THE ARCHAIC LITHIC ASSEMBLAGE FROM WEST BURLEIGH BAY, ONTARIO

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ABSTRACT

The Archaic Lithic Assemblage from West Burleigh Bay, Ontario

Janice M. Teichroeb

The objective of this thesis is to document the Archaic (ca. 10,000 to 2800 BP) lithic assemblage from the West Burleigh Bay site (BdGn-12) and to examine changes in raw material usage and flint-knapping skill during the Archaic period in southeastern Ontario. The use of coarse-grained, locally available, lithic material is a noted characteristic of the Archaic period in the Northeast and the West Burleigh Bay Archaic assemblage fits this model. One third of diagnostic Archaic tools excavated from the site were made on locally occurring, black, lightly metamorphosed, sedimentary material. Toolstone provenience and quality were assessed as were knappers' skill levels to determine if the tools were made with less care and skill or if the quality of the toolstone affected the appearance of finished tools. Analysis determined that flint-knapping skill levels at the West Burleigh Bay site remained constant throughout the Archaic but that raw material quality fluctuated.

Keywords: Ontario archaeology, Archaic, lithic technology, raw material provenience, raw material utilization

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Janice Teichroeb, November 2006

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Chapter 1

Introduction

The first use of the term Archaic as a cultural identifier was by New York Archaeologist William Ritchie (1932) in his profile of the Lamoka Lake site located in central New York. This term has since been extended across North America to include all post Paleoindian peoples without ceramic technology or agriculture (Ritchie 1994:31). Such a broad definition serves a purpose in placing regional variation within a temporal framework but does not provide sufficient structure and precision to enable a detailed comparison and analysis of a site or region. To remedy this, various authors developed regional chronologies that expanded on Ritchie's research and provided a means of dating and comparing Archaic artifacts within their regions or areas of research (e.g. Ellis et al. 1990; Mason 1981; Snow 1980; Tuck 1976; Wright 1972a, 1972b, 1995, 1999).

Regional definitions of the Archaic in Ontario delimit two broad geographic areas, the Canadian Shield in the north and the Great Lakes - St. Lawrence region in the south (Wright 1995:Chart I). In both regions the term Archaic assumes the broad definition of an aceramic period that post-dates the Paleoindian period, but regional chronologies and typologies are based on local artifact assemblages and site characteristics. During the Archaic, artifact assemblages became more varied and included woodworking tools, copper tools, and stone and bone fishing implements (Ellis et al. 1990:65-67; Wright 1995 266-270). The diversity of toolstone increased to include local, less flakable material and, in the south, the methods of manufacture broadened to include a wide variety of ground stone and chipped stone tool types. There was also an increase in the use of expedient tools such as flakes and hastily made points. Population density and regionalization increased over time and were evidenced by an increase in the number and variety of sites along with more intensive use and reliance on local resources.

In southern Ontario the Archaic spans over 7000 years and is divided into three somewhat arbitrary periods linked to changes in projectile point technology. These periods retain terminology set by Ritchie: Early, 10,000 to 8000 BP; Middle, 8000 to 4500 BP; and Late, 4500 to 2800 BP. The appearance of notched points at around 10,000 BP, interpreted as a change in hunting technology from thrusting spears to the atlatl, is used by most researchers as an indicator of the beginning of the Early Archaic (eg., Ellis et al. 1990:67; Wright 1995:121-122). The introduction of pottery in southern Ontario about 2800 BP demarcates the end of the Archaic. In northern Ontario the Archaic spans 10,000 to 1500 BP and is divided into three periods, the Early Shield culture, 10,000 to 6000 BP, Middle Shield culture, 6000 to 3000 BP, and Late Shield culture, 3000 BP to 1500 BP. Pottery appears much later in the north than in the south. For this reason, pottery is not used to mark the termination of the Archaic in the north. Instead, termination is marked by the appearance of smaller projectile points manufactured on good quality chert. This change in technology is interpreted to reflect the introduction of the bow and arrow (Wright 1995:272).

The West Burleigh Bay Site (BdGn-12)

The research presented in this study entails an analysis of the Archaic lithic assemblage from the West Burleigh Bay archaeological site. The site is located on a point of land on the north shore of Stony Lake, a short distance from Burleigh Falls. Ideally situated in a resource rich environment, Stony Lake is located in the middle Trent Valley in southeastern Ontario (Figure 1.1) and is one of an interconnected string of lakes and rivers that link Georgian Bay to Lake Ontario.

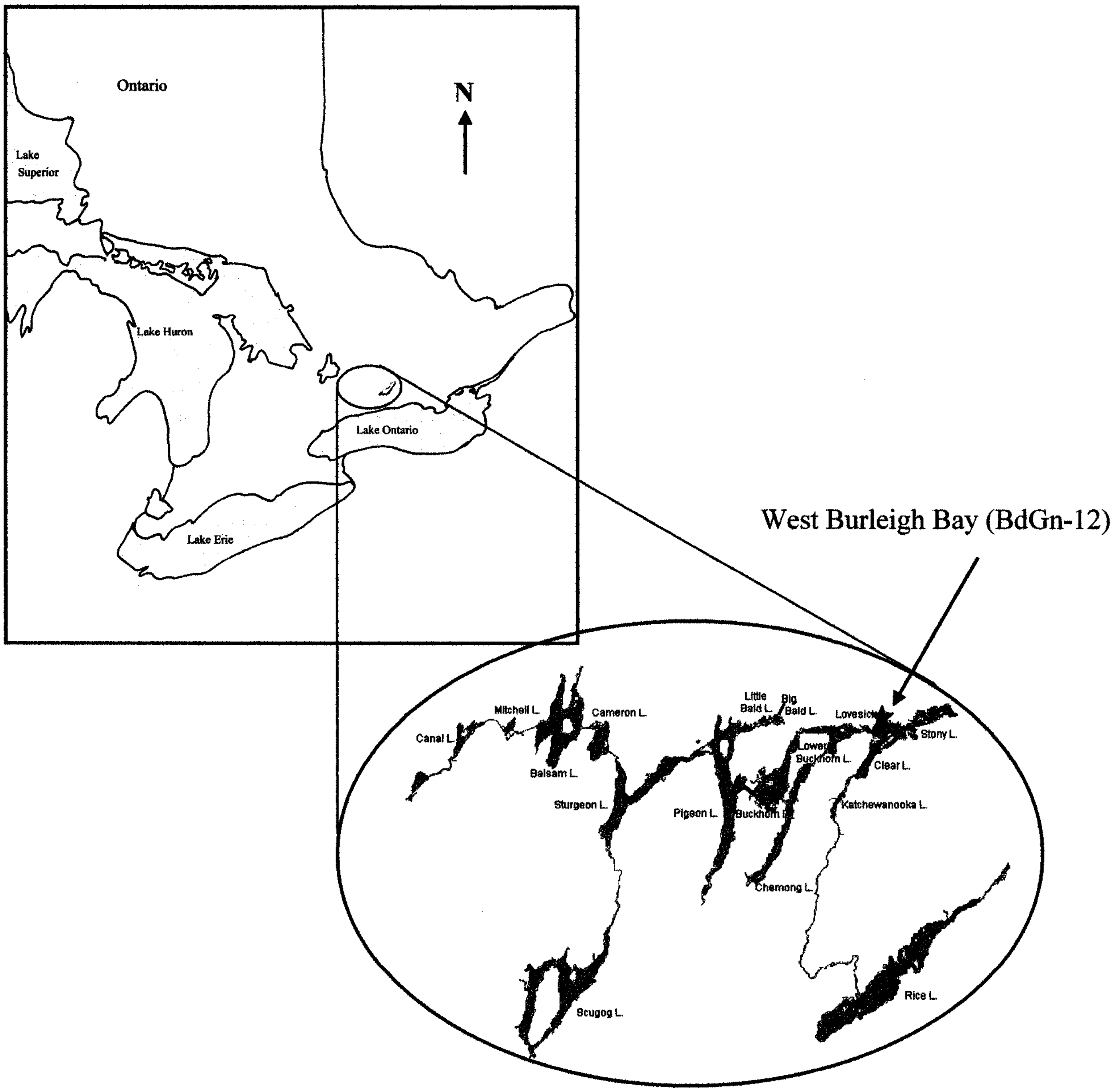


Figure 1.1 Location of West Burleigh Bay site

The topography of the site is rugged, consisting of a series of fossil terraces that rise in intermittent steps from the shoreline. The southern margin of the Canadian Shield merges with the lake at this juncture and, typical of the Shield, thin soil overlies a rocky base. Though most of the Stony Lake shoreline has been developed and landscaped by cottagers and resorts, the West Burleigh Bay site has remained largely undeveloped. The property was logged to the mid-twentieth century and it has been repeatedly burned, but the majority of disturbances to the soil have been through natural processes including water drainage and seepage, root disturbance and animal activity.

Excavation of the West Burleigh Bay site, by Trent University field school students during four field seasons from 2002 to 2005, has provided a unique opportunity to expand our knowledge of the people who once lived in the middle Trent Valley. Artifacts recovered from this site indicate that Native people inhabited the region shortly after the glaciers receded. During the post-glacial period, beginning around 13,000 BP, the region was covered by tundra-woodland, a habitat that attracted large mammals and the first human inhabitants (Karrow and Warner 1990:29). Paleoindian artifacts recovered from the West Burleigh Bay site attest to the very early presence of these people. Subsequent climatic warming resulted in changes to the flora and fauna in the region (Karrow and Warner 1990; McAndrews 1994; McAndrews and Turton 2004) and Archaic and Woodland lithic artifacts from the site reflect these changes. Excavations have determined that people lived at, or visited, this site on a recurring basis up to the present day. The artifact assemblage provides clues to not only the people who resided there and the environmental conditions that existed at the time, but also the social and political relationships of the people, and even their belief systems.

