Chert Raw Material Utilization at the Bark Site (BbGp-12), Peterborough County, Southern Ontario

Katie M. Biittner and Susan M. Jamieson

To understand how specific cherts were used in stone tool manufacture at the fifteenth-century Bark site (BbGp-12), Peterborough County, Ontario, 164 artifacts from the chert assemblage are analysed for their raw material attributes. A combination of macroscopic, petrographic, and palynological analyses are used to identify the provenance of the most abundant chert types used by site inhabitants, assigning them to the Onondaga, Fossil Hill, and Upper Gull River Formations. We conclude, contra *Eley and von Bitter (1989), that acritarch genus identification is not required to discriminate among these chert types. Instead, relative abundance of different palynomorph subgroups (based on morphology), and relative abundance of acritarchs versus other microfossils (chitinozoan, graptolite, scolecodont, and trilete spore fragments) are more significant identifying characteristics. The attribution of cherts to distant sources allows us to explore ideas about local kin-based access to high quality, exotic materials.*

It has long been acknowledged that macroscopic identification is an inadequate means for chert sourcing (e.g., Luedtke 1978, 1979:745, 1992). Nonetheless, this technique is commonly used by Ontario archaeologists as it is generally held to afford a reasonable degree of reliability while being both expedient and cost effective. For example, Susan Jamieson (1998, 1999b, 2000, 2002, 2004) routinely used such macroscopic identifications in both her licence and annual published reports on her field work at the fifteenth-century Bark site.

In 2005, Katie (Miles) Biittner evaluated the validity of Jamieson's macroscopic identifications of the Bark site cherts for her master's thesis research (Miles 2005). She re-investigated the site's chert artifact assemblage, examining macroscopic attributes and undertaking microscopic analysis for the first time. This latter effort consisted of both petrographic (mineralogical) and palynological (microfossil) analyses. This re-examination of the chert assemblage illustrated that Jamieson's original macroscopic identifications are comparable to the petrographic and palynological identifications. As only five potential chert sources were identified, Jamieson's analysis was adequate only in terms of establishing the general character of that assemblage. Raw material analysis outlined here suggests that at least eight separate chert types are present in the site's assemblage. Thus, it follows that macroscopic analysis is inadequate for a complete characterization of the chert artifacts and, consequently, inadequate for the determination of toolstone sources.

Background to the Bark Site

The Bark site (BbGp-12) is situated in the middle Trent River Valley, a few kilometers west of the City of Peterborough (Figure 1). It was discovered in 1983, when deep ploughing disturbed human remains and revealed several settlement features. With the approval of Curve Lake, Hiawatha, and Scugog First Nations, the site was immediately mapped, surface-collected and tested by Mima Kapches of the Royal Ontario Museum. In 1986 and 1987, Rick Sutton, then a master's student in the Department of Anthropology, McMaster University, conducted intensive surface collection and testing at the Bark site to obtain a more representative artifact sample and to identify the nature and extent of its settlement data. Sutton (1990:25,27) concluded that the Bark site was a single component Huron village dating to the mid-fifteenth century, one that was not situated for defence. On the

