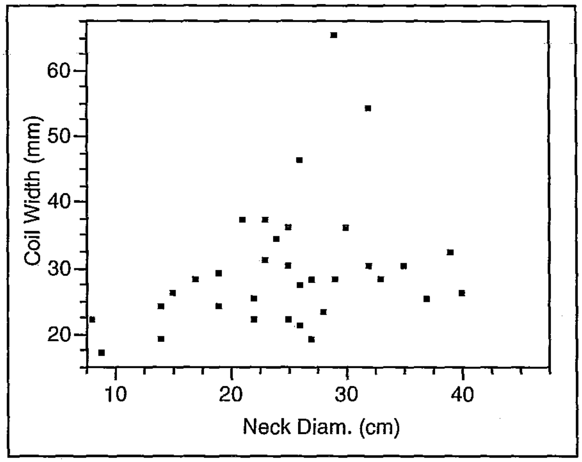
Figure 24. Correlation between coil height (mm) and neck thickness (mm). There is no clear pattern that directly associates coil height with neck thickness. Even when coils over 46 mm were excluded, there was still no pattern.

Because the previous analysis of vessel size was not conclusive, I also looked at rim and neck diameter in relation to coil height to see if I could discern a pattern. There is a trend of taller coils being associated with wider rims and necks (Figures 25 and 26). However, there are still sherds that demonstrate Fonger potters made wide-mouthed vessels using narrow coils.



$p = 0.0077$

Figure 25. Correlation between coil height (mm) and rim diameter (cm). There is a tendency for coil width to increase when rim diameter increases.



$p = 0.0242$

Figure 26. Correlation between coil height (mm) and neck diameter (cm). While the pattern is not absolutely explicit, there is a weak tendency for coil height to increase when neck diameter increases.

Petrography

Petrographic analysis could not add much information to the examination of vessel forming although it did allow a more accurate evaluation of the orientation of inclusions. Of the 20 sherds petrographically analyzed by Braun, 90% (n=18) have a chance orientation and the remaining 10% (n=2) have a clear orientation. The two sherds with a clear orientation are tempered with shell, whereas the sherds with a chance orientation are tempered with granite-based minerals.

Experiments

To parallel the observations of the Fonger material, I made vessels using a combination of forming methods. I built the base by pinching. I built up the body by coiling. Because paddling was used to form shell-tempered and some granite-based tempered sherds from the Fonger site, I paddled some of the sand-tempered and all of the shell-tempered vessels that I created. After both the coiled and paddled vessels were finished, I added necks and rims by coiling and created slightly constricted necks and flared-out rims. (For more detail see pages 40-41).

Summary

When manufacturing a vessel, potters had to decide on the vessel shape and size and what forming techniques to use. Fonger potters created two types of vessel body shapes, globular and flatter-bottomed, with constricted or straight necks. Necks could vary in constriction up to 8 cm narrower than the rim. In addition to constriction, vessel necks could fall within three ranges of heights. Vessel mouths (rims) could vary in diameter to create relatively narrow or wide mouthed vessels. On the rims, Fonger potters sometimes chose to form a collar, which could fall into two height categories and a range of thicknesses. The rims were also formed to face outwards, inwards, or up and could contain one of three types of lip forms, except for rims that faced inwards, which could only have flat type A lips. Castellations were not popular, but three different shapes could be formed. Fonger potters may have added more than one castellation per vessel, but I cannot say with certainty this occurred. Potters made a range of different-sized vessels, with thicker walled vessels (larger vessels) having larger sized temper, but because the data do not provide a clear picture, I cannot determine exact vessel sizes or capacities.

Three forming techniques were employed by potters to create their vessels. More than one technique could have been used to form a single vessel. Similar to my experiments, Fonger potters could have formed a base by pinching, formed the body by coiling and paddling, then added the neck and rim by coiling and finished off rim details, like collar thickness and height, by pinching.

<u>What Do These Choices Mean Mechanically/Functionally?</u>

The reasons why a potter forms a vessel in a specific shape or size can be influenced by the mechanical and functional requirements of the vessel. Globular-shaped vessels are better for cooking, because they have no sharp angles. Sharp angled vessels produce uneven heating and thermal stress when heated (Rye 1981: 27; Rice 1987: 226). In addition to a rounded shape, thin-walled vessels are better suited for cooking, because they have an increased resistance to thermal shock and conduct heat faster than thick-walled vessels (Rice 1987: 227). However, the single more angled, flatter based sherd as well as a number of thicker sherds exhibit evidence of being used for cooking.

Vessels used for storage would benefit from necks that were constricted. This is because neck constriction can reduce the amount of spillage or vessel content loss (Rice 1987: 226). In the Fonger assemblage there do not appear to be strict rules connecting vessel shape with function. For example, constricted neck sherds, which are suitable for storage vessels, are found in association with interior carbon deposits.

If vessels are being moved around a lot or are stored in high traffic areas, then thicker walls would be beneficial, because thicker walls can be more durable. Vessel size can also be related to wall thickness and coil height because "in general, larger vessels require thicker walls for structural support" (Rice 1987: 227). While it may not be true in all cases, there is a weak tendency for Fonger sherds to follow these patterns.

While these mechanical and functional properties associated with vessel shape and size would have influenced Fonger potters' choices, there are some choices that are unexplained by just looking at mechanics and function. Thin vessel walls can be more suitable for cooking, however, this does not mean that thick-walled vessels were not used for this purpose. Fonger potters created vessels with varying degrees of neck constriction, including non-constricted and constricted necks. While vessels of different degrees of neck constriction are better suited for certain functions, Fonger potters used non-constricted and constricted necked vessels for cooking.

Finishing

Macroscopic Analysis

After forming, potters finish the exterior and interior surfaces of their vessels. Macroscopic examination revealed that Fonger potters used one of seven techniques to finish the exterior surfaces of their vessels. The options were to smooth (n=781, 89%), burnish (n=51, 5.8%), use a cord-roughened paddle (n=8, 0.9%), smooth over the cord roughened surface (n=22, 2.5%), use a ribbed paddle (n=1, 0.1%), smooth over the ribbed surface (n=12, 1.4%) or scarify the surface (n=1, 0.1%) (Table 27). Potters finished the interior surfaces of their vessels as well, however, using only two techniques: smoothing (99.9%, n=875) or burnishing (0.1%, n=1).

Table 27. Distribution of exterior finishing techniques.

Finishing Technique	**Sherd Count**	**Sherd %**
Smoothing	781	89.2
Burnishing	51	5.8
Cord roughened paddle	8	0.9
Smoothed over cord	22	2.5
Ribbed paddle	1	0.1
Smoothed over ribbed	12	1.4
Scarifying	1	0.1
Total	876	100

These finishing techniques require different movements and tools. Smoothing requires potters to rub their hands or another soft object, such as a leaf, cornhusk or piece of hide, over vessel surfaces, while the vessel is still soft. Burnishing can be executed by using a different tool than smoothing, such as a polished stone, and by applying more pressure to the surface, while the vessel is leather-hard.

Another kind of secondary finishing, cord-roughening or ribbed paddling, includes the use of a paddle and possibly an anvil. At the Fonger site, the application of these methods had been used to also add texture to the surface, because paddles had been wrapped in cords or had ribbed impressions and were hit against the exterior surface of the vessel.

In some cases the cord-roughened and ribbed-paddled sherds were smoothed. The Fonger sample is comprised entirely of sherds, making it impossible to determine the pattern of this smoothing. For example, I cannot tell whether the entire vessel was smoothed over, or whether smoothing was done in a specific direction. Also, if potters were handling their vessels before the pots were completely dry, cord-roughened and ribbed paddle impressions may have been compressed or slightly distorted. If this occurred, sherds with paddled impressions may seem smoothed over but in reality this pattern would have been accidental and not a real step in the manufacturing sequence.

The final method of finishing exterior surfaces is by scarifying them, which is only found on one sherd in the entire sample. Scarification refers to the random lines incised over a vessel's surface with a sharply pointed tool.

On the exterior and interior surfaces of each sherd, no matter the finishing technique, I documented the existence and direction of smoothing lines from finishing. Smoothing lines can be distinguished from scraping lines because scraping lines are sharp and the act of scraping removes grains from the surface creating pits, whereas smoothing does not create sharp ridges and pits (Shepard 1971: 188-189 Fig-13). The majority of sherds did not have exterior (n=465, 53%) or interior (n=486, 55%) smoothing marks. In 38% of sherds (n=330) the smoothing marks on the exterior surface were all towards the same direction, while in 9% (n=81) their direction was random. On the interior surface of 38% of the sherds (n=333) the smoothing marks all followed the same direction, while in 7% (n=57) of cases their direction was random. However, because there are no whole vessels, I cannot determine if sherds that contain smoothing lines in the same direction were not part of a vessel, which was smoothed in various directions.

An interesting note is that sherds that have been smoothed on the exterior are not always smoothed on the interior and vice versa (Table 28). Thirty-five percent (n=304) sherds did not have smoothing marks. Twenty-one percent (n=182) of sherds had exterior but no interior smoothing, 18% (n=161) had interior but no exterior smoothing, whereas 26% (n=229) had both exterior and interior smoothing.

Table 28. The presence of exterior and interior smoothing.

	No Exterior Smoothing	**Exterior Smoothing**	**Total**
No Interior Smoothing	304	182	486
Interior Smoothing	161	229	390
Total	465	411	876

Experiments

To parallel my macroscopic observations, I smoothed the exterior and interior surfaces of the vessels I made using my hands. The macroscopic analysis of finishing implied some sherds may have been finished in more steps. As a result, on the remaining pots that I made, I used a chert scraper to remove bumps, even out surfaces and thin the walls. Once the vessels were completed, I examined the smoothing and scraping marks on the vessels I made and compared these impressions to the marks on the Fonger sherds. The finishing marks on the Fonger sherds are more similar to the smoothing marks made by my fingers than the scraping marks made by the chert scraper. Thus, I believe Fonger potters smoothed their vessel surfaces with their fingers and hands. However, they could have scraped their vessels with a different scraping tool, such as a piece of gourd, which would have left different scraping marks.

Summary

Fonger potters used seven types of exterior and two types of interior vessel finishes, where different tools and gestures were needed to execute the various techniques. The majority of sherds were only finished by being smoothed by potters' fingers. Some of the sherds finished by other techniques, such as those finished by cord-roughening or ribbed paddling, still display evidence of exterior and/or interior smoothing. Whether such smoothing was intentional or accidental is unclear.

There is an interesting relationship between vessel finish and the raw materials selected. Sherds with granite inclusions display the widest variety of finishing techniques, including smoothing, burnishing, cord roughening with a paddle, smoothing over the cord roughened surface, using a ribbed paddle, smoothing over the ribbed surface and scarifying. Considering that sherds tempered with granite-based material make up just over 99% of the sample, this diversity is expected. Shell-tempered sherds (n=7), which comprise less than 1% of the Fonger sample, were finished by smoothing (n=3, 42.9%), roughening with a cord paddle (n=2, 28.5%) and smoothing over the cord-roughened surface (n=2, 28.5%) techniques. This is very interesting, considering cord-roughened and smoothed-over cord are not popular finishing techniques within the Fonger sample (only 3.4% of the entire sample), yet the rare shell-tempered sherds contain these finishes. However, shell-tempered sherds have been found at other Neutral sites to be associated with cord-roughened finishes (Lennox and Fitzgerald 1990: 418).

I looked at the types of finishes applied to body, neck and rim sherds in order to see if different parts of a vessel could be finished with different techniques. Cord-roughened, ribbed paddle, smoothed-over ribbed and scarified finishes occur only on body sherds. Smoothed-over cord finish is found mainly on body sherds, with the exception of one neck sherd. Potters used burnishing and smoothing to finish bodies, necks and rims. As a result, textured vessel surfaces are only found on vessel bodies and rarely on vessel necks (Table 29).

Table 29. The types of finishing techniques and where they were applied on Fonger vessels.

Surface Finish	**Body**	**Neck**	**Rim**
Smoothed	X	X	X
Burnished	X	X	X
Cord-roughened	X		
Smoothed-over cord	X	X	
Ribbed paddle	X		
Smoothed-over ribbed	X		
Scarified	X		

A very interesting pattern appeared when I examined the correlation between surface finish and decoration. Because textured surfaces occur only on vessel bodies, I could only assess the correlation between surface finish and decoration by looking at body sherds. Body sherds with burnished, cord-roughened, smoothed-over cord, ribbed paddle, smoothed-over ribbed and scarified finishes do not contain decoration. Fonger potters only applied decoration to smoothed bodies. Although the texture produced by burnishing and paddling may have actually comprised the intended decorative effect, the absence of a geometric design, such as occurs on necks and rims is very interesting.

What Do These Choices Mean Mechanically/Functionally?

The type of surface finish can affect the mechanics and function of a vessel. Vessels with burnished surfaces are "harder and more resistant to abrasion" (Rice 1987: 355) because the act of burnishing "will compact and smooth the particles on the surfaces" (Rice 1987: 355). Consequently, vessels that are exposed to abrasion, such as vessels that contain materials requiring stirring, would possibly last longer if burnished. Burnishing can also decrease permeability (Rice 1987: 231). Thus, vessels used for cooking or storing liquids may have benefited from having a burnished finish.

Young and Stone (1990: 202) conducted experiments to see if vessels with textured surfaces have different heating and/or cooling rates than untextured, smoothed surface vessels and found that there was no difference. Textured finishes, such as cord roughening, smoothed-over cord, ribbed paddle, smoothed over ribbed paddle and scarified, do not conduct heat differently than smoothed or burnished finishes. However, textured surfaces offer a better grip (Rice 1987: 138) and thus are better suited for vessels that are transported or handled often. Correspondingly, Fonger sherds with textured surfaces demonstrate that they were used for cooking and possibly other functions not related to cooking, such as storage or transportation.

Decorating

Macroscopic Analysis

The aim of the macroscopic analysis was to understand the types of decoration Fonger potters applied and where decoration was applied. Fonger potters placed decoration on the bodies, necks, rims, lips, interior rims and castellations of their pots. They utilized only two techniques, incising and impressing, to apply the decoration but created five types of decoration. Incising was applied by a narrow-ended tool used with sufficient pressure to cut into clay, whereas impressing is the negative impression of a tool pressed into plastic or leather hard clay. When potters incised vessels they used one of three possible decoration types to create a pointy line, a trailed line or a notch. When they impressed decoration they created punctates or dentate stamp impressions.

The majority of body sherds were not decorated (n=570, 94%) but when potters did apply decoration to vessel bodies they usually applied impressed punctates (n=13, 39.4%), incised trailed lines (n=11, 33.3%) or a combination of both impressed punctate and incised trailed lines (n=6, 18.2%). Rarely were incised pointy lines used (n=2, 6%) and even more rarely were incised pointy lines used in conjunction with incised trailed lines (n=1, 3%) (Table 30). It is possible that combinations of these different decoration techniques were used more often than what is represented in this sample. This is because my data come from sherds, which may only represent a part of a larger decorative pattern that can only be observed if whole vessels are available.

Table 30. Decoration techniques on decorated body sherds.

Body Decoration	**Sherd Count**	**Sherd %**
Impressed punctates	13	39.4
Incised trailed lines	11	33.3
Impressed punctates and incised trailed lines	6	18.2
Incised pointy lines	2	6
Incised pointy lines and incised trailed lines	1	3
Total	33	100

If potters added decoration on the shoulders of vessels, it was predominantly impressed punctates (n=27, 64%), although there were cases with incised pointy lines (n=8, 19%), incised trailed lines (n=5, 12%), incised trailed lines with impressed punctates (n=1, 2.5%), or impressed dentate stamp impressions (n=1, 2.5%) (Table 31).

Table 31. Decoration techniques on decorated shoulder sherds.

Shoulder Decoration	Sherd Count	Sherd %
Impressed punctates	27	64
Incised pointy lines	8	19
Incised trailed lines	5	12
Impressed punctates and incised trailed lines	1	2.5
Impressed dentate stamps	1	2.5
Total	42	100

There is less neck decoration variation than body and shoulder sherd decoration variation. This might be because decoration occurs more frequently on both bodies and shoulders than on necks. However, when decoration was applied to vessel necks, potters added impressed punctates (n=7, 32%), incised trailed (n=9, 41%) or pointy lines (n=5, 22.5%) and seldom incised trailed lines in combination with impressed punctates (n=1, 4.5%) (Table 32).

Table 32. Decoration techniques on decorated neck sherds.

Neck Decoration	Sherd Count	Sherd %
Impressed punctates	7	32
Incised trailed lines	9	41
Incised pointy lines	5	22.5
Impressed punctates and incised trailed lines	1	4.5
Total	22	100

The widest variety of decoration is displayed on rims, which is likely related to the fact that potters decorated mostly all of their vessel rims. Incised trailed lines predominate rim decoration (n=44, 49.5%) followed by incised pointy lines (n=31, 35%). Less often impressed punctate (n=7, 8%) and incised notch (n=4, 4.5%) and more infrequently impressed dentate stamp (n=1, 1%) and incised pointy lines alongside either incised trailed lines (n=1, 1%) or impressed punctates (n=1, 1%) were used (Table 33).

Table 33. Decoration technique in decorated rim sherds.

Rim Decoration	Sherd Count	Sherd %
Incised trailed lines	44	49.5
Incised pointy lines	31	35
Impressed punctates	7	8
Incised notches	4	4.5
Impressed dentate stamps	1	1
Incised trailed lines and incised pointy lines	1	1
Impressed punctates and incised pointy lines	1	1
Total	89	100

Potters also decorated the interior of rims. Incised notches (n=21, 41%) and incised pointy (n=13, 25%) and trailed (n=16, 31%) lines were all popular. On one occasion, an impressed dentate stamp (2%) was used (Table 34).

Table 34. Interior rim decoration techniques on decorated rim sherds.

Interior Rim Decoration	Sherd Count	Sherd %
Incised notches	21	41
Incised pointy lines	13	25
Incised trailed lines	16	31
Impressed dentate stamps	1	2
Total	51	100

In contrast, potters chose to decorate vessel lips less often than rims. When potters did apply decoration to the lip surface, it was commonly impressed punctates (n=5, 50%) although incised trailed (n=3, 30%) and incised pointy (n=1, 10%) lines and incised notches (n=1, 10%) were also present (Table 35).

Table 35. Lip decoration techniques on decorated lips.

Interior Rim Decoration	Sherd Count	Sherd %
Impressed punctates	5	50
Incised trailed lines	3	30
Incised pointy lines	1	10
Incised notches	1	10
Total	10	100

Only five castellations were identified in the macroscopic analysis and out of the five, three were decorated, each with a different decoration type: one had incised pointy lines, another had incised trailed lines and the last had impressed punctates.

Summary

Fonger potters added incised pointy lines, incised trailed lines, incised notches, impressed punctates and dentate stamp impressions to their pots as decoration. They chose to apply a single type of decoration or a combination of decoration types, such as incised trailed lines in conjunction with impressed punctates.

If Fonger potters chose to apply decoration, they could add decoration anywhere on their vessels. Vessel necks and interior rims were not frequently decorated; body and shoulder decoration was more common, but rims, lips and castellations were the most popularly decorated areas.

What Do These Choices Mean Mechanically/Functionally?

The presence of geometric decorative patterns on the rim and neck do not affect the mechanics or function of a vessel. However, decoration may be a reflection of different social uses. There is no correlation between decoration and raw materials or decoration and vessel size. As a result, I cannot make any conclusions based on decoration type or location and use.

Firing

Macroscopic Analysis

Firing is a critical stage in the making of ceramic vessels as it is responsible for turning clay into pottery, giving the vessel its final colour and texture and seriously affecting important properties, such as solubility and strength. The aim of my macroscopic analysis was to understand the firing atmosphere and cooling conditions.

I determined the firing atmosphere by considering a number of observations, including the exterior and interior surface colours, the core colours, and the presence or absence of sooting and/or carbon deposits on both surfaces. When these variables are all taken into consideration 90% (n=785) of Fonger sherds were fired in oxidizing or incompletely oxidizing atmospheres. Because of the lack of archaeological evidence pertaining to firing structures, especially the lack of ovens and kilns in Ontario, and the fact that these atmospheric conditions are easily produced in open fires, I believe Fonger potters fired their vessels in an open bonfire or pit fire.

Because of the frequency of both carbon deposits and sooting, especially on the interior surfaces, I could only conclude with certainty that 2% (n=20) of the sample was fired in a reducing atmosphere. This was determined based on sherds that do not have evidence of sooting or carbon deposits, but do have very dark core and surface colours.

Twenty-one percent (n=182) of sherds have fire clouds on the exterior surface and 2.5% (n=22) have fire clouds on the interior surface. A fire cloud is "localized discoloration or fire-clouding, which occurs where fuel comes in contact with the ware or where a jet of gas from a smoky flame strikes it" (Shepard 1971: 92). As a result, the 20 sherds that appear to have been fired in a reducing atmosphere may be sherds that are fire clouded instead.

Ninety-three percent (n=812) of the sherds exhibited diffused boundaries between the surfaces and the core. This implies that vessels were cooled slowly after firing.

Cooling could include leaving vessels in the fire until the fire died down or removing the vessels to just outside of the fire, in a fashion similar to preheating. The 7% (n=64) of the sherds that contained sharp boundaries were cooled quickly. This could occur if vessels were removed from the fire while they were still hot. If multiple vessels were fired at a single time, then these sherds could be from vessels that were taken out of the fire first and therefore were cooled faster.

XRD

In relation to firing, the goal of XRD analysis was to determine whether Fonger potters fired their pots below or above 900°C. If vessels are fired at less than 900°C, then the clay minerals in the ceramic paste may be identified (Rice 1987: 385). Because illite, a clay mineral, could be identified in all of the Fonger sherds submitted to XRD, I conclude that Fonger potters fired their vessels under 900°C. This is consistent with temperatures reached in open bonfires.

Notably, XRD analysis identified added calcite (shell, $CaCO3$) in the two shell tempered ceramics that was separate from the calcite minerals in the clays (Table 16a and 16b). This is extremely important because this implies that the decomposition of shell did not occur in the Fonger ceramics, meaning that at least some of the Fonger ceramics were fired at very low temperatures (under 600°C) or that Fonger potters prevented shell decomposition in another way, such as pre-firing the shell. Pre-firing shell between 300°C and 400°C alters the composition of aragonite in the shell to calcite (Feathers 2006: 92). Because XRD did not identify aragonite as being present in the shell-tempered sherds and did identify calcite as being present in significant amounts, this suggests that the shell in the Fonger ceramics were pre-fired before being added to the clay pastes.

Re-Firing

The goal of re-firing six pieces of Fonger sherds was to eliminate any sooting and/or carbon deposits that occurred from use and any depositional changes to the colour of the sherds in order to show whether sherd colour differences were due to the chemical composition of the ceramic paste or to firing. The sherds from the Fonger site prior to re-firing exhibited a range of colours including brown, light brownish gray, light gray, very dark gray and black. After re-firing sherds at 900°C for six minutes in an oxidizing atmosphere, the sherds were either light brown or reddish yellow (Table 36). Based on this it appears that the differences in the colours of Fonger sherds are a result of the conditions vessels were fired under and how vessels were used and not necessarily because of chemical differences in the clay pastes Fonger potters were selecting.

Table 36. Colours of the sherds before and after re-firing.

Sherd #	**Provenience**	**Munsell Colour Before Re-Firing**	**Colour Description**	**Munsell Colour After Re-Firing**	**Colour Description**
3736(2)	Midden A	1 for grey 2.5/N	Black	7.5 YR 6/4	Light brown
2494(7)	Midden A	2.5 Y 7/2	Light gray	7.5 YR 6/6	Reddish yellow
3685(3)	Midden A	7.5 YR 5/4	Brown	7.5 YR 6/6	Reddish yellow
2017(17)	Midden B	2.5 Y 3/1	Very dark gray	7.5 YR 6/6	Reddish yellow
2030(3)	Midden B	10 YR 4/3	Brown	7.5 YR 6/6	Reddish yellow
1058(10)d	Midden B	2.5 Y 6/5	Light brownish gray	7.5 YR 6/4	Light brown

Test Tiles

The purpose of firing test tiles was to observe the solubility, fired colour and point of calcium carbonate decomposition of the different locally available clays when mixed with different types and amounts of locally available tempers. A part of each tile type was fired to 500°C, 600°C, 800°C and 900°C in an oxidizing tube kiln and held at the specific temperature for 6 minutes.

In general, unslaked, or natural clay samples were more soluble than slaked clay samples (Table 37). Fonger 1, St. George 4 and St. George 6 clay samples are more soluble than Fonger 2, Jerseyville 3 and St. George 5 clay samples.

Table 37. Test tile solubility after firing. All tiles fired over 600°C were not soluble.

Fired Temperature	Soluble	Non-Soluble
500°C	Fonger 1 Fonger 1 shell St. George 4 St. George 4 15% Sand St. George 4 25% Sand St. George 4 Shell St. George 4 Slaked St. George 4 Slaked 15% Sand St. George 4 Slaked 25% Sand St. George 4 Slaked Shell St. George 6 St. George 6 15% Sand St. George 6 25% Sand St. George 6 Shell	All other test tiles fired to 500°C
600°C	St. George 4 St. George 4 15% Sand St. George 4 25% Sand St. George 4 Shell St. George 4 Slaked St. George 4 Slaked 15% Sand St. George 4 Slaked 25% Sand St. George 4 Slaked Shell	All other test tiles fired to 600°C
800°C		All test tiles fired to 800°C
900°C		All test tiles fired to 900°C

When the tiles are fired at lower temperatures, such as 500°C, there is a higher chance that they can be soluble, since it is at temperatures above 600°C that clays go through chemical and mineral changes and it is around 900°C that the clay particles lose their ability to become plastic again (Rice 1987: 90). In the end, St. George 4 had the highest number of tiles that were soluble. If potters used this clay and fired their vessels under similar conditions (atmosphere, duration, and heating and cooling rates) to the test tiles, the vessels would have to be fired higher than 600°C to make absolutely sure that they were not soluble and, thus, could hold water.

I documented the colour of the fired tiles in order to observe how the colour changes as the firing temperature increases under oxidizing conditions. The colours of the tiles varied between the different clay types, as the temperature increased and with different types and amounts of temper (Table 38).

Table 38. Test tile colour after firing. S = slaked

	Munsell Colour					
Fired test tiles	**Light brown 7.5 YR 6/4**	**Reddish yellow 7.5 YR 6/6**	**Brown 7.5 YR 5/4**	**Light yellowish brown 10 YR 6/4**	**Yellowish brown 10 YR 5/4**	**Strong brown 7.5 YR 5/6**
500°	Fonger 1 Fonger 1 15% sand Fonger 1 25% sand Fonger 1 shell Fonger 1 (S) Fonger 1 15% sand (S) Fonger 1 25% sand (S) Fonger 1 shell (S) Fonger 2 Fonger 2 15% sand	St.George 4 15% sand (S) St.George 5 St George 5 15% sand St.George 5 25% sand St.George 6 St.George 6 15% sand St.George 6 25% sand St.George 6 shell	Fonger 2 shell (S) Jerseyville 15% sand (S) St.George 4 15% sand St.George 4 25% sand	Jerseyville 25% sand (S) Jerseyville shell (S)	Jerseyville (S) St.George 4 shell (S)	St.George 4 St.George 4 shell St.George 4 25% sand (S)

Table 38. Continued.

Fired test tiles	Light brown 7.5 YR 6/4	Reddish yellow 7.5 YR 6/6	Brown 7.5 YR 5/4	Light yellowish brown 10 YR 6/4	Yellowish brown 10 YR 5/4	Strong brown 7.5 YR 5/6
500°C	Fonger 2 25% sand Fonger 2 shell Fonger 2 (S) Fonger 2 15% sand (S) Fonger 2 25% sand (S) Jerseyville Jerseyville 15% sand Jerseyville 25% sand Jerseyville shell St.George 5 (S) StGeorge 5 15% Sand (S) St.George 5 shell (S)	St.George 6 (S) St.George 6 15% Sand (S) St.George 6 25% sand (S) St.George 6 shell (S)				
600°C	Fonger 1 shell Fonger 1 15% sand (S) Fonger 1 25% sand (S) Fonger 2 15% sand (S) Fonger 2 25% sand (S) Jerseyville Jerseyville 25% sand St.George 4 (S) St. George 5 shell St.George 5 25% sand (S) St.George 5 shell (S)	Fonger 1 Fonger 1 15% sand Fonger 1 slaked Fonger 1 shell (S) Fonger 2 Fonger 2 15% sand Fonger`2 25% sand Fonger 2 shell Fonger 2 (S) Fonger 2 shell (S) Jerseyville 15% sand Jerseyville shell Jerseyville (S) Jerseyville 15% sand (S) Jerseyville 25% sand (S) Jerseyville shell (S) St.George 4 St.George 4 15% sand St.George 4 25% sand St.George 4 shell St.George 4 (S) St.George 4 15% sand (S) St.George 4 25% sand (S) St.George 5 St.George 5 15% sand St.George 5 25% sand	Fonger 1 25% sand			St.George 4 shell (S)

Table 38. Continued.

Fired test tiles	Light brown 7.5 YR 6/4	Reddish yellow 7.5 YR 6/6	Brown 7.5 YR 5/4	Light yellowish brown 10 YR 6/4	Yellowish brown 10 YR 5/4	Strong brown 7.5 YR 5/6
600°C		St.George 5 (S) St.George 5 15% sand (S) St.George 5 25% sand (S) St.George 6 St.George 6 15% sand St.George 6 25% sand St.George 6 shell St.George 6 (S) St.George 6 15% sand (S) St.George 6 25% sand (S) St.George 6 shell (S)				
800°C	St.George 5 shell St.George 5 shell (S)	Fonger 1 Fonger 1 15% sand Fonger 1 25% sand Fonger 1 shell Fonger 1 (S) Fonger 1 15% sand (S) Fonger 1 25% sand (S) Fonger 1 shell (S) Fonger 2 Fonger 2 15% sand Fonger 2 25% sand Fonger 2 shell Fonger 2 (S) Fonger 2 15% sand (S) Fonger 2 25% sand (S) Fonger 2 shell (S) Jerseyville Jerseyville 15% sand Jerseyville 25% sand Jerseyville shell Jerseyville (S) Jerseyville 15% sand (S) Jerseyville 25% sand (S) Jerseyville shell (S) St.George 4 St.George 4 15% sand St.George 4 25% sand St.George 4 shell St.George 4 (S) St.George 4 15% sand (S) St.George 4 25% sand (S) St.George 5 St.George 5 15% sand St.George 5 25% sand St.George (S) St.George 5 15% sand (S)				St.George 4 shell (S)

Table 38. Continued.

Fired test tiles	Light brown 7.5 YR 6/4	Reddish yellow 7.5 YR 6/6	Brown 7.5 YR 5/4	Light yellowish brown 10 YR 6/4	Yellowish brown 10 YR 5/4	Strong brown 7.5 YR 5/6
800°C		St.George 5 25% sand (S) St.George 6 St.George 6 15% sand St.George 6 25% sand St.George 6 shell St.George 6 (S) St.George 6 15% sand (S) St.George 6 25% sand (S) St.George 6 shell (S)				
900°C	St.George 5 shell	Fonger 1 Fonger 1 15% sand Fonger 1 25% sand Fonger 1 shell Fonger 1 (S) Fonger 1 15% sand (S) Fonger 1 25% sand (S) Fonger 1 shell (S) Fonger 2 Fonger 2 15% sand Fonger 2 25% sand Fonger 2 shell Fonger 2 (S) Fonger 2 15% sand (S) Fonger2 25% sand (S) Fonger 2 shell (S) Jerseyville Jerseyville 15% sand Jerseyville 25% sand Jerseyville shell Jerseyville (S) Jerseyville 15% sand (S) Jerseyville 25% sand (S) Jerseyville shell (S) St.George 4 St.George 4 15% sand St.George 4 25% sand St.George s Shell St.George 4 (S) St.George 4 25% sand (S) St.George 5 St.George 5 15% sand St.George 5 25% sand St.George 5 shell St.George 5 (S) St.George 5 15% sand (S) St.George 5 25% sand (S) St.George 5 shell (S)				St.George 4 15% sand (S) St.George 4 shell (S)

Table 38. Continued.