Research Questions

The Archaic lithic assemblage from the West Burleigh Bay site comprises 2070 artifacts, of which 103 are diagnostic tools, and the balance are informal tools (20), scrapers (3), unfinished bifaces (48), cores (8), and debitage (1888). The artifacts represent repeated, temporary camps and, though the extensive time span combined with intermixture of artifacts in the soil limit the inferences that may be made, there are still a number of pertinent questions which may be addressed. Two documented traits of the Archaic period are subjected to particular examination in this study: the increased diversity of toolstone including less flakable material, and the appearance of thick, irregularly flaked, asymmetrical tools. After 8000 BP stemmed projectile points throughout the Northeast exhibited a "noticeable decline in refinement and morphological sophistication" (Morrow 1997:228) and have been described as hastily made with less skill than those manufactured during earlier periods (Ellis et al. 1990:66). There is a broad assumption that permeates the Archaic period literature of the Northeast that equates the changes in the appearance of Archaic tools to a decline in skill level and a decline in the effort expended in their manufacture. These value statements are based on comparison of visual characteristics and their veracity has never been tested. This study aims to determine if these assumptions are true or if there is an alternate reason for the observed changes. As a result, the primary objective of this research is identification of the quality of archaeological toolstones used and of knapper's skill levels to determine if tools were made with less care and skill or if the quality of the toolstone affected the appearance of the finished tools. A secondary objective is more general and includes an examination and documentation of the Archaic assemblage at the West Burleigh Bay site in order to augment the very limited knowledge of this period in Ontario. The following questions provide direction for this research.

For Finished Bifaces and Informal Tools in the Archaic assemblage:

1. What are the proportions of tools made on various raw materials?
2. Is it possible to determine the source of the raw materials used?
3. What is the proportion of tools made on local raw material to those made on non-local material?
4. Is there a relationship between the functional types of tools (e.g. projectile points vs. celts and gouges) and the types of raw material used?
5. Is there a relationship between the typological style (e.g. Otter Creek, Normanskill, Brewerton) of the tools and the type of raw material used?
6. Is it possible to determine a delimited period of time when various raw materials were used?

For Unfinished Bifaces manufactured on non-chert material in the Archaic assemblage:

7. What methods of manufacture were utilized at the site?
8. What is the fracture quality of the raw material?
9. What is the skill level of the people producing the bifaces?
10. Is there evidence that the raw material quality negatively affected the manufacture of bifaces?

This study follows three lines of inquiry to meet the research objectives. The first is to document the known Archaic assemblage from West Burleigh Bay and to situate it within the broader context of the Northeast. The second is to investigate lithic procurement strategies at West Burleigh Bay during the Archaic, and the third is to study the lithic reduction techniques employed at the site. The resulting analysis of the lithic artifacts will identify the methods of manufacture, the stages of manufacture performed at the site, the types of raw materials used, the styles of artifacts based on published typologies, and the temporal phases of the Archaic period to which they date. Methods of manufacture, tool styles and raw materials are the key components of this research and all are interrelated.

Thesis Organization:

The chapters in this thesis are organized in the following manner:

The second chapter *Social Organization and Political Interaction in the Middle Trent Valley during the Archaic Period* provides an overview of the current literature describing the Archaic period in the Northeast with special emphasis on southern Ontario. Also included is a discussion of the geology of the region and environmental changes that occurred during the Holocene. The third chapter *Approaches to Lithic Analysis* is a review of current lithics theory and outlines the inferences that may be made from the artifacts recovered from the West Burleigh Bay site. The fourth chapter *Research Methods* outlines research methods utilized, including sampling techniques, and statistical methods, to analyze the Archaic period lithics assemblage. The fifth chapter *Research Results and Analysis* provides a discussion of the results of the research. The results have been summarized into three broad categories; raw material usage, method of lithic production, and flint-knapper expertise. The sixth and final chapter *Summary and Conclusion* provides a summary of the research including a discussion of the Archaic period represented at West Burleigh Bay within the context of the Northeast and also suggestions for future research.

Chapter 2

Social Organization and Political Interaction in the Middle Trent Valley during the Archaic Period

The Archaic period is broadly interpreted as an early stage of hunting, gathering and fishing economies, a time when territories decreased and regional adaptations to Holocene environmental change were diverse (Ritchie 1994:32; Wright 1995:116; Yerkes 1986:226). The West Burleigh Bay archaeological site was inhabited on a recurring basis during the 7000-year span of the Archaic and consequently provides a wealth of information useful for investigating changes throughout the period. The site is located on the present shore of Stony Lake, which together with the interconnected lakes and rivers of the Trent-Severn water system provided, and continues to provide, a transportation route between the Upper and Lower Great Lakes (Figure 1.1). The purpose of this chapter is to develop a description of the social and political organization of Archaic peoples applicable to southeastern Ontario and the people who inhabited the West Burleigh Bay site.

The northeastern margin of Southern Ontario is demarcated by the southern edges of the Canadian Shield, a ground surface of bedrock. Stony Lake straddles the boundary of the Shield, and West Burleigh Bay is located on the rocky north shore. Thin, acidic soils covering the bedrock reveal very little stratigraphy and cause organic material to decay rapidly. The result, as is typical of sites on the Shield, is an inability to delineate time sequences through absolute dating methods (Wright 1995:262). Notwithstanding its northerly geographic location, the site is located within the Canadian biotic zone (Karrow and Warner 1990:8) indicating a biotic environment similar to the north shore of Lake Ontario rather than that typical of Shield sites. This is a transitional zone that consists of a mixture of southern-type deciduous trees and northern-type coniferous trees (Karrow and Warner 1990:8). In comparison to the Carolinian biotic zone, into which southwestern Ontario falls, the Canadian zone is cooler, less suitable for agriculture, and produces fewer nut-bearing trees, resulting in more restricted subsistence options. The location of this site requires that characteristics of both northern Shield Archaic and southern Great Lakes-St. Lawrence Archaic cultures be taken into consideration.

Limitations of the archaeological record in the middle Trent Valley, where organic materials are rarely preserved for more than a few hundred years, means that interpretation of the social and political organization of the Archaic people is reliant on theoretical models pertaining to hunter-gatherers. Lithic artifacts, knowledge of the paleoenvironment, and use of ethnographic studies of historic hunter-gatherer populations contribute to our understanding of the past relationships. The following is a blend of information collected from these various sources to develop an illustration of how the Archaic peoples may have lived in the middle Trent Valley. This illustration is not meant to be a comparative essay of previous research. Instead I have selected sources that I believe are the most appropriate for the region and provide the most depth and insight for understanding this particular site. Very little has been written on the social and political relationships of the Archaic people in Ontario, in part because any such description of the a distant past is speculative. This is not to say that it is invalid. Instead I believe that this type of scholarly speculation moves archaeology towards a deeper and more holistic understanding of the past.

Environmental Conditions during the Archaic

Retreating glaciers were responsible for the formation of a series of pro-glacial lakes in the Great Lakes basin. However, there are conflicting interpretations of the ages and extents of these lakes (Jackson et al. 2000; Morgan et al. 2000:13). I follow the recently proposed `Revisionist model' here, which argues that the high water levels in the southern Huron basin contemporary with an Early Paleoindian presence are not associated with the lake known as the Main Algonquin, as previously thought, but are instead associated with Lake Ardtrea, which is dated ca. 11,000 to 10,400 BP (Morgan et al. 2000:13-15). This lake extended east to the Kirkfield vicinity and likely as far east as Fenelon Falls (Karrow 1994:226; cf. Kaszycki 1985:122). Lake Ardtrea is thought to have drained through the Port Huron outlet into the Erie basin (Morgan et al. 2000:15) as well as through the Fenelon Falls outlet, and down the Trent Valley to the Ontario basin (Finamore 1985:129; Karrow and Warner 1990:15; Kaszycki 1985:122). Drainage through the Fenelon Falls outlet, at times referred to as the Algonquin River (Muller and Prest 1985:221), carved a zigzag path through the Trent Valley (Figure 2.1). Fossil terraces located at the West Burleigh Bay site are likely related to spillway terraces identified southeast of Fenelon Falls (Finamore 1985:129) and provide evidence of drainage events (Jamieson 2005:3).

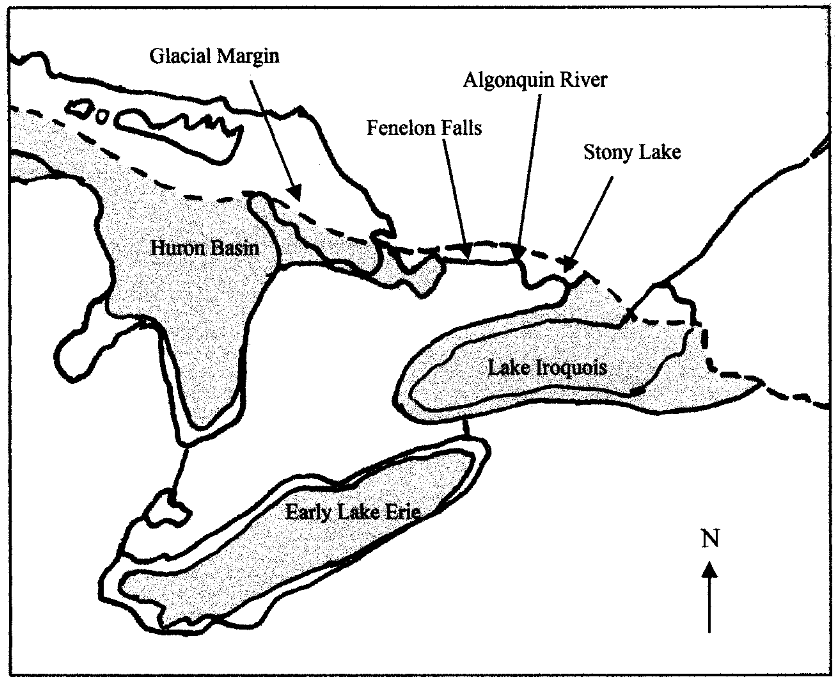


Figure 2.1 Lake Ardtrea drainage down the Algonquin River (adapted from Hough 1958:Figure 69)

Geological studies conducted to identify changes in water levels during the Holocene tend to focus on shorelines and drainage outlets of glacial and post-glacial lakes (Karrow 1994:229). As a result, the effects of changes on river valleys must be based on, and interpreted from, these studies. Alluvial deposition, water levels, and flow rates in the Trent Valley varied during the Holocene and were dependent on factors such as glacial lake drainage, differential crustal uplift, outlet adjustments, and drainage diversions (Eschman and Karrow 1985; Finamore 1985; Anderson and Lewis 1985). Though water levels in the Trent Valley varied widely throughout the Archaic, it is possible that after 10,000 BP when the glacial margin had retreated into northern Ontario, the Trent Valley was a navigable watercourse connecting the Huron basin to Early Lake Ontario (Karrow and Warner 1990:21,33; McAndrews 1994:187).