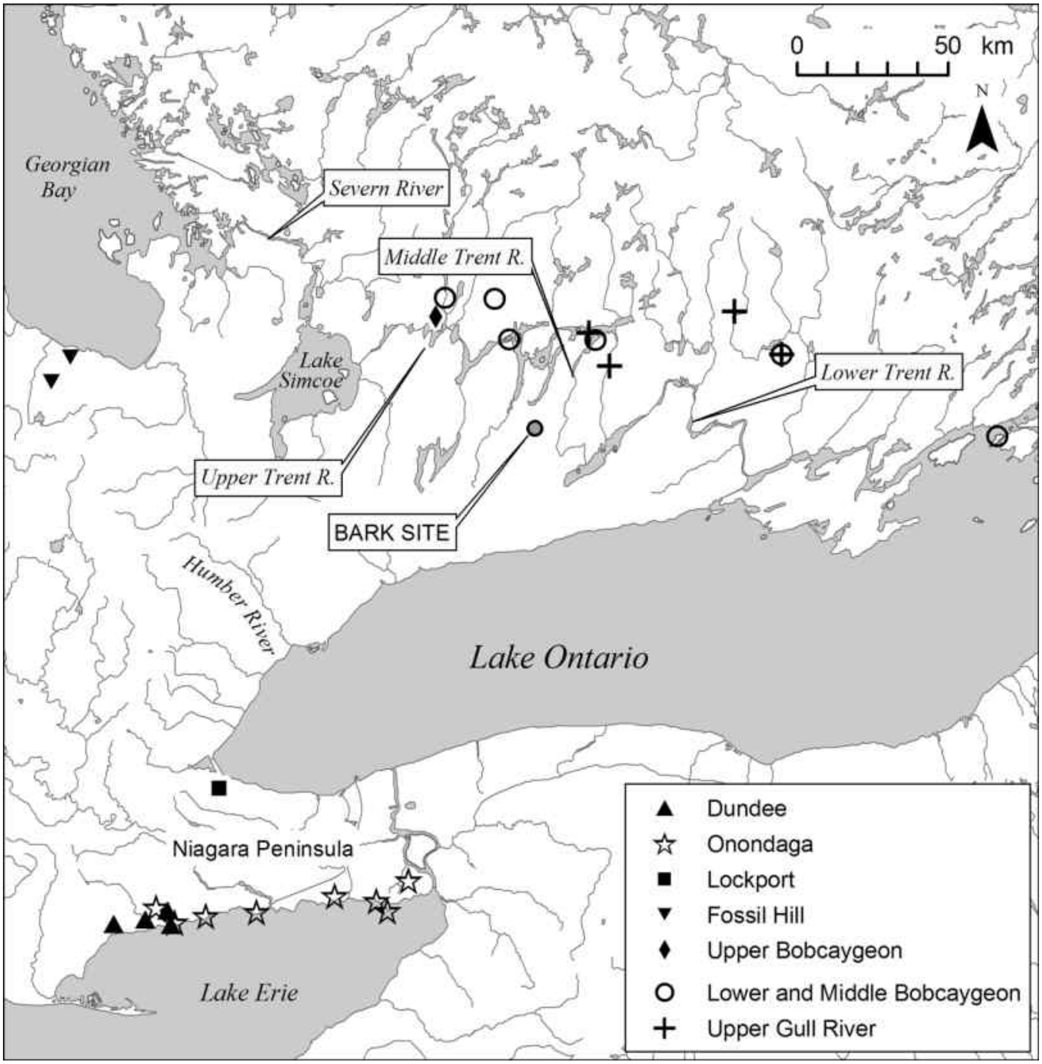

Figure 1. *Places in central southern Ontario mentioned in the text as well as modern collecting localities (natural outcrops, road-cuts, quarries) of cherts identified in the Bark site assemblage (this study); localities are those identified by Eley and von Bitter (1989:4).*

basis of the seasonality of recovered faunal and floral remains, he concluded that it had probably been occupied year round. Lastly, in 1997, 1999, and 2000, Susan Jamieson conducted a program of research at the site in conjunction with Trent University's field school in Ontario archaeology. She determined that the site had a late Pickering (Early Ontario Iroquoian) period component in addition to fifteenth-, early-sixteenth,- and late-nineteenth-or early-twentieth-century components. The main occupation dated to the fifteenth century. Ceramic diagnostics and overlapped pits, hearths and post moulds indicate intensive, prolonged occupation of the site locus at this time (e.g., Jamieson 2004).

Relatively little is known about the indigenous peoples who occupied the middle Trent Valley (Figure 1). Sutton (1990:1) states that "virtually no previous Iroquoian archaeological research has been conducted" there. The Wilson site was, however, excavated by Walter Kenyon (Royal Ontario Museum) in the 1950s and surveys of the Trent Valley were carried out by Trent University personnel in the 1960s and early 1970s. Readily accessible published archaeological information for the middle Trent Valley is limited to a detailed analysis of the Bark site settlement data (Sutton 1990) and summary papers on subsequent annual excavations at this site (Jamieson 1998, 2000, 2004), a description of the Brock Street burial (Kenyon and Cameron 1961) in the City of Peterborough, and discussions of the Peterborough Petroglyphs (Dewdney and Kidd 1967; Sweetman 1955; Vastokas and Vastokas 1973) near Nephton.

We know that during the fifteenth and sixteenth centuries, the archaeological record of the upper and lower Trent Valley indicates transformation and reorganization of society, including population migration and integration, restructuring and coalescence of smaller settlements into larger local villages (e.g., Damkjar 1990; Pendergast 1985; Ramsden 1977:70, 1988, 1989, 1996; Sutton 1990). This reorganization probably also occurred in the middle Trent Valley area. Although trade networks of earlier periods were maintained into the fifteenth century, there is, for this period, relatively little evidence for exotic lithic raw materials—"exotica"—in southern Ontario (Jamieson 1999a:184). Data from this period thus suggest increasing sedentism and regionalism combined with intensified use of local resources and pervasive local or short-distance alliances and exchanges initiated and maintained through ethnic and kin-group linkages (Jamieson 1992:77, 1999a:175, 184). We infer, therefore, that, during this period, emphasis was placed on toolstone that could be locally acquired but still had the prerequisite or desired flaking qualities. We follow Tankersley's (1989:265) definition that non-local materials come from a distance of more than 30 km whereas local materials are transported over a shorter distance.

The Bark site is located in a frontier area between Iroquoian-speaking and Algonquian-speaking peoples. Hence, there is a possibility that both peoples may have occupied the site (Jamieson 1998, 2004:71). Farther west, village site distributions have been used to infer increased trade—beginning at about A.D.1450—between representatives of these two language groups (Warrick 2000:451). Such trade is well documented into the seventeenth century (Jamieson 1981:20, 1999a:185). Interaction between the Trent Valley Iroquoians and other Iroquoian-speaking groups in Ontario has been inferred from distributions of material culture (Ramsden 1990; Warrick 2000). We think it likely that lithic raw materials were being exchanged among the different Iroquoian-speaking groups as well.

The chert assemblage analysed in this paper, which is composed of 1401 specimens, derives from Jamieson's 1997, 1999 and 2000 investigations at the Bark site. Chert is the most abundant lithic raw material (Table 1), a pattern consistent with that found at other sites in southern Ontario. Preliminary macroscopic analysis by Jamieson suggested that the Bark site assemblage is composed of cherts from five formations: Onondaga, Lower-Middle Bobcaygeon, Upper Bobcaygeon, Upper Gull River, and Lower Gull River. Lower and Middle Bobcaygeon Formation cherts have been combined into one type because they are indistinguishable (Eley and von Bitter 1989:10). Jamieson concluded that the majority of the Bark site artifacts were knapped from Upper Bobcaygeon Formation chert, with the next most abundant chert types coming from the Onondaga, Lower-Middle Bobcaygeon, Upper Gull River, and Lower Gull River Formations, respectively (Table 2). Some bedrock outcrop locations for these cherts are shown in Figure 1.

Table 1. *Lithic raw material distribution at the Bark site by maximal artifact category.*

Raw Material Type	Debitage		Flakes		Cores		Edge Retouch Tools		Edge Utilised Tools	
	n	%	n	%	n	%	n	%	n	%
Chert	832	80.5	478	75.4	68	94.4	15	93.8	1	50
Chloride Schist	152	14.7	135	21.3	0	0	0	0	0	0
Quartzite	18	1.7	10	1.6	2	2.8	1	6.2	1	50
Quartz	29	2.8	9	1.4	2	2.8	0	0	0	0
Unidentified	2	0.2	2	0.3	0	0	0	0	0	0
Total	1033	100	634	100	72	100	16	100	2	100

Table 2. *Frequency of Bark site cherts by maximal artifact categories as determined by Jamieson.*

Chert Type	Tool	Core	Debitage	Flake	Total
Onondaga	4	6	253	198	461
Upper Bobcaygeon	7	28	331	184	550
Lower/Middle Bobcaygeon	3	13	148	45	209
Upper Gull River	2	17	71	51	141
Lower Gull River	0	4	29	4	37
Total	16	68	832	485	1401

Raw Material Analyses

We know that to account for the natural variation in chert, both macroscopic and microscopic analyses are necessary for its characterization. According to Herz (2001:464), "the first step in an analysis of lithic material should be petrographic, preferably with thin sections." Petrographic analysis, the identification of the mineral composition of a rock, can be used to determine the composition and texture of the chert quickly and relatively inexpensively (Eley and von Bitter 1989:3).