Fired test tiles	Light brown 7.5 YR 6/4	Reddish yellow 7.5 YR 6/6	Brown 7.5 YR 5/4	Light yellowish brown 10 YR 6/4	Yellowish brown 10 YR 5/4	Strong brown 7.5 YR 5/6
900°C		St.George 6 St.George 6 15% sand St.George 6 25% sand St.George 6 shell St.George 6 (S) St.George 6 15% sand (S) St.George 6 25% sand (S) St.George 6 shell (S)				

Except for two tiles, which are strong brown, all the tiles fired to 900°C are reddish yellow in colour. Four out of the six re-fired Fonger sherds are reddish yellow as well. The other two re-fired sherds were light brown. Because of this and because the Fonger sherds were made from local clays, the colours of the Fonger sherds are the result of firing conditions, use and/or post-deposition conditions.

Because calcium carbonate physically changes when heated between 650°C and 900°C, which can be a potential problem to potters when the vessel re-hydrates, I documented at which temperatures calcium carbonate within the tiles expanded after firing, causing cracking and disintegration of the tile. Most cracking occurred in the tiles with shell temper. Tiles made with Fonger 1 clay did not crack except for the tiles tempered with shell. All shell tempered tiles made from Fonger 1 clay cracked, except for the tile fired at 500°C. Based on this, the point of calcium carbonate decomposition in Fonger 1 clay is 600°C. All tiles made from Fonger 2, Jerseyville 3, St. George 4, St. George 5 and St. George 6 clay stayed complete except for the shell-tempered ones, which cracked at 500°C and higher (Table 39). Based on this, the point of calcium carbonate decomposition for all clays other than Fonger 1 is 500°C. Because the Fonger sherds recovered were made from local clays and the shell temper survived, the shell-tempered vessels were either fired below 600°C or as the XRD results suggest, potters prevented this chemical reaction by pre-firing the shell before adding it to the clay paste.

Table 39. Test tile observations for the point of calcium carbonate decomposition.

Fired Temperature of Test Tile	Calcium Carbonate Decomposition	
	Yes	No
500°C	Fonger 1 Slaked Shell Fonger 2 Shell Fonger 2 Slaked Shell Jerseyville 3 Shell Jerseyville 3 Slaked Shell St. George 4 Shell St. George 4 Slaked Shell St. George 5 Shell St. George 5 Slaked Shell St. George 6 Shell St. George 6 Slaked Shell	Fonger 1 Shell and all sand-tempered tiles fired to 500°C
600°C	Fonger 1 Shell Fonger 1 Slaked Shell Fonger 2 Shell Jerseyville 3 Shell Jerseyville 3 Slaked Shell St. George 4 Shell St. George 4 Slaked Shell St. George 5 Shell St. George 5 Slaked Shell St. George 6 Shell St. George 6 Slaked Shell	Fonger 2 Slaked Shell and all sand-tempered tiles fired to 600°C
800°C	Fonger 1 Shell Fonger 1 Slaked Shell Fonger 2 Shell Jerseyville 3 Shell Jerseyville 3 Slaked Shell St. George 4 Shell St. George 4 Slaked Shell St. George 5 Shell St. George 5 Slaked Shell St. George 6 Shell St. George 6 Slaked Shell	Fonger 2 Slaked Shell and all sand-tempered tiles fired to 800°C

Table 39. Continued.

Fired Temperature of Test Tile	Calcium Carbonate Decomposition	
	Yes	No
900°C	Fonger 1 Shell Fonger 1 Slaked Shell Fonger 2 Shell Fonger 2 Slaked Shell Jerseyville 3 Shell Jerseyville 3 Slaked Shell St. George 4 Shell St. George 4 Slaked Shell St. George 5 Shell St. George 5 Slaked Shell St. George 6 Shell St. George 6 Slaked Shell	All sand-tempered tiles fired to 900°C

Experiments

Firing test tiles enables me to investigate the local raw materials by controlling the atmospheric conditions and firing variables. However, firing the vessels I created in an open bonfire allowed me to observe the solubility and fired colours of the vessels when more realistic, less controlled firing environments were used.

After the vessels were fired and had cooled for a significant period of time, I recorded the colours using a Munsell chart. The vessels after firing exhibited a wide range of colours and fire clouds (Table 40), which are characteristic of open fires. These colours are somewhat similar to the colours of the test tiles fired in the oxidized kiln.

Table 40. Experimental vessel colour observations after firing in the open fire.

Vessel Type	Munsell Classification	Description
Fonger 1 sand	7.5 YR 5/6	Strong brown
Fonger 1 shell	10 YR 6/1	Gray
Fonger 1 sand slaked	7.5 YR 5/4	Brown
Fonger 1 shell slaked	10 YR 6/1	Gray
Fonger 2 sand	10 YR 5/3	Brown
Fonger 2 shell	7.5 YR 6/6	Reddish yellow
Fonger 2 sand slaked	7.5 YR 6/6	Reddish yellow

Vessel Type	Munsell Classification	Description
Fonger 2 shell slaked	7.5 YR 6/6	Reddish yellow
Jerseyville 3 sand	10 YR 6/4	Light yellowish brown
Jerseyville 3 shell	10 YR 5/2	Grayish brown
Jerseyville 3 sand slaked	7.5 YR 6/6	Reddish yellow
Jerseyville 3 shell slaked	10 YR 5/2	Grayish brown
St. George 4 sand	10 YR 6/4	Light yellowish brown
St. George 4 shell	10 YR 6/2	Light brownish gray
St. George 4 sand slaked	10 YR 5/4	Yellowish brown
St. George 4 shell slaked	10 YR 6/3	Pale brown
St. George 5 sand	7.5 YR 5/6	Strong brown
St. George 5 shell	10 YR 6/2	Light brownish gray
St. George 5 sand slaked	10 YR 6/2	Light brownish gray
St. George 5 shell slaked	10 YR 6/2	Light brownish gray
St. George 6 sand	10 YR 6/2	Light brownish gray
St. George 6 shell	7.5 YR 6/6	Reddish yellow
St. George 6 sand slaked	10 YR 6/2	Light brownish gray
St. George 6 shell slaked	7.5 YR 6/6	Reddish yellow

Along with documenting the colour of the vessels, I also submitted a piece of each vessel to a solubility test. All vessels, except for St. George 5, Fonger 1 slaked, St. George 5 slaked and St. George 6 slaked were not soluble (Table 41). Although a number of test tiles tempered with shell were not soluble, it is interesting to note that all the tiles that were soluble had actually been tempered with shell.

Table 41. Experimental vessel solubility.

	Test Tile
Soluble	St. George 5 shell Fonger 1 shell slaked St. George 5 shell slaked St. George 6 shell slaked
Not Soluble	Fonger 1 sand Fonger 1 shell Fonger 1 sand slaked Fonger 2 sand Fonger 2 shell Fonger 2 sand slaked Fonger 2 shell slaked

	Test Tile
Not Soluble	Jerseyville 3 sand
	Jerseyville 3 shell
	Jerseyville 3 sand slaked
	Jerseyville 3 shell slaked
	St. George 4 sand
	St. George 4 shell
	St. George 4 sand slaked
	St. George 4 shell slaked
	St. George 5 sand
	St. George 5 sand slaked
	St. George 6 sand
	St. George 6 shell
	St. George 6 sand slaked

Summary

Fonger potters likely fired their vessels in an open bonfire or pit fire, creating oxidizing and incompletely oxidizing atmospheres. Potters fired their vessels under 600°C or under 900°C using a method other than manipulating the firing temperature to prevent the chemical change of shell. Because of the presence of fire clouds, I believe Fonger potters placed fuel directly on their vessels for firing. After the vessels were fired, potters let their pots cool slowly in the coals before removing the pots. Sometimes, the vessels were still fairly warm when they were taken out.

What Do These Choices Mean Mechanically/Functionally?

The conditions under which ceramic vessels are fired have a great impact on the mechanics and function of a vessel. Vessels created by raw materials from around the Fonger site, and fired at low temperatures, such as 500°C, in oxidizing or incompletely oxidizing atmospheres are likely to be soluble. A vessel that dissolves in water is limited in the possible functions it can be used for and the chances of being recovered by archaeologists are reduced. For example, it would not be able to hold liquids. However, this does not mean a soluble vessel cannot be used at all, because it could be used to hold dry goods. Potters can also alter an originally soluble pot in order to make it non-soluble. For example, a sealant, such as nut oil, could be applied to prevent water from penetrating the vessel walls. I cannot say whether Fonger potters sealed their vessels but this line of inquiry should be explored further.

Vessels fired over 700°C, like those of the experimental firing, are less likely to be soluble, but unless potters prevent the decomposition of shell, shell-tempered vessels will not survive. Nevertheless, vessels made from other materials, such as granite-based minerals, will be successful.

Shell temper can mechanically create an obstacle for potters. If Fonger potters used the raw materials and recipe I used to create shell-tempered vessels, the pots would not be successful if fired over 500°C. However, shell-tempered vessels could have been fired below 500°C, or potters could have dealt with the expansion of calcium carbonate in other ways. Another way to reduce calcium carbonate decomposition is to fire the shell before adding it to the ceramic paste (Feathers 2006: 92; Rice 1987: 410). This changes the shell into calcite (Feathers 2006: 92), which according to the XRD results is present in high amounts within the shell-tempered sherds from the Fonger site. This topic is expanded further in the next chapter.

Use

In conjunction with direct evidence, such as sooting and carbon deposits, I can approximate the intended function and in some cases the actual use of vessels by combining my data on raw materials, vessel shape, vessel size and surface finish. I will present the direct evidence of how Fonger people used their ceramic vessels, followed by a discussion of indirect evidence.

Direct evidence of use can be determined if whole vessels are found in situ or containing the original contents. For example, a vessel found in the corner of a longhouse holding plant remains is evidence that that a particular vessel was used for storage. Another line of direct evidence is the presence of sooting or carbon encrustations on the exterior and/or interior surfaces of a vessel, which suggests that the vessel was possibly used for cooking or as a container to fire something other than food. Because whole vessels were not recovered in situ containing stored goods at the Fonger site, I do not have direct evidence of particular vessels being used for storage. But I do have direct evidence of Fonger people using their ceramic vessels for cooking.

Thirty-six percent (n=313) of the Fonger sherds have evidence of carbon deposition on the entire or part of the interior surface. Ten and a half percent (n=93) of the sherds have possible carbon deposition and 53.5% (n=470) have no carbon deposition on the interior surface (Table 42). This suggests that while Fonger potters used ceramic vessels for cooking, they may have cleaned their cooking vessels, removing evidence of cooking, and likely used pots for other functions as well, such as storage or the transportation of goods that do not leave carbon deposits.

Table 42. Presence of interior carbon deposits.

Interior Carbon Deposits	**Sherd Count**	**Sherd %**
None	470	53.5
Possible	93	10.5
Partial	148	17
Fully Covered	165	19
Total	876	100

Vessels used for cooking over fires accumulate soot on the exterior surface as well as the interior carbon deposits. Ten point three percent (n=90) of the Fonger sherds have evidence of sooting on the entire or part of the exterior surface. One point seven (n=14) of sherds have possible sooting and 88% (n=778) have no sooting on the exterior surface (Table 43). It is interesting to note that there are no carbon deposits on the exterior surfaces of Fonger sherds. This could be because carbon was removed or cleaned off by potters, because carbon was burned off due to exposure to fire, or because food did not spill over on the exterior surface.

Table 43. Presence of exterior sooting.

Exterior Sooting	**Sherd Count**	**Sherd %**
None	772	88
Possible	14	1.7
Partial	75	8.7
Fully Covered	15	1.6
Total	876	100

Sooting on the exterior surface of a vessel provides information regarding how the vessel was situated over an open fire (Hally 1983: 10; Hally 1986: 275). According to Hally (1983), there is a predictable pattern of soot deposition on the exterior surface and carbon deposition on the interior surface of vessels that are used for cooking over a fire. Because I do not have any whole vessels to assess sooting patterns, I looked at the frequencies of carbon deposition on the interior surface and sooting on the exterior surface of body, shoulder, neck and rim sherds. There is more exterior sooting and interior carbon deposition on the upper portions, necks and rims, of Fonger sherds than on body sherds but there are still a number of body sherds with interior carbon deposits (29% n=183) and exterior sooting (7.5%, n=48) (Table 44 and 45). Because of this, I believe Fonger people suspended their ceramic pots above the fire for cooking but the distance between the fire and the vessel may have varied.

Table 44. Presence of exterior sooting on different types of sherds. Rim sherds have a higher frequency of exterior sooting compared to body and neck sherds.

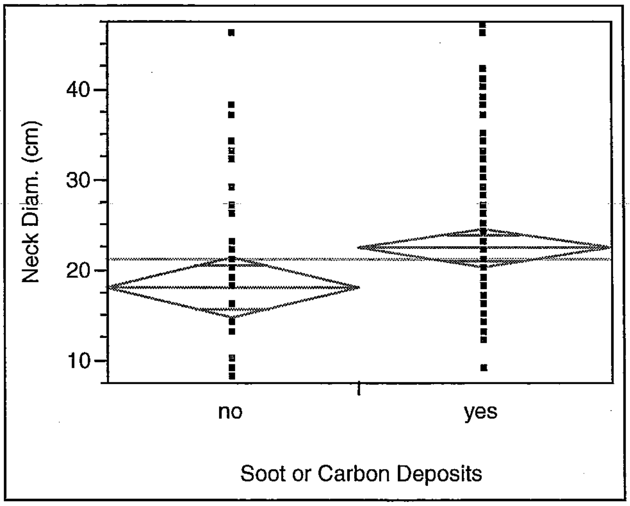
Exterior sooting	**Body/Shoulder**		**Neck**		**Rim/Castellation**	
	Sherd Count	**Sherd %**	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
None	573	90.5	113	80.8	3	3
Possible	12	2	1	0.7	12	11.5
Partial	41	6.5	21	15	1	1
Fully Covered	7	1	5	3.5	67	84.5
Total	633	100	140	100	103	100

Table 45. Presence of interior carbon deposits on different types of sherds. Rim sherds contain a higher frequency of carbon deposition than body and neck sherds.

Interior Carbon Deposits	**Body/Shoulder**		**Neck**		**Rim/Castellation**	
	Sherd Count	**Sherd %**	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
None	377	59.5	42	30	26	25
Possible	73	11.5	18	13	23	22.5
Partial	90	14	34	24	2	2
Fully Covered	93	15	46	33	52	50.5
Total	633	100	140	100	103	100

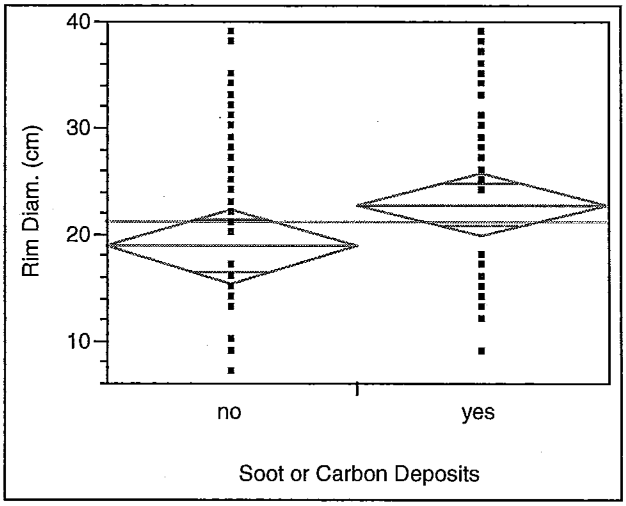
Fifty point eight percent (n=445) of the Fonger sherds do not have any carbon deposits on the interior surface and do not have sooting on exterior surface. These sherds could have been from vessels that were not used for cooking but for some other function, such as storage, or they could have come from non-sooted spots on sooted vessels. In order to see if sherds without any sooting or carbon deposits are different in any other way, I compared the raw materials, forming and finishing of sooted sherds to non-sooted sherds. There is no difference in the raw materials types or preparation techniques of sherds with or without soot and carbon deposits.

If vessels were used for the storage of liquids, I would expect that they would have more constricted necks than non-storage vessels in order to reduce spillage or evaporation of the contents. Neck sherds that do not display evidence of sooting or carbon deposits are on average 4.5 cm less in diameter than sherds with sooting and/or carbon deposits (Figure 27). Rim sherds that do not have sooting or carbon deposits are on average 4 cm smaller in diameter than sherds with sooting and/or carbon deposits (Figure 28). Another difference in vessel shape is that sherds with sooting and/or carbon deposits have on average 7.6 mm taller necks (Figure 29).



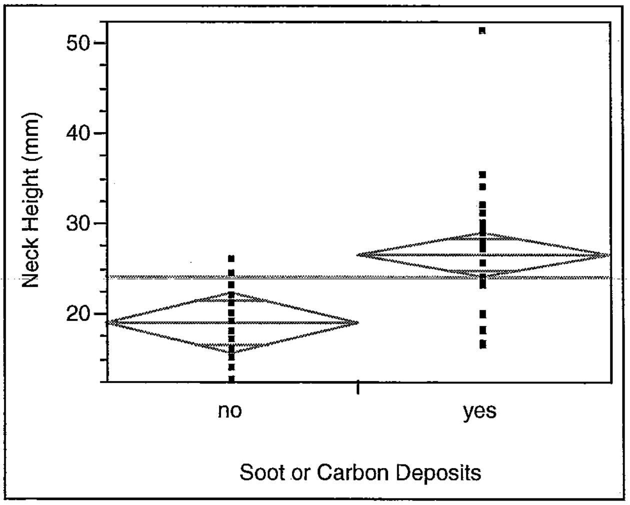
Soot or Carbon Deposits	N	Mean	Std Error	Lower 95%	Upper 95%
No	20	18.1	1.7	14.7	21.5
Yes	53	22.5	1.0	20.4	24.5

Figure 27. Neck diameter (cm) of sherds with soot or carbon deposits and sherds without soot. Only sherds with more than 5% of the neck preserved were considered. Necks with soot or carbon deposits are wider in diameter than those without.



Soot or Carbon Deposits	N	Mean	Std Error	Lower 95%	Upper 95%
No	18	18.9	1.7	15.4	22.4
Yes	26	22.8	1.4	19.9	25.7

Figure 28. Rim diameter (cm) of sherds with soot or carbon deposits and sherds without soot. Only sherds with more than 5% of the rim preserved were considered. Rims with soot or carbon deposits are wider in diameter than rims without.



Soot or Carbon Deposits	N	Mean	Std Error	Lower 95%	Upper 95%
No	14	19.1	1.7	15.7	22.5
Yes	28	26.6	1.2	24.2	29.0

Figure 29. Comparison of neck heights (mm) of sherds with soot or carbon deposits and those without. Necks with soot or carbon deposits are taller than necks without.

As noted previously, globular-shaped vessels are better for cooking than vessels with angles. To see if the Fonger people used flatter based vessels in different ways than globular vessels, I studied the flatter more angled based sherd (number 842) for evidence of use. Surprisingly, the entire interior surface of sherd 842 was covered with carbon, suggesting exposure to fire. This evidence may imply that vessels with different body shapes did not necessarily have different intended uses.

Functionally, when all other things are equal, vessels with thinner walls are better suited for cooking, while vessels with thicker walls are better suited to withstand bumping and knocking around. Interestingly, there is no difference in body or neck thickness of sherds with soot and/or carbon deposits and those without. This means that thick-walled vessels were used for cooking and thin-walled vessels may have been exposed to mechanical stress.

Vessels with burnished surfaces are generally harder and less permeable and would be best suited for holding or storing liquids. Sherds with and without sooting or carbon deposits were burnished. This makes sense, because a burnished vessel could store liquids or be used to cook liquids, such as corn soup. Textured surfaces, such as cord roughened or ribbed paddle, are better suited for vessels that are moved around a lot because the textured surface enhances the grip, but may still be advantageous for cooking. There are sherds with a textured surface that have soot and/or carbon deposits and others that do not. This demonstrates that there is no correlation between textured surface finishes and use. Cooking vessels may have been moved around just as much as storage vessels, or all vessels may have been intended to be multi-functional.

As demonstrated previously, Fonger potters likely made a range of vessel sizes. Different sized vessels, even if they are in every other respect identical, can be used differently, suggesting the same intended function, but different social uses (Skibo 1992: 148). Smaller vessels could be used for cooking food for few people, serving individuals or transporting goods. Medium sized vessels could be used to cook food for one or two families, for storing or transporting goods. Larger vessels could be used to cook food at feasts or for very large families or for storing large amounts of goods, such as corn flour or beans. It would be unlikely that large vessels were used to transport goods because as vessel sizes increase so do vessel weights.

Summary

Fonger people used ceramic vessels for cooking and possibly as storage or transport containers. Cooking vessels may have been situated directly in the fire or suspended above the fire. Fonger vessel use is not related to the types of raw materials Fonger potters selected or the preparation techniques that they used. Use is also not related to vessel body shape, wall thickness or surface finish. However, vessels with more neck and rim constriction were likely also used for storage, transporting goods or other non-cooking related functions. Vessels with taller necks were used primarily for cooking. This might be related to the fact that vessels were suspended over a fire. Vessels with larger necks may be easier to hang over a fire, if they were held up by rope tied around the neck. Also, taller necks may reduce the amount of food that spatters or boils over. Interestingly, in my sample sherds with taller necks have more interior carbon and exterior sooting then sherds with shorter necks.

Testing Warrick's Hypothesis: Spatial Differences within the Site

Warrick (1984a, 1984b) hypothesized that there were two separate but closely interacting groups within the Fonger village. To test if this hypothesis is reflected in the manufacture of ceramics, I compared the decisions potters made at each step in the ceramic operational sequence in the east and west wards of the site.

Raw Materials Selection and Preparation

Both wards use overall the same kinds of raw materials. Based on the results from petrographic analysis and XRD, potters from the west and east wards used similar types of clays that contained similar naturally occurring inclusions. As identified in the macroscopic analysis, potters from both wards selected granite-based minerals and shell as temper. However, petrographically, even though the sample size is fairly small (only 10 sherds from each ward), visible differences in the selection of granite-based temper were identified. On the west side of the site, potters selected tempering materials with more hornblende as the dominant material, whereas on the east side potters selected more quartz rich materials (Table 46). Also, the three sherds with added granite-based inclusions smaller than 0.5 mm all came from the west ward. Given the small sample size this pattern of slight differences in raw material selection is at best a hypothesis to be tested further with a larger sample size.

Table 46. Petrographic Analysis: Inclusion types of sherds from midden A in the west ward of the site and midden B in the east ward.

	Midden A (West Ward)		**Midden B (East Ward)**	
Inclusion type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Biotite	1	10	0	0
Feldspar	2	20	2	20
Feldspar, biotite	1	10	1	10
Feldspar, quartz	0	0	1	10

Inclusion type	Midden A (West Ward)		Midden B (East Ward)	
	Sherd Count	Sherd %	Sherd Count	Sherd %
Granite	1	10	1	10
Hornblende	1	10	0	0
Quartz	0	0	2	20
Quartz, hornblende	2	20	0	0
Quartz, biotite	0	0	1	10
Quartz, hornblende, biotite	1	10	1	10
Shell	1	10	1	10
Total	10	100	10	100

There is no disparity in the size of temper within the sherds from the east and west wards. There is a slight difference in the shape and sorting of temper, but the difference is not statistically significant (Table 47 and 48).

Table 47. Macroscopic Analysis: Inclusion shapes in the sherds from the west and east wards.

Inclusion Shape	West Ward		East Ward	
	Sherd Count	Sherd %	Sherd Count	Sherd %
Angular	487	82	251	88
Sub-angular	92	16	31	11
Sub-rounded	12	2	3	1
Total	591	100	285	100

Table 48. Macroscopic Analysis: Inclusion sorting in the sherds from the west and east wards.

Inclusion Sorting	West Ward		East Ward	
	Sherd Count	Sherd %	Sherd Count	Sherd %
Very poorly to poorly	410	69	186	65
Moderately	158	27	77	27
Well to very well	23	4	22	8
Total	591	100	285	100

Macroscopically, I identified that there are more sherds with more temper in the west ward than in the east. The more accurate petrographic analysis also suggests that west ward potters made more vessels with larger amounts of temper. However, this discrepancy is not statistically significant (Table 49).

Table 49. Petrographic Analysis: Comparison of inclusion amount (in %) by ward.

Inclusion Amount (%)	**Midden A (West Ward)**		**Midden B (East Ward)**	
	Sherd Count	**Sherd %**	**Sherd Count**	**Sherd %**
20	0	0	2	20
25	1	10	0	0
30	1	10	1	10
35	1	10	2	20
40	4	40	2	20
45	1	10	1	10
50	2	20	2	20
Total	10	100	10	100

As a result, there is no major difference in the selection and preparation of the raw materials between the east and west wards, except that west ward potters seem to prefer hornblende heavy granite-based temper and to make more of their pots using greater (40-50%) amounts of temper.

Forming

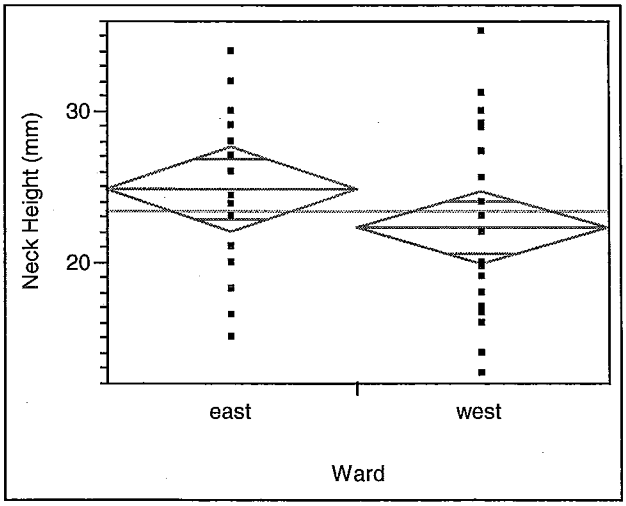
In order to see if pots were formed differently in the two wards, I looked for differences in the types of vessel shapes and sizes made and forming techniques used by potters from the east and west wards.

Vessel shape can vary in terms of body shape, neck height, collar height and thickness, rim direction, lip thickness, lip shape or castellation type. Potters from both wards created rounded bodies forming globular-shaped pots. The single exception is a possible base sherd from midden A (west ward) that comes from a flatter more angled bottomed vessel. There is a slight difference in the neck heights of vessels from the east and west wards (Figure 30). The single very tall necked sherd identified in the sample is from the west ward. When this sherd is eliminated, necks from the east ward are on average 2.5 mm taller than necks from the west. Other than the very tall neck, given that these are hand-made ceramics, this difference of 2.5 mm is probably not be significant.

Rim sherds can be shaped in many ways including the presence of a collar and its height, rim direction, and lip shape and thickness. Seventy-one percent of the rim sherds from the west ward have a collar, compared to 66% of the vessels from the east ward (Table 50). On average, there is no difference between the heights and thicknesses of the collars from the west and east wards (Figures 31 and 32). However, there are differences in rim direction and lip shape. Potters from both wards created vessels with rims that were directed up and out. However, only potters from the east ward made rims that face in. Interestingly, of all the rim directions in the east ward 18% (n=8) of rims were shaped inwards (Table 51). Of the three types of lip forms, round type A and flat type A are found in similar proportions in the west and east wards (Table 52). Flat type B is only found in the east ward, but is only represented on two sherds. Except for one extra thick lip on a sherd from the east ward, there is no disparity between the lip thicknesses on the sherds from the two wards (Figure 33).

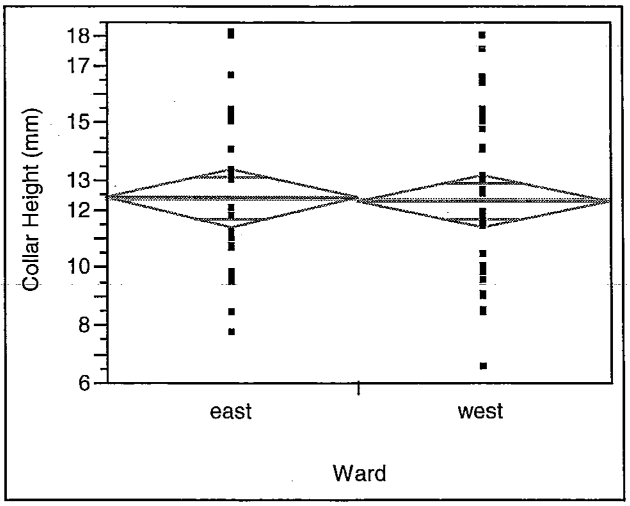
Table 50. Comparison of rims with and without collars from each ward.

	West Ward		**East Ward**	
Collar	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Absent	15	29	16	34
Present	37	71	31	66
Total	52	100	47	100



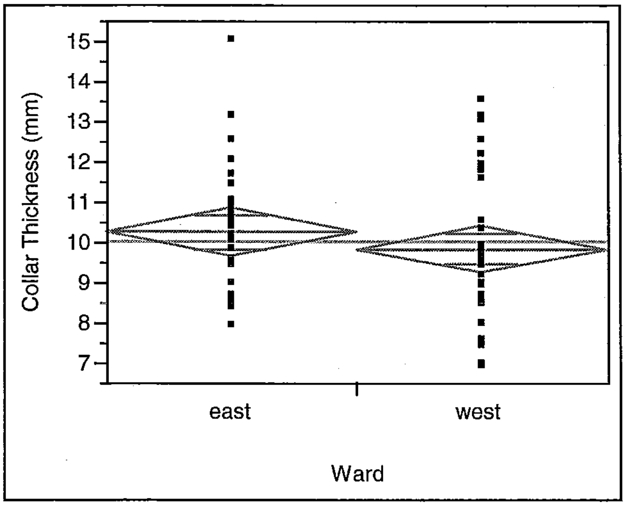
Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	18	24.9	1.4	22.1	27.6
West	23	22.3	1.2	19.9	24.8

Figure 30. Comparison of neck heights (in mm) of sherds from each ward. The tall necked sherd from the west ward has been removed. When the tall necked sherd removed, east ward necks are slightly taller than west ward necks.



Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	29	12.4	0.5	11.4	13.4
West	37	12.3	0.5	11.4	13.2

Figure 31. Comparison of collar heights (in mm) in each ward. There is virtually no difference between the collar heights from the east and the west wards.



Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	31	10.3	0.3	9.7	10.9
West	35	9.8	0.3	9.3	10.4

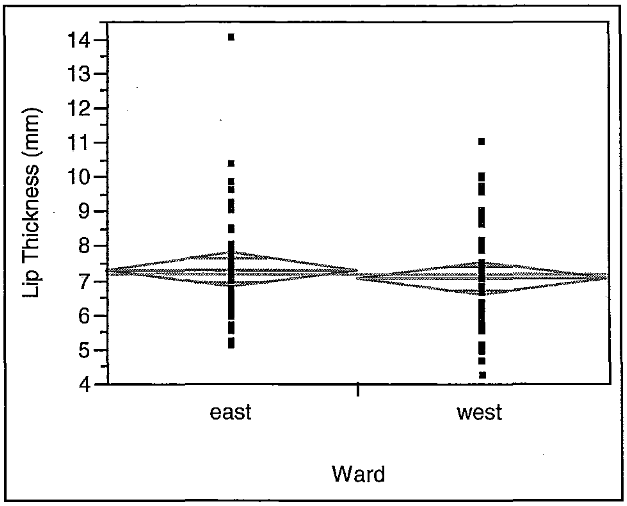
Figure 32. Comparison of collar thicknesses (mm) from the east and west wards. There is almost no difference between the collar thicknesses from the east and west wards.