Drainage of Lake Ardtrea around 10,400 BP marked the end of this high water phase (Morgan, McAndrews and Ellis 2000:15). Resultant low water levels between ca. 10,000 and 5500 BP are known as Lake Stanley in the Huron basin and Lake Hough in the Georgian Bay basin. They occurred as a result of deglaciation and the opening of the North Bay outlets. Drainage through the Trent Valley would have been greatly reduced or even halted during this time. McAndrews and Turton (2004:2) note that sedimentation began in the Burleigh Falls area about 9800 BP. This, in turn, implies that the Algonquin River may have stopped flowing 10,000 to 9000 years ago. Over the next 5000 years isostatic uplift of the North Bay outlet redirected the flow of water exiting the Huron basin southward through the Port Huron outlet toward the Erie basin. Known as the Nipissing transgression, water levels during this phase were in flux. As outlets were altered, water levels in the Huron and Georgian Bay basins rose and fell. A high water phase is suggested around 5000 BP that possibly lasted for only a short time before receding. Trent Valley water levels would also have been affected by this process. By 3000 BP water levels in the Huron basin stabilized approximately three meters below the high level phase of the Nipissing transgression, resulting in the formation of Lake Algoma. Subsequent downcutting of the Port Huron outlet led to lowering of the water to present levels.

In the Ontario basin ca. 12,000 BP, the early phase of glacial Lake Iroquois was a high water stage that extended up the Trent Valley (Muller and Prest 1985:220). Rice Lake was likely a bay within an arm of Lake Iroquois at this time. The Algonquin River contributed to the high water phase by draining Lake Algonquin into Lake Iroquois. A large delta in the Peterborough area was formed during this time. By 11,400 BP, the

Admiralty Phase, early Lake Ontario entered a low water stage that rose and fell very slowly over the ensuing 6000 years. The Nipissing Flood phase, resulting from alterations in Huron basin outlets, peaked in the Ontario basin ca. 4000 BP with higher than present water levels that subsided within 1000 years. During this time reduced water flow from the Trent Valley likely had minimal impact on the water levels of Lake Ontario.

Current water levels at Stony Lake are artificially maintained to accommodate the Trent-Severn system. The earliest terraces remain visible above the present shoreline but occupations that occurred during low water phases have been inundated.

Climatic changes during the Holocene were the result of "interplay of movements of continental cyclonic weather systems, fluctuating Great Lakes levels and associated climatic influences, and site-specific microclimate regimes." (Karrow and Warner 1990:35). Changes in forest composition reflect these climatic changes. During the Early Holocene ameliorating winters and warm, dry summers that were longer and warmer than present resulted in changes in the landscape in eastern Ontario from treeless tundra to spruce forest by ca. 10,000 BP (Karrow and Warner 1990:33-35; McAndrews and Turton 2004:2). After 10,000 BP a gradual increase in atmospheric humidity in conjunction with warm summers led to the replacement of spruce forests by jack pine. Fossil pollen and spore identification from sedimentation cores lifted from Lovesick Lake (adjacent to Stony Lake) and Axe Lake (150 km northwest of Lovesick Lake) provide evidence of climate change in the vicinity of West Burleigh Bay (McAndrews and Turton 2004). According to this evidence jack pine forests were dominant between 9800 and 8500 BP but were replaced by white pine by 8000 BP, suggesting a gradual increase in humidity and a continuation of hot summers. These forests would have been similar to, although not directly analogous with a modern boreal forest, insofar as a variety of hardwood and mast trees such as oak were present. In this relatively open boreal forest, subsistence resources were probably woodland caribou and/or elk, moose, beaver, hare and fish (Dibb 2004:126; Lennox 2002:8).

With the exception of a mid-Holocene warm/dry period between 6000 and 3000 years ago (Yu and McAndrews 1994:151), after ca. 7500 years ago the southern Ontario climate shifted from deglacial to postglacial (Yu 2003:387), and moderated to near modern temperatures with cooler summers and atmospheric humidity slightly lower than present values. Mixed coniferous-deciduous forest dominated the region. In the vicinity of West Burleigh Bay hemlock and white pine were common. Pollen evidence of abundant water lily (*Nuphar* and *Nymphaea*) after ca. 8500 BP from Lovesick Lake indicates low water levels of approximately 1 m deep (McAndrews and Turton 2004). Low lake levels suggest a drier environment and/or a reduction of flow through the Trent-Severn system. An essentially modern but slightly drier climate was established during the Middle (8000 to 4500 BP) and Late Archaic (4500 to 2800 BP). Subsistence resources at this time likely included a wide variety of aquatic animals, as well as waterfowl attracted to the rich marshy environment. Deer, fish, beaver, hare, duck and turtle as well as seasonal plants such as berries, sedges, and later in the Archaic, wild rice, were all possible food items utilized during the Middle and Late Archaic (Ellis et al. 1990:111-114; Jamieson 2002:31; Ritchie 1994:34).

Social Organization, Subsistence and Settlement Patterns

The social organization of the Archaic period people is classified as a mobile, small band organization with simple social structure (Ritchie 1994:32-33). This is based on the presence of small, ephemeral sites that usually lack any trace of dwellings, fortifications, storage pits and graves. Exceptions exist, but are generally associated with the Late Archaic. Band organization likely consisted of aggregates of several families who worked together as basic social-economic units (Leacock 1998:142; Ritchie 1994:34; Rogers 1969:26). Extended groups were united by common needs of hunting, gathering and sharing food, but research shows that cooperation between groups of individuals is highly dependent on the size of the group and the relatedness of the group (Bettinger 1991:162; Ritchie 1994:77). Kin-based groups have a tendency to be more cooperative than non kin-based groups.

Band membership was fluid, with families joining and dispersing for a variety of reasons, including seasonal resource fluctuation or even as a result of personal friendships and animosities. Ethnographic study of the Montagnais-Naskapi indicated they were particularly loosely structured and fluid (Leacock 1998:143-148). A contradiction between expectations of group consensus and individual autonomy may have contributed to the movement of people between bands (Bettinger 1991:162). Leacock (1998) determined that Montagnais-Naskapi decision-making was by consensus, within and between family units, and that leadership was irrelevant, as decisions that affected the group were never made unilaterally. At the same time, personal autonomy was also valued. Each person was required to show initiative and decisiveness while considering his or her responsibility to the band as a whole. As a result, people moved freely between bands and this constant movement of people subverted any development of authority and maintained an egalitarian society (Woodburn 1998:91-92). Differences in social status, if present in bands, were negligible and may have been based on abilities or age. For the Ojibwa, leadership was based on circumstances and need, and leaders were selected by consensus for their ability to "lead the way" (Johnston 1976:61-62). Leaders usually held only advisory or persuasive power (Johnston 1976:61; Ritchie 1994:34,77).

All able-bodied adults, both men and women, contributed to the activities required for procuring and processing food items (Lovisek et al 1996:174; Paap and Paap 1998:244). There was a distribution of labour based on gender but roles were complementary and interdependent. Leacock (1998:146) describes the relationship as one where men and women were valued for their unique contributions to the group.

Early Archaic (10,000 to 8000 BP)

Though reduced territories and increased regional variation are hallmarks of the Archaic period, these indicators do not appear in the scanty archaeological record for the Early Archaic. For example, following his analysis of the Late Paleoindian-Early Archaic McKean site, Lennox (2002:8) concluded that most of the artifacts and the settlement-subsistence system showed strong affinities with what we regard as Late Paleoindian. The assemblage's primary distinguishing characteristics were the notched, unfluted projectile points. Early Archaic point styles are very similar across much of eastern North America and non-local cherts continue to be significantly represented in established during the Paleoindian period, upwards of 250 kilometres in a single direction (Ellis et al. 1990:70,77; Stothers 1996:181,197).

As noted above, the primary subsistence resources during the Early Archaic were likely caribou and/or elk, moose, beaver, hare and fish. For example, evidence from the ca. 10,000-9000 BP McKean site in Simcoe County shows that Early Archaic hunter-gatherers followed a generalized subsistence strategy, akin to their temporal predecessors, including the hunting of large cervids and fishing (Lennox 2002). One characteristic of fauna in northern latitudes is that there are large numbers of few species. These would have required considerable group mobility as people were forced to focus on what was seasonally available and plentiful (Ritchie 1994:34). Both Paleoindian and Early Archaic hunter-gatherers in eastern North America followed a generalized subsistence strategy, including hunting large game, and foraging and fishing when possible (Meltzer and Smith 1986:5). Even though there is continuity there is also a pattern of gradual diversification over time. The Paleoindians in Southern Ontario had a specialized 'focal' adaptive strategy focusing on the highly migratory caribou that inhabited the tundra environment (Cleland 1976:60; Meltzer and Smith 1986:3). The large numbers of few species of fauna in the northern latitudes had implications for the foraging strategies of the human inhabitants, forcing them to focus on what was available and plentiful. This inverse relationship between number of species and abundance holds true in more temperate environments as well. The result is that rich environments rarely have more than one or two resources available at any one time in sufficient quantities to provide sustenance (Meltzer and Smith 1986:6). Consequently, the strategy for hunting and gathering becomes more generalized or "diffuse' during the Early Archaic. A richer environment with a hunting strategy that relied less on migratory caribou and/or elk and more on forest dwelling deer negated the need to cover vast territories (Stothers 1996:186).