Petrographic Analysis

The usual technique for preparation of thin-sections involves the use of a thin-bladed diamond-tipped saw to make two parallel cuts close together at a carefully selected place in the side of the specimen to a depth of about 5-10 mm, leaving a slice as thin as 0.5 mm (Clough and Woolley 1985:93). This rock slice is ground down until perfectly flat and has an even thickness of around 0.03 mm. It is then cemented onto a glass slide (Clough and Woolley 1985:93). The thickness of the slide is important because the "inference colours displayed by minerals under a polarizing microscope vary according to their thickness" (Clough and Woolley 1985:93), as polarized light will refract differently at varying thicknesses. A standard thickness, such as 0.03 mm, ensures that specific minerals always display a similar range of colours, thus aiding in identification and comparison of samples.

As chert is composed of quartz and its variants (chalcedony and opal), a general optical description of quartz will aid in textural analysis. Quartz composition is the most distinctive feature of chert sources. Quartz is most readily distinguished by its lack of colour, the nature of its cleavage and visible twinning, uniaxial positive features, undulose to sharp extinction, low relief and weak birefringence, or polarization at 90 degree angles (Deer et al. 1992; Moorehouse 1959). Cloudiness can be caused by fluid inclusions, ranging from less than a micron to several millimeters in maximal dimension. Such inclusions are common and can be abundant in quartz (Deer et al. 1992). Cleavage is the tendency of a crystallized substance to split along definite crystalline planes, yielding smooth surfaces.

A number of different attributes can be examined within each thin-sectioned sample. Attributes such as texture, groundmass, silica fabric, inclusions, and the angularity, roundness and shape or sphericity of grains are used to differentiate between different chert types (Clough and Woolley 1985; Eley and von Bitter 1989; Parkins 1974; Wahlstrom 1955; Winchell 1965:1; Writt 1975). Unfortunately, studies of chert are usually hampered by the lack of consistency among publications (Writt 1975:3).

Textural variation is typically the most distinctive feature allowing for the identification of different chert types and/or sources. Textural variation is used to describe the size and shape of mineral grains (Clough and Woolley 1985:94; Writt 1975:11). Under a polarizing microscope, quartz crystals composing chert are measured in microns (μm) and classified as cryptocrystalline, microcrystalline, or chalcedonic quartz. Crystals less than 3 μm and too small to show optical properties are classified as cryptocrystalline. Crystals less than 10 μm showing waxy extinction are classified as microcrystalline. Crystals that are 5 to 100 μm with submicroscopic water-filled pores of about 0.1 μm in diameter are classified as chalcedonic quartz (Eley and von Bitter 1989:8; Folk and Weaver 1952:501). In chert, the quartz crystals are associated in recognisable patterns termed silica fabrics, produced either by the dissolution of original minerals and their replacement by quartz, or by the growth of quartz crystals in void spaces (Eley and von Bitter 1989:8). The texture of chert depends on the type and combination of silica fabrics making up its groundmass—cherts with a uniform microcrystalline groundmass are fine-textured, whereas chalcedonic and drusy quartz mosaics are coarse to very coarse-textured (Eley and von Bitter 1989:8; Writt 1975:14). These varying degrees of coarseness are determined by the relative proportions of the quartz grain sizes, which can be assessed by plotting the percentages of the fine-sized grains against the medium and coarse size grains (Writt 1975:11, 15). Physical measurements, including the overall coarseness of the texture, the percentage of chalcedony, and the size and amounts of void fillings help to delineate and delimit the specific texture type (Writt 1975:15). Grain angularity, roundness and shape are used to describe the quartz crystals and to refine the texture types.

Scholars have demonstrated the utility of petrographic analysis in chert provenance determination (Boxt and Reedy 1985; Clough and Woolley 1985; Eley and von Bitter 1989; Hess 1996; Janusas 1984; Lavin and Prothero 1992; Pollock et al. 1999; Prothero and Lavin 1990; Shelley 1993; von Bitter and Eley 1984, 1997). Prothero and Lavin (1990) and Lavin and Prothero (1992) employed petrographic analysis in their study of northeastern and middle-Atlantic region cherts. Very few of these cherts were distinctive macroscopically. Prothero and Lavin (1990:562) were easily able to distinguish them petrographically. Weathering in the form of post-depositional oxidized rings, oxidized opaques, and leached carbonates allowed Lavin and Prothero (1992:110) to distinguish cherts acquired from secondary versus primary sources.

Petrographic analysis has a few important advantages over other means of sourcing analysis. First, it is relatively inexpensive. Thin sections can usually be done for as little as five dollars per specimen and the method requires only a petrographic microscope. Entry level petrographic microscopes can, however, cost upwards of $15,000. It is also relatively easy to learn (so say Prothero and Lavin!), involves simple comparative identification procedures, and yields a "wealth of information" about texture, mineralogy, mode of origin, and chert diagenesis that is not available from other methodologies (Prothero and Lavin 1990:577). Although the preparation of thin sections can be time-consuming, the time spent "in the mechanical operation of grinding rocks is not only remunerated by interesting and instructive preparations, but adds also to a complete knowledge of their physical structure, gained by close observation of the various features they present during the process of variation" (Fritz-Gaertner 1878:219).