Table 51. Comparison of rim directions from the east and west wards. Both wards have sherds with outward and upward facing rims but only the east ward has rims with inward facing lips.

	West Ward		East Ward	
Rim Direction	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
In	0	0	8	18
Out	44	86	32	71
Up	7	14	5	11
Total	51	100	45	100

Table 52. Lip forms from the east and west ward. Both wards have flat type A and round type B lips but only the east ward has sherds with flay type B lips.

	West Ward		East Ward	
Lip Form	**Sherd Count**	**Sherd %**	**Sherd**	**Sherd %**
Flat type A	42	82	36	84
Flat type B	0	0	2	4.5
Round type A	9	18	5	11.5
Total	51	100	43	100

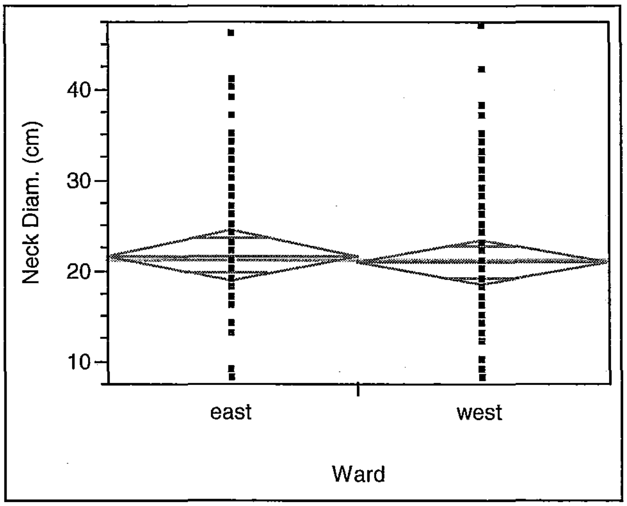


Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	44	7.3	0.3	6.8	7.8
West	50	7.1	0.2	6.6	7.5

Figure 33. Comparison of lip thicknesses (mm) on rims from the east and west wards. There is no difference between the lip thicknesses from the east and west wards.

There were only five castellations in the entire sample so any apparent pattern can only be considered at best a hypothesis to be tested with further data. Both the east and west ward potters made turret castellations. Two of three of the castellations from the east ward are turret shaped compared to one of two from the west. There is one notched shaped castellation from the east ward and one incipient notched shaped from the west. Thus, the notched castellations were not found in the west ward and incipient notched castellations were not found in the east, but the numbers involved are too small to carry and significance.

Vessel shape is also related to neck diameter because, as demonstrated for the entire Fonger sample, a range from constricted to straight-necked pots were made. Potters from the east and west wards created similar ranges of neck diameters (Figure 34).



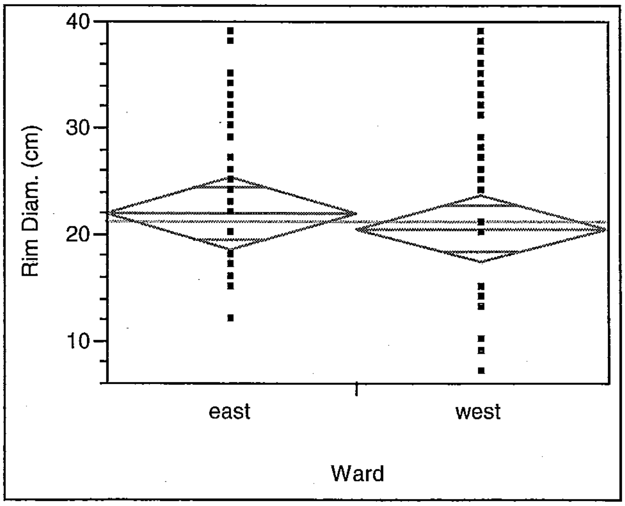
Ward	N	Mean	Std Error	Lower 95%	Upper 95%
East	32	21.7	1.4	19.0	24.5
West	41	20.9	1.2	18.5	23.3

Figure 34. Comparison of neck diameters (cm) from the east and west wards. Only those sherds with 5% or more of the neck preserved were considered. There is virtually no difference in the neck diameters from the two wards.

Rim diameter is correlated with both vessel shape and size. The rim diameters from both wards are almost identical, with only the east ward being 1.5mm wider, which in handmade ceramics may just be within the variation around the wall of a single vessel (Figure 35). As a result, if rim diameter is a reflection of the relative size of a vessel, then potters from the east and west wards were making the same range of vessel sizes.

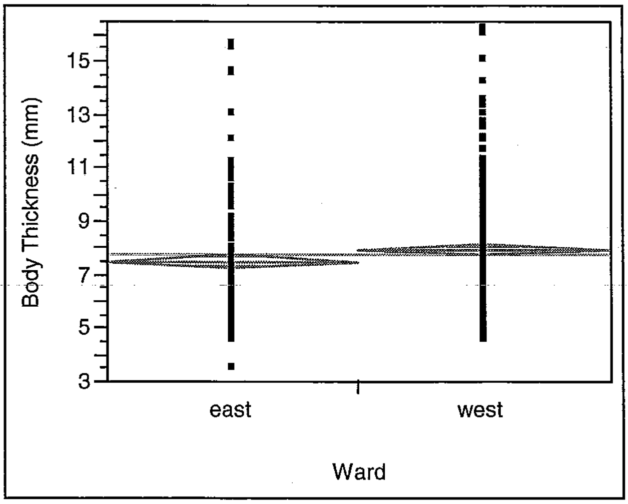
Even though I demonstrated previously that Fonger vessel size is only weakly related to wall thickness, I still compared vessel wall thicknesses from the two wards. When I evaluated vessel body and neck thicknesses from the west ward to the east ward, there was virtually no difference (Figures 36 and 37).

There are three methods of forming vessels that Fonger potters used to construct their pots. West and east ward potters utilized coiling, pinching and paddling in similar frequencies (Table 53).



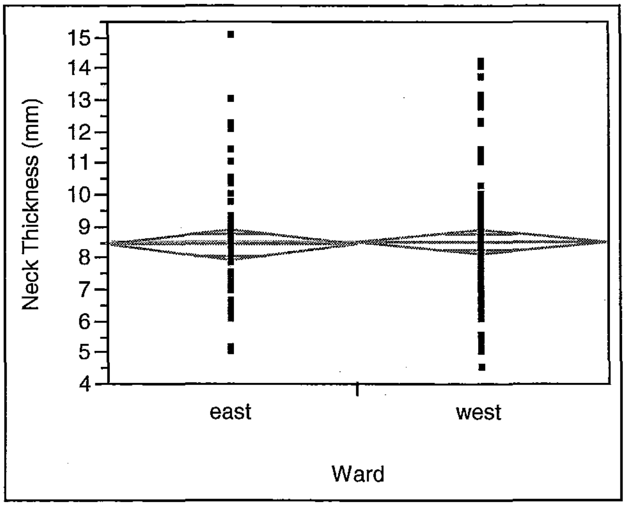
Ward	N	Mean	Std Error	Lower 95%	Upper 95%
East	20	22.0	1.7	18.6	25.4
West	24	20.5	1.5	17.4	23.7

Figure 35. Comparison of rim diametres (cm) from the two wards. Only those rims with 5% or more preserved were considered. There is almost no difference between the rim diameters from the east ward and the rim diameters from the west ward.



Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	197	7.5	0.1	7.2	7.8
West	453	7.9	0.1	7.7	8.1

Figure 36. Comparison of body thicknesses (mm) on the sherds from each ward. There is almost no difference between the two wards.



Ward	Number	Mean	Std Error	Lower 95%	Upper 95%
East	66	8.4	0.2	7.9	8.9
West	112	8.5	0.2	8.1	8.9

Figure 37. Comparison of neck thicknesses (mm) on the sherds from each ward. There is no difference between the two wards.

Table 53. Types and frequencies of forming techniques used in the west and east wards. The frequencies are similar.

	West Ward		East Ward	
Forming Method	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Undetermined	436	74	200	70
Coiling	72	12	46	16
Pinching	22	4	8	3
Paddle and Anvil	61	10	31	11
Total	591	100	285	100

The shape and orientation of voids, as observed by the petrographic analysis, was the same in the sherds found in both wards. As mentioned earlier, sherd 1039, found in the west ward, is unique in its unusual void shape and orientation.

To summarize, there is absolutely no difference between the two wards at the Fonger site in the sizes of vessels made, or the types or frequencies of forming techniques used, except possibly for sherd 1039. However, there are a number of differences in the shapes of vessels from the east and west wards. Characteristics in the west ward that are not present in the east include a flatter based sherd, a very tall necked sherd and an incipient notched castellation. Characteristics in the east ward that are absent from the west include rims that face inwards, flat type B lip forms and a single notched castellation. Because only one or two sherds represent these differences, I cannot say with absolute certainty that the two wards created distinctly different vessel shapes.

Finishing

There are several similarities in the frequencies of the types of finishing techniques potters used. Potters from both wards created smoothed, cord-roughened paddled, smoothed-over cord roughened paddled and smoothed-over ribbed paddled exterior surfaces (Table 54). Smoothing was the choice of finish on 91% of east ward sherds and 88.5% of west ward sherds. One percent of the sherds from each ward were finished by using a cord-roughened paddle. Three point five percent in the east and 2% in the west ward were finished by smoothing over cord roughened paddled surfaces. Two percent in the east and 1% in the west ward were finished by smoothing over ribbed paddled surfaces.

Table 54. Exterior finish by ward.

Finishing technique	West Ward Sherd Count	Sherd %	East Ward Sherd Count	Sherd %
Smoothed	523	88.5	258	90.5
Burnished	42	7.1	9	3.2
Cord-roughened Paddle	6	1.0	2	0.7
Smoothed-over cord	12	2.0	10	3.5
Ribbed paddle	0	0	1	0.35
Smoothed-over ribbed	7	1.18	5	1.75
Scarified	1	0.17	0	0
Total	591	100	285	100

Differences between the east and west wards can be identified in the frequencies of scarified, ribbed paddled and burnished exterior surfaces. Only one sherd from the east ward (0.4%) was finished by using a ribbed paddle. Only one sherd from the west ward (0.2%) was finished by scarification. Because there is only one sherd from each of these techniques in the entire sample evaluated in this thesis, the significance of this difference cannot be further ascertained. The most interesting difference is in the frequencies of burnished sherds between the two wards. Of all the sherds from the west ward, 7% (n=42) are burnished on the exterior surface, compared to 3% (n=9) in the east ward. Except from one sherd from the west ward, which has interior surface burnishing, all sherds from both wards had smoothed interior surfaces.

Decorating

Decoration occurs on the bodies, shoulders, necks, rims, lips, interior rims and castellations of Fonger vessels. To see if potters from the west ward applied different decorative patterns or the same patterns in different areas of their vessels than potters from the east ward, I compared types and frequencies of decoration on different types of sherds.

As noted previously, there are five types of body sherd decoration: impressed-punctates, incised pointy lines, incised trailed lines, incised pointy lines with incised trailed lines and incised trailed lines with impressed punctates. All five decoration types are found in the west ward (Table 55). This is in contrast to the east ward where potters decorated vessel bodies only using impressed punctates (n=4, 57%) or incised trailed lines (n=3, 43%).

Table 55. Body sherd decoration type from the east and west wards.

	West Ward		East Ward	
Decoration type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Impressed-punctates	9	34.5	4	57
Incised pointy lines	2	7.5	0	0
Incised pointy and incised trailed lines	1	4	0	0
Incised trailed lines	8	31	3	43
Incised trailed lines and impressed punctates	6	23	0	0
Total	26	100	7	100

Interestingly, when comparing the types of shoulder decoration applied by potters from the east and west wards, east ward sherds display more variation than the west (Table 56). However, the sample sizes of the different types of decoration are small, so the pattern should only be considered tentative. The majority of the east and west ward shoulder sherd decoration (70% and 62.5% respectively) is impressed punctates. Incised pointy lines are also present in the east ward (10%) and the west ward (22%). The remaining sherds of the west ward sample contain incised trailed lines. Ten percent of the east ward sample was decorated with impressed dentate stamps and the remaining 10% with incised trailed lines with impressed punctates.

Table 56. Shoulder sherd decoration types from the east and west wards.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Impressed dentate stamped	0	0	1	10
Impressed-punctates	20	62.5	7	70
Incised pointy lines	7	21.9	1	10
Incised trailed lines	5	15.6	0	0
Incised trailed lines and impressed punctates	0	0	1	10
Total	31	100	10	100

The frequencies of the types of neck decorations used by potters from the east and west wards are very similar (Table 57).

Table 57. Neck sherd decoration types from the east and west wards.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
impressed punctates	4	36.3	3	27
incised pointy lines	3	27.2	2	18
incised trailed lines	4	36.3	5	45
incised trailed lines impressed punctates	0	0	1	10
Total	11	100	11	100

Out of all the locations where potters applied decoration, the widest variation of decoration types was exhibited on the rim. There is a distinct difference in the frequencies of the various types of decoration between the east and west wards (Table 58).

Table 58. Rim sherd decoration types from the east and west wards.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
impressed dentate stamped	0	0	1	2.4
impressed-punctates	6	12.5	1	2.4
incised notched	3	6.25	1	2.4
incised pointy lines	21	43.75	10	24.4
incised pointy lines and impressed punctate	0	0	1	2.4
incised pointy lines and incised trailed lines	1	2.1	0	0
incised trailed lines	17	35.4	27	66
Total	48	100	41	100

Potters did not decorate the lips of their vessel rims often but, when they did, they used decorative patterns that were common in both wards, but also some that were unique to each ward (Table 59). It must be stressed that decoration on the lip was not very popular resulting in a small sample size. Thus, the patterns are only tentative.

Table 59. Lip decoration types from the east and west wards.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
impressed-punctates	1	33.3	4	57
incised notched	1	33.3	0	0
incised pointy lines	0	0	1	14
incised trailed lines	1	33.3	2	29
Total	3	100	7	100

Fonger potters applied four types of interior rim decoration (Table 60).

Table 60. Interior rim decoration on the sherds from the east and west wards.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Impressed dentate stamped	1	3	0	0
Incised notched	17	59	4	18
Incised pointy lines	7	24	6	27
Incised trailed lines	4	14	12	55
Total	29	100	22	100

There were only five castellations in the entire sample. Of these, three were decorated, one from the east ward and two from the west (Table 61).

Table 61. Castellation decoration by ward.

	West Ward		East Ward	
Decoration Type	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Impressed-punctates	1	50	0	0
Incised pointy lines	1	50	0	0
Incised trailed lines	0	0	1	100
Total	2	100	1	100

To summarize, west ward potters used a wider range of body decoration types than east ward potters. This contrasts with shoulder and neck decoration, because east ward potters used four decoration types, whereas west ward potters only used three decoration types. The widest range of decoration types is exhibited on rim sherds. On rims, east and west ward potters have four decoration types in common, but these types are found in different frequencies within the two wards. Furthermore, while west ward potters applied incised pointy lines with incised trailed lines, east ward potters did not. Similarly, while east ward potters added incised pointy lines with impressed punctates and impressed dentate stamps, west ward potters did not. While pot lips were not a popular place to apply decoration, both west and east ward potters added impressed punctates and incised trailed lines on the lips of their vessels. Potters from the west used incised notches on vessel lips and potters from the east used incised pointy lines. The types of decoration on interior vessel rims are the same from both wards, except that an impressed dentate stamped sherd was found in the west. The decoration on castellations is different in the east and west wards.

Firing

Sherds from both wards were fired in oxidizing, incompletely oxidizing and reducing atmospheres (Table 62).

Table 62. Firing atmospheres of the sherds from each ward. The firing atmospheres of some sherds could not be accurately determined due to sooting.

	West Ward		East Ward	
Firing Atmosphere	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Oxidizing	51	9	17	6
Incompletely oxidizing	482	82	235	82
Reducing	14	2	6	2
Undetermined (sooted)	44	7	27	10
Total	591	100	285	100

Sherds from both wards exhibit sharp and diffused boundaries (Table 63). Based on the very little variation, in terms of firing, between the two wards, I can say that east and west ward potters fired and cooled their vessels in similar ways.

Table 63. Boundaries between surfaces and cores of each sherd by ward.

	West Ward		East Ward	
Boundaries	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
Diffused	541	92	271	95
Sharp	50	8	14	5
Total	591	100	285	100

Use

The only direct evidence of use I have is the presence of sooting on the interior and exterior surfaces of sherds. There is minimal difference in the frequencies of sherds with sooting between the two wards (Tables 64 and 65). Because there is not much difference in the indirect evidence relating to use, such as raw materials, vessel shape or finishing, and there are similar proportions of sooting on sherds from the east and west wards, I suggest that Fonger people used ceramic vessels in very similar ways, no matter which ward they occupied.

Table 64. Exterior soot on sherds from the east and west wards.

	West Ward		East Ward	
Exterior Soot	**Sherd Count**	**Sherd %**	**Sherd Count**	**Sherd %**
None	527	89	245	86
Possible	11	2	3	1
Partial	46	8	29	10
Fully Covered	7	1	8	3
Total	591	100	285	100

Table 65. Interior carbon deposits on the sherds from the east and west wards.

Interior Carbon Deposits	**West Ward**		**East Ward**	
	Sherd Count	**Sherd %**	**Sherd Count**	**Sherd %**
None	324	55	146	51
Possible	60	10	33	11.5
Partial	92	15.5	56	20
Fully Covered	115	19.5	50	17.5
Total	591	100	285	100

Chapter 5: Discussion

In this chapter, I summarize the results and situate ceramic manufacture within the social context of daily life of the Fonger villagers. I also outline the range of variation in the choices potters made at each step and address where more 'communal' ways of making a vessel are exhibited and where potters could possibly express more freedom of choice. I address the scale and organization of ceramic production, the issue of two different groups of potters within the village and the presence of shell-tempered ceramics.

Raw Materials Selection

The raw materials Fonger potters selected demonstrate how factors other than function and mechanics can influence a potter's choice, how raw material selection is situated within a social web and how raw materials are more informative than previously thought by Ontario archaeologists.

The environment surrounding the Fonger site provided several clay deposits, which potters could have exploited. These clays are all relatively similar in composition, but not identical. The limited range of variation in the clays Fonger potters selected is a reflection of the limited range of variation in the locally available raw materials.

Because the clays actually used by potters are not identical, Fonger potters either did not collect their clays from the exact same deposit or collected their clays from different layers within a single deposit. As a result, there may not have been a communal clay source frequented by all potters. However, individual potters could have visited a single clay deposit regularly or potters may have collected clay from several different areas within the vicinity of the village.

The presence of only two types of temper, granite-based minerals and shell, indicates a very limited range of variation in the tempering materials Fonger potters selected. However, there is great variation within the granite-based temper. Being composed of more than one mineral, the nature of granite facilitates the presence of several different minerals in the Fonger sherds. In addition, different types of granite contain different types and proportions of minerals. Because the Fonger sherds do not contain all the same kinds of granite minerals in similar proportions or the same sizes and shapes, I suggest Fonger potters selected a wide range of granites, including granites at different stages of weathering and decomposition, to add as temper.

While potters selected only granite or shell, the environment surrounding the Fonger site offered several other types of temper, such as large sand or organic material. Gosselain and Livingstone-Smith (2005: 39) have shown ethnographically that potters "have a much narrower perception of what 'appropriate materials' are" than the choices that are available to them. As a result, Fonger potters may not have considered materials other than granites and shell as appropriate for pottery making. Showing that granite and shell were not their only available options may appear as a mundane point, yet its implications have not been explored in the study of Iroquoian ceramics.

How Raw Material Selection Fits Into Daily Life

In order to draw inferences about how raw material selection and collection related to everyday life, we must think about who would have been involved in ceramic manufacture and the possible daily activities Fonger people were engaged in.

There is a commonly held assumption that Iroquoian women were the primary manufacturers of ceramics, though evidence of this comes only from the ethnohistoric accounts of the Huron by the Jesuits (Schoolcraft 1847: 223-224; Trigger 1976: 39; Waugh: 1916: 54-55; Wrong: 1939: 109). There is no physical or documented evidence that explicitly states who manufactured Neutral ceramics, but until proven otherwise, I assume that women primarily made Fonger ceramic pots.

By assuming women made ceramic vessels, I can focus my attention on the activities in which women engaged on a daily basis, and see how raw material selection and collection was integrated into their lives. While it is possible that potters searched for raw materials as a specific activity, it is likely that raw materials were discovered in the process of performing other tasks. Gosselain and Livingstone-Smith (2005: 40), in their ethnoarchaeological study of Cameroon potters, have demonstrated that "it is while performing other activities, and especially activities which force them to dig the ground (e.g. tending fields, building houses, digging wells) or to frequent places such as riverbeds or swamps, that potters, members of their family or any of their acquaintances may 'discover' a new source". If Neutral women, like Huron women, were responsible for horticulture and other plant related subsistence practices, such as gathering wild plants, then identification and collection of raw materials could have been incorporated into these daily activities. Clearing, tending and harvesting fields would have exposed clay deposits and while gathering wild plants and berries or getting water potters could come across granite rocks and shells. As a result, raw materials selection would have been a supplemental activity to other tasks.

The collection of shell temper may have been connected with different daily activities, such as fishing. Potters could have harvested shells strictly for tempering purposes or collected shells for a different use, using shell by-products as temper. For example, it is possible that when shell beads were being manufactured the excess was used for temper. In addition, the contents of shells may have been eaten and the shells saved for temper. However, there is no evidence at the site that shells were stored for future use. As a result, I suspect potters collected shell when they needed to manufacture shell-tempered vessels.

Fuel for firing ceramic vessels would have been extremely accessible to Fonger potters in the surrounding environment of hardwood forests and from the by-products of harvesting corn, such as corn husks and stalks. Fuel would have been collected not only for firing ceramic pots but also for other activities, such as cooking or heating longhouses.

Daily activities, in which ceramic manufacture is embedded, are a part of and are shaped by larger annual cycles. Allen and Zubrow (1989) suggest that the optimal time of year, based on environmental conditions, for ceramic manufacture for New York Iroquoian potters would have been during the summer. I would agree with Allen and Zubrow (1989) that the collection of raw materials would most likely have taken place during warmer months. In the winter, snow would have covered clay deposits and tempering materials, and the frozen ground would have made it difficult to extract clay.

While the collection of ceramic raw materials could take place all year round, it does not mean that this was actually the case. Other activities may have been more of a priority than making vessels at certain times of the year. For example, during planting or harvesting time, potters would likely have had less time to make pots. However, non-ceramic making activities may not totally disrupt the ceramic operational sequence, because certain steps in vessel manufacture can take place in stages. For example, the collection of raw materials can be done at one time of the year, while forming, finishing and decoration can take place at another time, if raw materials are stored. Fonger villagers could have stored clay and temper in longhouses or in separate storage huts. In fact, in house 11 Warrick (1984b: 60) uncovered "a single clay-filled pit" which he suggested, "perhaps stored raw materials for pot manufacturing". Storage of raw materials was not found in other locations at the Fonger site for several reasons. First, not all Fonger potters may have stored raw materials. Second, if women created vessels for their immediate family to use, as Allen has suggested, women would not make many more than 10 vessels per year (Allen 1992: 40). As a result, clay would not need to be collected in vast amounts. Third, other small clumps of clay or granite may not have been identified as raw materials storage. Finally, all areas of the site were not fully excavated.

Raw Material Preparation

The raw material preparation techniques employed by Fonger potters included more than one stage and each of these stages had a different level of variability. For example, crushing temper, whether granite-based or shell, was an activity in which all potters engaged consistently and was followed by sorting the temper, sometimes well and other times poorly. In contrast, there is much more variation displayed in the amount of temper potters added to the ceramic paste.

As demonstrated in the previous chapter, angled temper, which is often the product of crushing, influences the mechanical properties of a vessel. Fonger potters may have been consciously aware of the mechanical benefits of creating angled temper and adding it to ceramic pastes. As I noticed in my raw materials survey, the local clays were naturally coarse. However, the Fonger potters seem to have cleaned their clays from those inclusions and added temper they had crushed, either granite or shell. It appears then that this step was perceived as important in the sequence.

Crushing temper creates many different sized particles. It takes more time and effort to target and create smaller temper sizes. As a result, the degree of temper sorting and size is related to the amount of time potters dedicated to temper preparation. This is important because the longer it takes to manufacture a vessel the less time potters have to perform other activities, such as tending fields, harvesting corn or cooking. While the majority of Fonger sherds (68.1%) are poorly to very poorly sorted, there are some sherds that are better sorted. There are a number of reasons for this range of variation. First, the degree of sorting may be personal preference, where potters sometimes desired better-sorted temper. Second, the degree of sorting represents the time potters had to dedicate to raw materials preparation. Other activities, such as planting fields or harvesting corn, may have taken precedence, reducing the time potters had for temper sorting.

The amount of temper added to ceramic pastes influences the mechanical and functional properties of a vessel. However, due to the wide range of variation in the amount of temper (20-50%) added by potters and because there are no clear connections between the amount of temper and the shapes and sizes of vessels at the Fonger site, I suggest that the amount of temper potters added to their ceramic pastes is more related to potters' preferences and clay workability.

How Raw Materials Preparation Fits Into Daily Life

In order to place raw materials preparation, including clay and temper, into a broader context of everyday life at the Fonger site, I had to think about my macroscopic, microscopic, and experimental results in relation to what we already know about the daily tasks of the Neutral.

Through the experiments I conducted, I realized there was a difference in the workability of slaked and unslaked clay. If Fonger potters slaked their clay, there could be archaeological evidence. This evidence would consist of containers lined with clay, since clay would be deposited on the interior surfaces and container bottoms. Evidence of this was not found on the Fonger sherds. However, containers other than ceramic pots, such as wooden vessels or storage pits, could have housed slaking clay. Wooden containers were not found at the Fonger site, but this does not mean they did not exist. Storage pits are very common and typical of Neutral sites and were identified within longhouses at the Fonger site (Warrick 1984b: 29, 149). Fonger house 4 contained a "deep-basin storage pit, lined with a clay bottom" (Warrick 1984b: 46), which may have acted as a pit for slaking clay. However, because this pit also contained chert and faunal material (Warrick 1984b: 46), it may have also acted as a storage area for raw materials. If Ontario archaeologists look at storage areas as possible evidence for ceramic raw material storing, we may be able to gain a more detailed understanding of how ceramic manufacture fit into everyday life.

Alternatively, potters may not have slaked their clay at all. The Fonger ceramics do not contain large naturally occurring inclusions, which occurred in all the clays collected in the raw materials survey. The large inclusions needed to be picked out prior to forming. Because of this, if clays were not slaked, at a minimum Fonger clay preparation included removing large inclusions. I found that this is easiest to do when the clay was dry and crushed. This allowed me to identify and pick out large inclusions amidst fine clay particles.

Drying clay would take up space and would extend the time needed to manufacture a vessel. Drying clay does not need to be held within a container as long as it is sheltered from moisture. Clay could be piled up within a longhouse, covered and piled outside, or stored within separate cabins. Archaeologically, small clay piles, especially beyond the confines of a longhouse may not be identified as being intentional accumulations.

The act of pulverizing clay can be very similar to temper preparation. Temper added to the Fonger ceramics was crushed, but the specific techniques used to crush clay or temper cannot be explicitly identified archaeologically. However, by situating ceramic manufacture within the wider context of a village, we can gain insight into the techniques possibly used to prepare raw materials. This is because techniques used to pulverize clay and/or crush temper could have been adopted from techniques used for other activities, such as using grinding stones for preparing plant foods, or using upright corn grinders. The knowledge, equipment and physical motion needed to crush corn could be easily applied to crush dry clay and/or temper. At the Fonger site hammerstones and pestle and mortars were recovered (Warrick 1984b: 102), which could have been used for ceramic raw materials preparation and their close re-examination would be worthwhile.

Gosselain and Livingstone-Smith (2005: 33) demonstrated in their ethnoarchaeological study of clay selection and processing practices in Cameroon that, within a single village, different raw material processing techniques can be present. When Gosselain and Livingstone-Smith (2005: 33) asked potters why this occurred, the reason was that it was the way they were taught and was habitual. Within the Fonger site, there could have been more than one way to prepare raw materials. For example, to prepare clay, potters may have slaked their clay, picked out large inclusions or both. To prepare temper, some potters may have used hammerstones, while others used upright corn pounders.

As demonstrated above, raw materials can be collected at anytime throughout the year, although more probably during the warmer months when the ground was not frozen This means that raw materials can be prepared at anytime of the year if clay and temper was prepared in longhouses or other sheltered areas during the winter. Some steps in the ceramic operational sequence do not need to be completed within a single sitting, such as raw materials selection and collection, whereas others, such as shaping, finishing and decoration, must be done in a timelier manner.

Forming

Fonger potters created a variety of different vessel shapes and sizes, using several types of forming methods. Because whole vessels were not recovered at the Fonger site, I had to investigate vessel shape by studying separate sherds from different areas of vessels.

Different parts of Fonger vessels display different ranges of variation in terms of shape. Fonger potters made at least two vessel body shapes, globular bodies with rounded bases and straighter bodies with flatter bases. While I can confidently say that Fonger potters manufactured at least two body shapes, this does not mean that only two ceramic body shapes existed. For example, globular vessels could have been elongated horizontally, in varying degrees, to make squat wider vessels, which have been identified at other Neutral villages (Lennox and Fitzgerald 1990: Figure 13-4).

While there are functional and mechanical differences in vessels with angles and vessels more rounded in shape, these differences did not govern the way in which Fonger vessels were used. For example, globular vessels are better suited for cooking but sooting was found on the exterior surface and carbon deposits on the interior surface of the flatter bottomed sherd and on body sherds from globular vessels. Because of this and because all body sherds are slightly arced, except for the single flatter based sherd, I suggest potters were creating globular shaped vessel bodies, because it was the socially expected way to manufacture a vessel. It is possible that potters did not see creating other body shapes as being an option. The flatter bottomed sherd appears to stand out against the 'typical' body shape. As a result, this shape could be interpreted as being a reflection of the potter's individuality. However, flat-based vessels with similar design and decoration have been identified at other Neutral sites (Lennox 1984: 76; Lennox and Fitzgerald 1990: 417 Figure 13-4). As a result, it seems that the potter who created the flatter more angled bottomed sherd was acting within a wider set of beliefs, which may transcend the Fonger site, that govern how vessels can be shaped.

Fonger potters created vessels of various neck heights that fall into three size categories, including a single sherd representing a tall neck, various neck constrictions, from straight to very constricted, and various neck diameters that range from very small (8 mm) to very large (46 mm). While alone these individual attributes (neck height, neck constriction and neck diameter) have a smaller range of variability, when these attributes are considered together and joined in various combinations, the range of variation expands considerably.

Finer shaping details on the rims of Fonger vessels, such as collar thickness and height, lip and rim thickness, rim direction, and lip and castellation shape, also display a wide range of variation. Fonger potters created vessels with short or tall collars in an array of thicknesses, rims that could face in one of three directions, and thin, thick or fat lips. Vessel lips could be in one of three lip shapes but lip shape is related to rim direction. If Fonger potters chose to make their vessel rims face inwards then the lip shape was flat type A. If potters created upward or outward looking rims then any lip shape could be chosen. Other than the relationship between rims that face inwards and lip form, vessel rim attributes were combined to create multiple rim shapes.