Though the Early Archaic forest environment has no modern parallel, the current Canadian boreal forest has an environment suited to caribou and elk and provides a reasonable analogue. Caribou are migratory and can travel upwards of 2400 km during their annual cycle, covering anywhere between tens to hundreds of thousands of square kilometers (Burch 1972:345-356). Migration timing, length and direction are highly variable between caribou species, among caribou populations, and from year to year. Nevertheless, most caribou move to a calving area on the tundra in spring or early summer and into a winter range in the forest during the fall. These two predictable movements are exploited by the people who hunt them.

Elk similarly move about the landscape and do not have a static home range (Banfield 1977:399-400). Elk can be found in both mountainous and level terrain. They prefer open areas such as marshy meadows and river flats but are quite flexible in their choice of habitat and will occasionally be found in coniferous forests. Elk that reside in areas of level terrain, as is the case for much of the boreal forest margins of present day Canada, will spend summers among wooded hillsides and lake shores and migrate to open grasslands seeking out areas of lighter snowfall such as windblown slopes in winter. During the summer months, females band together with their calves while males form their own bachelor groups. After the rutting season in the fall the male and female bands combine to forage as a single unit until spring when the females separate once again to bear and rear their calves. As with the caribou, elk are predictable in their annual migrations and this knowledge is used to the advantage of the people who hunt them.

Ethnographic evidence, from the mid-twentieth-century, of the Chipewyan of northern Saskatchewan provides a description of hunting strategies used to exploit the transition zone of the boreal forest in Subarctic Canada (Jarvenpa and Brumbach 1988; Sharp 1977) and helps to explain possible hunting strategies of the Early Archaic. The more northerly of the Chipewyan inhabited the forest-tundra transition zone and focused primarily on hunting caribou. They led hunting expeditions to both the barren grounds in summer and to the edge of the boreal forest in winter (Sharp 1977:379). In contrast, the more southerly boreal forest dwelling Chipewyan supplemented their primary food sources of moose and fish by making winter hunting expeditions to the north to fish, trap, and hunt caribou (Jarvenpa and Brumbach 1988:599,601). The implication for Early Archaic peoples is that cervids were an important resource and the degree of exploitation was likely dependent on the seasonal availability of these and alternate resources as well as the group's proximity to the forest-tundra transition zone.

Toolkits manufactured by Early Archaic people consisted of generalized and maintainable tools in a manner similar to those produced by Paleoindian groups. However, Archaic toolkits tended to incorporate a greater variety of tool styles and used a wider range of raw materials, from both local and non-local sources (Ellis et al. 1990:77). Bifacial tools continued to be manufactured on fine grained cherts but coarser grained raw materials were also used. There was an increased reliance on locally available materials including chert obtained from secondary glacial/riverine deposits rather than from non-local bedrock. While Archaic populations in Ontario traversed smaller areas than their Paleoindian counterparts, they were not sedentary people. Ellis et al. (1990:78) propose that changes in lithic usage corresponded to low water levels, providing access to previously inaccessible materials (Ellis et al. 1990:78). Alternatively, restricted access to quarries or greater familiarity with a region may have promoted the use of local toolstone.

The changes to the lithic material and to styles of tools indicate the beginning of an open-ended approach to raw material acquisition. There is generally a decrease in the rate of resharpening; an increase in the use of unmodified flakes; and an increase in the use of heavy, less portable tools (Ellis et al. 1990:78). These changes suggest a trend toward decreasing mobility and a greater use of local materials.

Middle Archaic (8000 to 4500 BP)

Sites representing the Middle Archaic in Ontario are scanty. This may be due to poor recognition of Middle Archaic artifacts or it may be the result of higher modern water levels and the inundation of sites that were established during low water periods (Ellis et al. 1990:80). A study of Middle Archaic sites in the Central Michigan Uplands supports the premise of submerged sites (Lovis et al. 2005). Contrary to earlier suppositions that low site densities corresponded to low carrying capacities (Fitting 1968), the study by Lovis et al. (2005:670) concluded that a large number of low-visibility upland sites represent dispersed seasonal hunting groups and postulated that an expanding population intensively used shoreline sites that have been inundated by Lakes Michigan and Huron. At Lovesick Lake, near Burleigh Falls, fish weirs radiocarbon dated to ca. 6650 BP have been discovered by Parks Canada divers. These point to the potential contribution of spring and fall fish runs to the Middle Archaic diet. From this and other sites that have been identified in Ontario, it is evident that during this period the typical identifying traits of the Archaic emerged (Ellis et al. 1990:81). There was extensive use of coarse-grained lithic material for formal and informal tools. Ground and polished stone tools including knives, points, and bannerstones appeared in significant numbers, and utilization of informal tools dramatically increased. Wood working tools such as gouges, axes and chisels also became more prevalent (Wright 1995:224; Clermont and Chapdelaine 1998:28).

By 5500 BP the environment in southeastern Ontario was slightly warmer and slightly drier than the modern climate (Karrow and Warner 1990:34). A more stable and productive environment may have been the catalyst for changes observed in the archaeological record for the Middle Archaic period. During this time, there is evidence of an increase in population and a decrease in the area exploited during seasonal rounds (Ellis et al. 1990:93). Larger populations competed for resources and may have been restricted in their movement by neighboring bands. There is also evidence of a reduction in the number of residential camps occupied in a year, longer occupation of seasonal camps, and reuse of campsites on an annual basis. Restricted movement may have forced groups to occupy productive sites for longer periods of time with the result that larger, more intensively utilized sites appear in the archaeological record. Changes to subsistence procurement are evident in the tools used to hunt, collect, and process materials. Differences in local environments resulted in regional variation reflecting the variation in subsistence foci.

The Allumette and Morrison Island sites, located on the Quebec side of the Ottawa River near Pembroke, provide important insight into the Middle Archaic in southeastern Ontario. These two single component sites, dated to 5240±80 BP (Kennedy 1970) and 4700 BP (Clermont and Chapdelaine 1998) respectively, are located on well-drained, flat terraces downstream from fast flowing rapids (Chapdelaine et al. 2001:103-105). The Ottawa River has been recognized as a copper transportation route from Lake Superior to the east and as a result, not only were these areas occupied from early spring until late fall for their abundant fish resources but also, both sites were used as copper workshops and sacred burial lands. Burials varied and consisted of extended and articulated interments, cremated remains, and disarticulated and bundled burials (Ellis et al. 1990:90), suggesting that the remains of people who died away from the site were purposely interred here because of its sacred nature. The inclusion of numerous grave goods including copper, stone and bone tools, a turtle rattle, and the use of red ochre (Clermont and Chapdelaine 1998:19-20) indicate a greater emphasis on ritual during the Middle Archaic.

Late Archaic (4500 to 2800 BP)

The Late Archaic may be divided into three temporal phases based on projectile point types; narrow point, broad point, and small point (Ellis et al. 1990:Figure 4.18). The narrow points are similar to Ritchie's Lamoka points from New York State (Ritchie 1932) and are interpreted as reflecting a mast forest adaptation (Ellis et al. 1990:98). Broad points are extremely widespread in the Eastern Woodlands and may represent the diffusion of a particular weapon system, one possibly developed for the exploitation of anadromous fish (Ellis et al. 1990:99-100) or deer (Wright 1995:220), and likely do not represent a population intrusion. Broad point sites tend to be located in areas of mixed topography along major river systems (Ellis et al. 1990:105) such as the Trent Valley. These points reflect an adaptation to upland resources rich in game, and in Ontario, the large points have been interpreted as possible thrusting spears for use in deer drives. Small points are indicative of the Terminal Archaic and imply the adoption of a new weapon system, possibly the bow and arrow, which required smaller more precise points (Snarey and Ellis 2006). This may signal a change in hunting techniques and may also reflect cultural changes (Ellis et al. 1990:106; Wright 1995:272). Small point sites tend to be located in lakeshore and marshland environments (Ellis et al. 1990:107).

Late Archaic sites are more abundant than earlier Archaic sites (Ellis et al. 1990:93). This may be a function of increased population, or it may be that during the Late Archaic lakes and rivers had reached modern levels, inundating earlier sites, allowing for Late Archaic sites to be sited on shorelines that have remained intact. At some sites, preserved organic material has enabled study of the faunal species consumed, and has also provided suitable material for radiocarbon dating.

There is conclusive evidence of an aquatic orientation at the Rocky Ridge and Knechtel sites along the Lake Huron shoreline, with large quantities of fish, duck, turtle and beaver bones represented (Ellis et al. 1990:111). Deer bone is also present but increases over time suggesting a change in subsistence focus. It may be that the environment changed with falling lake levels from an aquatic environment to a drier one which favoured deer.

By the Late Archaic there is evidence from southwestern Ontario and northern New York State that bands were occupying at least two distinct types of sites on a seasonal basis. Lakeshore sites in rich environmental zones were occupied during the spring through fall months to take advantage of a broad range of foods, including aquatic animals, deer, and a variety of seasonal plants (Ellis et al. 1990:114; Ritchie 1994:34). During the fall and winter months, interior sites were occupied, where deer hunting and, in the more southerly mast forests, nut collecting were the focus.

In extreme southwestern Ontario, located in the more temperate Carolinian biotic zone, sites were located to take advantage of open water, marshlands, grasslands and forest environments. Aquatic animals, deer, and nuts were all incorporated into the Archaic diet (Ellis et al. 1990:112). Small sites indicate that groups were likely limited to microbands (Ellis et al. 1990:112). It is not known if the number of sites in an area represents occupation of a single microband at different times or the contemporaneous occupation of multiple microbands.

A second type of site identified in southwestern Ontario is the upland or interior camp (Ellis et al. 1990:113,114). Hearth features have been excavated that may represent the presence of oval house structures. The environment of the upland camp would have been ideal for fall nut gathering and for fall and winter deer hunting.

At the Lamoka Lake site in New York State (Ritchie 1994:76) and at the Thistle Hill site in southwestern Ontario (Woodley 1990:49) evidence suggests that the environment at these Late Archaic sites may have been rich enough to support central bases where groups could spend most of the year. At the McIntyre site, on Rice Lake in southeastern Ontario, evidence of large storage pits and a variety of food sources suggest a very rich environment suitable for spring through fall occupation (Johnston 1984).