As with any analytical technique, petrography has some limitations. First, thin-sectioning is a destructive technique. This may be fine for debitage and source samples, but the majority of archaeologists and curators may be reluctant to cause even minimal damage to type or rare artifacts. Second, petrography is dependent on variation, and chert can be homogeneous among sources and heterogeneous within a source (Luedtke 1992). Finally, petrographic analysis does not allow for the discernment of the chemical composition of the chert. This is severely limiting when there are no distinguishing macroscopic and microscopic properties visible, even in thin section. Chert is predominantly composed of quartz with the main cause of variation being the presence of impurities. If these impurities occur, and they can be present in amounts of parts per million (ppm), chemical analysis is the only means of detection.

Palynological (Microfossil) Analysis

Whereas petrographic analysis can be used to distinguish cherts from different formations, microfossil analysis allows for separation of cherts from distinct members within a formation. Customarily, microfossils are used in petrographic and stratigraphic investigations to aid in characterizing and determining the age of cherts (Eley and von Bitter 1989:9; Martin 1993:476). Cherts are generally replacements of marine sediments, so microfossils incorporated into them during their formation can include many distinct marine plants and animals (Eley and von Bitter 1989:9; Luedtke 1992:26). The importance of microfossils in chert stems from the fact that they are frequently the only fossils present in the rock and are also extremely resistant to destructive geological processes, such as weathering, dissolution and recrystalisation (Eley and von Bitter 1989:9).

Microfossil analysis is conducted by examining pollen and spores. The palynological processing required for this analysis involves destroying all of the rock except the acid resistant organic material: the rock sample is first digested in hydrochloric and hydrofluoric acid; the organic material (kerogen) remaining is then separated and concentrated on a micro slide. This organic material is then oxidized and sieved to make the organic-walled microfossils (pollen, spores, dinoflagellates, etc.) easier to identify. Using a polarizing microscope equipped with a micrometre, the slides can then be examined and analysed.

Microfossils common to southern Ontario cherts include scolecodonts, chitinozoans, and trilete spores. These microfossils are counted and noted for presence/absence only. Specific genera are not identified, as this identification is unnecessary for chert type differentiation. On the other hand, acritarchs, as the most abundant microfossil present in southern Ontario cherts, are investigated more thoroughly. Following the methodology established by Eley and von Bitter (1989:9) for measuring the composition of acritarch assemblages, the number of acritarchs from each subgroup is noted and expressed as a percentage of the total. When genera can be identified, generic diversity is recorded for each subgroup.

Eley and von Bitter (1989), Parkins (1974), Writt (1975), and von Bitter and Eley (1984, 1997) have each undertaken investigations of southern Ontario chert sources (see Figure 1 for bedrock source locations). These studies have demonstrated the utility of both petrographic and palynological techniques of analysis in distinguishing among chert formations, as well as, among members within formations. While Eley and von Bitter's (1989) work offers the definitive analysis of chert formations in southern Ontario, Parkins (1974) provides an excellent examination of the Edgecliff and Clarence Members of Onondaga Formation chert. Parkins's (1974:28) conclusion that too little information is available on acritarch assemblages in the Onondaga Formation (and other southern Ontario) cherts to make acritarch assemblage data useful in determining the source of flaking debris remains true, despite the more recent work of Eley and von Bitter (1989). Only when used in conjunction with macroscopic and microscopic (petrographic) analysis can acritarch assemblage data be successfully applied to archaeological raw material provenance investigations (Parkins 1974).

Conversely, macroscopic and thin section analyses alone are insufficient for chert characterization in the majority of cases (Janusas 1984:27). In her examination of Kettle Point Chert, Janusas (1984:82) found that the combination of thin section analysis and macroscopic analysis is worthwhile and that this combined approach to analysis cannot be "discarded in favour of some other technique" as observations may be made and recorded which "might otherwise be overlooked" if only one or the other method is employed.

Sampling Strategy

Owing to the large population size of the Bark site assemblage and the limited time and resources of the investigator, the Bark site chert assemblage was sampled using a stratified random approach. Debitage and flakes recovered from excavation units were place in corresponding squares representing the original grid on a gridded tabletop. All of the squares were sampled. Using a table of random numbers, 10 percent of each of the debitage and flake sub-populations was randomly selected to provide the subsample from that unit. All artifacts recovered from features (except middens) were studied because features are believed to represent a narrower time frame of use than the rest of the site. Likewise, 100 percent of cores and 100 percent of informal tools were studied. In all, a total of 164 specimens were analysed using a combination of macroscopic and microscopic techniques (Table 3). Of the 164 specimens selected, only

135 specimens were large enough to be thin-sectioned for examination of petrographic structures and only 39 were large enough to processes palynologically.

Table 3. *Population and sample size.*

Maximal Artifact Category	Population	Sample Size (n)
Debitage	832	43
Flakes	485	80
Cores/Core fragments	68	33
Informal Tools	16	8
Total	1401	164

Results

Table 4 presents attributes that were assessed for each of the three methods of analysis. For macroscopic analysis, these attributes include colour, patina, lustre, mottling, banding, and speckling. For petrographic analysis, they include texture and inclusions. The palynological analysis was helpful in confirming or otherwise refining the results of the macroscopic and petrographic analyses.

Macroscopic Attributes

Artifact size proved to be a limitation in that some attributes (e.g., patina) were impossible to assess for smaller pieces . As cores (mean size grade, 13-18 mm) are generally larger than flakes and debitage (mean size grade, 7-12 mm), cores are easier to characterize on the basis of macroscopic attributes. Patina and colour together are the most diagnostic raw material attributes. Patina cannot always be reliably assessed as it can be influenced by features of the rock (chemical composition, mineralogy, structure), features of the depositional, weathering or formation environment (soil pH, rainfall, temperature, bacterial activity, drainage), and position of the rock in, or on, the soil (Sheppard and Pavlish 1992:41). When colour and patina suggest the presence of more than one type of raw material, lustre, as well as the presence or absence of mottling, speckling and banding can aid in distinguishing those types.