Because I do not have access to whole vessels from the Fonger site, I do not know how vessel body shape relates to neck or rim shape. Based on this, I do not know if specific neck or rim shapes are associated with globular bodies or with the flat-bottomed vessel. If any neck shape could be added to any body shape then the whole range of vessel shapes Fonger potters created could have been great. However, it is possible that vessel shapes created by Fonger potters were more limited.

There are several possible explanations why Fonger potters may have created a wide range of vessel shapes. If potters did not manufacture pots on a regular basis, then they likely did not develop a rhythm or distinct motor habits. As a result, no two vessels would be exactly the same. Similarly, if women were producing vessels for their own individual families, then many people were manufacturing pots, each making decisions throughout the operational sequence.

My theoretical orientation follows the assumption that outliers or exceptions to the norm are instances where potters chose to express their individuality or where potters were working within a different set of social 'rules' for vessel manufacture. Non-conventional vessel shapes at the Fonger site include the flatter more angled bottomed sherd, a very tall neck and a very thick or fat lip. However, these shapes have been found in limited numbers on vessels from other Neutral sites (Lennox and Fitzgerald 1990: Figure 13-4). As a result, the potters who made these shapes were likely acting within a wider web of social beliefs and relations that stretch beyond the Fonger site.

Because there are no whole vessels and because Fonger potters manufactured a variety of different shapes, I cannot estimate the exact vessel sizes created. However, as Braun (2003) has suggested for Middleport Iroquoian villagers, Fonger villagers may have used smaller vessels for individual use, medium sized vessels for everyday cooking for individual families and larger vessels for larger family groups and feasting.

Fonger potters employed three different forming techniques (paddling, pinching and coiling), demonstrating that Fonger vessel forming was not homogeneous. While a single technique could have been used to manufacture an entire vessel, a combination of forming techniques also could have been used to create a single pot. It is likely, because this thesis investigates potters from a single village who quite possibly would have observed or communicated with other potters, that Fonger potters were aware of all three techniques, even if they did not use them. However, because the number of rims and necks that were made by paddling are much less than the number of body sherds made by paddling, I believe vessels were made using a combination of techniques.

How Vessel Forming Fits Into Daily Life

How vessel forming fit into the daily and annual activities of Fonger potters was likely dependent on a number of factors, such as the storage of raw materials and unfinished vessels, the environment and other seasonal activities. If raw materials were stored, then vessel forming could have been performed when other activities, such as planting and harvesting, were not a priority or dominating a potter's time, for instance in the evenings or during the winter. If materials for ceramic making were stored, vessels could be made at any time of year as long as potters could make and dry their vessels indoors during the winter. Even though Allen and Zubrow (1989) determined that the optimal time of year for making ceramics would be between June and September based on weather patterns, this does not mean that vessels were not made at other times of the year.

Finishing

Fonger potters applied a wide variety of exterior vessel finishes and a limited number of interior finishes. While there are functional and mechanical benefits to using different types of surface finishes, the reasons why Fonger potters chose to apply a specific type of finish may not have necessarily been related to function or mechanics. In Gosselain's (1998) study of Cameroon potters, different finishing techniques, which can easily be adopted by different potters, are "not so much because of the performance characteristics they allow as it is the visual aspect they confer to vessels and because of the symbolic meaning put into them by both producers and users" (Gosselain 1998: 99). If this statement can be applied to Fonger potters, then visually communicated meaning might explain why there are seven exterior surface finishes and only two interior finishes. The interior finish would have not been seen and, thus, any visual meaning would be lost.

It is difficult to separate where potters were acting within wider, more broadly based social 'rules' and where potters expressed more individuality, because all of the finishing techniques Fonger potter used have been identified on vessels recovered from other Neutral sites (Fitzgerald 1982: 109-112; Lennox 1984: 78-84, 244-247). As a result, all seven techniques might have been socially 'acceptable' and potters were 'free' to choose any one of these techniques, expressing their own individuality within a socially structured way of doing things.

Interestingly, six out of the seven exterior finishing techniques are represented in only 11% of the entire sample. Potters may have been able to freely choose any one of the seven finishing techniques, but smoothing was just the more popular choice.

Now, what is very interesting is that when I explored if surface finish is connected to other choices potters made, I realized that within the seven shell-tempered sherds in the sample, two of the atypical surface finishes, cord roughened paddling and smoothing over cord, were used. This is interesting, because the rare temper type is paired with rare finishes. However, these exterior finishes are also found on sherds made with granite-based temper and shell-tempered sherds are also smoothed. As a result, I cannot discern a direct one-to-one relationship between surface finish and temper type.

How Vessel Finishing Fits Into Daily Life

Unlike the collection and preparation of raw materials and vessel forming, which can be done independently at different sittings, the timing of vessel finishing is dependent on the previous step, forming. This is because finishing must be done before the vessel is completely dry, leaving enough time for decoration to be applied. Once a potter decides to form a vessel, he/she is committed to the finishing and decorating steps of the operational sequence within a limited timeframe, depending on the wetness of the clay paste. As a result, if other tasks or activities, such as harvesting or planting, interrupt the manufacture of vessels during these steps in the operational sequence, vessels may never be completed. While potters can control the rate at which a vessel dries by keeping the pot in a cool damp place or in high humidity, the finishing of a vessel is ultimately dependent on when forming is done.

Some finishing techniques take longer than others, taking away from or interrupting other tasks. For example, burnishing can take longer than other techniques and smoothing a vessel that was formerly paddled by a cord roughened or ribbed paddle is an extra step that would extend the amount of time potters took at this step.

The types of tools used for finishing, like those used for raw materials preparation, could have been adopted from other activities, for example chert scrapers used for scraping hides could have been used for scraping or smoothing vessel surfaces or awls for creating clothing could have been used for scarifying exterior vessel surfaces. Also, items that may not seem like obvious ceramic making tools could have been used, such as cornhusks or pieces of hides for smoothing. At the Fonger site, Warrick (1984b: 106) recovered "four metasedimentary rocks with extremely smooth surfaces" which he suggests, and I agree, "may have been used for smoothing or burnishing the exteriors of clay pots during manufacture".

Decorating

Fonger potters could choose from five decoration types and applied decoration to vessel bodies, shoulders, necks, rims, lips, interior rims and/or castellations. On the different types of sherds, Fonger potters applied one decoration type or a combination of two decoration types. Sherds from different parts of vessels display different ranges of decoration variation: five types or combinations of decoration types were applied to body and shoulder sherds; four types or combinations of decoration were applied to neck sherds, rim sherd lips and interior rims; seven types or combinations were applied to rims; and three types were applied to castellations.

Fonger potters only applied geometric decorative designs to smoothed finishes. Sherds that were burnished, cord roughened, smoothed-over corded, ribbed paddled, smoothed-over ribbed or scarified were not decorated. I thought that a possible reason was that decoration would not be as visible on textured surfaces. While this might be the case, it does not explain the lack of decoration on burnished surfaces.

The presence of geometric decorative design patterns does not affect the physical mechanics or function of a vessel but can affect social concepts of function or use. For example, a specific decoration type may be associated with a specific type of cooking or food, while another type of decoration may be associated with the storage of corn or beans. However, because I do not have enough information about the actual use of vessels with different types of decoration and without residue analysis of sherds with different types of decoration, which is beyond the scope of this thesis, I cannot determine if this was the case.

Like finishing, Fonger potters may have been able to choose the type of decoration to apply from a number of socially acceptable options. Within these options, potters may have been able to display individual agency by electing to apply any one or a combination of communally deemed 'appropriate' decoration types to their vessels.

How Vessel Decoration Fits Into daily Life

Like surface finish, decoration needs to be applied before the vessel is completely dry. As a result, decorating is chronologically linked to forming, finishing and the length of time it takes for a vessel to dry. Therefore, if a potter were to apply decoration they would need to do so in a limited period of time. Because the application of decoration must be completed in a limited timeframe and because applying decoration takes time, this step, just like surface finishing, may interfere with other daily activities. However, to

Fonger potters the application of decoration was a definite step in order to complete a vessel. Interestingly, only 5% (n=5) of rim sherds have absolutely no decoration. While it is possible that decoration was not continuous around vessels, it is also possible that the potter or potters responsible for manufacturing the vessels to which these sherds belonged were lazy, pressed for time or chose to express their individuality or abided by different social 'rules' by not applying rim decoration.

Like the previous steps, potters may have adopted tools from other technologies. At the Fonger site bone awls, modified beaver incisors, bronze and iron awls were recovered (Warrick 1984b: 128, 130, 136, 141), which could have been used as ceramic manufacturing tools.

Firing

Fonger potters fired their ceramic vessels in open bonfires or shallow pit fires. Only 2% of Fonger sherds display evidence of possibly being fired in a reducing atmosphere. While reducing firing atmospheres may have been intentionally created, reducing conditions may have been accidentally produced within an open fire or pit fire. Other pots and/or large amounts of fuel, limiting the amount of oxygen available to vessel surfaces may have covered pots, generating localized reducing conditions. Since the gray colours on sherds that result from such reducing conditions do not correlate with any other aspect of the vessels (i.e. shape, size, inclusions), I think that dark colours were not intentionally sought out and only appeared as patches on the surfaces of vessels.

There is a wide range of variability when looking at the attributes that I used to determine the firing atmosphere of Fonger ceramics. For example, exterior sherd colour varied from orange to black. However, this range of variation corresponds with the variable conditions created by open fires. For example, within a single open fire, vessels positioned in different areas will be exposed to different temperatures. Also, the amount of fuel that touches the surface of vessels will also alter their colour. This is just within a single firing. The range of variation, especially in terms of surface colour, will fluctuate much more between firing episodes. As a result, the nature of open or shallow pit firing facilitates a wide range of firing related attribute variation. This variation, when combined with use alterations to ceramics, only compounds the confusion of determining the firing atmosphere confidently.

Fonger potters typically let their vessels cool before taking their vessels out of the fire but sometimes vessels were removed while they were still relatively hot, creating sharp boundaries between sherd surfaces and cores.

How Vessel Firing Fits Into Daily Life

How ceramic vessel firing fits into the daily activities of Fonger life would have been contingent on the location, size and organization of firings. If vessels were fired in the central hearths of longhouses, then finding ceramic sherds and waste in association with hearths under a meter in diameter within longhouses, such as in house 11 at the Fonger site could be explained (Warrick 1984b: 58, 59). For example, vessels that were not completely dry may have broken, leaving behind pieces of ceramics in the hearths. However, the presence of ceramic sherds in hearths may be the result of cooking accidents or their use in propping up pots.

If ceramic vessels were fired within longhouses then firing could take place at any time of year. Winter weather would not affect firing because longhouses minimized the effects of wind and extremely cold temperatures.

If large firings occurred then they could not take place during the winter, due to the difficulty of reaching and sustaining high temperatures. However, when I fired vessels, I was surprised I could obtain a temperature over 700°C, although the firing occurred in the late fall and frost was on the ground. It was possible to sustain higher firing temperatures when I sheltered the wind. As a result, Fonger potters could have created ways to prolong the outdoor 'firing season'.

If large firings occurred, then it is possible that an individual potter fired all her vessels for the year at a single time. If this were the case, unless vessel production happened once a year, potters would have had to store dried unfired vessels they created until the firing. As a result, unfired vessels would have had to be kept in storage out of the way of traffic and moisture. In addition, if many vessels were fired at a time, then some vessels would have to be stored for future use. However, there was not a lot of space for the storage of extra ceramic vessels within a longhouse. So, unless fired vessels were stored in sheltered areas outside of longhouses, probably vessels were not stored, which would suggest potters did not fire all the vessels they would need in a year at the same time.

Based on the previous discussion, if large vessel firings were a common practice, then groups of potters likely came together to fire their vessels. This type of firing would promote interactions between potters. These may have been forums that facilitated the transmission of technological knowledge and ideas surrounding ceramics. However, one individual may have been responsible for firing a group of vessels made by several different potters. This type of large firing would permit the remaining potters to participate in different activities, contributing in other ways to the community.

Use

I cannot discern how Fonger potters actually used the ceramic vessels they manufactured other than for cooking. This is because when I studied the direct evidence of use, cooking had left the only clear evidence, based on sooting and carbonized deposits. The raw materials selected, and their preparation did not correlate with other variables such as thickness or surface finish that can affect the performance characteristics of a vessels. As a result, I could not find a pattern suggesting only certain attributes were associated with cooking or particular kinds of cooking methods and other attributes associated with another vessel function.

It is possible that Fonger villagers used ceramic vessels in a general fashion, without having distinct vessel use categories. For example, a vessel used for cooking one day could be used for storage on another. As a result, a single ceramic vessel may have been used for multiple functions. Alternatively, Fonger potters did not have different recipes for different uses. So even if one vessel was always used for cooking and another one always for storing, we would not be able to discern them solely based on the basis of characteristics such as raw materials.

How Vessel Use Fits Into Daily Life

Based on direct evidence of use, it is evident that Fonger ceramic vessels were used for cooking. Because whole vessels are not available for this investigation, I could not identify distinct sooting patterns, which could suggest whether vessels were placed in or over fires. Ceramic vessels could have been suspended above the fire or placed directly into the fire. Waugh, while studying Iroquoian food and food preparation techniques, comments on both these ways of using a cooking vessel: "the rounded bottoms [of vessels] were evidently adapted equally for standing in the light soil, which usually formed the floors of the cabins, or for maintaining an upright position in the fire" and "the extension rim found on most of the pots, suggests that they could have been tied about the neck with bark cord or vines and suspended from poles arranged either tripod-fashion, or between crotches" (1916: 56). An alternative method of cooking, where hot stones were placed directly in containers to heat the contents has been documented for cooking meat in bark containers. Father Joseph Jouvency described this method of cooking being used by the Indigenous people at his mission in Acadia from 1611-1613:

> "Before pots, kettles and other vessels of the sort were brought to them from France they used receptacles of closely joined bark; but, because they could not place them with safety over the flames, they devised the following way of the cooking meat: They cast a large number of flint stones into the fire until they had become red-hot. Then they would drop these hot stones one after another into a vessel full of cold water and meat. In this manner the water was heated and the meat cooked more quickly and more easily than one would suppose" (Thwaites 1896-1901: 1:283-285).

This method of cooking could have easily been transferred to cooking in ceramic vessels.

Cooking in ceramic vessels would have been a daily activity at Fonger, especially if soup cooked in the morning was the main single meal of the day as Waugh (1916: 46-

47) has suggested for other Iroquoian groups. However, ceramic vessels may have been used as storage or transportation devices. From the discussion in the previous chapter, I argued that there are some shapes that are better suited for certain functions than others. For example, tall and narrow necked vessels are better for storing liquids because they reduce evaporation and spillage. However, Fonger potters did not strictly adhere to what we consider ideal.

Scale and Organization of Production

The goal of this thesis was not to investigate the scale or organization of ceramic production. However, based on my data, I can make some comments. If there was a small group of potters who manufactured ceramic vessels for the use of people throughout the Fonger site, I would expect there to be limited variation in the types of raw materials, raw material preparation, forming, finishing, location and type of decoration and firing, resulting in consistent similarity in ceramic operational sequences. I would anticipate that potters developed more skill as they manufactured more vessels. I would also expect there to be evidence of vessel manufacture in well-defined areas at the site. Contrastingly, if a woman manufactured her own set of ceramic vessels for her own family's use, I would expect there to be more variation in the steps of the operational sequence and less skill, because potting would be a secondary task to many people, as opposed to a more prominent task to a limited number of individuals.

The actual evidence from the Fonger site suggests that there is a wide range of variability, especially in the selection of raw materials, and in the forming, finishing and decorating of Fonger vessels. This implies that there was not a limited group of specialist potters producing ceramic pots for the community regularly. Instead, there were a number of potters producing ceramic vessels occasionally.

My limited assessment of Fonger ceramic organization and production appears to contrast with Martelle's (2002) conclusions that Huron ceramic making was a more specialized activity. This does not mean that I necessarily disagree with Martelle, only that the organization of ceramic production for the Huron may have been different than the ceramic production at the Fonger site. The difference in the organization of ceramic production between Huron and Neutral ceramics from the Fonger site reinforces the fact that we should not look at all Iroquoians as a homogeneous group manufacturing their ceramic pots in the same way.

Were There Two Groups of Potters?

Similarities

Fonger potters from the west and east wards cleaned their clays and added temper resulting in similar clay pastes. Temper was prepared, added and sorted similarly in both wards. While I identified three types of forming methods, all three were represented in similar proportions in both wards. Even though I could not identify exact vessel sizes, both wards have similar ranges of vessel rim and neck diameters and wall thicknesses. Vessels from the east and west wards were fired and used in similar ways.

Differences

The only difference in the raw materials between the two wards is that west ward ceramics contain more biotite tempering than the east ward ceramics, whereas the east ward ceramics contain more quartz. Because the shape and size of temper is similar in the ceramics from both wards but the mineral content is slightly different, I suggest that the potters from the west ward were selecting more biotite rich granites, whereas potters from the east ward were selecting more quartz rich granites. The west ward also contained a wider variety of vessel body and neck shapes. The single tall necked sherd and single flat-bottomed sherd both originated in the west ward. Conversely, east ward ceramics do not exhibit these extreme differences in vessel body and neck shape. Between the two wards there are more differences in the finer shaping details, such as rim direction, lip form and castellation type, of rim sherds. There are also discrepancies in the occurrences of different finishing techniques in the wards as well as decoration types and combinations of types.

Possible Explanations

The clays pastes are all relatively similar, yet slightly different, likely because potters made their clay pastes according to personal preferences rather than following strict rules. Contrastingly, while there are two categories of temper, shell and granite-based, from which both the east and west ward potters selected, the types of granites selected were different. There are several possible explanations for this difference in temper, including:

1) biotite rich temper was considered a more 'appropriate' temper type to west ward potters and quartz rich temper was considered a more 'appropriate' temper type to east ward potters,

2) potters from the west ward discovered granite-based temper with more biotite and continued to used this source, whereas potters from the east ward did not come across biotite rich tempering material,
3) potters on one side of the site were closer in proximity to different materials than potters on the other side of the site or,
4) with 35 statistical tests of differences between the east and west wards, one or two would show significant results even where no real difference was present just on the basis of chance.

Even though the forming techniques were the same, the range of vessel shapes was different between the two wards. Possible reasons for this difference include:
1) inconsistencies in vessel shapes made by an single potter due to not producing enough vessels to develop a rhythm,
2) the west ward was the location of ceremonies or important village leaders, housing more elaborate vessels,
3) because these shapes have been found at other Neutral sites (Lennox 1984: 76; Lennox and Fitzgerald 1990: 417 Figure 13-4), the rarer shapes may have been a standard component of the Fonger ceramic assemblage, but only present in limited numbers, resulting in only one sherd from the two differently shaped vessels being recovered or,
4) a potter or group of potters from the west ward were intentionally creating differently shaped vessel bodies and necks.

In addition to creating different vessel body and neck shapes, potters from the two wards created different rim shapes. I believe there were socially constructed ways to shape a ceramic vessel and that these social rules were slightly different between the east ward and the west ward. Within this communally guided logic to vessel shaping, potters chose to abide by their residentially bounded guidelines, reaffirming their place within their ward. At the same time potters made certain decisions not to follow these rules, expressing individuality or communicating, confirming or establishing relationships with individuals or groups outside their ward, thus creating a range of variation within each ward, rather than a single recipe of vessel manufacture from each ward.

By choosing to form, finish and decorate their vessels in different ways from other members of the Fonger community, potters communicated meaning and relationships to other people within the village and to people beyond the Fonger site. It is possible that the potter of the flatter-bottomed vessel may have been reaffirming or establishing relationships with groups or individuals not part of the Fonger village. By doing this, the potter would differentiate herself from other Fonger community members, but unite herself with other people or groups of people. However, by using the same clay and the same forming and firing techniques used by other Fonger potters, a potter could reaffirm her place within the Fonger community, at the same time linking herself with other groups. In this way, potters communicated that they were a part of the Fonger community while at the same time a part of another community or a wider social group.

In conclusion, there is built-in (temper) and visual or added differences (forming, finishing, and decorating) between vessels from the two wards but there are also several components in Fonger ceramic manufacture that are not differentiated between wards. This suggests that while there are overarching social rules or concepts about how a vessel should be made that all Fonger potters followed, there are some choices potters made that may follow residentially distinct behaviours, possibly suggesting two groups of potters. In addition, some choices made by potters may be a reflection of potters' ties to communities beyond the Fonger site.

The Anomaly of Shell-Tempered Ceramics

It has been assumed that shell-tempered sherds found on Neutral Iroquoian sites were made by captive Fire Nation women who brought vessels to the site (Fitzgerald 1982: 97-98; Lennox 1981: 356, 358; Lennox 1984: 92). This assumption presumes pots equal people; if a different type of vessel occurs, then there must be different people at the site. Another assumption has been that the contents within foreign looking vessels were traded into Iroquoian sites, rather than the actual ceramic vessels being the trade commodity (Latta 1991: 377). As a result, there are four scenarios that can explain why shell-tempered vessels are found at the Fonger site:

1) shell-tempered ceramics were traded into the site,

2) shell-tempered ceramics were brought by foreign women,

3) shell-tempered ceramics were made locally by foreign potters, or

4) shell-tempered ceramics were manufactured by local potters.

To understand why shell-tempered ceramics were found at the Fonger site, I outline the expectations for each of these scenarios followed by the actual archaeological data.

First, if foreign women brought shell-tempered vessels to the site, I would expect these vessels to be made from non-local or exotic raw materials. I would also expect that other steps in the operational sequence would be very different from the granite-based ceramics at the Fonger site, such as the type of surface finish or decoration.

Second, if shell-tempered vessels or vessel contents were traded into the site I would again expect the vessels to be made of non-local materials and have differences in the other steps of the operational sequence.

Third, if captive women manufactured shell-tempered vessel locally I would first and foremost expect the vessels to be made from locally available materials. Also, I would expect forming techniques to be different, because it is very difficult to modify forming techniques, because they are related to motor habits, as well as other unusual steps in the operational sequence. There may be some transmission or exchange of knowledge (Michelaki 2006: 5) between original potters from the Fonger site and captive women through observation, facilitating the adoption of techniques by both Fonger and foreign potters.

If foreign potters were manufacturing vessels at the Fonger site, there is a possibility that these people were incorporated into the community, possibly by marriage. As a result, if mothers taught their daughters the craft of pot making, the formerly foreign women may have taught their daughters to make shell-tempered ceramics. Subsequently, the daughters would teach their daughters, resulting in a perpetuation of shell tempered ceramics being manufactured at Neutral sites by Neutral potters who had ancestral ties to non-Neutral shell temper manufacturing communities. This explanation could account for the increase over time in the presence of shell tempered ceramics at Neutral sites (Fitzgerald 1982: 95) because as the women creating shell tempered sherds passed on their way of manufacturing ceramics to the following generations the number of potters making shell tempered vessels would increase (Michelaki 2006: 2).

Finally, if local Fonger potters manufactured shell-tempered vessels, then potters may have been extremely innovative or they may have copied or adopted ideas from other groups of potters. It would have been difficult and trying for Neutral potters to attempt suddenly to construct or reproduce shell-tempered ceramics without the technological knowledge associated with shell temper. This is because shell temper cannot be easily substituted for granite temper if the vessels were fired over 650°C. The use of shell temper creates a major problem because there are decomposition and chemical changes when fired between 650°C and 900°C. As a result, unless Fonger potters already fired their sherds with granite temper at very low temperatures, without technological knowledge about shell temper, potters would have had to learn how to manipulate their ceramic firing practices in order to prevent shell decomposition or learn how to deal with the chemical changes of shell temper in alternate ways, such as pre-firing, which seems to have occurred at the Fonger site. There needs to be more research focusing on the firing temperatures of ceramics before the presence of shell-tempered vessels in order to better understand the technological knowledge of firing practices before and after the use of shell temper. Interestingly, at the Hood site, a historic Neutral town, shell-tempered sherds were found in association with salt (Lennox 1984: 76), which is known to reduce the chemical reaction associated with using shell as temper (Rye 1976). It would be interesting to follow up on this notion by investigating residues on shell-tempered vessels, any association of salt with shell-tempered sherds from other

Neutral sites, and how the shell-tempered making potters from the Fire Nation managed the chemical reaction.

I would also expect that if local potters were initiating the use of shell-tempered ceramics that other steps of the operational sequence would not extend outside the granite-based ceramics range of variation. Nevertheless, two questions in particular, which I cannot answer in this thesis, arise:

1) why would potters go to the effort of trying to create shell-tempered vessels when granite-based vessels were used for hundreds of years; and

2) if shell-tempered vessels were beneficial in some way, how would local Fonger potters know this?

The XRD results of the two shell-tempered sherds submitted for analysis indicate that the vessels the sherds came from were manufactured using local materials from around the Fonger site. The two sherds did not have identical clay pastes. Because of this, these two sherds support the other XRD results that potters likely made their clay pastes based on personal preferences. Also, the difference in the clay pastes used indicates that the two shell-tempered sherds subjected to XRD were not from the same ceramic pot. This evidence demonstrates that the shell-tempered sherds found at the Fonger site were made locally and not traded into the site. However, based on the raw materials, I cannot determine if foreign potters living in the community, descendants of foreign potters, or traditionally local Fonger potters manufactured the pots, which produced these sherds. To resolve this, I must investigate other steps in the operational sequence of shell-tempered vessels.

In order for shell to be added to clay, it was prepared by pre-firing and then crushed. Pre-firing shell between 300°C and 400°C changes the composition of shell to calcite, making it much easier to crush than natural shell (Feathers 2006: 92; Rice 1987: 407 Table 14.1: 410). When shell has been pre-fired it breaks into platy shapes, which contrasts to the blocky shape that shell breaks into when it has not been pre-fired (Feathers 2006: 92). All the shells in the Fonger sherds have a platy shape and the two shell-tempered sherds analyzed by XRD contain calcite. As a result, I believe that Fonger potters may have pre-fired their shell used for temper. Shells may have been prepared just like granite-based temper using tools such as hammer stones, mortar and pestles or corn grinders.

The only forming difference between shell-tempered sherds and granite-based sherds is that shell-tempered sherds are on average thinner. Interestingly, similar findings were found at the Christianson (Fitzgerald 1982: 110), Hamilton (Lennox 1981: 259), Bogle I (Lennox 1984: 213) and Walker (Wright 1981: 71) Neutral villages. There is only one shell-tempered rim sherd in the sample and this rim falls into the range of variation identified in the granite-based sherds in terms of rim direction (outward facing), lip shape (flat type A), lip thickness (7.4 mm) and rim diameter (34 cm).

Out of the seven shell-tempered sherds within the Fonger sample, three sherds have a smoothed finish, including the single shell-tempered rim sherd. The remaining four sherds were paddled, using a cord-roughened paddle. Of these cord-roughened paddled sherds, two were smoothed over after being cord paddled. It is unexpected that the majority of shell-tempered sherds were cord paddled because only 3.5% of the entire

Fonger sample was cord-roughened or smoothed over corded. Interestingly, other Neutral sites, such as Bogle I, Bogle II, Hood and Christianson, also have shell-tempered ceramics in high association with cord paddled exterior surfaces (Lennox 1984: 214, 245, 76; Fitzgerald 1982: 109). It is possible that if a vessel was made using shell temper then potters believed that it was appropriate to either smooth or cord paddle the exterior surface. This is unlike granite-based sherds where it was much more popular to smooth a vessel than to cord paddle it.

Out of the seven shell-tempered sherds, six are body sherds and one is a rim sherd. Decoration was not applied to shell-tempered body sherds. This may be because potters did not apply any decoration to shell-tempered vessel bodies or, like the granite-based sherds, body sherd decoration was not popular on shell-tempered vessels. On the single shell-tempered rim sherd, impressed decoration occurs on the rim and lip. On the rim dentate stamped impressions occur and on the lip impressed punctates occur. Impressed punctates on the lips of rims are found on granite-based lips as well. However, dentate stamped impressions do not occur on any other rims in the entire Fonger sample. Only one other sherd, which contains granite-based temper, has impressed dentate stamped impressions but these occur on the shoulder.

All the shell-tempered sherds were fired in an incompletely oxidizing atmosphere, like most of the granite-based sherds. Direct evidence of use on shell-tempered sherds comes from partial sooting deposits on the surfaces of some of the sherds. Six out of seven sherds have no exterior sooting and five of the seven do not have interior sooting. Accordingly, five shell-tempered sherds do not display evidence of being used for cooking, whereas two of the sherds display evidence of being exposed to fire, most likely due to cooking. Presently, it does not appear that shell-tempered sherds were used differently than granite-based sherds. However, it would be interesting to explore the possibility of differences in vessel contents based on different tempering materials by conducting residue analyses on sherds from the Fonger site.

To summarize, shell tempered ceramics can be differentiated from granite-based ceramics at the Fonger site by the presence of shell temper, thinner walls, higher percentage of cord-roughened paddle and smoothed over cord finished exterior surfaces, and dentate stamped impressions on the rim. However, shell tempered ceramics cannot be distinguished from granite-based ceramics by the type of clay selected, the preparation of temper, the forming techniques, vessel shape, the types of finishing techniques, body or lip decoration, the firing atmosphere, and how vessels were used. As a result, there are two levels of differentiation between shell and granite-based tempered sherds, built-in-variation (the two types of temper) and added-on-variation (surface finish and decoration) (Chilton 1998: 159). These two types of variations combined into a single vessel reaffirm, negotiate and/or challenge the potter's place in society and convey meaning both through the production of the vessel and by the visual information applied to the surface (Chilton 1998: 134, 159). It appears that while there are obvious differences, which potters and other members of the Fonger community would be exposed to in and on shell tempered vessels, there are more similarities than differences in the shell and granite-based vessels. However, these similarities are more difficult to change once a potter has learned to make vessels. For example, the forming and shaping of vessels are directly related to the way a potter thinks of a vessel and the motor skills associated with vessel manufacture, which are cognitively more difficult to change.

I am tempted to conclude that by making choices during the manufacturing of ceramics that are the same throughout the community, potters making shell-tempered ceramics were following certain Fonger social structures and rules of manufacturing a vessel, while at the same time expressing their individuality by making non-conformist choices. However, these choices may be a reflection of a different set of beliefs of how to manufacture a vessel from a separate community that overlap with Fonger ideas of ceramic manufacture. For example, potters of the Fire Nation, where shell-tempered ceramics in Neutral sites have been thought to originate, may use forming and finishing techniques, apply body and lip decoration, and create firing atmospheres similar to Fonger potters. Additionally, the non-conformist choices of potters using shell temper could be a reflection of potters challenging social rules and beliefs, while at the same time expressing ties to other communities. For example, a single shell-tempered rim sherd is the only sherd at the Fonger site with dentate stamped impressions on the rim but a shell-tempered sherd from Hood, a Neutral village, also contains dentate stamped impressions on the rim (Lennox 1984: 80). As a result, without further investigations into how potters from other communities manufacture their vessels, I cannot determine if the shell-tempered ceramics from the Fonger site were a reflection of individual potters making non-conventional choices or potters expressing and/or reaffirming relations with other Neutral or non-Neutral groups.

It is only through more locally focused microscaled studies of ceramic manufacture, like this investigation, which are then situated within a wider macroscaled context that it is possible to determine if shell-tempered ceramics found on Neutral sites were made by originally Neutral Fonger potters making a few non- standard choices, or were made by Fonger potters who are expressing connections to other groups, or if shell-tempered ceramics were made by originally foreign potters using local materials.