Seasonal patterns of aggregation and dispersal are common in the ethnographic literature for hunter-gatherer bands, including the Montagnais-Naskapi in northern Quebec (Leacock 1998), the Chipewyan in northern Saskatchewan (Brumbach and Jarvenpa 1997), and the Ojibwa of northern Ontario and the Cree of south-central Quebec (Rogers 1969). These patterns varied according to environment and resources. In the Trent Valley, it is likely that bands continued to follow a cycle of accessing seasonally available resources, centered on congregation at prime fishing locations during the spring, summer and fall, and dispersal into inland hunting territories during the late fall and winter.

By the Late Archaic there is increased visibility, both in size and in number of sites, probably as a result of increased population (Ellis et al. 1990:93). Increasing sedentism at this time follows a variant of the travelers and processors model described by Bettinger and Braumhoff (1982:488-489; Bettinger 1991:100-102). The model states that as populations increase, diet breadth and processing times will also increase. In addition, rates of return will decrease and so will the benefits of traveling to new sites. The result is that the time spent at a particular site will increase and the total travel time between sites will decrease. In the archaeological record this pattern would manifest as larger sites with more elaboration of tool assemblages. In the travelers and processors model, groups that follow more sedentary processor strategies displace groups who maintain more mobile traveler strategies. We have no evidence that supports competition or the displacement of any groups at this time, but there is evidence of larger more elaborate sites.

The McIntyre site, located on Rice Lake approximately 60 km south of Stony Lake via the Otonabee River, has Middle and Late Archaic components interpreted as resulting from warm-weather (spring, summer and fall) activities (Johnston 1984:81). Discovery of large hearths and a diversity of projectile points indicate this was a site where bands congregated from distant locales to take advantage of the broad resources available at the water's edge and in the surrounding woodlands.

Remains of a variety of food sources were recovered, including fruit and nuts (Yarnell 1984), and fish, deer and beaver (Naylor and Savage 1984). Examination of cores taken from lake and marsh sediments reveals an influx of aquatic grasses, probably wild rice, beginning 4000 years BP (McAndrews 1984:173). Historic period wild rice stands were reportedly located at Stony and Buckhorn Lakes, including a stand approximately one kilometer from the West Burleigh Bay site (Jamieson 2002:31). Wild rice in this region of the Trent-Severn system, including Rice Lake, likely dates to the Late Archaic. Though no wild rice remains were recovered at the McIntyre site, ethnographic evidence (Vennum 1988) and archaeological evidence (Hart et al 2003) indicate wild rice was a significant resource for First Peoples during the historic period, was consumed during the Woodland period, and suggests it was a likely food source for Archaic peoples as well. Sedge is another native aquatic plant that has been identified as a food source in Manitoba and northern New York State (Hart et al 2003:629) but has not been specifically identified at the McIntyre site. However, the roasted tuberous roots of this plant may also have been a component of the Archaic diet in southern Ontario. The large pits recorded at the McIntyre site are interpreted as either meat roasting pits or parching pits for wild rice (Johnston 1984:81). I would suggest that parching pits are the more likely explanation due to the proximity to wild rice marshes, but both interpretations suggest multi-band congregation. Bird remains are also conspicuously absent from the site. During the eighteenth century both First Peoples and Europeans noted that fowl were more "fat and delicious" when consuming a diet of rice rather than fish (Vennum 1988:55). Often the ducks were so fat from the abundance of rice they were unable to fly and were easily knocked into the canoes with a paddle. The absence of bird remains at the McIntyre site may be due to poor preservation rather than a disregarded resource. It is important to note that inference of resource use based solely on resource abundance is tenuous, and though counterintuitive, abundance does not always mean a resource was included in the diet (Bettinger 1991:87). In this case, however, ethnographic reports of historic era peoples lend credibility to the inference.

For the historic Ojibwa ricing was one of the social and sacred highlights of the year. Bands congregated to socialize with family and friends seen only periodically, and they also gave thanks to the creator for the gift of nourishment provided by the sacred wild rice plant (Pomedli 1998:258-260). While we have no way of knowing if Archaic peoples also revered wild rice, the McIntyre site does provide us with evidence of multi-band congregation and we can infer from that that socializing, and alliance building, including marriage, were functions of the time spent together.

During the late fall and winter, bands dispersed into smaller family groups under the direction of the eldest male (Rogers 1969:28). Though these smaller family groups usually accessed the same hunting area every year, the band as a whole hunted in contiguous areas and individual hunting areas could shift from year-to-year. Hunting was the primary means of subsistence at this time when snow cover became an advantage for tracking game as deep snow slowed the animals down, making capture easier (Snow 1981:107). Late winter was the most dangerous time of the year. It was the time of year when stored surpluses were likely depleted and severe weather hampered hunting.

Early spring signaled the beginning of the harvest of spawning fish and the return of migratory waterfowl (Rogers 1969:29). Fish weirs at Atherley Narrows, about 125 km by canoe west of Stony Lake, and recently identified fish weirs in neighboring Lovesick Lake (Jamieson 2003:6), were likely sites of early spring congregations (Johnston 1984:81). West Burleigh Bay also affords an excellent environment for fishing due to ideal spawning habitats and the proximity to the rapids at Burleigh Falls and Perry's Creek (Jamieson 2003:6). Both spring and fall spawning species are present in the vicinity today and may well have been present during the Archaic. The tradition of seasonal use of the West Burleigh Bay site continued with local Ojibwa into the recent past (Jamieson 2003:50).

Mortuary practices became more ritualized during the Late Archaic and the Glacial Kame complex has been associated with the terminal Archaic in southern Ontario (Ellis et al. 1990:115). Exotic grave goods included large marine shell gorgets, copper tools, birdstones and a variety of tools and decorative items.

The presence of designated cemeteries implies that bands occupying the surrounding territory gathered for periodic ceremonies to inter their dead. There may have been an annual ceremony, held in conjunction with seasonal rounds, to inter all band members who had died during the previous year (Ellis et al. 1990:118). Inclusion of grave goods has been interpreted as indicative of some status differences ascribed through age or special abilities, suggesting the band structure was still egalitarian.

Boneless graves consisting of red ochre, chipped stone and copper tools on Shield sites indicate elaborate mortuary ritual in the north by 2000 BP (Wright 1995:262). At the West Burleigh Bay site a number of discoveries suggest the presence of at least one boneless grave. A greasy pit feature was excavated with a portion of a gorget and large ground schist axe recovered from the bottom margin. Nearby downslope units contained a copper point, red ochre nodules, portions of gorgets, and pairs of complete, intact projectile points.

Social and Political Interaction

Regional adaptations in the Northeast are usually associated with major drainage areas, suggesting territorial distribution of bands (Ritchie 1994:32). The Trent Valley was likely navigable throughout the entire history of the West Burleigh Bay site (Jamieson 2003:8) so we would expect to see regional interaction along this route. Regional variation becomes more diverse over time with the result that unique projectile point styles and evidence of exotic materials may be traced to distant regions. For example, a Susquehanna Broad point and a portion of a steatite bowl recovered from the West Burleigh Bay site indicate trade or exchange networks that ultimately extended into New York and Pennsylvania (Jamieson 1999:181).

Identification of interaction is often associated with the appearance of different artifact styles (Ritchie 1994; Wright 1995). Exotic or unusual tool types may be the result of immigration, trade or diffusion. There is very little conclusive evidence of long distance interaction during the Early and Middle Archaic periods so inferences based on tool styles and lithic sources form the bulk of the evidence. Considerably more information exists for the Late Archaic, when regional variation was more distinct.

Early Archaic Interaction (10,000 to 8000 BP)

In Ontario, Early Archaic sites are rare but seem to be more common in the southern areas than in the north (Ellis et al. 1990:70). Northerly sites tend to be multi-component suggesting that the earliest Archaic people were contemporaneous with the Late Paleoindian groups. An influx of people from the south may have moved into regions abandoned by Paleoindian peoples as they moved northward with the shifting environmental zones (Stothers 1996:204). This interpretation implies that the Archaic people were immigrants and that overlapping tool assemblages denote group interaction. Alternatively, the tool assemblages may represent different cultural groups visiting the site at different times or they may represent a change in technology to accommodate changes in the resources available as a result of environmental changes.

Contact between people living on the Shield and those living in the Great Lakes St. Lawrence region likely occurred from the earliest periods of occupation. However, Wright's (1995:121,261-295) examination of the Shield culture suggests there was more interaction within the Shield culture than outside of it. He believes the historic Algonquians were the descendants of the Shield culture. His basis for this is the interconnectedness of culture and language over broad areas (Wright 1995:261).

Non-local chert resources in Ontario assemblages indicate either long distance population movements or strong inter-group linkages during the Early Archaic. Non-local chert from southwestern Ontario sites includes cherts from a number of locales in Michigan and Ohio (Stothers 1996:194-204). Rates of non-local chert were very high during the initial stage of the Early Archaic but as populations became more settled in the northerly areas, local cherts became more common. This pattern is evident at the West Burleigh Bay site. Of the eight projectile points identified as dating to the Early Archaic, only one is made of local chert.

Middle Archaic Interaction (8000 to 4500 BP)

Burials located 600 km north of Thunder Bay around 7000 BP, a time when the environment was a boundary area between the boreal forest and lichen woodland zones, represent people who likely moved north with the shifting environment (Wright 1995:125). Recovered at this northern Shield burial site was a full-grooved stone gouge, diagnostic of the Early Archaic in the Maritimes and Great Lakes St. Lawrence regions. Wright interprets this as evidence of a trading relationship between the Shield culture and the cultures to the southeast.