Petrographic Attributes

Texture is the most useful petrographic attribute. It is measured along an ordinal scale as determined by the nature of the carbonate fabric. Properties assessed microscopically are used to infer raw material quality. Fine-grained cherts are considered to be of high quality; coarse-grained cherts, low quality. Following Brantingham et al. (2000), cherts in this study can be ordered on a scale or index of quality (Figure 2).

Chert texture is greatly affected by inclusions. Their presence or absence is one of the most useful and significant petrographic attribute measurements. This study determined that the most useful inclusions for determining texture are peloids, pellets, quartz eyes, glauconite, and ferrunginous minerals.

Palynological Attributes

All of the processed samples had microfossils present. Few of them were, however, identifiable owing to a high degree of fragmentation. Acritarchs from seven of the eleven subgroups were visible in most of the samples: sphaeromorphitae, acanthomorphitae, herkomorphitae, netromorphitae, polygonomorphitae, pteromorphitae, and prismatomorphitae. In other words, all of the acritarch subgroups found by Eley and von Bitter (1989:9) in southern Ontario cherts occur in this sample, including the following acritarch genera: *Veryhachium*, *Multiplicisphaeridium*, *Micrhystridium*, *Cymatiosphaera*, *Diexallophasis*, *Polyedryxium*, *Pterospermella*, *Baiomeniscus* and *Baltisphaeridium*. The samples could not be characterized by their acritarch assemblage composition as these assemblages are not specific to any chert source and are common to numerous chert types. Other microfossils that were present were too fragmentary for identification, though they most likely represented chitinozoans, scolecodonts and conodonts. Some definitive scolecodonts were present. However, these, too, are common to numerous chert types.

Whereas the samples could not be characterized by acritarch assemblage composition, almost all samples contained other microfossils and microlites. Following Lentifer and Boyd's (1999) morphology-based subgroups for phytolith classification, three generalised chert types could be identified using these other microfossil and microlite assemblages. Group 1 cherts contain large (15–30 μm) microlites with fewer numbers

Table 4. *Distinguishing macroscopic and microscopic attributes for Bark site cherts.*

	Kettle Point	Fossil Hill	Lockport	Dundee	Onondaga	Upper Bobcaygeon	Lower/Middle Bobcaygeon	Upper Gull River
Macroscopic Features								
Black to dark grey colour	X			X			X	X
Dark to light grey colour		X			X			
Blue-grey colour					X	X		
Light grey colour			X					
"Rusty" patination	X							
Light (yellow or buff) patination		X		X		X		X
Staining			X					
Speckling		X						
Mottling				X				
Vitreous lustre					X			
Waxy lustre							X	X
Dull lustre				X	X			
Peloidal texture						X		
Visible inclusions					X			
Petrographic Features								
Carbonate groundmass				X				
"Murky" groundmass			X		X		X	
Organic matter	X						X	
Chalcedony fabric		X					X	
Drusy quartz mosaic fabric		X						
Void-infilling quartz mosaic fabric	X						X	
Quartz "eyes"								X
Carbonate rhombs			X					
Ferruginous rhombs	X				X			
Peloids						X		
Pellets							X	
Palynological Features								
Dominant acritarch:								
Leiosphaerdium		X						
Veryhachium		X		X	X			
Cymatiosphaera		X			X			
Polyedryxium					X			
Pterospermella				X	X			
Multiplicisphaeridium		X	X					
Micrhystridium			X	X				
Other palynomorphs dominant	X		X					
Rare microfossils						X	X	X

of other palynomorph fragments. Group 2 cherts contain small (1–10 μm) microlites with equal numbers of other palynomorph fragments. Finally, Group 3 cherts have palynomorph fragments but do not contain any microlites. Instead, these cherts can be characterized by their acritarch assemblages. These microlite/microfossil groupings do not, however, correspond with the chert types as determined by macroscopic and petrographic analyses, which suggests that microlites do not accurately differentiate chert types.

Often more than one means of analysis is required before an artifact can be assigned a single chert type. Furthermore, certain chert types are more reliably identified using one method of characterization over another. An example of this is Upper Gull River Formation chert, which can be easily identified using petrographic analysis,

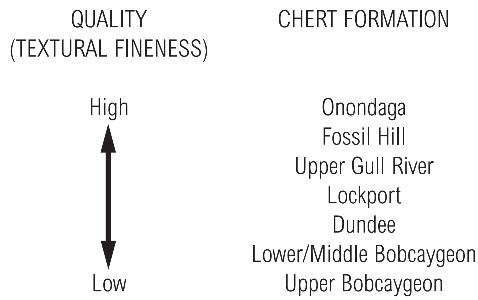

Figure 2. *Southern Ontario cherts ordered by knapping quality.*

owing to the presence of quartz "eyes" unique to this material.

Table 5 shows the distribution of items in the sample of 167 artifacts examined by chert type using all methods of analysis. A single chert type could not be assigned to 37 artifacts (22 percent of the sample). Chert type distribution is relatively consistent between and within maximal artifact categories. Onondaga Formation, Fossil Hill Formation, and Upper Gull River Formation cherts are the most common raw material types.

Problems with Different Approaches to Analysis

Macroscopic Analysis

Macroscopic analysis is rarely straightforward. Julig et al. (1988:233) have noted how for "almost a century these problems associated with the visual identification of chert types and source areas have evoked comment in the archaeological literature." Luedtke (1978, 1979:745, 1992) states "visual identification is inadequate for any serious study of chert material types." Although Luedtke (1979:745) recognizes, among other researchers, that cherts from different sources are often visually distinctive and archaeologists "working in a particular geographic region quickly become familiar with the most common local chert types," several problems are associated with the visual identification of cherts.