Chapter 6: Conclusion

In order to study Neutral ceramic technology at the Fonger site, I employed a methodology that combined macroscopic, petrographic and x-ray diffraction analyses with experiments and a raw materials survey. This methodology not only allowed me to study the actual choices Fonger potters made but also permitted me to explore the possible influences behind potters' choices.

Throughout this thesis I have tried to demonstrate that function or mechanics of the final product do not strictly govern the choices potters make. Fonger potters made choices throughout the entire ceramic operational sequence that reflect a response to community-based social structures and beliefs of ceramic manufacture. This response was in the form of conformity, reiterating that potters were members of the community, or in the form of unconventional choices, which were a reflection of relationships to people outside the Fonger community. Because there is little dependence or minimal linkages between a choice made at one step in the operational sequence to a choice made at another step, except for inward facing rims and lip form, potters could choose at each stage of ceramic manufacture from a range of different options that displayed their traditional values or individuality.

Through a raw materials survey, I collected several clay and temper samples from around the Fonger site. By investigating several variables, including shrinkage, colour when fired and point of calcium carbonate decomposition of the local clays when mixed with different amounts and types of temper, I was able to better understand the specific mechanical, functional and environmental influences that may have had an effect on

Fonger potters' choices. Experimental firing and re-firing tests in conjunction with macroscopic and x-ray diffraction analyses helped me determine that Fonger ceramics were fired under 900°C in oxidizing or incompletely oxidizing atmospheres, like those produced by open fires.

In this thesis, I investigated whether the ceramic technology at the Fonger site reflects two groups of potters, one group from the west ward and the other from the east ward. The similarities in the ceramic manufacture of the west and east wards include the selection of local materials, temper preparation, forming techniques, vessel rim and neck diameters, vessel wall thicknesses, firing conditions and use. The differences between the two wards include the minerals in the granite-based temper, vessel shape, type and frequency of exterior surface finish, and the location, presence, and frequency of decoration. While there may be differences in how potters from the east ward made their vessels when compared to potters from the west ward, without investigations into how ceramics were made within each individual house and into how ceramics were made at other Neutral sites and by non-Neutral groups nearby, it is not yet possible to determine if there were actually two separate but closely interacting groups of potters.

In this thesis, I also addressed the presence of shell-tempered vessels at the Fonger site. Some interesting conclusions related to the shell-tempered sherds at the Fonger site are that they were made from local materials and the shell was pre-fired before being crushed and added to the clay pastes. There need to be more detailed comparative investigations into how shell-tempered vessels were manufactured at other

Neutral sites and non-Neutral sites, such as those of the 'Fire Nation', in order to better understand the reasons why potters used shell temper, the transmission of knowledge associated with shell-tempered vessels and relationships between Fonger potters and other groups.

From this study, a number of questions arose, begging further research. First, there should be residue analyses conducted in order to see if different types of foods were cooked or stored in different types of vessels. For example, were different foods placed in thicker vessels than in thinner vessels? Were different foods cooked in shell-tempered vessels than in granite-tempered vessels? Second, there should be spatial and temporal comparisons of the ceramic technology from other Neutral sites in order to see technological changes over time and differences across the Neutral territory. Third, there should be comparisons of the ceramic technology of Neutral groups with non-Neutral groups, such as the 'Fire Nation', 'Huron' and 'Seneca'. These lines of inquiry will lead to a better understanding of which choices in the operational sequence are more conventionally 'Neutral', which ones reflect relationships with other groups and which choices reflect individuality or personal preference.

Appendix 1

The macroscopic data sheet (Adopted from Michelaki 2005, pers. comm.).

Fonger (AhHb-8) Ceramics Macroscopic Data Sheet

Sherd #: AhHb-8____________ provenience:___________________ Design:

Preservation

body neck shoulder rim castellation

Shape and Size

Rim diam. & % preserved: __________ __________ Collar height:________mm
Neck diam. & % preserved:__________ __________ Neck height:________mm
Max. diam. & % preserved: Maximum height:
Lip thickness: ________mm Collar thickness:_________mm Neck thickness: mm
Rim thickness:_________mm Body thickness:__________mm

Rim Direction: up out in

Lip Form: *Flat*: Type A Type B

Rounded: Type A Type B

Castellation: Turret Incipient Pointed Pointed Notched

Raw materials

Kind of inclusions: black mica golden mica quartz/feldspar orthoclase plagioclase quartz shell other ____________.

Percent of inclusions: %

Sorting: very poor poor fair good very good

Orientation: clear medium chance

Shape: very angular angular sub-angular sub-rounded rounded well rounded phyllo-like

Size: _______mm very fine fine medium coarse very coarse

Forming

Coiling coil width:______mm Paddle and anvil Pinching Invisible

Finishing

smoothed:	ext.	int.	ribbed paddle:	ext.	int.
burnished:	ext.	int.	smoothed over cord:	ext.	int.
scarified:	ext.	int.	smoothed over ribbed:	ext.	int.
cord roughened paddle:	ext.	int.	slipped:	ext.	int.

Decoration

Note: for exterior mark the position of the decoration: R=rim, N=neck, S=shoulder, B=body

incised-pointy: impressed fingernail: none:

incised-trailed: impressed punctate:

incised notched: impressed dentate stamped:

impressed linear: other: ________________.

Drying

Cracks : vertical web straight base none

Firing

All oxidized All reduced Oxidized exterior-reduced interior

Reduced exterior-oxidized interior Oxidized sandwich Reduced Sandwich

Ox-Red-Ox-Red Red-Ox-Red-Ox Ox-Red-Ox-Red-Ox-Red

Red-Ox-Red-Ox-Red Ox-Red-Ox-Red-Ox Other

Cracks: firecracks star-shaped spalling dunting none

Surface colour: *Exterior*: Orange Brown light brown fire clouded black gray dark gray

Interior: Orange Brown light brown fire clouded black gray dark gray

Core colour: black black-gray gray brown light brown orange orange-brown orange-red other

Boundaries: sharp diffused

Use						
Wear patterns: none	*Interior*: all	partial	*Exterior*: all	partial		
Soot :	none	all	partial			

Comments

____

____

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____

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_______________________.

Appendix 2

The macroscopic observations/variables that were used to determine the steps and variations within the steps of the operational sequence and the corresponding human behaviour.

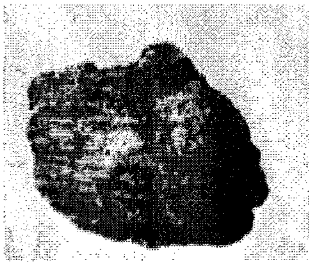
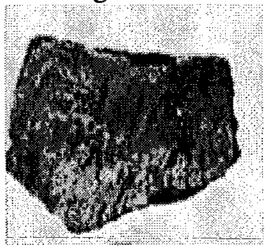
Steps in the Operational Sequence	Macroscopic Observation/Variable	Human Behaviour
Raw Materials Selection and Preparation	Type of inclusions	Potters randomly or specifically select raw materials from a range of available options.
Raw Materials Selection and Preparation	Temper amount	Potters may have targeted specific amounts.
Raw Materials Selection and Preparation	Inclusion shape	Potters may have selected tempers that did not need preparation because the temper was naturally weathered and broken down into usable sizes or they may have prepared their tempers (crushing up).
Raw Materials Selection and Preparation	Inclusion size	Potters may have targeted specific sizes.
Raw Materials Selection and Preparation	Degree of inclusion sorting	Potters may have spent time sorting out temper in order to target specific sizes or may have chosen naturally well sorted clays.
Vessel Forming	Inclusion orientation	Potters use different techniques to form their vessels, which can force inclusions to align in specific ways.
Vessel Forming	Cracks	Potters use forming techniques that leave specific types of cracks or breakage patterns.
Vessel Forming	Rim and lip shape, neck and collar height, collar and neck thickness, rim and lip thickness	Potters create different shapes of vessels that require different forming techniques.
Vessel Forming	Rim and neck diameter	Potters create different sized vessels that possibly relate to different functions and uses.
Vessel Finishing	Presence/absence and direction of smoothing marks.	Potters can smooth vessels carefully in the same direction or quickly and/or randomly or not at all.
Vessel Finishing	Exterior and interior finish	Potters finish their vessels using various techniques and tools.
Vessel	Decoration type	Potters choose to decorate their vessels or not. If

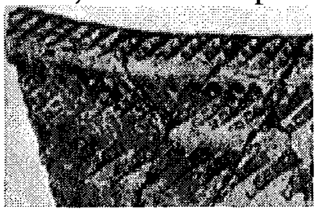
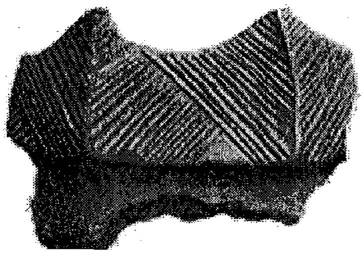
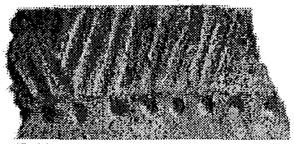
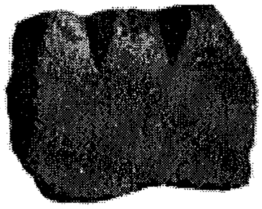
Decorating	and location	so, potters decide where, how and what object to use to apply the decoration.
Vessel Firing	Exterior and interior surface and core colours.	Potters create different firing atmospheres that can be determined by surface and core colours.
Vessel Firing	Sharp or diffused boundaries	Potters can take vessels out of the fire while hot, which cools vessels fast or potters can leave the vessels in the fire to cool slowly.
Vessel Use	Exterior and interior wear	Vessel use can leave markings on the surfaces.
Vessel Use	Sooting and carbon deposits	Carbonized deposits and sooting are evidence for cooking or being near a fire.

Definitions of the macroscopic variables (adopted from Michelaki 2005, pers. comm).

Variable	Definition
Raw Materials Selection and Preparation	
Inclusions	All particles other than clay, no matter whether their source was natural or human. Use a fresh break and 20x magnification. Quartz is glassy and hard, usually white, grey or clear; Mica occurs as thin flakes or sheets; Plagioclase is a feldspar that is light coloured, hard and can be white, grey or blue (Marshak 2001: 110). Shell occurs white and platy.
% of Inclusions	Percentage of inclusions within the clay body. Use a fresh break and 20x magnification to compare to charts outlined by Matthew et al. (1991).
Sorting	Refers to the homogeneity of the sizes of inclusions within the clay body: if there are many widely different sizes, then the sorting is very poor; if all the inclusions are more or less of the same size, then the sorting is good. Use a fresh break and 20x magnification to compare to inclusion sorting chart (Orton et al 1993: 239).
Shape	Refers to the shape of the inclusions. Use a fresh break and 20x magnification to compare to sphericity/roundness estimation chart (Orton et al 1993: 239).
Size	Estimation of the smallest and largest inclusions in a fresh cut section of each sherd. Use a fresh break and 20x magnification to compare to charts outlined by Matthew et al (1991: 211-263).
Forming	
Maximum Diameter	Circumference of vessel at point of maximum diameter. Measured on exterior surface. Use rim diameter chart (Rice 1987: 223).
% Diametre Preserved	Percentage of the vessel that is preserved in the measurement of the rim, neck or max. vessel diameter. Use rim diameter chart (Rice 1987: 223).
Rim Height	Vertical height from lip to base of rim. Use calipers.
Collar Height	Vertical height from lip to base of collar. Use calipers.
Neck Height	Vertical height from lip to neck inflection. Use calipers.

Height To Max. Diameter	Vertical height from lip to point of max. vessel diameter. Use calipers.
Lip Thickness	Thickness of vessel at point of max. thickness at edge of rim. Use calipers.
Collar Thickness	Thickness of vessel at point of max. collar diameter. Use calipers.
Neck Thickness	Thickness of vessel at point of inflection. Use calipers.
Rim Thickness	Thickness of vessel at 1 cm below lip. Measured on rims without collar only. Use calipers.
Body Thickness	Thickness of vessel 2 cm below neck inflection for necked vessels, or at 4cm below lip. Use calipers.
Lip Form	Flat type A Flat type B Round type A Round type B
Castellation Form	4 types: a) turret b) pointed c) incipient pointed and d) notched
Finishing	
Smoothed	Surface with regular overall texture and a matte appearance. Produced by wiping the wet clay with the hand or a soft, smooth piece of fabric.
Burnished	Surface with regular overall texture and a shiny appearance. Produced by repeatedly pressing a hard, smooth implement, such as a pebble, over the surface of the leather hard pot. The clay platelets are aligned parallel to each other and to the surface, reflecting the light.
Scarified	Roughly scratched surface. The moist surface of the vessel was scraped with a handful of twigs or reeds. The markings may occur horizontally or obliquely and often criss-cross one another. Very rarely they seem to have been produced by a toothed implement used in a careless fashion.  (Wright 1973: Plate VII Figure 2)
Cord Roughened Paddle	A cord-wrapped paddle is used, producing rough vertical, parallel cord impressions. Generally, the cord roughened pattern is applied vertically and has visible "twine" impressions, while the ribbed paddle one is often applied horizontally and has no "twine" impressions.

	 (MacNeish 1952: Plate VI Figure 3)
Ribbed Paddle	Produced either by a ribbed paddle, or by a thong-wrapped paddle. Consists of a series of parallel impressions, usually applied to the vessel horizontally (although there are cases of oblique and criss-cross patterns).  (Wright 1973: Plate VII Figure 11)
Smoothed Over Cord Roughened Paddle	The cord-roughened paddled surface has been eventually smoothed, which partially obliterates the original surface treatment.  (Wright 1973: Plate VII Figure 7)
Smoothed Over Ribbed Paddle	The ribbed-paddled surface has been eventually smoothed, which partially obliterated the original surface treatment.
Decorating	
Impressed	Negative of a tool pressed into plastic or leather hard clay. No clay is removed. There are 2 different kinds of impressed decoration: a) punctate  (MacNeish 1952: Plate XXIX Figure 4)

	and b) dentate stamped  (Wright 1973: Plate V Figure 1)
Incised	Decoration by narrow ended tool used with sufficient pressure to cut into clay. There are 3 different kinds: a) pointy b) trailed and c) notched.
Pointy	The tool that is used has a pointy edge and leaves behind a line that is narrow, deep, V-shaped and sharply defined.  (MacNeish 1952: Plate XXIII Figure 6)
Trailed	The tool that is used has a flat edge and leaves behind a line that is shallow, wider than 1.5 mm, striated and bordered by small lumps of clay pushed aside in the process.  (MacNeish 1952: Plate X Figure 4)
Notched	Part of the ceramic has been removed or cut out. Usually on the lip or the base of the collar.  (MacNeish 1952: Plate XV Figure 2)
Firing	
Firing atmosphere	Observations (colour and boundaries) made on fresh break, starting from the exterior to the interior surface.
Core	Colour of the sherd core. Observations made on fresh break.
Boundaries	Nature of boundaries between surface colour and core colour (i.e. sharp or diffused). Observations made on a fresh break and compared to

	cross-section chart (Rye 1981: 116).
Cracks	Present or absent: a) star-shaped cracks, radiating from large inclusions or b) network of superficial cracks.
Surface colour	Colour of both the exterior and interior surfaces.
Use	
Use	The presence or absence of sooting and/or encrustations on both the exterior and interior surface. Notice potential use-related wear.

Appendix 3

The information supplied to Greg Braun prior to the petrographic analysis to inform him of the data that I was seeking.

What I Want to Know	Why	Observation
Are the inclusions natural? What inclusions occur naturally in the clay?	If the inclusions are not naturally occurring in the clay, potters added temper.	Kind, size, shape
If visible, are there different types of clays being used?	Potters may have been targeting specific types of clays or different clays may be associated with other steps in the operational sequence.	Differences in clay matrix
How much temper was added?	Potters could have mixed clay and temper together in specific amounts or randomly. The amount of temper has an effect on the functional and mechanical properties of vessels.	Amount
What shapes are the inclusions?	Inclusion shape can inform me of how potters prepared temper as well as the type of temper potters used.	Shape
What size are the inclusions?	Potters may have selected specific sizes for temper. The preferred temper size may occur naturally or potters may have spent time sorting temper. Size might also indicate the type of temper that was used. Temper size affects the functional and mechanical properties of vessels.	Size
To what degree are inclusions sorted?	The degree to which the temper is sorted can indicate how much time potters spent on this step. This also might indicate the kind of temper potters used.	Sorting
How are inclusions orientated?	The orientation of inclusions is related to the formation of the vessel.	Orientation
Are there different 'recipes'?	Potters may have used different raw materials or prepared their raw materials differently but there may be consistencies in these differences. For example, well-sorted temper may be associated with a specific size of temper.	The range of variation and links from one step to the next

APPENDIX 3: Petrographic Report by Gregory Braun

Methodology

As part of the analysis performed by Carrie Rai for her MA thesis, twenty ceramic samples from the Fonger Site were prepared for thin-sectioning and petrographic examination using a polarized light microscope. These thin-sections were examined at 40x and 100x magnification under plane and polarized light in order to identify rock inclusions and constituent minerals by their optical properties.

Minerals were identified as specifically as possible, however due to the relatively small inclusion size of many particles, in some cases only the membership of a larger group (e.g. clinopyroxenes, plagioclase) could be ascertained. The maximum length of each inclusion was measured categorically, with five ranges: 0.5-1 mm, 1-2 mm, 2-4 mm, 4-6 mm, and 6-8 mm. Two additional ranges (<0.25 mm and 0.25-0.5 mm) were used to measure naturally occurring inclusions in selected thin-sections so that the mineralogy of the clays could be characterized. Where a grain was composed of several different minerals, it was identified as the constituent forming the majority of the grain. Whenever possible, the relative proportions of mineral constituents were estimated and the rock fragment was identified using the QAPF modal classification and according to guidelines set by the International Union of Geological Sciences (Le Maitre 2002). In order to compensate for the small sample size, this modal identification was often compared with the results of the grain counts before a final identification was made. Other data were recorded for each thin-section according to Prehistoric Ceramics Research Group methodology, including particle shape, sorting, orientation, and overall density (PCRG 1997).

Results

In the fabric descriptions below, when describing particle size the most frequent size category and its corresponding value will be given. When describing shape, the proportion of the rounded categories (well-rounded, rounded, and sub-rounded) or the angular categories (sub-angular, angular, and very angular) will be given, whichever is greater. Any noteworthy aspects of mineralogy will also be described. The full petrographic data are presented in Appendix A.

The characteristics of inclusions less than 0.5 millimetres in diameter were recorded for three samples: 2395-1-C, 2074-1, and 1719-14. Due to the large number of inclusions present in this size range, one-quarter of each sample was assessed and the results multiplied to estimate the overall counts. It was found that inclusions less than 0.5 millimetres comprised 93% on average of all inclusions. In addition, the majority of inclusions were composed of quartz or feldspars, minerals which have a relatively high resistance to mechanical or chemical alteration and so are less likely to decompose than the mafic minerals (eg. biotite or hornblende); they were also rounded in shape. Overall, the dominance of rounded minerals that are highly resistant to alteration indicates that the majority of inclusions less than 0.5 millimetres in diameter were naturally occurring in clays and are glacial in origin. Several samples do not fit this pattern, and had significant amounts of added temper present in this size range: amphiboles in samples 1334, 2079-1b, and 2395-1-C; and shell in samples 1687-Ab and 2030-10-E. An examination of the frequency distributions and shape for these inclusions indicates that they are added inclusions and are not naturally occurring. When these inclusion types are ignored, the mineralogy of drift inclusions for all twenty samples is petrographically indistinguishable. XRD or heavy mineral analysis must be used to characterize clay mineralogy for these samples.

Overall, clays appeared well-mixed; few bands or lenses of clay with differing inclusion densities were noted (with the exception of 1039). The orientation of inclusions was, for the most part, random, although tabular inclusions with low sphericity, such as mica and shell, tended to be aligned parallel to the sherd surfaces (exceptions noted below).

Voids were present in each sample and were elongated, generally running parallel to the sherd surface. The one exception was sample 1039: its voids were less elongated and were not always parallel, perhaps indicating a different manufacturing method.

1719-14 This sample was tempered with quartz syenite fragments up to 4 millimetres in diameter, with 56% falling within the 0.5-1.0 millimetre range. Particle shape ranged from well-rounded to very angular, with 66% falling within the angular categories. Inclusions in this thin-section exhibited poor sorting and a 35% overall density. No specific particle orientation was discerned. This sample resembles 1260-8.

1260-8 This sample was tempered with quartz syenite fragments up to 4 millimetres in diameter, with 65% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 61% falling within the rounded categories. Inclusions in this thin-section were moderately sorted and had a 35% overall density. No specific particle orientation was discerned. This sample resembles 1719-14.

1334 This sample was tempered with hornblende-rich quartz syenite fragments up to 6 millimetres in diameter, with 76% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 62% falling within the angular categories. Hornblende was ubiquitous, both as individual grains and in rock fragments. Inclusions in this thin-section exhibited moderate sorting and a 50% overall density. No specific particle orientation was discerned.

2079-1b This sample was tempered with syenite fragments up to 4 millimetres in diameter, with 47% falling within the 1-2 millimetre range. Particle shape ranged from rounded to angular, with 63% falling within the angular categories. Hornblende and biotite formed the majority of the mafic minerals. Inclusions in this thin-section were well sorted and had a 40% overall density. No specific particle orientation was discerned.

1719-g This sample was tempered with peralkaline granite fragments up to 6 millimetres in diameter, with 67% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 52% falling within the rounded categories. Mafic minerals included mainly ortho- and clinopyroxenes and biotite. Some plagioclase grains exhibited minor metamorphism. Inclusions in this thin-section exhibited poor sorting and a 50% overall density. No specific particle orientation was discerned.

2074-1 This sample was tempered with alkali feldspar granite fragments up to 4 millimetres in diameter, with 67% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 56% falling within the angular categories. Inclusions in this thin-section exhibited poor sorting and a 40% overall density. No specific particle orientation was discerned. This fabric is similar to that of 1525-3.

1525-3 This sample was tempered with alkali feldspar granite fragments up to 4 millimetres in diameter, with 70% falling within the 0.5-1.0 millimetre range. Particle shape ranged from well-rounded to angular, with 58% falling within the angular categories. Inclusions in this thin-section were poorly sorted and had a 40% overall density. No specific particle orientation was discerned. This fabric is similar to that of 2074-1.

2405-2 This sample was tempered with alkali feldspar granite fragments up to 4 millimetres in diameter, with 78% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 63% falling within the angular categories. The presence of rutile in quartz and significant alteration in feldspars may suggest that the parent material had undergone prolonged weathering. Inclusions in this thin-section were well-sorted and had a 50% overall density. No specific particle orientation was discerned.

1039 This sample was tempered with alkali feldspar granite fragments up to 4 millimetres in diameter, with 50% falling within the 1-2 millimetre range. Particle shape ranged from rounded to very angular, with 65% falling within the angular categories. Elongated or ovoid clay lenses with higher inclusion densities were frequently visible in this thin-section indicating that unlike the rest of the sample, this clay was poorly mixed during manufacture. In addition, voids appear relatively less frequently, and often do not run parallel to the sherd surface. Overall, inclusions in this thin-section exhibited moderate sorting and a 40% density. No specific particle orientation was discerned.

3679-1 This sample was tempered with alkali feldspar granite fragments up to 4 millimetres in diameter, with 54% falling within the 0.5-1.0 millimetre range. Particle shape ranged from well-rounded to sub-angular, with 72% falling within the rounded categories. Biotite was fairly common and constitutes the sole mafic mineral. Inclusions in this thin-section were poorly sorted and had a 35% overall density. No specific particle orientation was discerned.

2395-1-C This sample was tempered with hornblende granite fragments up to 4 millimetres in diameter, with 74% falling within the 0.5-1.0 millimetre range. Particle shape ranged from well-rounded to very angular, with 51% falling within the rounded categories. Mafic minerals consisted entirely of hornblende, which was very common. Inclusions in this thin-section were poorly-sorted and had a 45% overall density. No specific particle orientation was discerned.

1752-7 This sample was tempered with biotite granite fragments up to 4 millimetres in diameter, with 62% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to very angular, with 75% falling within the angular categories. Biotite was fairly common and constitutes the sole mafic mineral. Inclusions in this thin-section were well sorted and had a 40% overall density. No specific particle orientation was discerned.

1277-12 This sample was tempered with granite fragments up to 6 millimetres in diameter, with 62% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to sub-angular, with 52% falling within the angular categories. Some naturally occurring sandstone fragments were also found. Inclusions in this thin-section were moderately sorted and had a 20% overall density. No specific particle orientation was discerned.

1250F This sample was tempered with what appears to be granite fragments up to 4 millimetres in diameter, with 43% falling within the 1-2 millimetre range. Due to the small number of temper particles present, this identification must be regarded as tentative. Particle shape ranged from well-rounded to very angular, with 80% falling within the angular categories. Heavy alteration was apparent in both alkali and plagioclase feldspars. Inclusions in this thin-section were moderately sorted and had a 20% overall density. No specific particle orientation was discerned.

2030-10-E This sample was tempered with shell fragments up to 4 millimetres in diameter, with 69% falling within the 0.5-1.0 millimetre range. Due to the laminated texture of these fragments, particle shape could not be assessed but sphericity was very low. Inclusions in this thin-section exhibited poor sorting and a 45% overall density. Shell particles were oriented roughly parallel to the sherd surfaces. This fabric resembles that of 1687-Ab.

1687-9b This sample was tempered with shell fragments up to 4 millimetres in diameter, with 75% falling within the 0.5-1.0 millimetre range. Due to the laminated texture of these fragments, particle shape could not be assessed but sphericity was very low. Inclusions in this thin-section exhibited poor sorting and a 50% overall density. Shell particles were oriented roughly parallel to the sherd surfaces. This fabric resembles that of 2030-10-E.

1285-9b This sample was tempered with quartz monzonite fragments up to 4 millimetres in diameter, with 58% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 56% falling within the rounded categories. The majority of mafic minerals were hornblendes and clinopyroxenes, including augite. Inclusions in this thin-section exhibited poor sorting and a 30% overall density. No specific particle orientation was discerned. This fabric resembles that of 2525A.

2525A This sample was tempered with quartz monzonite fragments up to 4 millimetres in diameter, with 50% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 55% falling within the angular categories. Mafic minerals included hornblende, augite, and biotite. Inclusions in this thin-section were poorly-sorted and had a 40% overall density. No specific particle orientation was discerned. This fabric resembles that of 1285Ab.

1711-5 This sample was tempered with monzodiorite (80%) and granite (20%) fragments up to 4 millimetres in diameter, with 65% falling within the 0.5-1.0 millimetre range. Particle shape ranged from rounded to angular, with 62% falling within the angular categories. Mafic minerals consisted primarily of augite in the monzodiorite fragments, and muscovite in the granite fragments. Inclusions in this thin-section were moderately sorted and had a 25% overall density. No specific particle orientation was discerned.

2030-12 This sample was tempered with granodiorite (70%) and quartz syenite (30%) fragments up to 4 millimetres in diameter, with 53% falling within the 0.5-1.0 millimetre range. Particle shape ranged from well-rounded to very angular, with 55% falling within the angular categories. Mafic minerals consisted primarily of biotite. Inclusions in this thin-section were moderately sorted and had a 30% overall density. No specific particle orientation was discerned.

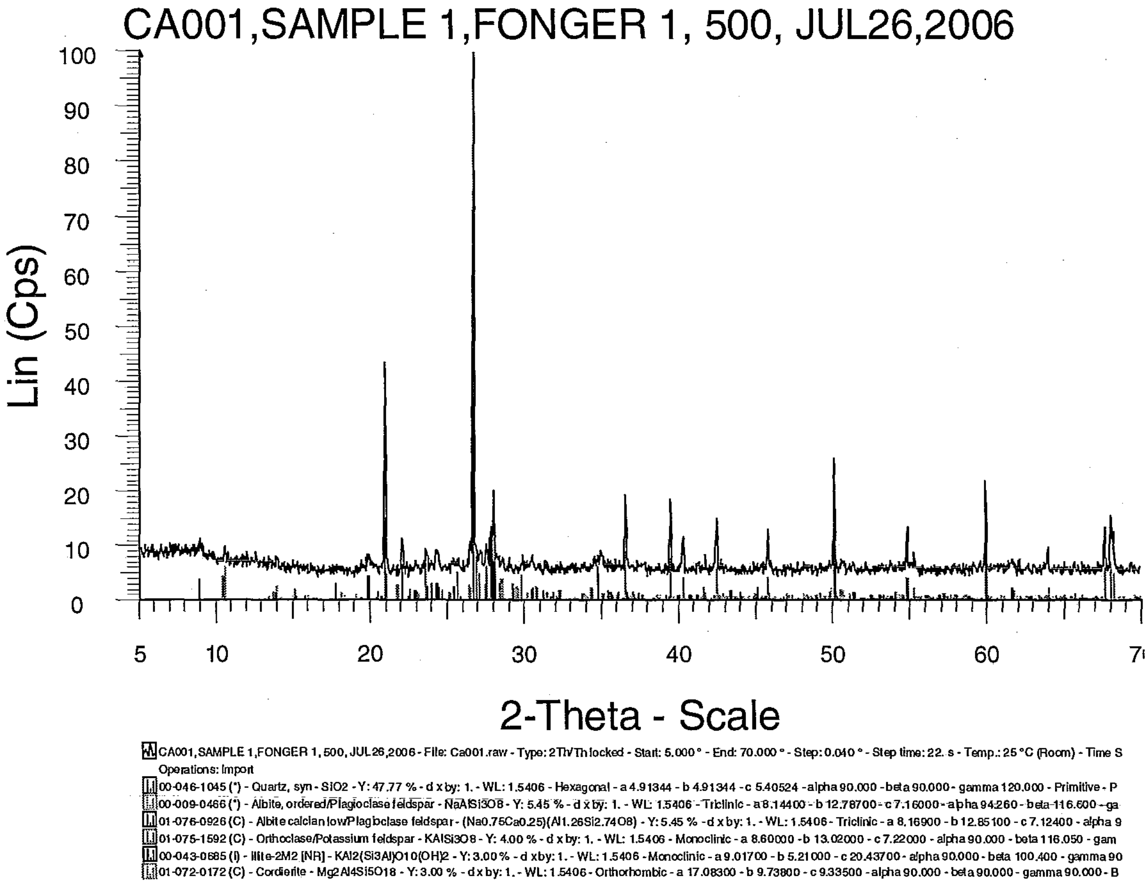
References

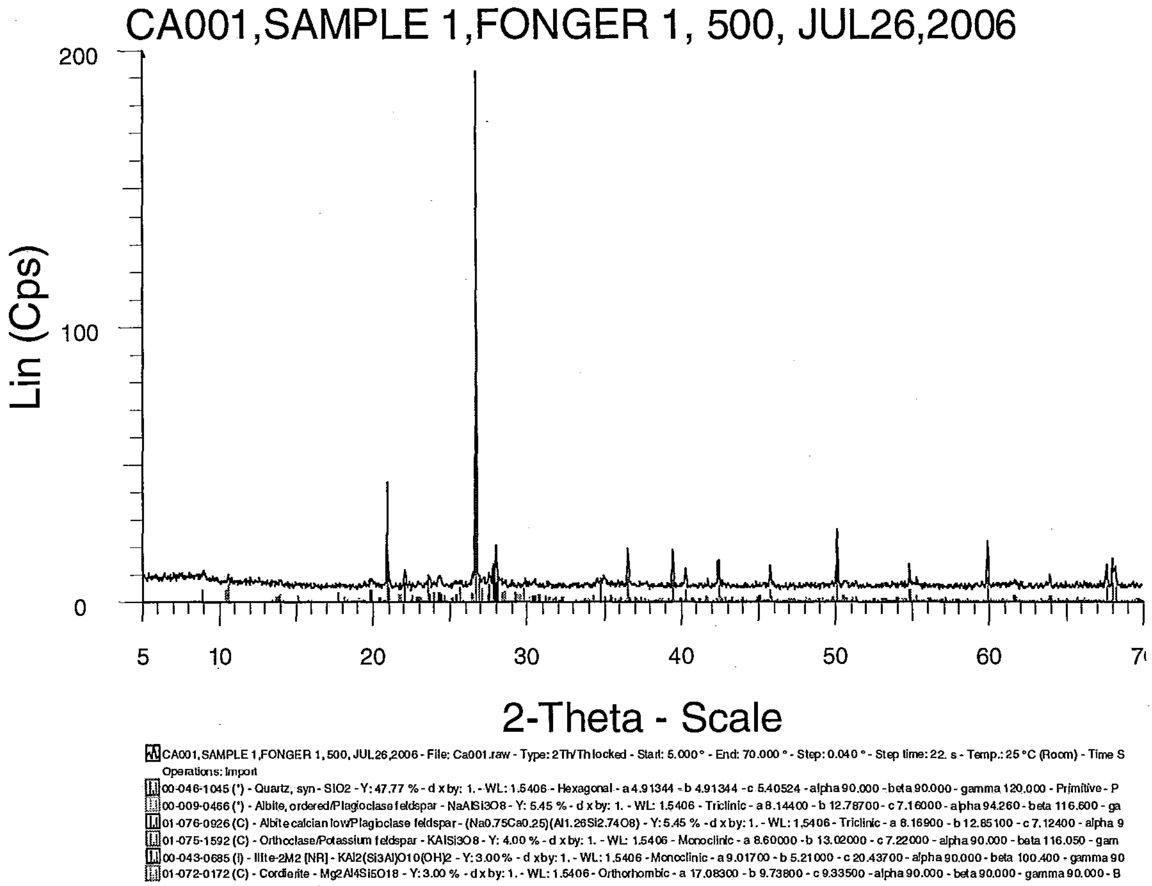
Le Maitre, R.W. (ed)
2002 *Igneous Rocks: a Classification and Glossary of Terms, 2nd Edition.* Cambridge University: Cambridge.