Evidence from southeastern Ontario indicates close ties to the St. Lawrence drainage (Jamieson 1999:180; Lackowicz 1996:200-203). Ground stone artifacts in Ontario are generally restricted to eastern Ontario and are rarely recovered from southwestern Ontario sites. Thirty ground stone artifacts were recovered from the West Burleigh Bay site, fourteen of which were projectile points or portions of bifaces. One of the points (Figure 2.2) exhibits an engraved cross-hatching design strikingly similar to engravings on a ground stone gouge recovered near Sudbury (Wright 1995:Figure 31). Wright (1995:249,210) notes that the design, among others, has much in common with maritime designs. A study of Maritime Archaic engraved soapstone by Fitzhugh (1985) provides a comparison of incised stone and bone objects in the Northeast and notes broad design similarities that incorporate geometric compositions, including hatching, that appear to be produced rapidly and without artistic formality. The study includes objects from Vermont dating to the Paleoindian period, from Labrador dating to the Maritime Archaic, and from southern Ontario dating to the Late Archaic. Fitzhugh (1985:103) interprets the use of these engraved designs by Northeastern Algonquian cultures as symbolic of spirit-world relationships and also as evidence of extreme longevity of sacred designs.

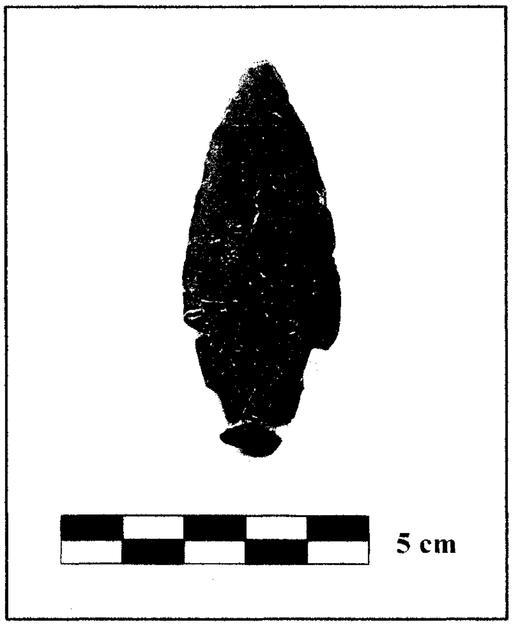


Figure 2.2 Ground slate point with cross-hatching

Copper implements were also traded in the Middle Archaic. A copper point recovered from a Shield site located west of Lake Superior near the Ontario - Minnesota border has been dated to 6,800 BP. Large quantities of copper items in the Ottawa Valley (Chapdelaine et al 2001; Clermont and Chapdelaine 1998:97; Ellis et al. 1990:90) indicate trade around the north shore of Lake Superior and down the Ottawa River. The peak period of copper utilization was between 6000 and 3000 BP (Wright 1995:270).

Regular interaction between people living in southeastern Ontario is generally assumed but not often demonstrated. One compelling example is the recovery of a number of chlorite schist celts from the West Burleigh Bay site that are very similar to axes and adzes manufactured at the Healey Falls site, located north of Campbellford, Ontario (Ross et al. 1997:158; Teal et al. 2003:20). All but one of the chlorite schist celts recovered from the West Burleigh Bay site was in a finished state and no flaking debris was recovered. This indicates the celts were manufactured elsewhere and transported to the site. It is possible that the people who manufactured the celts brought them to the site on Stony Lake, but it is more likely they arrived through trade or exchange since both sites represent spring to fall occupations. In addition, several metasedimentary bifaces, with associated resharpening debris, have been recovered from the Healey Falls site (though they have been identified as shale). However, no early stage bifaces were recovered indicating they were likely made elsewhere, possibly at West Burleigh Bay, and transported to the site.

Late Archaic Interaction (4500 to 2800 BP)

Changes in lithic technologies during this period are indicative of intra- and inter-regional trade (Jamieson 1999:181). Broad points recovered in Ontario are stylistically similar to points originating from the lower Great Lakes region (Ellis et al. 1990:100) and provide evidence of inter-regional interaction. Though Wright (1995:220) suggests elements of the Susquehanna Archaic culture reached southern Ontario via the Atlantic coast and along the St. Lawrence Valley, Jamieson (1999:181) prefers a New York linkage. Evidence of interaction between southwestern Ontario and central and western New York and northern Pennsylvania has been established (Ritchie 1944, 1994). The recovery of Susquehanna related artifacts at the West Burleigh Bay site suggests an expansion of that linkage. Artifacts recovered from the West Burleigh Bay site also include some that are typical Shield forms, indicating that contact or exchange took place between the Trent Valley and northern Ontario.

The Glacial Kame mortuary complex is the most convincing evidence for contact and long distance exchange between southern Ontario, the upper Great Lakes, the Atlantic coast, and the headwaters of the Mississippi, among other distant locales (Ellis et al 1990:115,118). Though regional differences are evident there are a number of characteristics that unify this complex. First of all, burials consisted of primary and secondary interments as extended, flexed and bundle burials (Converse 1980:17). Additionally, red ochre was used and copper and shell beads, tubular pipes, birdstones, and bone and antler objects often accompanied the deceased. Throughout the complex area exotic items such as copper, galena and marine shell were exchanged principally for use in mortuary ritual (Jamieson 1999:182). Regional manifestations occurred indicating that while people were importing ideas and exotic goods they were interpreting them and using them according to their cultural beliefs. In Ontario interments in elevated features were often accompanied by exotic grave goods, paired items, and clay balls (Jamieson 199:182). This mortuary complex fluoresced during the Woodland period, but the origins lay in the Late Archaic.

Summary

The social organization of the Archaic people changed gradually over 7000 years. Retreating glaciers with a concomitant change in the environment, from tundra to woodland, affected subsistence strategies. Subsistence procurement strategies changed from a primary focus on migratory caribou and/or elk to a more diverse and localized focus on deer, fish and plant resources which affected settlement patterns and social and political interaction. Early Archaic people traversed vast distances during their seasonal rounds, continuing a strategy established during the Paleoindian period. By the Middle Archaic small populations were following a broad-spectrum mode of subsistence with greatly reduced distances traveled on their seasonal rounds. As populations increased, so did social interaction and social complexity. By the end of the Late Archaic, social networks and trading networks with distant populations exchanged ideas and technology that continued into the Woodland period.

Chapter 3

Approaches to Lithic Analysis

Lithic tools and materials are among the most common artifacts recovered from archaeological sites. Discarded and broken tools, cores, flaking debris, as well as failed and broken pieces from all stages along the manufacturing continuum may be present in a lithic assemblage. As a result lithics provide an accessible means of inferring aspects of culture. All modes of lithic technology, including raw material acquisition, manufacture, use, and recycling may be studied. Lithic analysis typically incorporates both technological and typological approaches. Technological approaches study the raw materials and manufacturing methods used to produce lithic tools whereas typological approaches focus on the morphology of finished tools to make cultural inferences. Both approaches are addressed in this chapter.

Several avenues may be explored in the interpretation of lithic assemblages. The format of this chapter begins with a discussion of the relationship between the technological organization of stone tools and subsistence strategies. This is followed by a section on toolstone including a summary of the characteristics that constitute ideal raw material, and factors that affect toolstone selection. Methods for identification of raw materials and their provenience are also included. The third section of the chapter explains how lithic reduction techniques and the resulting morphological features can be interpreted to determine methods of tool manufacture and flint-knapping expertise. The final portion of the chapter outlines typological analysis of finished tools that may be used to infer cultural, spatial and temporal variation.

Organization of Lithic Technology

In broad terms, lithic tools are technological devices that aid in attaining specific goals, often those pertaining to the acquisition of food resources. Additionally, the role of stone tools "is to solve the problem of spatial and temporal differences between the location of lithic raw material and the location of stone tool use, while meeting the functional needs of the tasks for which the tool is used" (Parry and Kelly 1987:300). Since there are many styles and types of tools that produce the same end-result, the individual flint-knapper consciously decides the type of tool to manufacture. The decision is based on (1) environmental constraints (Binford 1980; Bleed 1986; Nelson 1991), which affect (2) the types of resources to be acquired (Bleed 1986), (3) the mobility strategy employed by the group (Binford 1980; Kelly 1988; Lurie 1989; Parry and Kelly 1987), (4) the degree of risk or the chance of failure for resource acquisition (Bleed 1986; Torrence 1989), (5) raw material availability (Andrefsky 1994, Jeske 1989), and (6) the amount of time available for resource acquisition (Bleed 1986; Nelson 1991). Tool production will also be affected by (7) past experiences, preferences and cultural norms of the knapper (Sassaman 2000, Sinclair 2000).

Lithic tool manufacture generally follows one of, or a combination of, two strategies, curated or expedient, although Nelson (1991:62) adds a third, opportunistic behavior. Curation is defined as "a strategy of caring for tools and toolkits that can include manufacture, transport, reshaping, and caching or storage" (Nelson 1991:62). It includes the preparation of tools or raw materials prior to, and in anticipation of, their use and assumes that time and/or materials are limited. In contrast, expediency refers to a technology that exerts a minimum amount of effort in locales where time and materials are highly predictable. Nelson's (1991:62) third strategy, opportunistic behavior, is the use of materials at hand to solve unanticipated problems. Curation and expediency are not mutually exclusive and both may be utilized depending on the tasks performed, and the time and materials available. They may even represent various stages of the tool use-life continuum (Morrow 1999:224). The assemblage from West Burleigh Bay consists predominantly of tools manufactured using bifacial technology, which is considered a curated strategy. The remainder of this discussion will refer to both expedient and curated strategies but the primary focus is on the organization of curated technologies.

The strategies used to manufacture lithic tools are conditioned by a number of environmental factors that affect the temporal and spatial availability of food and raw material resources (Bleed 1986:744; Nelson 1991:59-62). Mobile hunter-gatherers make decisions based on resource predictability, on distribution, seasonality and mobility of resources, as well as size and patchiness of resource areas and on potential hazards that may be encountered. Curated tool designs address a number of factors that make them especially suited to use by a highly mobile group.

Tool design addresses, and is conditioned by, the requirements of reliability, maintainability, flexibility, versatility, and portability (Bleed 1986; Nelson 1991:66-76). To address reliability, a design will be sturdy, overdesigned (stronger than minimally needed), and understressed (used at less than full capacity) (Bleed 1986:739). The reliable toolkit is prepared or maintained by specialists in advance of use, and consists of standardized and redundant parts. Bleed (1986:739) suggests that reliable tools are best suited for capture and processing of large seasonally abundant game that have a predictable location but where capture time is unreliable. Characteristics of reliable design that appear in the archaeological record include evidence of standardized replacement parts, such as blade technology, and evidence of standardized haft form and size (Nelson 1991:68-69).