First, this kind of expertise on the part of the archaeologist is the result of years of experience and frequent handling of the material. Second, this knowledge can be "arcane" and difficult to communicate (Luedtke 1979:745). These problems become "particularly acute when analysts attempt to deal with widespread social interaction

Table 5. *Chert type distribution for maximal artifact categories determined by agreement of results of macroscopic, petrographic and palynological analyses.*

Chert Type	Tool	Core	Debitage	Flake	Total
Assignable to Single Types					
Fossil Hill	1	3	6	25	35
Kettle Point	1	1	3	1	6
Onondaga	3	19	10	9	41
Lockport	0	0	1	2	3
Dundee	0	1	3	0	4
Upper Bobcaygeon	0	1	1	2	4
Lower/Middle Bobcaygeon	0	1	2	5	8
Upper Gull River	2	5	9	10	26
Assignable to Multiple Types					
Onondaga/Fossil Hill/Dundee	0	1	0	0	1
Onondaga/Lockport	1	0	0	0	1
Onondaga/Kettle Point	0	0	1	0	1
Onondaga/Fossil Hill	0	0	0	1	1
Onondaga/Dundee	0	0	0	2	2
Onondaga/Lower Bobcaygeon	0	0	1	0	1
Onondaga/Bois Blanc	0	0	2	3	5
Onondaga/Bois Blanc/Dundee	0	0	0	3	3
Fossil Hill/Bois Blanc	0	0	2	2	4
Dundee/Bois Blanc	0	0	0	1	1
Upper Gull River/Lower Bobcaygeon	0	0	1	0	1
Lower/Middle/Upper Bobcaygeon	0	0	0	10	10
unknown	0	0	2	4	6
Totals	8	32	44	80	164

spheres and the concomitant movement of lithic materials over long distances between widely spaced source areas" (Julig et al. 1988:233). These problems are a possibility considering the scope of this research, inasmuch as the raw material sources potentially available to the site residents were widely spaced in a large geographical region. A third problem is the frequent disagreement among experts about the correct classification of any one sample. Although characterization is often undertaken with the intention to "sort and characterize the recovered lithics by source and feature so as to produce macroscopic categories that (are) distinguishable with reasonable certitude" (Katalin 1998:3), the problem is in achieving that very goal. How does one create macroscopic categories that are "reasonable" and mutually exclusive? In their attempts to "objectify the process of chert identification through visual characteristics" (Luedtke 1979:745), researchers assign more significance to some attributes, less to others, and change the criteria for definition from one type to another. By combining macroscopic, petrographic, and palynological approaches to analysis, the limitations of expertise and the chance of error in chert type discrimination have been reduced.

Another problem with macroscopic analysis is the large number of attribute-states that are not unique to a single chert type. Macroscopic features are "not always diagnostic of a single source, and are difficult to assess objectively" (Prothero and Lavin 1990:562). To clarify, colours are grouped together by Eley and von Bitter (1989:14) (e.g., "white, grey to dark grey" as one colour type in their chart). Rankin (1998:208) cites the difficulty in distinguishing between Lockport Formation and Onondaga Formation cherts by only assessing visual characteristics. She was unable to distinguish from which host formation the cherts in the Nodwell collection came. Onondaga Formation chert is also difficult to distinguish from Dundee Formation, Lockport Formation, Fossil Hill Formation, and Bois Blanc Formation cherts.

In this study, the only artifacts classified as "unknown" raw material type are either flakes or debitage, which implies that macroscopic analysis requires the examination of larger pieces. This conclusion is supported by the smaller number assignable to more than one type of chert (e.g., Onondaga/Fossil Hill) identified among the larger pieces. Small implements "may obviously be made as required from chance finds such as flint pebbles from a stream bed or exposures of ancient gravel, and in both cases these are likely to be at some distance from the parent rock" (Sieveking et al. 1972:151). Research on lithic materials from the Munsungun Lake Formation suggests that hand specimen (macroscopic) characteristics combined with polarised light microscopy are "viable techniques for assigning lithic provenance" Pollock (et al. 1999:269). The provenance of rhyolite, quartzes, metamorphic and igneous rocks was successfully identified using these techniques. Essentially, macroscopic analysis used independently of other means of raw material characterization is accurate only for larger artifacts.

Palynological Analysis

The biggest problems with the palynological analysis presented here derive from the small sample size and the small size of the artifacts. Only 35 artifacts were deemed to be large enough by the laboratory to warrant palynological processing. When analysed for acritarchs and other palynomorphs, these samples did not produce representative microfossil assemblages.

Although the work done by Eley and von Bitter (1989) suggests otherwise, acritarch genera identification is not required to differentiate between chert types from different formations. Instead, relative abundance of different palynomorph subgroups (based on morphology), and relative abundance of acritarchs versus other microfossils (chitinozoan, graptolite, scolecodont, and trilete spore fragments), appears to be more significant for identification. The largest difficulty encountered was in distinguishing between acritarch genera using only a binocular microscope. Electron microscopy is required for the identification of distinguishing generic attributes, such as process termination type and surface structures. The Bark site data suggest that focusing on the entire palynomorph assemblage is a better means of characterization. Other palynomorphs (chitinozoans, scolecodonts and graphtolites) were, however, often too fragmentary to identify. Non-acritarch palynomorph assemblages appear to be more useful for an accurate characterization of cherts.

Petrographic Analysis

Petrographic attributes, notably texture, are used to determine the relative quality of cherts present at the Bark site, enabling study of the relationship among lithic raw material abundance, raw material quality and the design of lithic tool kits. Both Onondaga and Fossil Hill cherts are high quality and, relative to the location of the Bark site, non-local (exotic). We anticipated exhaustive use of these materials. On the contrary, however, we found they were used in an expedient fashion. By way of explanation, we suggest that these cherts were being selected for their perceived aesthetic or social characteristics, or both.