PCRG (Prehistoric Ceramics Research Group)
1997 *The Study of Later Prehistoric Pottery: General Policies and Guidelines for Analysis and Publication, Revised Edition.* Occasional Papers Nos. 1 and 2.

Appendix 5: X-Ray Diffraction Charts

Provided by Wen-He Gong from the McMaster University X-Ray Diffraction Facility at the Brockhouse Institute for Materials Research.




CA001,SAMPLE 1,FONGER 1, 500, JUL26,2006
200
100
0
Lin (Cps)
5
10
20
30
40
50
60
7
2-Theta - Scale
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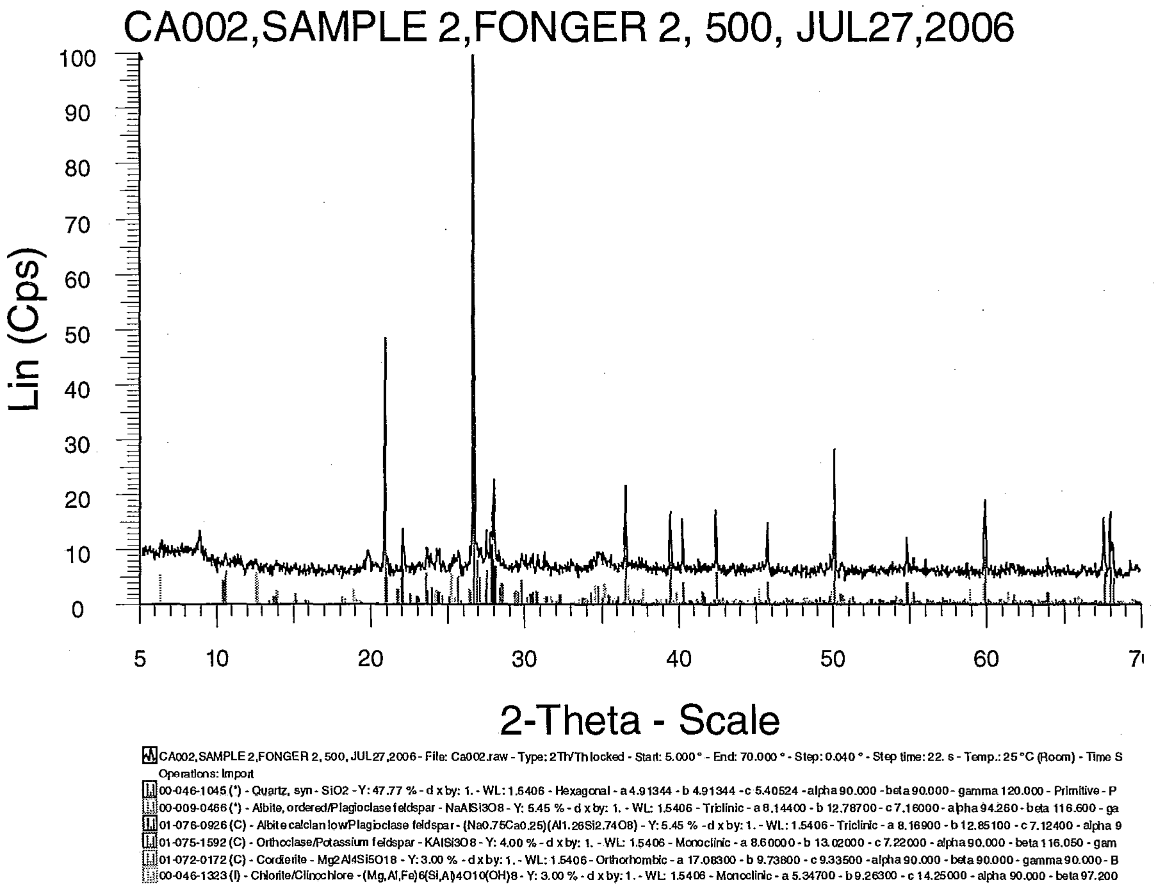
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 9.01700 - b 5.21000 - c 20.43700 - alpha 90.000 - beta 100.400 - gamma 90
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orthorhombic - a 17.08300 - b 9.73800 - c 9.33500 - alpha 90.000 - beta 90.000 - gamma 90.000 - B


CA002,SAMPLE 2,FONGER 2, 500, JUL27,2006
Lin (Cps)
100
90
80
70
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50
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30
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10
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5
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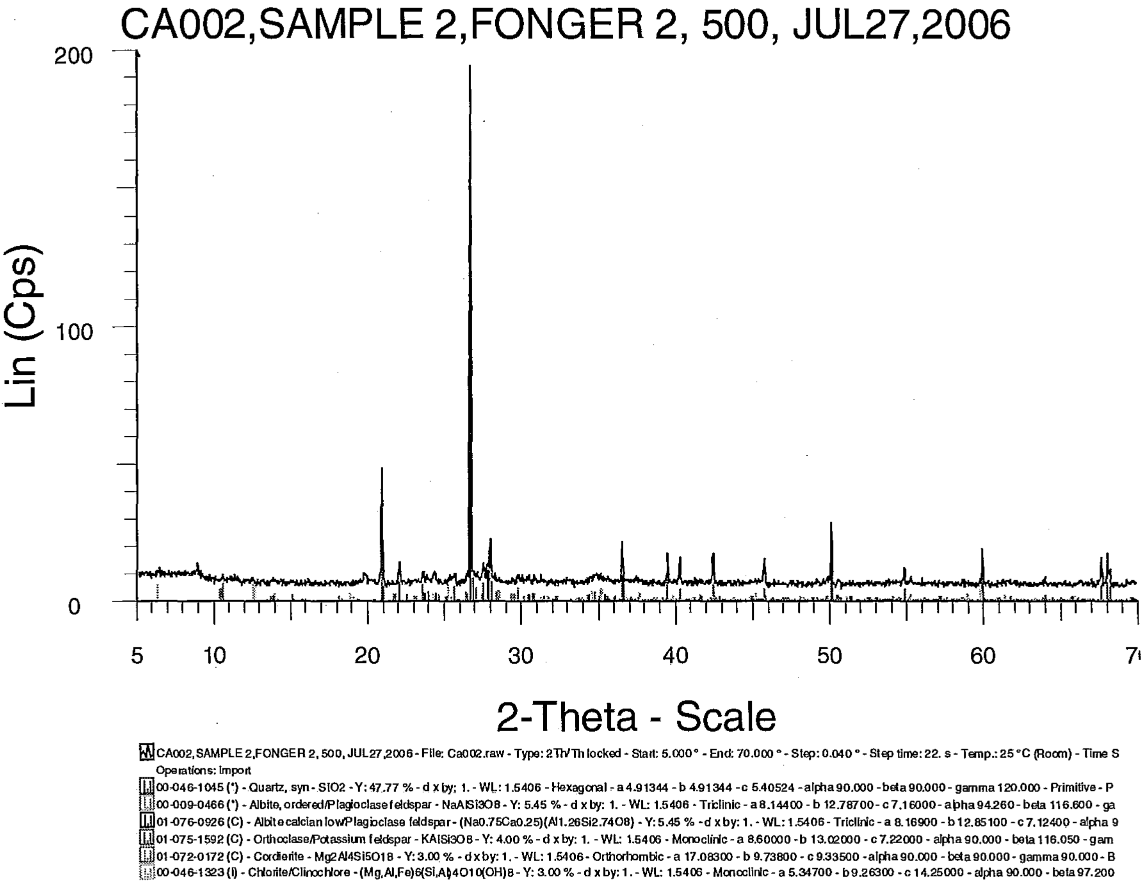
20
30
40
50
60
7
2-Theta - Scale
CA002,SAMPLE 2,FONGER 2, 500, JUL27,2006 - File: Ca002.raw - Type: 2Th/Th locked - Start: 5.000 ° - End: 70.000 ° - Step: 0.040 ° - Step time: 22. s - Temp.: 25 °C (Room) - Time S
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orthorhombic - a 17.08300 - b 9.73800 - c 9.33500 - alpha 90.000 - beta 90.000 - gamma 90.000 - B
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 5.34700 - b 9.26300 - c 14.25000 - alpha 90.000 - beta 97.200


CA002,SAMPLE 2,FONGER 2, 500, JUL27,2006
Lin (Cps)
200
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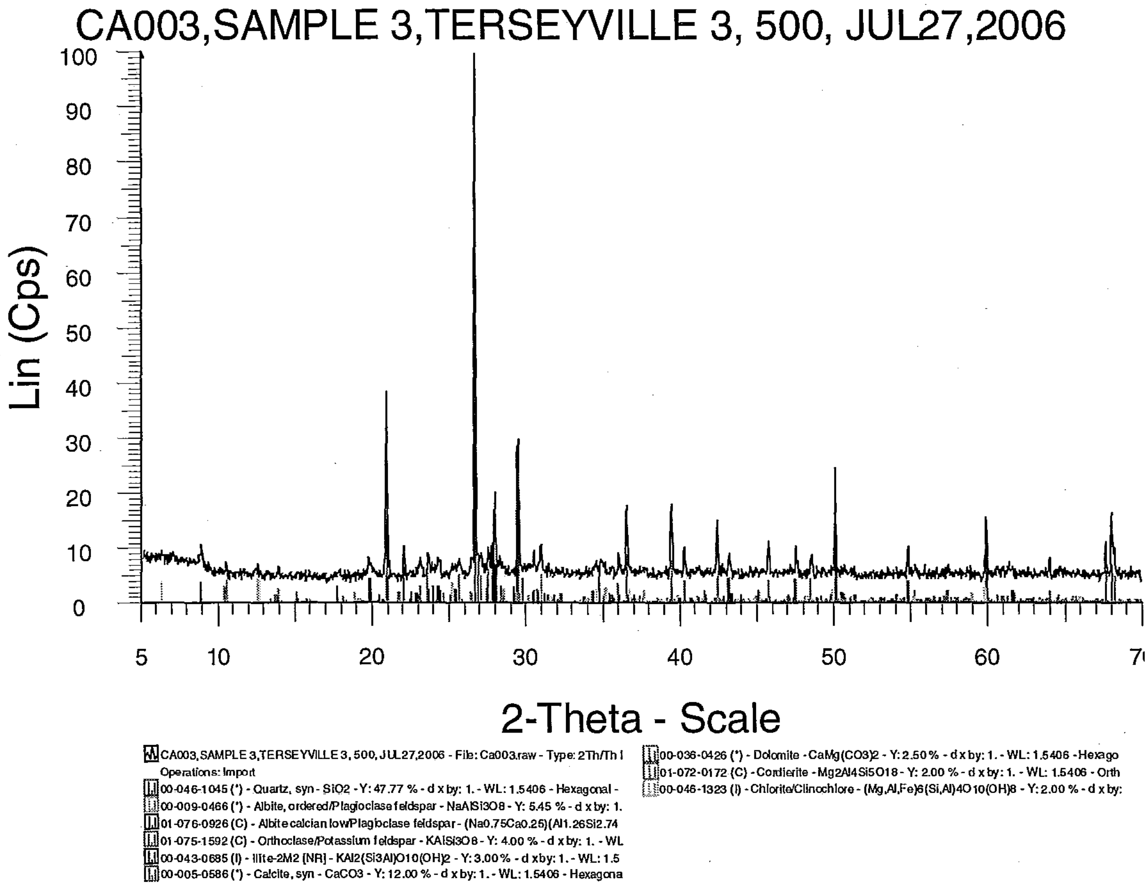
2-Theta - Scale
CA002,SAMPLE 2,FONGER 2, 500, JUL27,2006 - File: Ca002.raw - Type: 2Th/Th locked - Start: 5.000 ° - End: 70.000 ° - Step: 0.040 ° - Step time: 22. s - Temp.: 25 °C (Room) - Time S
Operations: Import
00-046-1045 (*) - Quartz, syn - SIO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orthorhombic - a 17.08300 - b 9.73800 - c 9.33500 - alpha 90.000 - beta 90.000 - gamma 90.000 - B
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 5.34700 - b 9.26300 - c 14.25000 - alpha 90.000 - beta 97.200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Lin (Cps)
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60
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2-Theta - Scale
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Operations: Import
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00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
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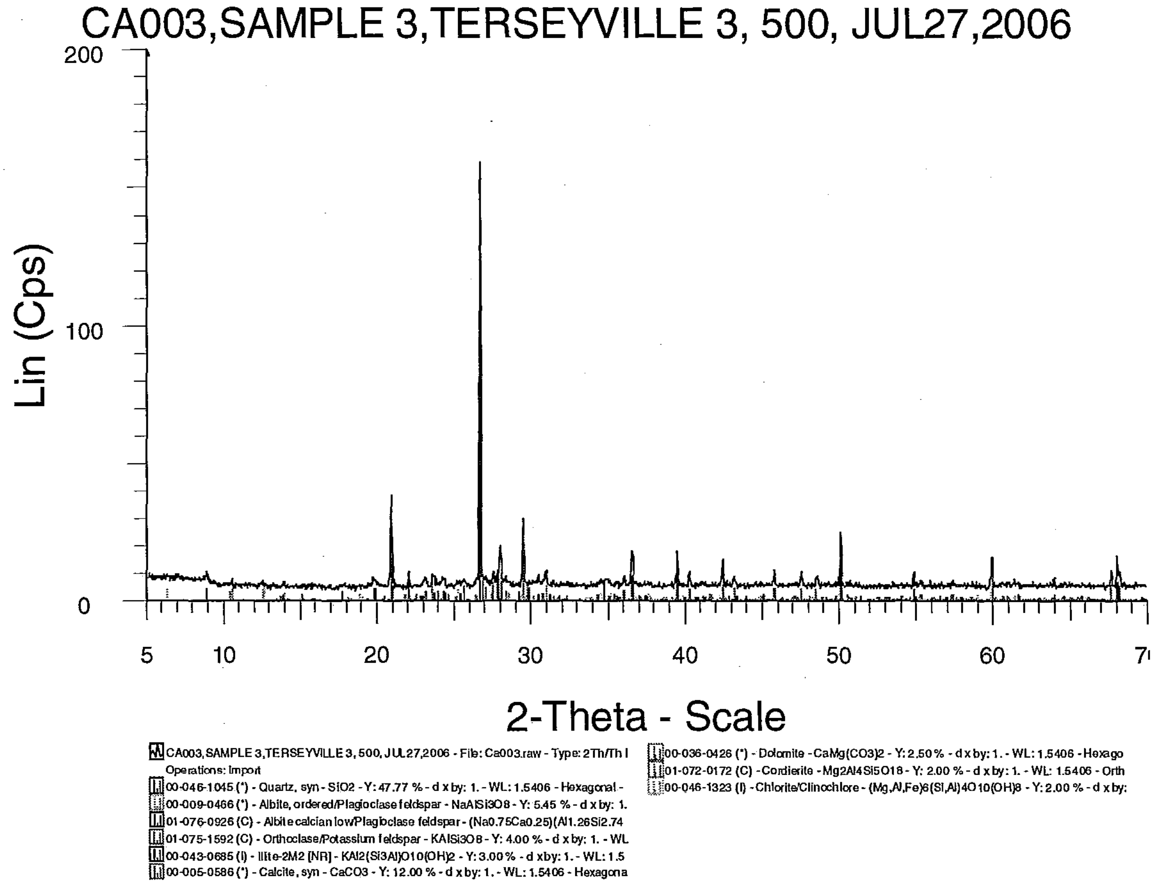
CA003,SAMPLE 3,TERSEYVILLE 3, 500, JUL27,2006
Lin (Cps)
200
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2-Theta - Scale
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Operations: Import
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01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
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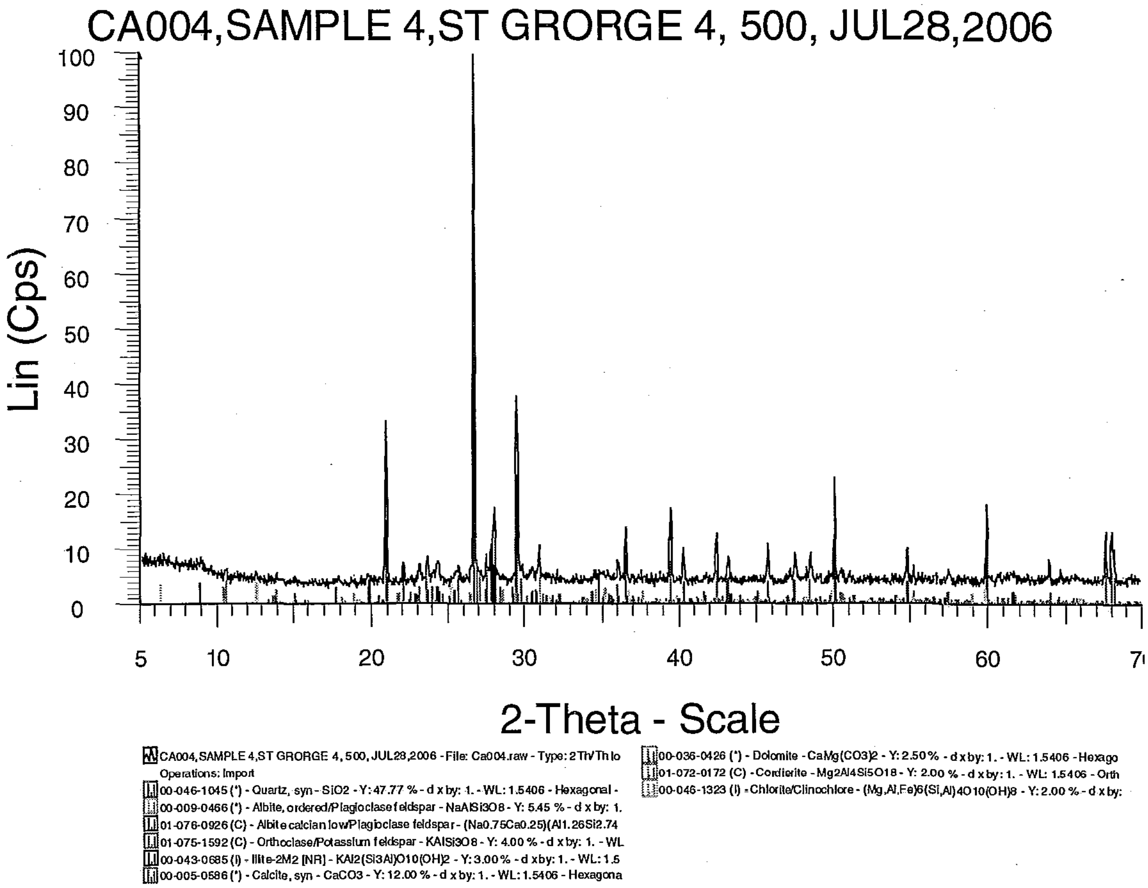
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Lin (Cps)
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2-Theta - Scale
CA004,SAMPLE 4,ST GRORGE 4, 500, JUL28,2006 - File: Ca004.raw - Type: 2Th/Th lo
Operations: Import
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00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
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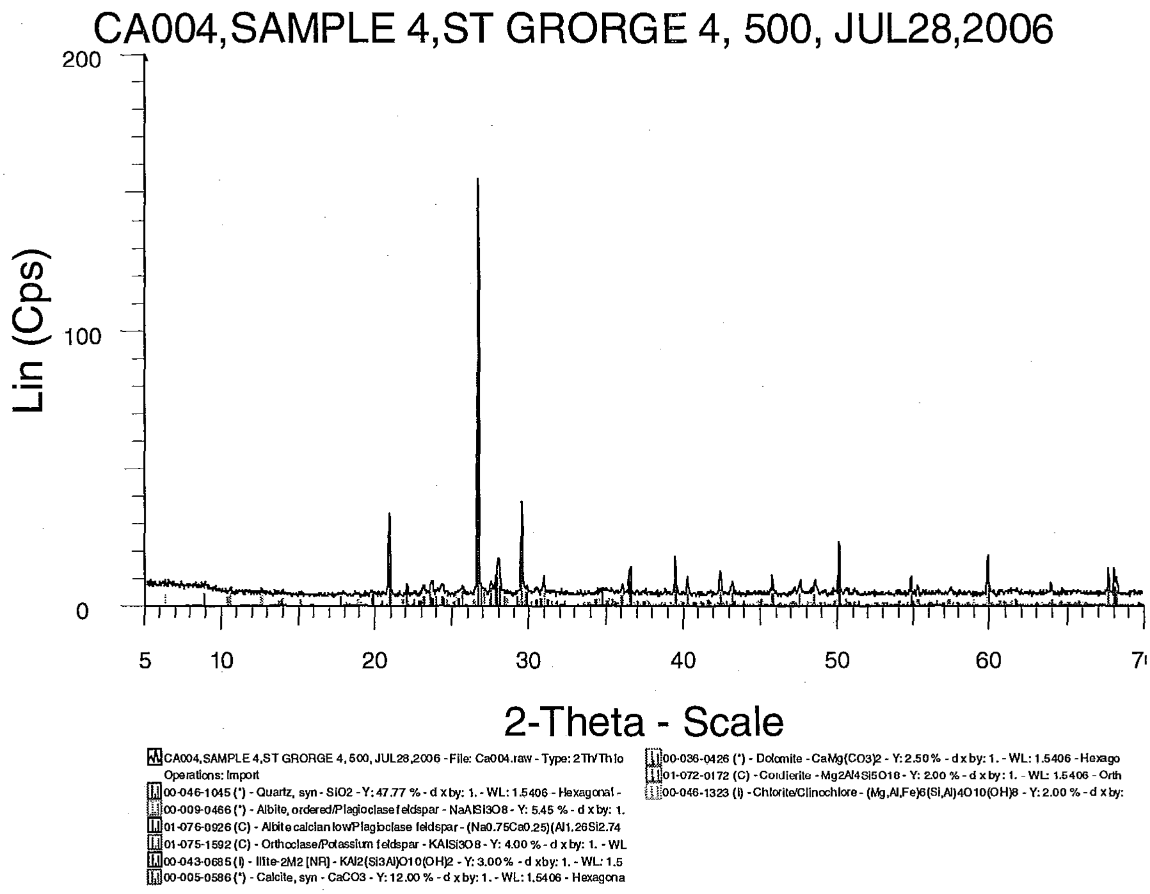
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7
2-Theta - Scale
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00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
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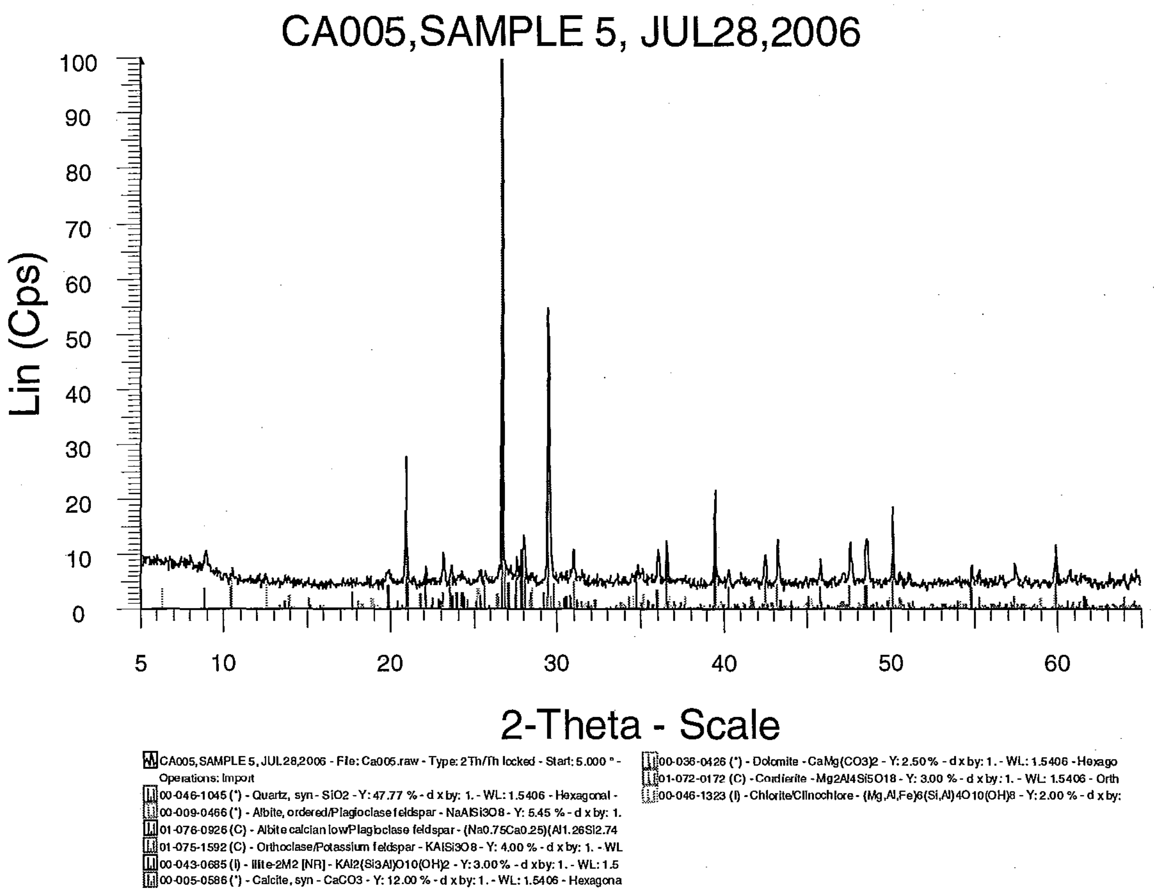
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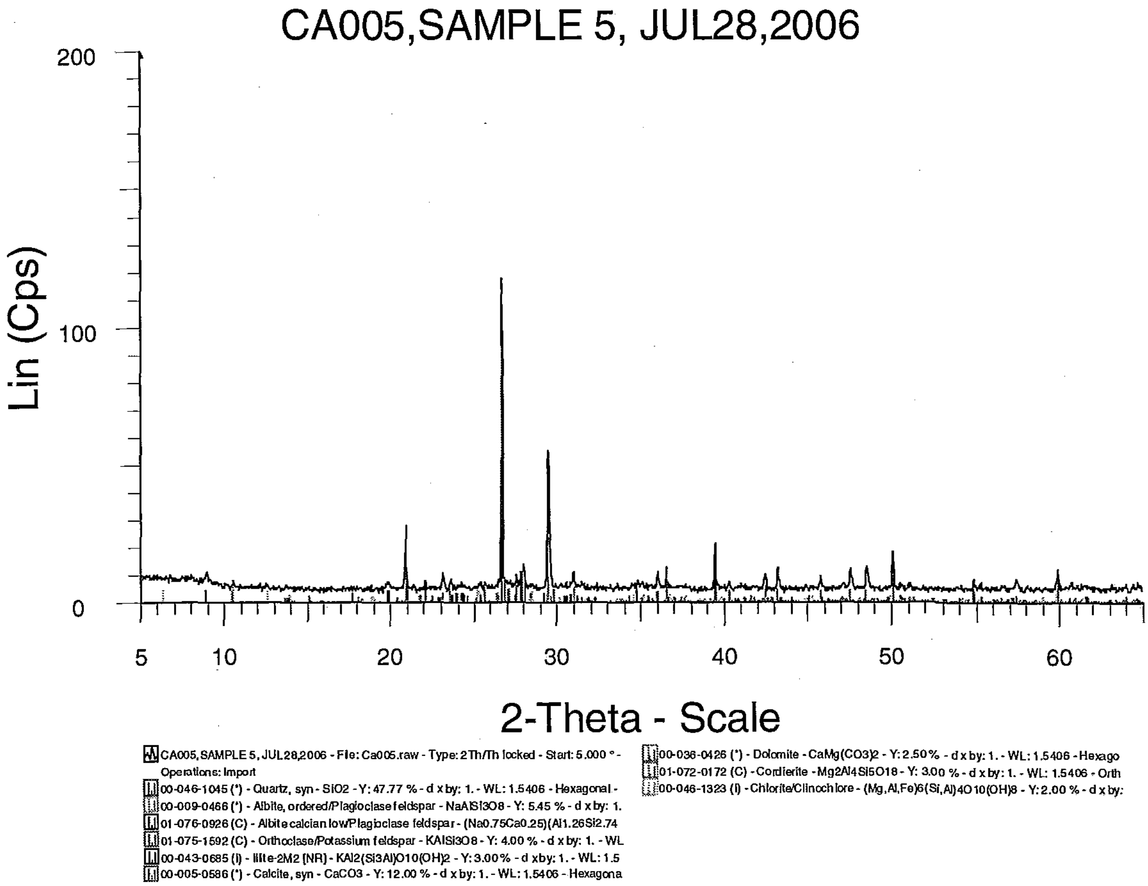
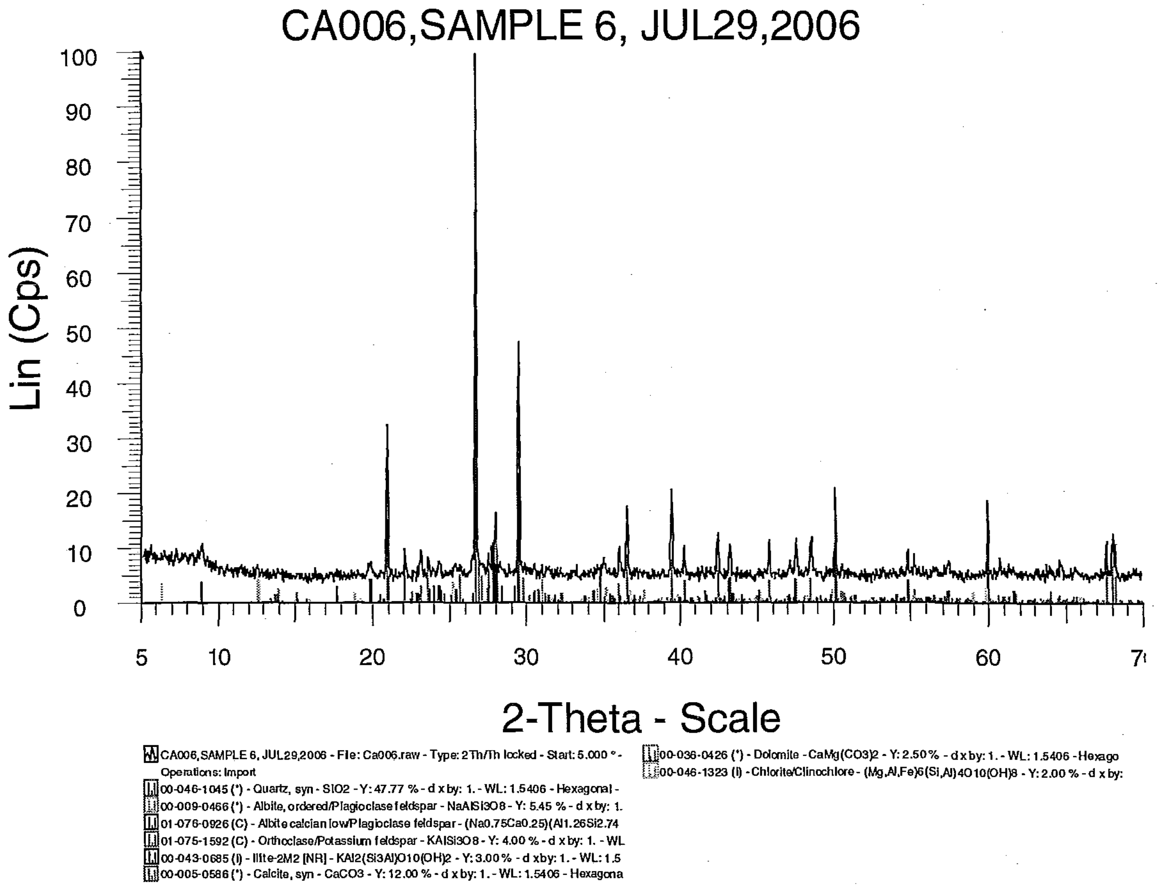
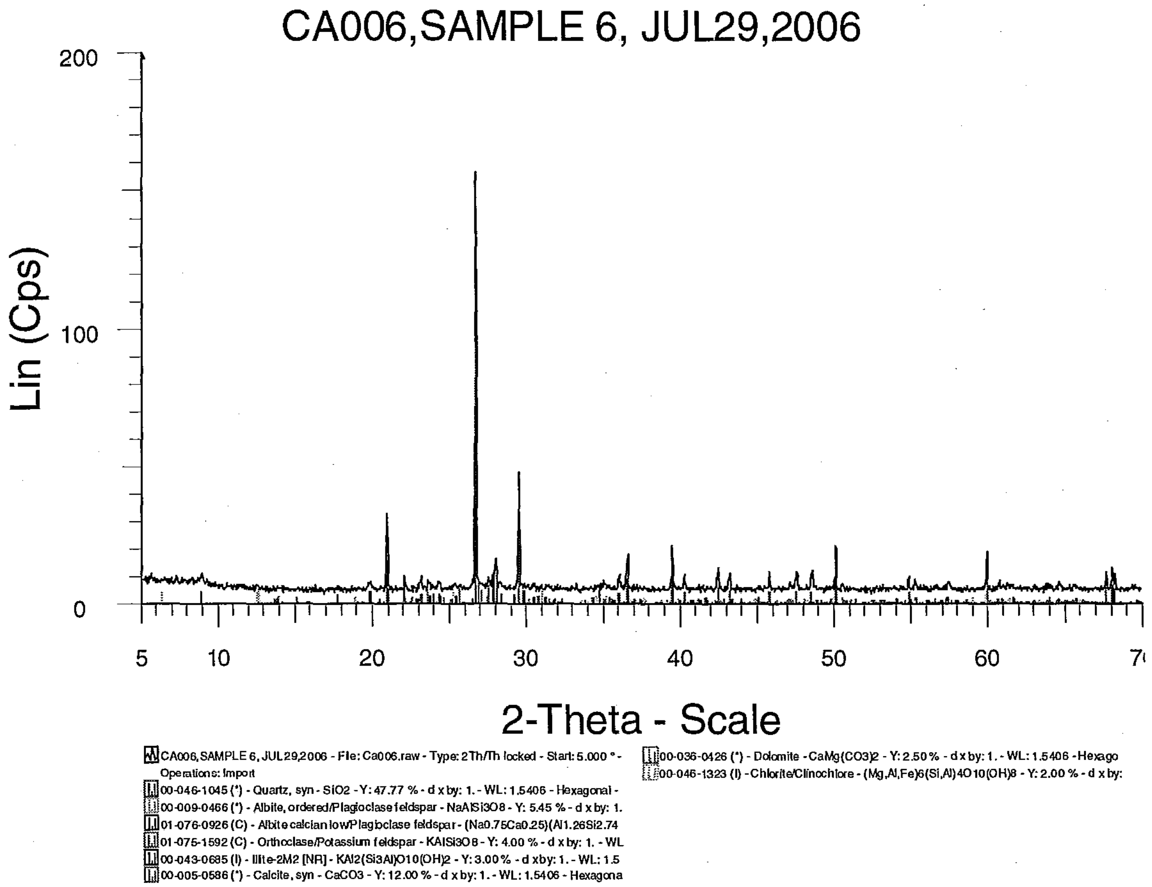
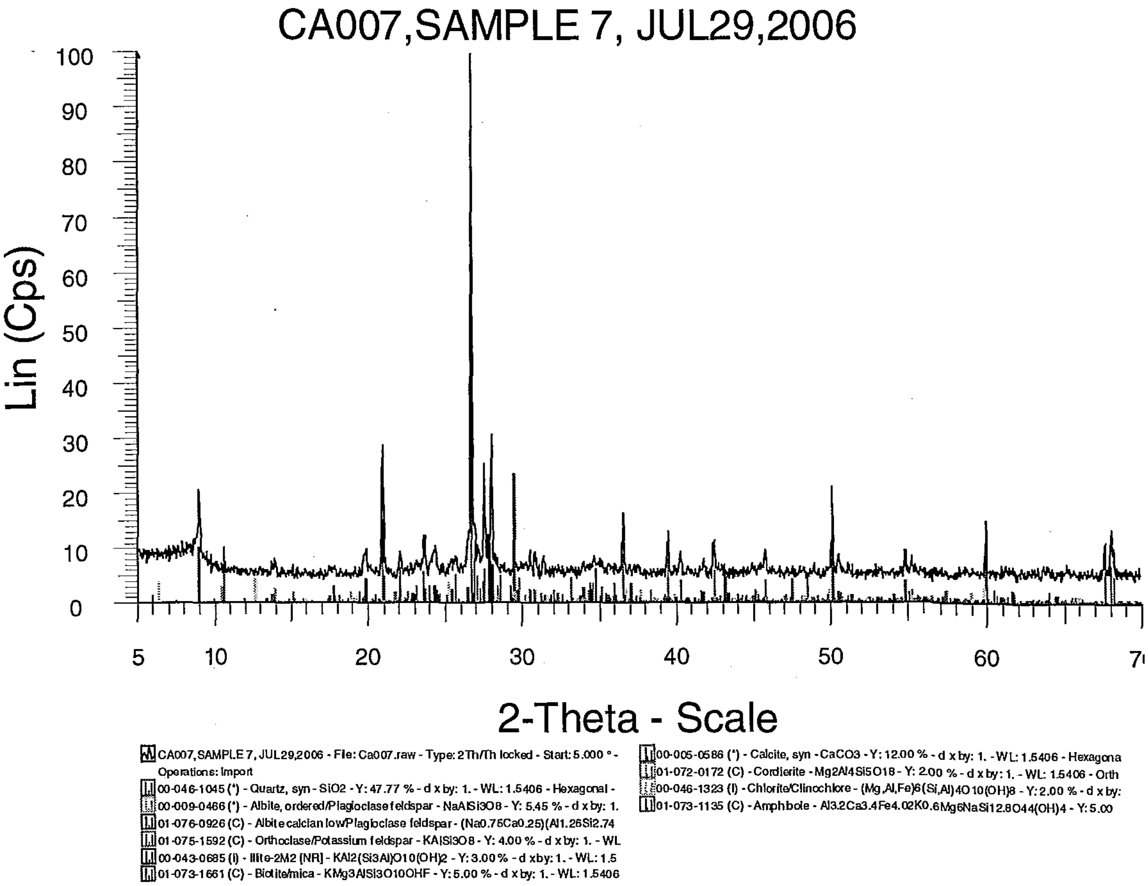
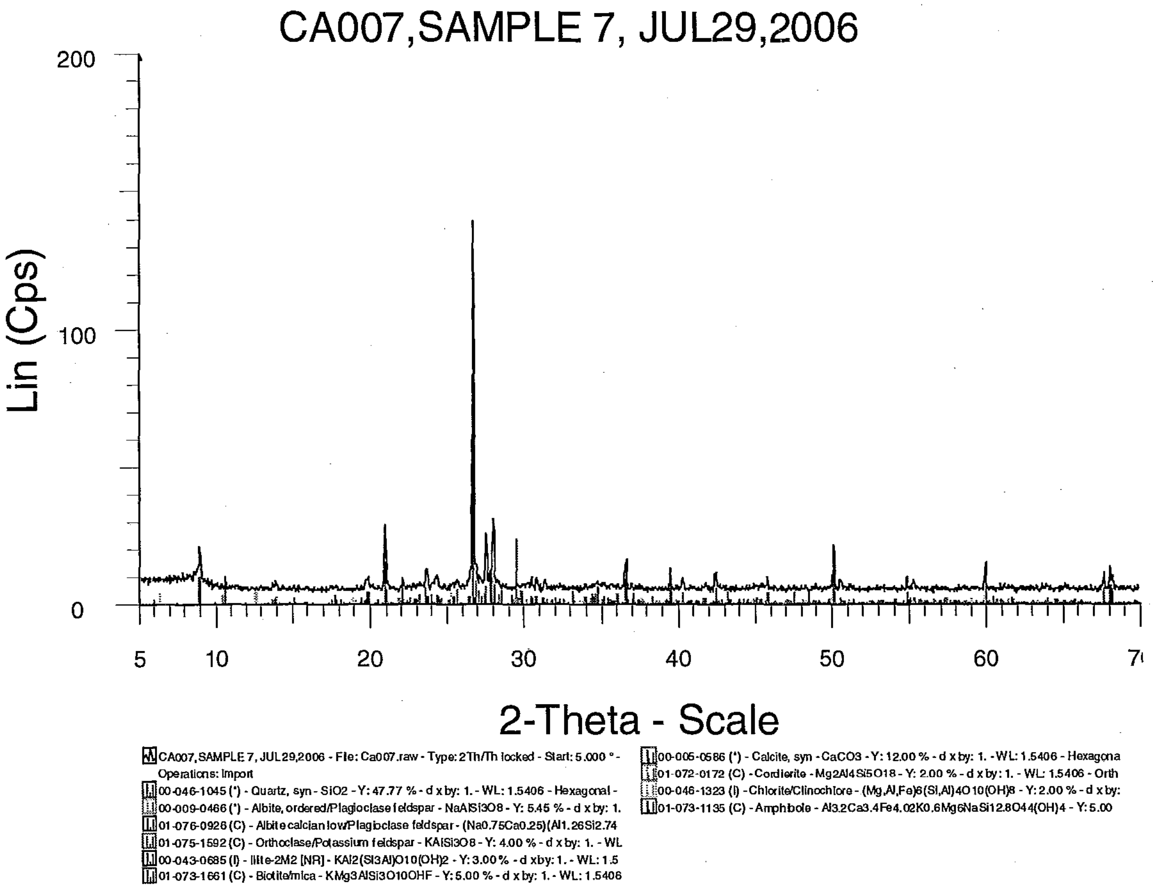
40
50
60
2-Theta - Scale
CA005,SAMPLE 5, JUL28,2006 - File: Ca005.raw - Type: 2Th/Th locked - Start: 5.000 ° -
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orth
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:

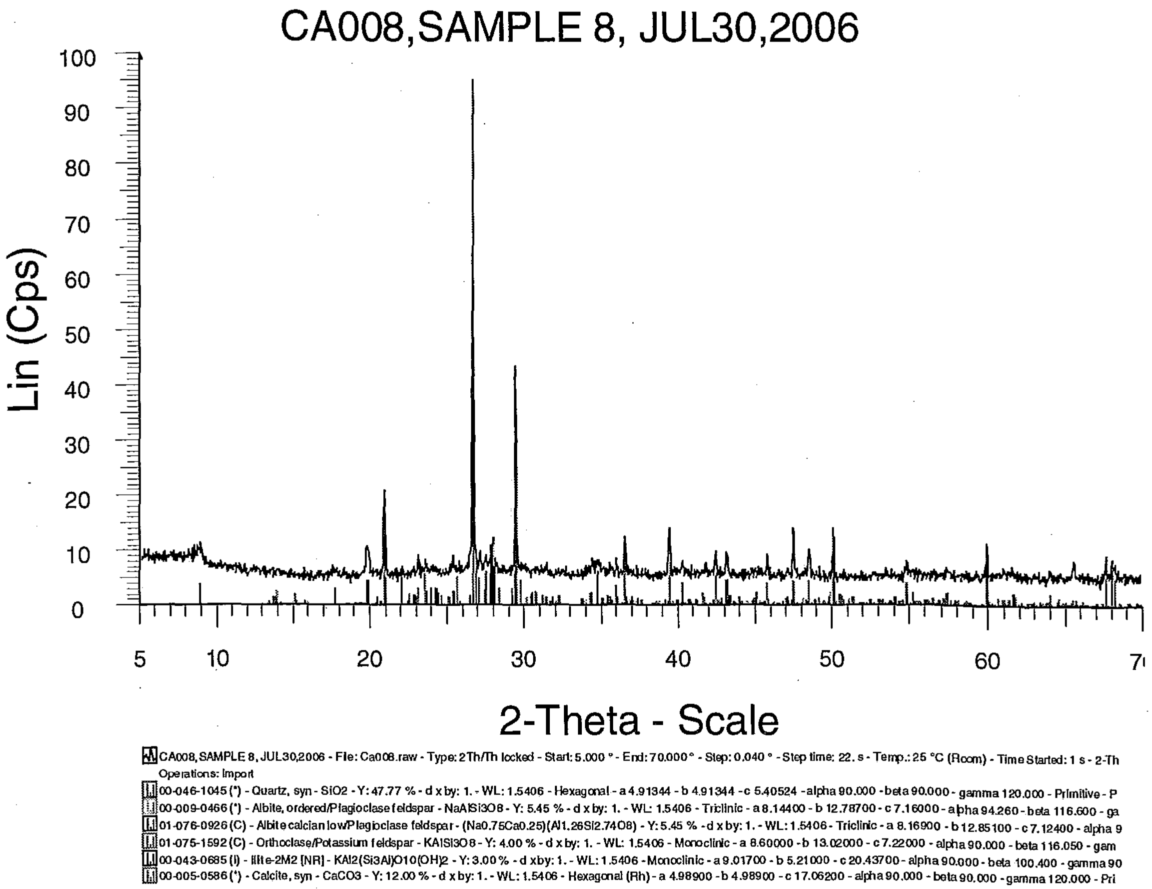

CA005,SAMPLE 5, JUL28,2006
Lin (Cps)
200
100
0
5
10
20
30
40
50
60
2-Theta - Scale
CA005, SAMPLE 5, JUL28,2006 - File: Ca005.raw - Type: 2Th/Th locked - Start: 5.000 ° - Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orth
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:

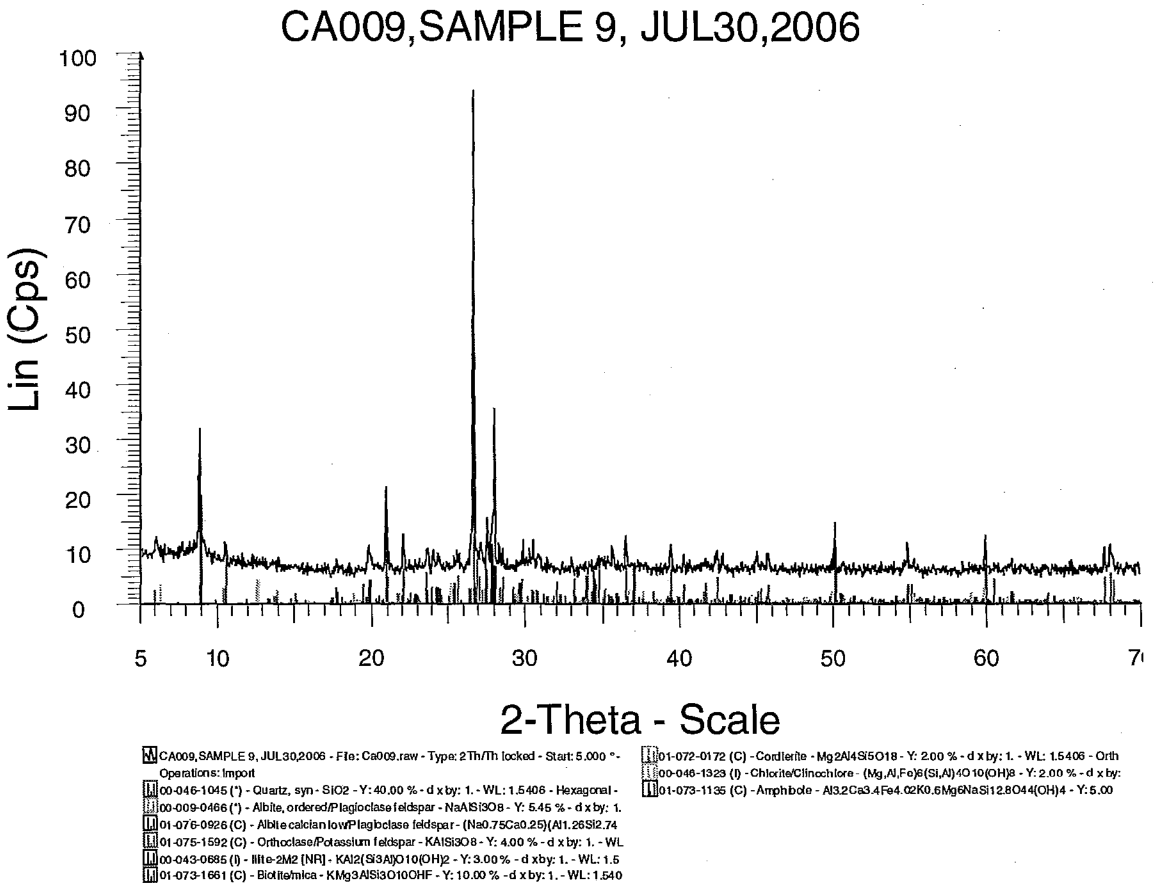

CA006,SAMPLE 6, JUL29,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA006,SAMPLE 6, JUL29,2006 - File: Ca006.raw - Type: 2Th/Th locked - Start: 5.000 ° -
Operations: Import
00-046-1045 (*) - Quartz, syn - SIO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:

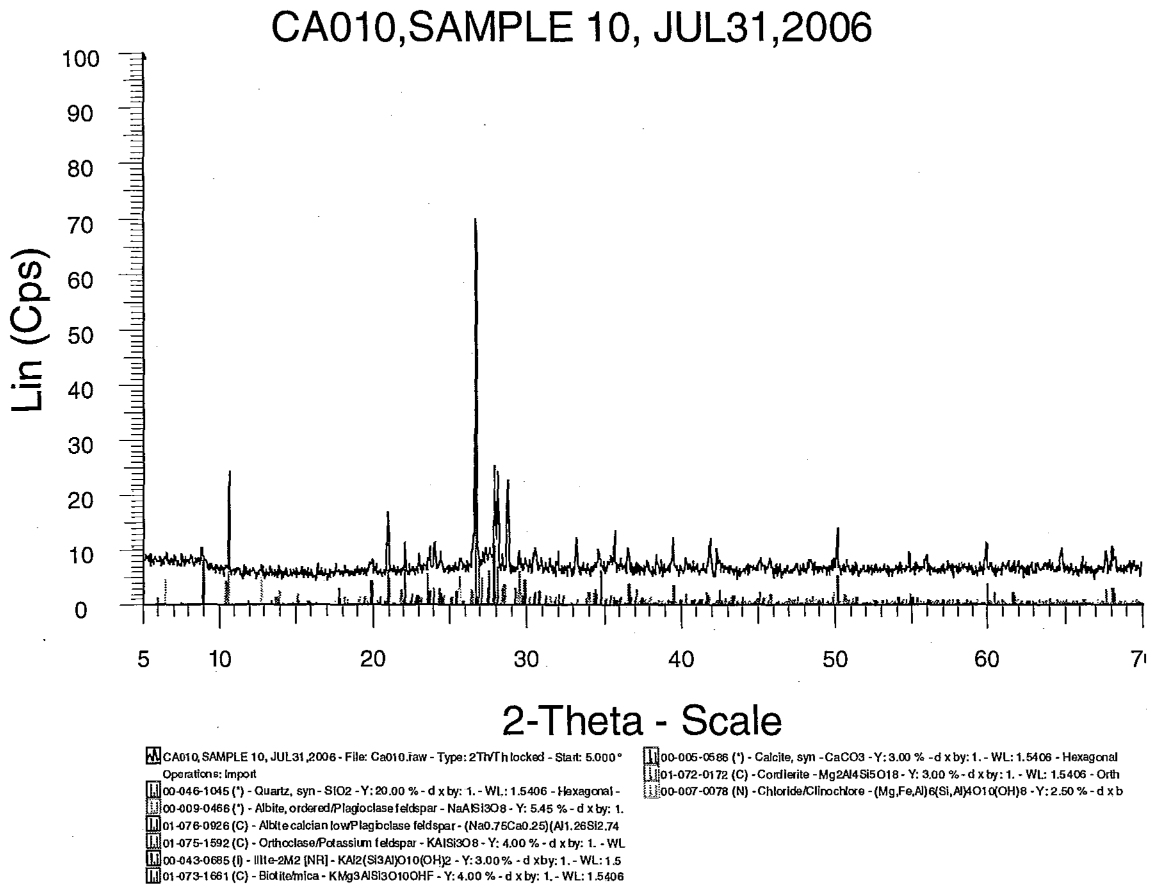

CA006,SAMPLE 6, JUL29,2006
Lin (Cps)
200
100
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA006,SAMPLE 6, JUL29,2006 - File: Ca006.raw - Type: 2Th/Th locked - Start: 5.000 ° -
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:

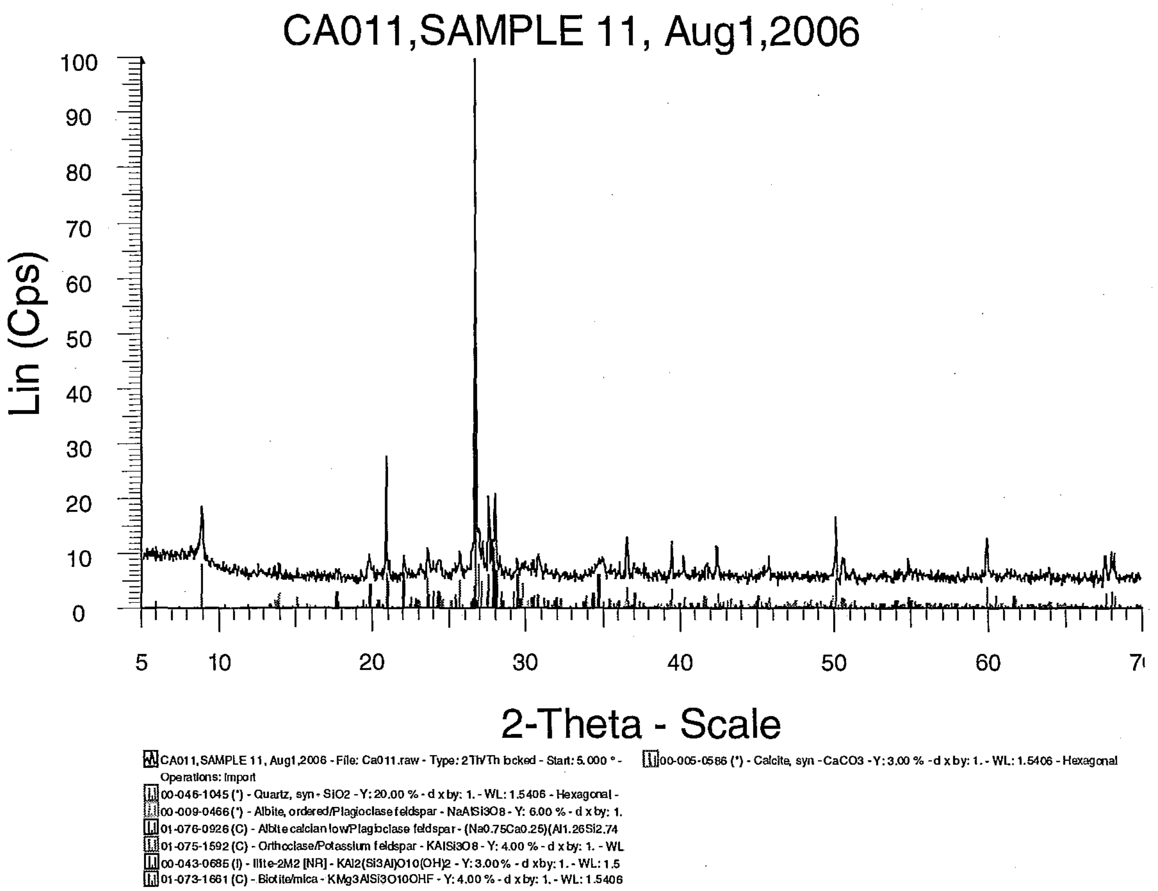

CA007,SAMPLE 7, JUL29,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA007,SAMPLE 7, JUL29,2006 - File: Ca007.raw - Type: 2Th/Th locked - Start: 5.000 ° - Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 5.00 % - d x by: 1. - WL: 1.5406
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:
01-073-1135 (C) - Amphibole - Al3.2Ca3.4Fe4.02K0.6Mg6NaSi12.8O44(OH)4 - Y: 5.00

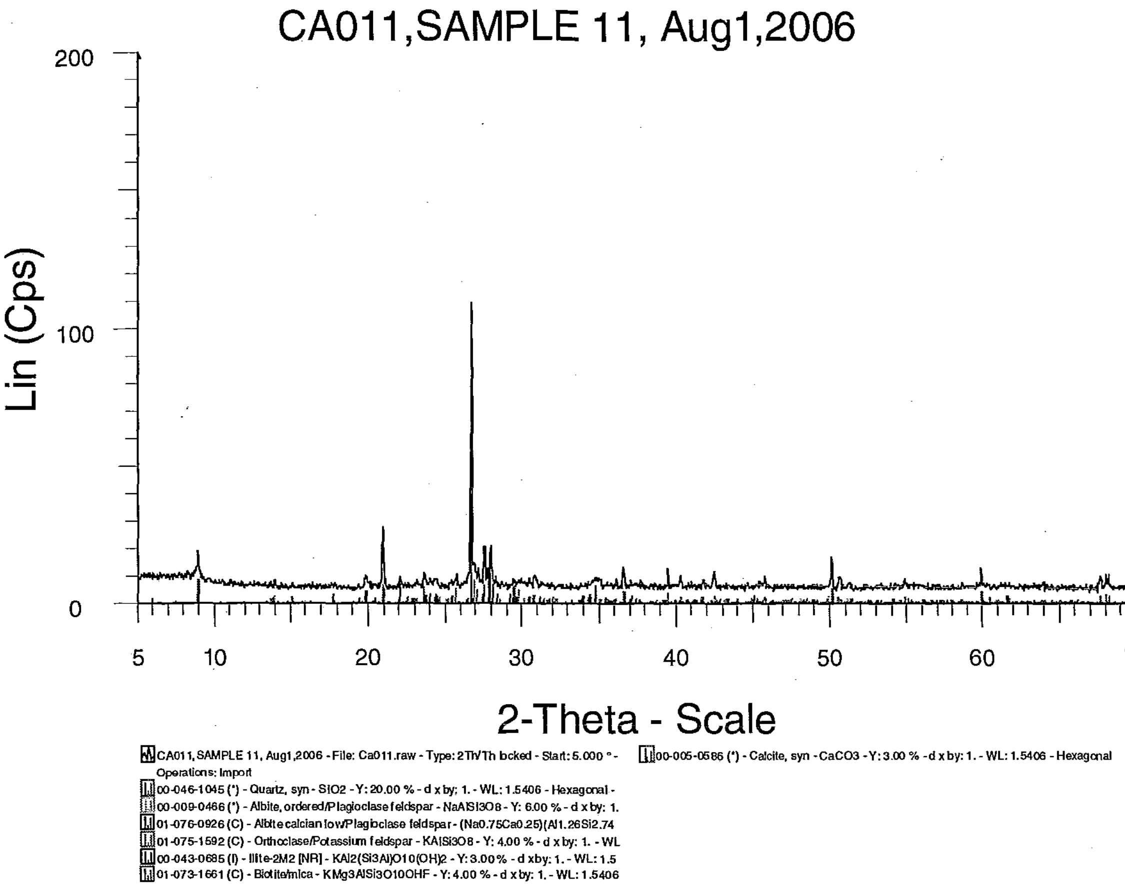

CA007,SAMPLE 7, JUL29,2006
Lin (Cps)
200
100
0
5
10
20
30
40
50
60
7(
2-Theta - Scale
CA007,SAMPLE 7, JUL29,2006 - File: Ca007.raw - Type: 2Th/Th locked - Start: 5.000 ° - Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 5.00 % - d x by: 1. - WL: 1.5406
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagona
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:
01-073-1135 (C) - Amphibole - Al3.2Ca3.4Fe4.02K0.6Mg6NaSi12.8O44(OH)4 - Y: 5.00