A second aspect of curated tool design pertains to maintainability. A maintainable design is suited to a number of functions. It may be flexible, meaning its form can be altered to meet a variety of needs or it may be versatile, meaning it has a generalized form to meet a variety of needs (Nelson 1991:70). A maintainable design is modular and can be easily rejuvenated, or repaired with replacement parts, by the user. It is light and portable and is designed for partial function to avoid total failure (Bleed 1986:739-741). A maintainable toolkit is best suited for exploitation of resources that are continually available but follow an unpredictable schedule. Bifacial core tools are an example of a maintainable design, as are replaceable foreshafts and variable tip forms with similar hafting elements.

Hayden et al. (1996:12) take exception to the differentiation between reliable and maintainable toolkits. Instead, they suggest that both, along with the requirements for flexibility and versatility, are aspects of multifunction tools. This is a valid observation and throughout this study the term multifunction will refer to tools that are reliable, maintainable, flexible and versatile.

Transportability is a significant design consideration for mobile populations and requires toolkits be small and lightweight. Parry and Kelly (1987) determined a strong correlation between mobile populations and the use of bifacial (or curated) technology and a complementary correlation between sedentary populations and expedient technology.

Bifacial tools and bifacial core technology are especially suited to mobile populations because of their portability. These are multifunction and multiuse tools that fill technological requirements with a small number of items (Parry and Kelly 1987:298). Their generalized form allows them to be used for a variety of functions and their design allows for repeated resharpening and reuse. Another significant advantage of bifacial tools is their secondary use as bifacial cores. Flakes removed from a biface produce highly effective expedient tools. A disadvantage of bifacial technology is the significant investment of time and materials required. Bifacial flint-knapping is a skill that requires training and experience to develop competency. Even when competency is achieved, production and maintenance of tools is more time consuming than for expedient technology. Other disadvantages of bifacial tools include retouch that can dull the tool edge, reducing cutting effectiveness, and decreased efficiency due to a generalized rather than specific task design. In contrast, expedient core technology produces tools, such as unretouched flakes, that are typically used once and are suited to a single task. This technology requires significantly less manufacturing effort and produces tools that are often more efficient and more effective than bifacial tools. However, it is not a very portable technology and relies on the availability of sufficient time and raw materials. Thus the benefits of portability outweigh the added costs of bifacial technology for a highly mobile population (Parry and Kelly 1987:299)

Toolstone

Raw Material Properties

Lithic materials require a number of properties to be suitable for use as toolstone. Ideally they should be homogeneous, isotropic, and highly siliceous with a smooth and fine grained texture (Andrefsky 1998:40; Cotterell and Kamminga 1987:677; Crabtree 1972:5). Equally important are properties of elasticity, rigidity, flexibility and brittleness (Crabtree 1967:24, 1972:18). Though limited to these particular properties, toolstone can originate from vastly different origins and may be of either mineral or rock classification. Geologists define minerals as naturally occurring, inorganic solids, with a definite crystalline internal structure and a relatively fixed chemical composition (Eyles 2002:59). Rocks are a conglomerate of one or more minerals locked together. There are over 3,000 types of minerals but only eleven that are common in rock formation (Eyles 2002:60). Of these eleven, seven are silicates. Silicon tetrahedrons, composed of four large negatively charged oxygen atoms and one smaller positively charged silica atom, bond in a number of configurations to produce silicate minerals with different properties (Figure 3.1). Neosilicate minerals, such as olivine, are composed of isolated tetrahedrons. Inosilicate minerals bond in single or double chains, forming minerals such as augite and hornblende respectively. Phyllosilicates bond in two-dimensional sheets and form minerals such as mica and tectosilicate minerals are tetrahedra bonded in a complex three-dimensional framework. The tectosilicate microstructure is important because it provides the isotropic properties essential for controlled fracture, providing one of the properties required for suitable toolstone (Cotterell and Kamminga 1987:677). Quartz and feldspar are the two most common silicate minerals in the earth's crust and both are tectosilicates (Eyles

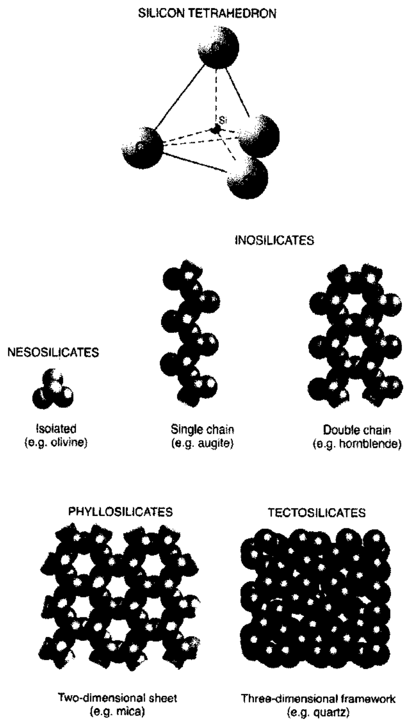


Figure 3.1 Building blocks of silicate minerals (Eyles 2002:59, figure used with permission).

2002:59-60). However, Quartz, rated 7 on the Mohs' hardness scale, is harder and stronger than feldspar, with a hardness level of 6, making it a more useable toolstone.

Rock composition and texture are determined by the processes of formation, or rock genesis. Rocks are continuously being created, destroyed and formed anew. At any point in time rocks may by observed in all states along the continuum of change (Andrefsky 1998:45). Geologists classify rocks as igneous, sedimentary or metamorphic based on their method of formation. Igneous rock is formed from cooled and solidified molten lava. Depending on the rate of cooling, it may consist of very large crystals formed by cooling very slowly, deep within the earth's crust, or it may be very glasslike when crystal development is impeded by cooling quickly on the earth's surface (Eyles 2002:45-50). Basalt, rhyolite, granite and obsidian are all forms of igneous rock that have been used in archaeological contexts.

Sedimentary rocks form in one of two ways, they may be clastic, which results from deposition and lithification of mineral and rock fragments eroded from existing rocks, minerals, and organic debris, or they may be chemically formed through precipitation in mineral-rich waters (Eyles 2002:50-55). Few clastic sedimentary rocks are appropriate for tool production. According to Andrefsky (1998:50), there are a number of characteristics that allow for controlled flaking of sedimentary rocks. The material must be fine-grained (grain size under 1/16 mm), possessing uniform hardness and composition, be very hard and brittle and it must fracture conchoidally. Highly silicified sedimentary rocks such as silicified sandstones make useable toolstone. Silicification occurs when quartz solute penetrates clastic sedimentary rocks and hardens. Since quartz is a very hard mineral the proportion of silica in the rock affects its hardness and its fracture characteristics. Alternatively, siltstone and shale are examples of fine-grained clastic sedimentary rocks that fracture conchoidally but are not highly silicified. Diagenesis, or post depositional alteration, to these fine grained rocks can result in the formation of argillites and hornfels (Andrefsky 1998:56; Rapp 2002:51). Argillites are formed at low temperatures and pressures, creating a material that, though softer than materials silicified with quartz, will fracture conchoidally. Hornfels result from metamorphism at high temperatures and pressures re-crystallizing the parent material and making it a dense and brittle material that also fractures conchoidally.

Sedimentary rocks formed through chemical precipitation include salt, limestone and microcrystalline quartz (Andrefsky 1998:51-54). Chemical precipitate sedimentary rocks are produced when chemical elements are dissolved during the rock weathering process and are subsequently precipitated into cavities to form minerals. Most chemical precipitates are too soft and soluble to be useful as toolstone, however, when the chemical precipitate is silicon dioxide the result is the formation of quartz. Quartz genesis is believed to occur in a deep sea environment where silica secreting diatoms and the skeletons of silica rich diatoms dissolve and saturate ocean floors with silica in the form of opal-A (Andrefsky 1998:52; Luedtke 1992:23-27). Subsequent precipitation of opal-A into opal-CT, produces an amorphous, unstable, form of quartz that is not suitable for use as toolstone. However, when opal-CT dissolves and re-crystallizes, crystalline quartz is formed. Crystalline quartz occurs in macrocrystalline, microcrystalline, and fibrous forms, which are suitable for toolstone (Figure 3.2).

Macrocrystalline quartz is a rare form and appears as large free-standing six-sided crystals. Microcrystalline quartz, also referred to as cryptocrystalline quartz, is much more common and in archaeological contexts is commonly referred to as regional forms of chalcedony, chert, flint and jasper (Andrefsky 1998:51; Luedtke 1992:5). Fibrous quartz, or chalcedony, can be distinguished microscopically from microcrystalline quartz by its fibrous nature but archaeologists often use the term chalcedony to denote translucent cherts. Luedtke (1979:745; 1992:5) prefers an all inclusive definition of chert that encompasses all microcrystalline quartz, with chalcedony and flint as particular forms of chert. Flint is defined as high-quality, dark nodular chert specifically from chalk formations in southern England and chalcedony is recognized as fibrous quartz.