Raw Material Use and Implications at the Bark Site

The results of our analysis of the Bark site assemblage suggest that if curated artifacts were produced at the Bark site they were carried away and retouched elsewhere. In earlier excavations (1986-87) at this site, however, Sutton recovered seven complete projectile points—four bases and four mid-sections. On the basis of macroscopic characteristics, he determined that they were produced from Onondaga chert. We did not examine these artifacts. If the tools are in fact made of Onondaga chert, then it is likely that both curated and expedient reduction strategies were used at the site and that different raw material types were being used in distinct ways. Some members and localities of Onondaga chert at bedrock source (Figure 1) are of better quality than others. The expedient and curated utilization of Onondaga chert could, therefore, represent a difference in raw material quality.

Following the ideas of Morrow and Jeffries (1989), the Bark site raw materials may have been acquired within an embedded pattern of mobility. The difference in the way chert tools of non-local and local origin were manufactured and discarded is not evident in the recovered lithic assemblage, which suggests that non-local cherts were procured without additional energy, time and labour costs to the group. However, down-the-line trade presents another, more likely means of procurement. Support for down-the-line trade, as opposed to embedded procurement, is found in the large number of wasted or exhausted cores in the Bark site assemblage, smaller cores being expected at increasing distances from the source, or towards the "end" of the line.

The numerous waterway systems in southern Ontario would have supported a down-the-line trade network, allowing lithic raw materials to be transported from the north shore of Lake Erie northwards, around the west end of Lake Ontario, up the Humber River to Lake Simcoe and into the Trent River–Severn River system (Figure 1). Alternatively, chert could have been carried northwards to Lake Huron and Georgian Bay, or from Lake Erie east through Lake Ontario, then northwest up the Trent River towards Lake Simcoe. During the fifteenth century, the Trent-Severn waterway and its New York linkages were a significant route of transportation (Kapches 1994:13) as were other routes through the Niagara Peninsula, southwestern Ontario and to the north (Jamieson 1999a:184).

Some of the exotic raw materials could have been acquired from secondary sources, such as till. Bobcaygeon cherts, for example, occur in till south of Lake Simcoe and across Durham region to the east (Eley and von Bitter 1989:25; von Bitter and Eley 1984:135,143). Some raw material may have come from fluvial deposits where cherts, at least smaller pebbles, have been transported within river channels. This explanation, however, has drawbacks:

> in theory, a piece of chert could be transported hundreds of kilometers by a glacier and then somewhat farther by the rivers that drain it; in reality, transport is a destructive process and a number of studies have shown that rocks tend to decrease in size exponentially as they are

> carried away from their sources. Thus, the probability of finding chert in usable quantities and sizes decreases as one moves away from the primary source.... [And] the definition of a usable size fragment varies by culture. In Late Woodland Michigan, fragments as small as 3 cm in diameter were worked using bipolar percussion... [though] for most stone-using peoples, usable fragments were considerably larger [Luedtke 1992:102].

Parkins (1974:25) has noted that chert is too brittle to resist glacial erosion, and Jamieson (1984:67) states that "it is relatively uncommon for cherts to be moved great distances from their sources, either by glacial or riverine transport, in any quantity." We conclude, then, that although small pebbles of certain cherts from exotic sources may have been available in a local context, these raw materials are not significant in the lithic assemblage at the Bark site.

We can use petrographic attributes, notably texture, to examine the relationship between lithic raw material abundance, raw material quality and the design of lithic tool kits (Andrefsky 1994:30; Brantingham et al. 2000). Brantingham et al. (2000:261) find that the impact of raw material quality is a constant constraint through all stages of reduction. However, Akridge and Benoit (2001:143) note that "cherts were also praised for their aesthetic value." For example, Late Woodland peoples in Michigan preferred the "strikingly colourful" Upper Mercer chert in ritual contexts (Luedtke 1978). For the Anishnabe, Onondaga cherts are prized for their association with Niagara Falls, one of the stopping places on their migration westward. They may have been secondarily prized by the Ontario and League Iroquois for their associations with supernatural beings (Barbeau 1915:8-9, 306; Smith 1983:9).

The Bark site posits an interesting problem when one examines socio-technical organization. Although material culture recovered from the site has been used to suggest it is a Huron site (Sutton 1990), the settlement data do not conform with the supposed Iroquoian site model. Instead, Jamieson (1998, 2004:71) has suggested that both Iroquoian and Algonquian peoples occupied the site. Iroquoian populations are matrilineal whereas Algonquian populations are patrilineal. Difference in kin organisation will affect how and by whom raw materials are moved by human agents.

The effect of kin organization on raw material movement ties into trade rights. Trade or exchange interactions often are limited to a few, select individuals. Typically, these individuals are men, who pass on their rights to trade (and associated prestige) to their next of kin—from uncle to nephew in matrilineal groups and from father to son in patrilineal groups. Gould and Sagger's (1985:120) work with Australian Aborigines found that although stone tool making was not an exclusive male activity, only men made special purpose trips to obtain lithic materials. This strict division of labour by sex can be attributed, in part, to the patriarchal social organization of the groups involved in long-range social networks. Nine out of thirteen lithic source localities visited in their study had sacred associations and only men with "specific affiliations to those sites could approach" these localities (Gould and Saggers 1985:120). At the Bark site, the analysis of technological organization does not help in determining cultural identity: assemblages with mixed technological strategies are typical of both Algonquian and Iroquoian peoples. Concerning the possibility of identifying differences in technological strategies used within domestic and non-domestic settings at the Bark site, no definitive statement can be made owing to the high degree of site disturbance.

Renfrew and Bahn (1996:336) state that there is a "real equivalence between the interaction seen as a communications system and the interaction as a system for the exchange of material goods." Around the time the Bark site was occupied, notions of prestige, authority, and status associated with exotic materials were diminishing. Instead, there was an increasing dependency on close-range ties and an intensified use of local resources in this part of Ontario (Jamieson 1999a:184, 1992:73). This suggests that maintaining long distance interactions during a period of sedentism, regionalism, and consolidation

(Jamieson 1992:77) was a way to facilitate close kin relationships rather than reflecting a desire for exotic raw materials and their associated ideological concepts. These ideological concepts—prestige, status and authority—could have been transferred from an earlier association with raw material to the participation in trade (trading rights) instead. Prestige, status and authority, resulting in power, could be ascribed both to those individuals involved in trade and to the trade goods themselves.