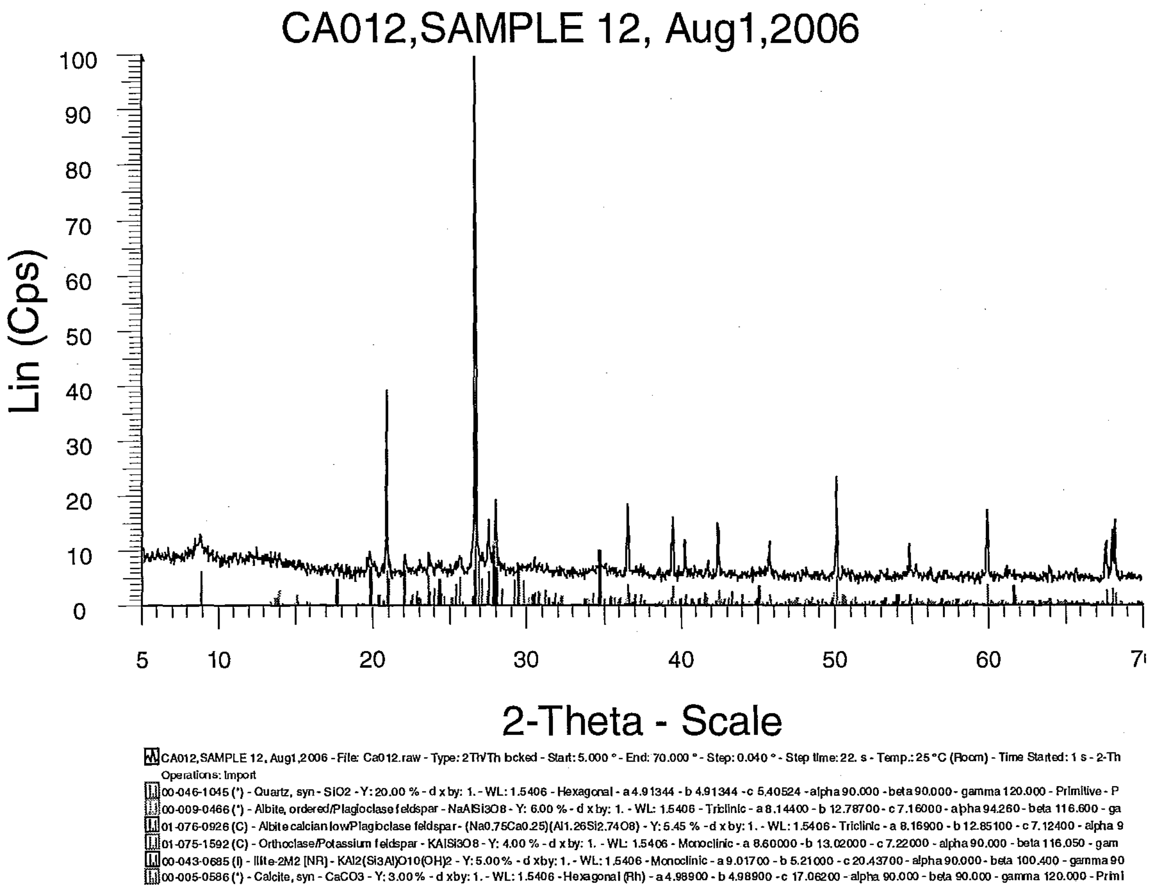

CA008,SAMPLE 8, JUL30,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
70
2-Theta - Scale
CA008,SAMPLE 8, JUL30,2006 - File: Ca008.raw - Type: 2Th/Th locked - Start: 5.000 ° - End: 70.000 ° - Step: 0.040 ° - Step time: 22. s - Temp.: 25 °C (Room) - Time Started: 1 s - 2-Th
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 47.77 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 9.01700 - b 5.21000 - c 20.43700 - alpha 90.000 - beta 100.400 - gamma 90
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 12.00 % - d x by: 1. - WL: 1.5406 - Hexagonal (Rh) - a 4.98900 - b 4.98900 - c 17.06200 - alpha 90.000 - beta 90.000 - gamma 120.000 - Pri

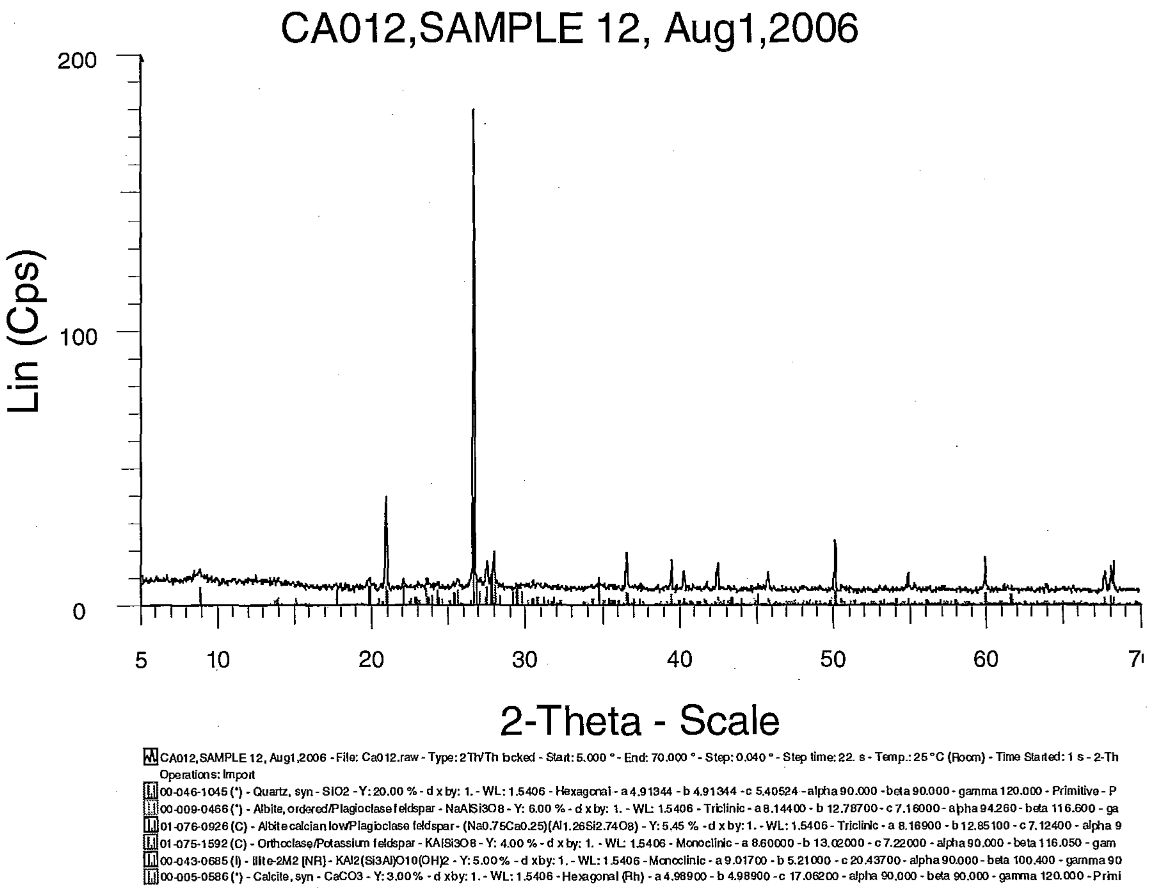

CA009,SAMPLE 9, JUL30,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA009,SAMPLE 9, JUL30,2006 - File: Ca009.raw - Type: 2Th/Th locked - Start: 5.000 ° - Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 40.00 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 10.00 % - d x by: 1. - WL: 1.540
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 2.00 % - d x by: 1. - WL: 1.5406 - Orth
00-046-1323 (I) - Chlorite/Clinochlore - (Mg,Al,Fe)6(Si,Al)4O10(OH)8 - Y: 2.00 % - d x by:
01-073-1135 (C) - Amphibole - Al3.2Ca3.4Fe4.02K0.6Mg6NaSi12.8O44(OH)4 - Y: 5.00

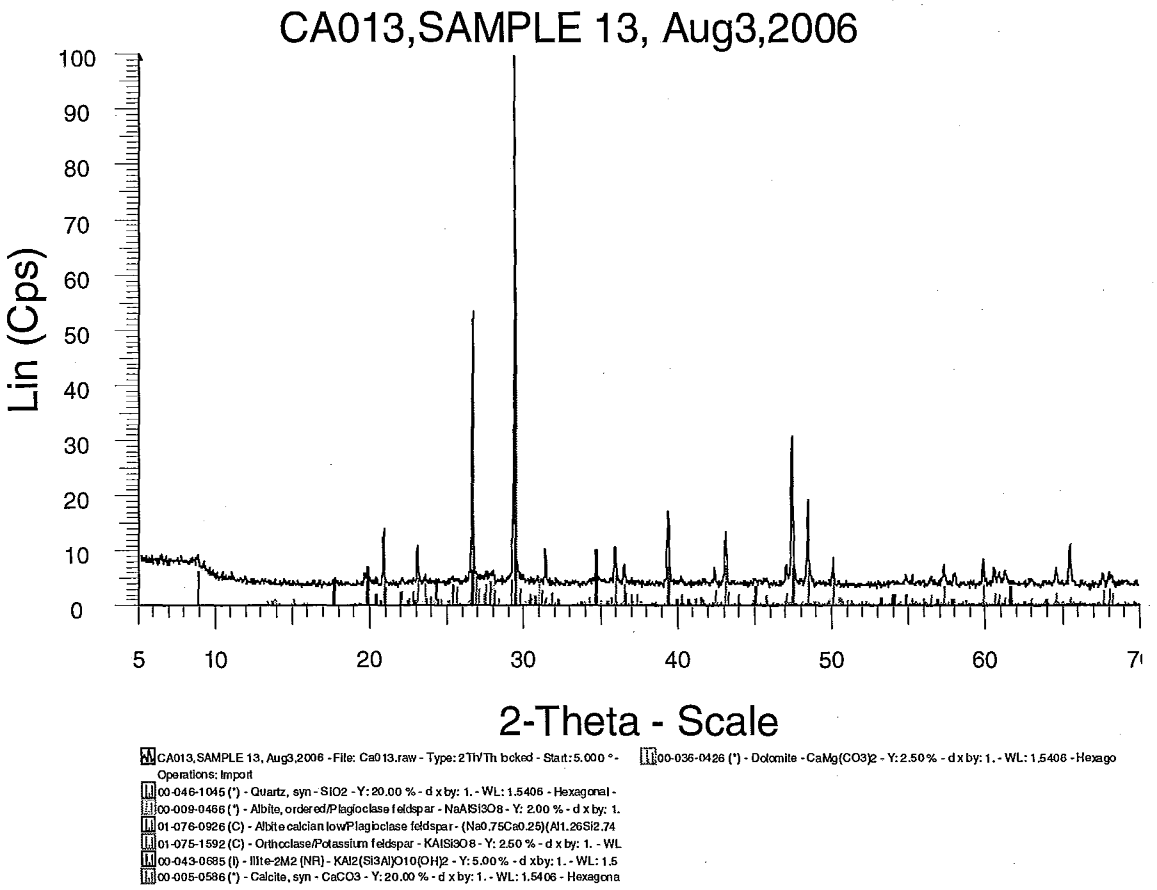

CA010,SAMPLE 10, JUL31,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA010, SAMPLE 10, JUL31,2006 - File: Ca010.raw - Type: 2Th/Th locked - Start: 5.000°
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 5.45 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d xby: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 4.00 % - d x by: 1. - WL: 1.5406
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Hexagonal
01-072-0172 (C) - Cordierite - Mg2Al4Si5O18 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Orth
00-007-0078 (N) - Chloride/Clinochlore - (Mg,Fe,Al)6(Si,Al)4O10(OH)8 - Y: 2.50 % - d x b


CA011,SAMPLE 11, Aug1,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA011,SAMPLE 11, Aug1,2006 - File: Ca011.raw - Type: 2Th/Th locked - Start: 5.000 ° -
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 6.00 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 4.00 % - d x by: 1. - WL: 1.5406
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Hexagonal


CA011,SAMPLE 11, Aug1,2006
Lin (Cps)
200
100
0
5
10
20
30
40
50
60
70
2-Theta - Scale
CA011,SAMPLE 11, Aug1,2006 - File: Ca011.raw - Type: 2Th/Th locked - Start: 5.000 ° -
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagonal -
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 6.00 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 3.00 % - d x by: 1. - WL: 1.5
01-073-1661 (C) - Biotite/mica - KMg3AlSi3O10OHF - Y: 4.00 % - d x by: 1. - WL: 1.5406
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Hexagonal


CA012,SAMPLE 12, Aug1,2006
Lin (Cps)
100
90
80
70
60
50
40
30
20
10
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA012,SAMPLE 12, Aug1,2006 - File: Ca012.raw - Type: 2Th/Th bcked - Start: 5.000 ° - End: 70.000 ° - Step: 0.040 ° - Step time: 22. s - Temp.: 25 °C (Room) - Time Started: 1 s - 2-Th
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 6.00 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 5.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 9.01700 - b 5.21000 - c 20.43700 - alpha 90.000 - beta 100.400 - gamma 90
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Hexagonal (Rh) - a 4.98900 - b 4.98900 - c 17.06200 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primi


CA012,SAMPLE 12, Aug1,2006
Lin (Cps)
200
100
0
5
10
20
30
40
50
60
7
2-Theta - Scale
CA012,SAMPLE 12, Aug1,2006 - File: Ca012.raw - Type: 2Th/Th bcked - Start: 5.000 ° - End: 70.000 ° - Step: 0.040 ° - Step time: 22. s - Temp.: 25 °C (Room) - Time Started: 1 s - 2-Th
Operations: Import
00-046-1045 (*) - Quartz, syn - SiO2 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagonal - a 4.91344 - b 4.91344 - c 5.40524 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primitive - P
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 6.00 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.14400 - b 12.78700 - c 7.16000 - alpha 94.260 - beta 116.600 - ga
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74O8) - Y: 5.45 % - d x by: 1. - WL: 1.5406 - Triclinic - a 8.16900 - b 12.85100 - c 7.12400 - alpha 9
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 4.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 8.60000 - b 13.02000 - c 7.22000 - alpha 90.000 - beta 116.050 - gam
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 5.00 % - d x by: 1. - WL: 1.5406 - Monoclinic - a 9.01700 - b 5.21000 - c 20.43700 - alpha 90.000 - beta 100.400 - gamma 90
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 3.00 % - d x by: 1. - WL: 1.5406 - Hexagonal (Rh) - a 4.98900 - b 4.98900 - c 17.06200 - alpha 90.000 - beta 90.000 - gamma 120.000 - Primi


CA013,SAMPLE 13, Aug3,2006
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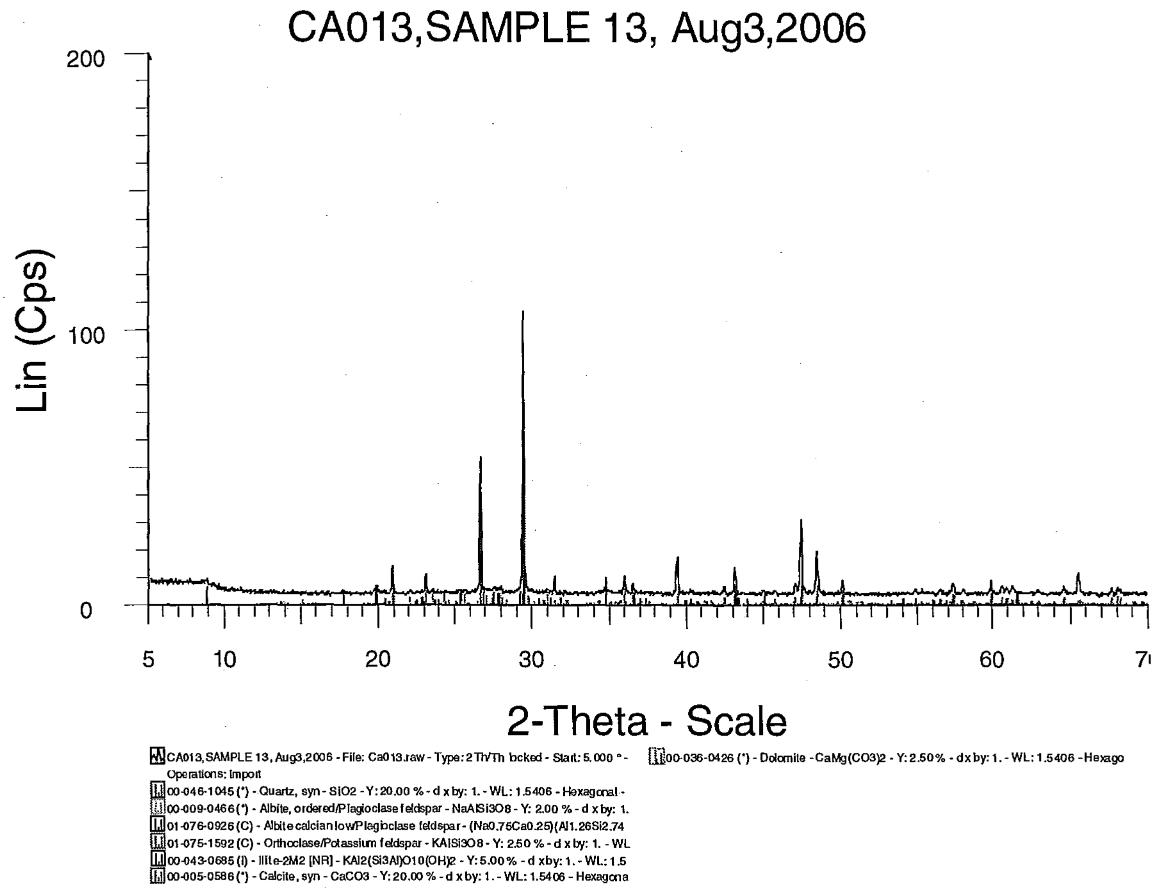
00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 2.00 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 2.50 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 (NR) - KAl2(Si3Al)O10(OH)2 - Y: 5.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago


CA013,SAMPLE 13, Aug3,2006
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00-009-0466 (*) - Albite, ordered/Plagioclase feldspar - NaAlSi3O8 - Y: 2.00 % - d x by: 1.
01-076-0926 (C) - Albite calcian low/Plagioclase feldspar - (Na0.75Ca0.25)(Al1.26Si2.74
01-075-1592 (C) - Orthoclase/Potassium feldspar - KAlSi3O8 - Y: 2.50 % - d x by: 1. - WL
00-043-0685 (I) - Illite-2M2 [NR] - KAl2(Si3Al)O10(OH)2 - Y: 5.00 % - d x by: 1. - WL: 1.5
00-005-0586 (*) - Calcite, syn - CaCO3 - Y: 20.00 % - d x by: 1. - WL: 1.5406 - Hexagona
00-036-0426 (*) - Dolomite - CaMg(CO3)2 - Y: 2.50 % - d x by: 1. - WL: 1.5406 - Hexago

Bibliography

Allen, K. M. S. (1992). Iroquois Ceramic Production: A Case Study of Household-level Organization. In Ceramic, Production and Distribution: An Integrated Approach. Editors: G. J. B. III and C. A. Pool. Oxford, Westview Press: pp.133-154.

Allen, K. M. and E. B. W. Zubrow (1989). Environmental Factors in Ceramic Production: The Iroquois. In Ceramic Ecology, 1988. Editors: C. C. Kolb. Britain, BAR International Series 513: pp. 61-95.

Arnold, D. E. (1985). Ceramic Theory and Cultural Process. Cambridge, Cambridge University Press.

Bourdieu, P. (1977). Outline of a Theory of Practice. Cambridge, Cambridge University Press.

Boyle, D. (1888-89). Archaeological Report: Townships of York and Vaughan. Annual Report of the Canadian Institute. Appendix to the Report of the Minister of Education, Ontario, Warwick and Sons, Toronto: pp. 19-20.

Boyle, D. (1888-89). Notes: Pottery. Annual Report of the Canadian Institute. Appendix to the Report of the Minister of Education, Ontario, Warwick and Sons, Toronto: pp. 21-23.

Braun, G. V. (2003). Iroquoian Pottery: Function and Use. Unpublished M.A. Thesis, Department of Anthropology, University of Southampton.

Bronitsky, G. and R. Hamer (1986). Experiments in Ceramic Technology: The Effects of Various Tempering Materials on Impact and Thermal-shock Resistance. American Antiquity 51(1): 89-101.

Chilton, E. S. (1998). The Cultural Origins of Technical Choice: Unraveling Algonquian and Iroquoian Ceramic Traditions in the Northeast. In The Archaeology of Social Boundaries. Editors: M. T. Stark. Washington, D.C., Smithsonian Institution Press: pp. 132-160.

Cooper, M. S. (1996). A study of the Neutrals. Many Voices: A Collective History of Greater Fort Erie. Editors: J. Davies and J. L. Felstead. Ridgeway, Ontario, Fort Erie Museum Board: pp. 14-25.

Cowan, W. R. (1972). Pleistocene Geology of the Brantford Area, Southern Ontario. Ontario, Ontario Department of Mines.

Curtis, J. E. and M. A. Latta (2000). Ceramics as Reflectors of Social Relationships. Ontario Archaeology 70: 1-15.

Dobres, M.-A. (2000). Technology and Social Agency: Outlining a Practice Framework for Archaeology. Oxford, UK, Blackwell Publishers.

Dobres, M.-A. and C. R. Hoffman, Editors. (1999). The Social Dynamics of Technology: Practice, Politics, and World Views. Washington, D.C., Smithsonian Institution Press.

Donaldson, W. S. (1958). Research Guide to Pottery Sequences in Ontario. Ontario Archaeology 5(2): 1-7.

Emerson, J. N. (1956). Understanding Iroquois Pottery in Ontario. Ontario Archaeology 3: 1-64.

Emerson, J. N. (1968). Understanding Iroquois Pottery in Ontario: A Rethinking. Special Publications of the Ontario Archaeological Society 2: 1-132.

Engelbrecht, W. (1980). Methods and Aims of Ceramic Description. In Proceedings of the 1979 Iroquois Pottery Conference. Rochester, New York, Research Division: pp. 27-29.

Feathers, J. K. (1989). Effects on Temper on Strength of Ceramics: Response to Bronitsky and Hamer. American Antiquity 54(3): 579-588.

Feathers, J. K. (2006). Explaining Shell-Tempered Pottery in Prehistoric Eastern North America. Journal of Archaeological Method and Theory 13(2): 89-133.

Fitzgerald, W. R. (1982). Lest the Beaver Run Loose: The Early 17th Century Christianson Site and Trends in Historic Neutral Archaeology. Ottawa, National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 111

Fitzgerald, W. R. (1990). Chronology to Culture Process: Lower Great Lakes Archaeology, 1500-1650. PhD Dissertation. Department of Anthropology. Montreal, McGill University.

Fitzgerald, W. R. (2001). Contact, Neutral Iroquoian Transformation, and the Little Ice Age. In Societies in Eclipse. Editors: D. S. Brose, C. W. Cowan and R. C. Mainfort. Washington, Smithsonian Institution Press: pp. 37-47.

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

Gosselain, O. P. and A. Livingstone-Smith (2005). The Source: Clay Selection and Processing Practices in Sub-Saharan Africa. In Pottery Manufacturing Processes: Reconstruction and Interpretation. Editors: A. Livingstone-Smith, D. Bosquet and M. Martineau. Oxford, BAR International Series: pp. 33-47.

Hally, D. J. (1983). Use Alteration of Pottery Surfaces: An Important Source of Evidence for the Identification of Vessel Function. North American Archaeologist 4(1): 3-26.

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

Harrington, M. R. (1908). Some Seneca Corn-Foods and Their Preparation. American Anthropologist 10(4): 575-590.

Hawkins, A. L. (2001). Genoa Frilled Pottery and the Problem of the Identification of the Wenro in Huronia. Ontario Archaeology 72: 15-36.

Kapches, M. (1994). The Hill Site: A Possible Late Early Iroquoian Ceramic Firing Site in South-Central Ontario. Northeast Anthropology 48: 91-102.

Kenyon, I. (1982). The Grimsby Site: An Historical Neutral Cemetery. Toronto, Ontario, Archaeological Monograph, Royal Ontario Museum.

Latta, M. A. (1991). Captive Bride syndrome: Iroquoian Behavior or Archaeological Myth. In Archaeology of Gender - Calgary: Archaeological Association, University of Calgary, Proceedings, Chacmool Annual Conference: No. 22: pp. 375-382.

Lemonnier, P. (1986). The Study of material culture today: toward an anthropology of technical systems. Journal of Anthropological Archaeology 5: 147-186.

Lemonnier, P. (1990). Topsy Turvy Techniques: Remarks on the Social Representation of Techniques. Archaeological Review from Cambridge 9(1): 27-37.

Lennox, P. A. (1981). The Hamilton Site: A Late Historic Neutral Town. Ottawa, National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 103.

Lennox, P. A. (1984). The Bogle I and Bogle II sites: Historic Neutral Hamlets of the Northern Tier. Ottawa, National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 121.

Lennox, P. A. (1984). The Hood Site: A Historic Neutral Town of 1640 A.D. Ottawa, National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 121.

Lennox, P. A. and W. R. Fitzgerald (1990). The Culture History and Archaeology of the Neutral Iroquoians. In The Archaeology of Southern Ontario to A.D. 1650. Editors: C. J. Ellis and N. Ferris. London, Ontario, Ontario Archaeological Society: pp. 405-456.

Lennox, P. and I. Kenyon (1984). Was that Middleport Necked or Pound Oblique? A study in Iroquoian Ceramic Typology. Ontario Archaeology 92: 13-26.

Livingstone-Smith, A. (2001). Bonfire II: The Return of Pottery Firing Temperatures. Journal of Archaeological Science 28: 991-1003.

MacNeish, R. S. (1952). Iroquois Pottery Types. Ottawa, Canada, National Museums of Canada. No.

Mahias, M.-C. (2002). Pottery Techniques in India: Technical variations and social choice. In Technological Choices: Transformation in Material Cultures since the Neolithic. Editor: P. Lemonnier. London, Routledge: pp. 157-180.

Marshak, S. (2001). Earth: Portrait of a Planet. New York, W.W. Norton and Company.

Martelle, H. (2002). Huron Potters and Archaeological Constructs: Researching Ceramic Micro-stylistics. PhD Dissertation. Department of Anthropology. Toronto, University of Toronto.

Matthew, A. J., A. J. Woods, C. Oliver (1991). Spots Before the Eyes: New Comparison Charts for Visual Percentage Estimation in Archaeological Material. In Recent Development in Ceramic Petrology. Editors: A. Middleton and I. Freestone. London, British Museum: pp. 211-263.

Michelaki, K. (2005). Personal Communication. McMaster University, Hamilton, Ontario. May 2005.

Michelaki, K. (2006). Integrating Archaeological Sciences and Social Theory to Gain a New Insight into Iroquoian Ceramics. Paper presented Canadian Archaeological Association Meeting. May 26, 2006, Toronto, Ontario.

Noble, W. C. (1978). The Neutral Indians. In Essays in Northeastern Anthropology in Memory of Marian E. White. Occasional Publications in Northeastern Anthropology. Editors: W. Engelbrecht and D. K. Grayson. Rindge, NH, Department of Anthropology, Franklin Pierce College. No. 5: pp. 152-164.

Noble, W. C. (1980). Thorold: An Early Historic Niagara Neutral Town. In Villages in the Niagara Peninsula. Proceedings of the Second Annual Niagara Peninsula History Conference. Brock University, St. Catherines: pp. 43-55.

Noble, W. C. (1984). Historic Neutral Iroquois Settlement Patterns. Canadian Journal of Archaeology 8(1): 3-27.

Orton, C., P. Tyers, A. Vince (1993). Pottery in Archaeology. Cambridge, Cambridge University Press.

Raguin, E. (1965). Geology of Granite. New York, Interscience Publishers.

Ramsden, P. (1977). A Refinement of Some Aspects of Huron Ceramic Analysis. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 63.

Rice, P. M. (1987). Pottery Analysis. Chicago, The University of Chicago Press.

Ridley, F. (1961). Archaeology of the Neutral Indian. Port Credit, Ontario, Etobicoke Historical Society.

Rye, O. S. (1976). Keeping your temper under control: Materials and the Manufacture of Papuan Pottery. Archaeology and Physical Anthropology in Oceania 11(2): 106-137.

Rye, O. S. (1981). Pottery Technology: Principles and Reconstruction. Washington, D.C., Taraxacum Inc.

Schoolcraft, H. R. (1847). Notes on the Iroquois: Contributions to American History Antiquities, and General Ethnology. Albany, Erastus H. Pease.

Shepard, A. O. (1971). Ceramics for the Archaeologist. Washington, D.C., Carnegie Institution of Washington.

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

Skibo, J. M. (1992). Pottery Function: A Use-alteration Perspective. New York, Plenum Press.

Smith, D. G. (1983). An Analytical Approach to the Seration of Iroquoian Pottery. London, Museum of Indian Archaeology (London), An Affiliate of the University of Western Ontario.

Staff of the Engineering and Terrain Geology Section Ontario Geological Survey (1980). Aggregate Resources Inventory of Brantford Township Brant County Southern Ontario. Toronto, Ontario, Ministry of Natural Resources.

Steponaitis, V. P. (1984). Technological Studies of Prehistoric Pottery from Alabama: Physical Properties and Vessels Function. In The Many Dimensions of Pottery: Ceramics in Archaeology and Anthropology. Editor: S. E. V. Leeuw. Amsterdam, Universiteit van Amsterdam: pp. 79-128.

Stewart, F. L. (2000). Variability in Neutral Iroquoian Subsistence: A.D. 1540-1651. Ontario Archaeology 69.

Stewart, F. L. and W. D. Finlayson (2000). Subsistence at the Irving-Johnston Village and the Question of Deer Tending by the Neutrals. Canadian Journal of Archaeology 24: 17-39.

Stimmell, C., R. B. Heinmann, R.G.V. Hancock (1982). Indian Pottery from the Mississippi Valley: Coping with Bad Raw Materials. In Archaeological Ceramics. Editors: J. S. Olin and A. D. Franklin. Washington, DC, Smithsonian Institution Press: pp. 219-228.

Tani, M. (1994). Why Should More Pots Break in Larger Households? Mechanisms Underlying Population Estimates From Ceramics. In Kalinga Ethnoarchaeology: Expanding Archaeological Method and Theory. Editors: W. A. Longacre and J. M. Skibo. Washington, Smithsonian Institution Press.

Thwaites, R. G. (1896-1901). The Jesuit Relations and Allied Documents. 73 vols. Burrows, Cleveland.

Tite, M. S., V. Kilikoglou, G. Vekinis (2001). Strength, Toughness and Thermal Shock Resistance of Ancient Ceramics, and their Influence on Technological Choice. Archaeometry 43: 301-324.

Trigger, B. G. (1976). The Children of Aataentsic: A History of the Huron People to 1660. Kingston, McGill-Queen's University Press.

Trigger, B. G., L. Yaffe, D. Dautet, H.. Marshall, R. Pearce (1984). Parker Festooned Pottery at the Lawson Site: Trace-Element analysis. Ontario Archaeology 42: 3-11.

Trigger, B. G., L. Yaffe, M. Diksic, J.-L. Galinier, H. Marshall, J.F. Pendergast (1980). Trace-Element Analysis of Iroquoian Pottery. Canadian Journal of Archaeology 4: 119-144.

Van Der Leeuw, S. (2002). Giving the Potter a Choice: Conceptual aspects of pottery techniques. In Technological Choices: Transformation in Material Cultures since the Neolithic. Editor: P. Lemonnier. London, Routledge: pp. 238-288.

Warrick, G. (1984). The Fonger Site: A Protohistoric Neutral Community, Revised Version of Original Report Submitted to the Ontario Heritage Foundation in January, 1982, in accordance with the Ontario Heritage Act 1974.

Warrick, G. (1984). Reconstructing Ontario Iroquoian Village Organization. Ottawa, National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper. No. 124.

Waugh, F. (1903). Attiwandaron or Neutral Village Sites in Brant County. Annual Archaeological Report for Ontario for 1902: pp. 70-79.

Waugh, F. W. (1916). Iroquois Foods and Food Preparation. Ottawa, Government Printing Bureau.

Wright, G. K. (1963). The Neutral Indians: A Source Book. Rochester, N.Y., New York State Archaeological Association.

Young, L. C. and T. Stone (1990). The Thermal Properties of Textured Ceramics: An Experimental Study. Journal of Field Archaeology 17(2): 195-203.