McGuire (1992:132) states that power becomes significant when access to raw material sources is influenced or determined by lineage and territorial rights. Control over the rights to raw material sources can belong to certain lineages or groups, and not others. Likewise, some lineages or groups may have rights to trade for materials from these sources, while others do not. This differential control could affect the composition of a chert assemblage at a site if its occupants did not include a lineage with trading rights, or kin relations with groups with access to, or control over, raw material sources, or both. Warrick (1984) proposes that Iroquoian households were composed of corporate kin groups that did not compete with each other for wealth but, rather, formed economic and political coalitions. Nonetheless, these coalitions were themselves competitive with each other. This competition emphasizes the role that the structure or organization of kinship relations played in the dynamics of trade and exchange, status and prestige. Among the seventeenth-century Ontario and League Iroquois, for example, only certain kin groups were entitled to name chiefs.

To summarize, status, prestige, and authority, which once were associated with the use of the raw material itself, later came to be associated with control over (or rights to) the raw material source. As control or trade rights were acquired by (or maintained by) kin organization, the maintenance of kin relations would have facilitated long distance trade. For example, pilgrimages to acquire chert, or status to enable access to, and use of, materials associated with a sacred place (such as Onondaga chert from the vicinity of Niagara Falls), create considerable prestige for the material itself. An implication is that expedient reduction and exhaustive use of high quality, exotic cherts at the Bark site indicate more than the satisfaction of purely technological needs. These particular toolstones not only had aesthetic appeal: they also conveyed social prestige.

Conclusion: Future Research

The raw material analysis outlined here suggests that at least eight chert types are present. The original characterization conducted by Jamieson (1999b, 2000, and 2002), which identified five potential chert raw material sources, is adequate only insofar as it established the general character of the Bark site assemblage. Macroscopic analysis alone is not an adequate means for chert type differentiation.

Fifteen years have passed since Eley and von Bitter's definitive chert typology was published. Since then, a number of new chert sources have been discovered that have not yet been characterized, and the characterization of older, known sources has come into question. All chert sources in southern Ontario and the Upper Great Lakes region need to be re-examined.

As Eley and von Bitter have established the baseline data for southern Ontario chert sources using petrography and palynology, we propose that chemical sourcing of these same sources is the next necessary step. Compositional (chemical) characterization usually provides reliable evidence for trade and exchange in determining whether the material was acquired locally or more distantly. Luedtke (1979, 1992) found, however, that chemical sourcing is not always successful with lower Great Lakes cherts. There is often too much overlap in the chemical fingerprints of the different sources. Cost and time required for analysis is another reason why petrographic and palynological analyses were selected over chemical analysis in this study.

The identification and description of palynomorph assemblages has not been undertaken for most chert raw materials recovered from archaeological assemblages. There will have to be a significant amount of data collection before palynological analysis can be used as an effective and efficient method of determining chert provenance.

Finally, the analysis of chert must occur within an archaeological context for each and every chert source separately, allowing us to address the questions of how and when raw material types were used and sources exploited. For example, how was Onondaga chert, specifically, used? What are the temporal and spatial distributions of sites with Onondaga chert? Was this raw material reduced in an expedient manner, a curated manner, or both, at each site? Once this information is in hand, then the correlation between sites, as well as the correlation between chert types, can be examined. To follow our previous example, if Onondaga chert is found at a site, what other cherts are commonly found in the same assemblage? By answering these questions, we will finally be able to clearly elucidate larger regional patterns of ancient trade and exchange.

The only limitation of these forms of analysis is that they are destructive. Consequently, until curators and archaeologists alike become willing to "sacrifice" their finds and collections, petrographic and palynological analysis of chert assemblages will continue to be underused as a technique for acquiring information about technological, behavioural and functional activities at a site. We must be willing to move beyond these ideas of "destruction" in order to recognise the vast amount of information to be obtained through these investigations. Post-processual lithicists now have the means for moving away from morphology and function-based typologies towards understanding social and ideological structures from lithic assemblages.

On the basis of this research we suggest the future of raw material sourcing in the Great Lakes region, and southern Ontario specifically, lies in: the investigation of local and regional chert sources and the compilation of these sources into a comprehensive catalogue; the application of chemical sourcing (e.g., ICP-MS, INAA, XRF) to chert investigations; detailed palynomorph and phytolith analyses for all chert sources; and the application of archaeological context to chert sources.

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Afin de comprendre la façon dont certaine variété de silex était utilisé dans la fabrication d'outils de pierre au site Bark (BpGp-12), Comté de Peterborough, Ontario, les attributs des matières premières de 164 artefacts de l'ensemble d'objets de silex sont analysés. Une combinaison d'analyse macroscopique, pétrographique et palynologique est utilisé afin d'identifier la provenance des types de silex les plus utilisés par les habitants du site. Les formations Onondaga, Fossil Hill et Upper Gull River sont identifiées. Nous concluons, *contra* Eley et von Bitter (1989), que l'identification du genre acritarche n'est pas nécessaire pour différencier entre ces types de silex. Au contraire, des caractéristiques plus significatives sont l'abondance relative de différents sous-groupes palynomorphes (basé sur la morphologie), et l'abondance relative d'acritarches comparativement à d'autres microfossiles (spore de chitinozoan, de graptolite, de scolécodonte, et de trilète). L'attribution du silex à des sources lointaines nous permet d'explorer des thèmes comme l'accès aux matériaux exotiques de haute qualité par des groupes parentés locaux.

Katie M. Biittner
Department of Anthropology
13-15 Tory Building
University of Alberta
Edmonton, Alberta, Canada T6G 2H4
katie.biittner@ualberta.ca

Susan M. Jamieson
Department of Anthropology
Trent University
Peterborough, Ontario, Canada K9J 7B8
sjamieson@trentu.ca