Metamorphic rocks are formed deep below the Earth's surface and include any igneous, sedimentary or even metamorphic rocks that have been altered by pressure, temperature or chemical conditions. Metamorphic alterations to sedimentary rocks that increase silica content or make the rock harder can produce rocks suitable for use as toolstone. Some metamorphic rocks used as toolstone include argillite, slate, quartzite and gneiss (Kooyman 2000:36). Metamorphism of sandstone causes the grains of quartz sand in the clastic rock to meld together resulting in a material that will fracture

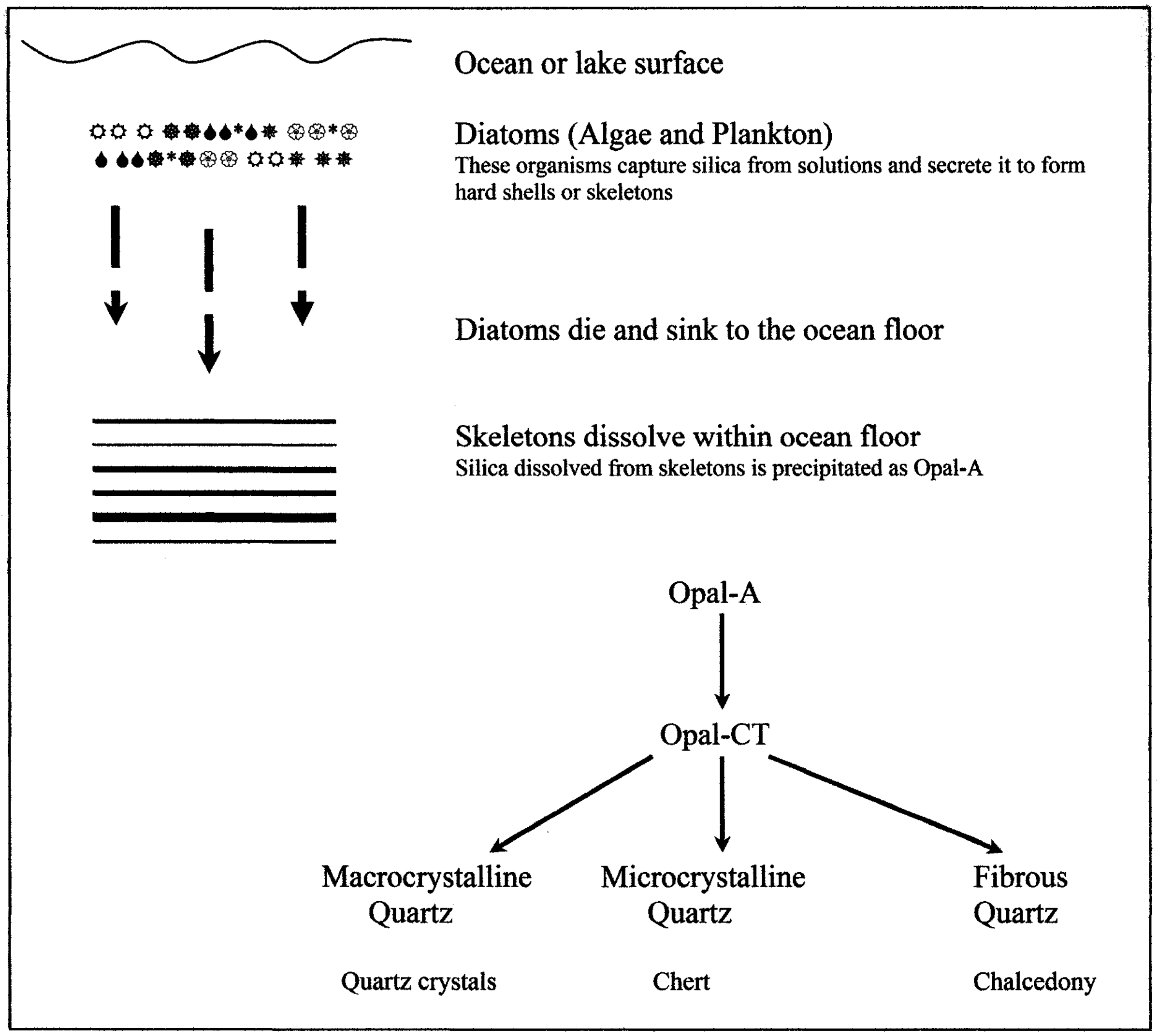


Figure 3.2 Schematic diagram of quartz genesis showing silica transformation from diatoms to Opal-A to Opal-CT to crystalline quartz (Andrefsky 1998:53).

across grains, instead of around grains, and break in a conchoidal manner (Andrefsky 1998:55). Silicified, fine-grained clastic sedimentary rocks that have metamorphosed can also be useful as toolstone. Argillites are the result of metamorphism at low temperatures and pressures that transform shales and siltstones into materials that will fracture in a predictable manner.

In summary, ideal toolstone is brittle, homogeneous, isotropic, cryptocrystalline, and highly siliceous with a smooth texture (Andrefsky 1998:40; Cotterell and Kamminga

1987:679; Crabtree 1972:5). These properties are necessary for fracture to occur in a controlled and predictable manner. Chert, chalcedony, obsidian and fine-grained basalt are all examples of ideal toolstone. Toolstone that is coarse-grained, contains flaws or inclusions, or that has distinct bedding planes, will fracture in an uncontrolled manner. Coarse-grained material tends to crumble. Material with flaws, inclusions or bedding planes tends to break prematurely resulting in a higher proportion of hinge and step fractures, and fractures along bedding planes and flaws (Andrefsky 1998:50; Cotterell and Kamminga 1987:678; Crabtree 1972:5).

Toolstone Selection

Selection of toolstone for mobile hunter-gatherers is dependant on factors including availability, quality, and the type of tool being produced. Biface technology requires good quality material that is large enough to enable manufacture of the proposed tool (Parry and Kelly 1987:300). Availability of raw material generally pertains to proximity to the source, but may also pertain to open access across cultural or territorial boundaries (Bamforth 1986:40). In northern climates availability includes seasonal access since sources may be covered in snow and ice during the winter months. If suitable material is not available locally it must be obtained through trips to quarries or through trade. Meltzer (1989:12-13) identifies four methods of acquiring toolstone: direct acquisition, indirect acquisition, direct acquisition from secondary sources and indirect acquisition from secondary sources. Direct acquisition refers to obtaining toolstone from the primary geological source. Indirect acquisition is the receipt of material from a primary source through trade or exchange. Direct acquisition from secondary sources refers to obtaining toolstone from a secondary geological source, such as a cobble bed. Indirect acquisition from secondary sources is the receipt of material from a secondary source through trade or exchange. Binford (1979:259) argues that raw material procurement is an embedded function of seasonal rounds for mobile hunter-gatherers. Raw material acquisition through trade or directly from the primary or secondary source is included. While this is likely the most common method of aquisition, Gould and Saggers (1985) provide ethnographic evidence for special procurement trips not associated with subsistence activities.

In their study Gould and Saggers (1985) established that social and cosmological factors affected the selection of toolstone and, in some instances, poorer quality materials were used even when good quality raw material was available. Their research determined that toolstone collected on visits to sacred sites was just one aspect of the trip. Of primary importance was the establishment and retention of social networks during meetings with members of patrilineages which controlled the sites.

Bamforth (1991:217) cautions against using simplistic global models that link a single cause, such as mobility patterns (e.g. Binford 1980; Shott 1986), to selection of toolstone and organization of technology. Instead, he recommends that any interpretation of technological adaptation must be made in the local context within which the tools were produced. Raw material selection and tool manufacture were likely the result of a complex mix of strategies that included, but were not restricted to, mobility patterns. Research by Andrefsky (1994) provides support for this point of view.

Andrefsky's (1994) study in the Western United States identified a relationship between the quality of local raw material and the types of lithic tools that were manufactured, regardless of the mobility strategy practiced by the group. Andrefsky defined tools as either formal or informal tools, roughly conforming to curated and expedient tools respectively. In Andrefsky's study, production of formal tools was more prevalent when good quality raw material was scarce. In this case scarcity included local geological scarcity as well as the inability to procure non-local raw material through cultural means. Furthermore, production of informal tool types was prevalent when there was an abundance of poor quality raw material. This study suggests that availability of toolstone affects the ratio of formal to informal tools, regardless of the settlement patterns expressed.

Provenience of Raw Material

Central to the identification of toolstone is the ability to determine the provenience, or source, of the material (Andrefsky 1998:41). Accurate identification of the source of toolstone allows for interpretation of cultural choices, including mobility patterns and interaction with others (Kooyman 2000:25). Methods used to identify raw materials and determine their source fall into macroscopic, microscopic, or trace element analysis categories.

Macroscopic techniques have the advantage of being inexpensive since they require only reference books and a simple form of magnification such as a hand lens, a jeweler's loupe or, for added precision, a standard microscope. The disadvantage of macroscopic techniques is that they are prone to error. In a comparison designed to test the validity of macroscopic identification of Ontario chert, Miles (2005) compared the macroscopic identification of chert from the Bark site, in southern Ontario, to identification via a combined macroscopic, petrographic, and palynological analysis. Miles (2005) determined that macroscopic identification correlated to identification based on combined information from all three methods at a rate of 78%. The high rate of accuracy in this case is likely due to the significant experience and knowledge of Ontario chert by the analyst who performed the original macroscopic identification. Luedtke (1979:745) notes that though variation exists between chert locations and can often be used to visually identify chert, it is really an inadequate method because visual variation can occur within formations and even within a single outcrop. However, macroscopic techniques remain the most widely used method of identifying lithic material, primarily because it is inexpensive and also because experience results in knowledge of commonly used regional toolstone.

Eley and von Bitter's (1989) reference manual of southern Ontario cherts provides macroscopic, microscopic and microfossil characteristics for each distinct chert formation. In southern Ontario, chert occurs as nodules or lenses in sedimentary limestone and dolomite (Eley and von Bitter 1989:1). These bedrock deposits are the primary sources of the various cherts but secondary sources of the same materials occur in glacial, stream, beach and talus slope deposits (Luedtke 1979:745) and would have been available for use as toolstone. This means that even when chert can be correlated to a specific bedrock source, it is important to understand that collection of toolstone may have been from either a primary or secondary source and often there is no way to distinguish between the two.

Macroscopic techniques may also be used to identify toolstone other than chert. Macroscopic identification of non-chert toolstone requires the use of geological reference

The greatest disadvantage of this method is that creating thin sections destroys the archaeological sample.

There are a number of geochemical techniques that may be used to further analyze lithic material. All geochemical techniques (e.g. x-ray fluorescence spectrometry) identify the elements of stone at an atomic level but do not identify chemical compounds, minerals, fossils, or texture (Andrefsky 1998:42). Elements of the stone are classified as major elements if they comprise less than 2% of the sample, minor elements if they comprise between 2% and 0.1% of the sample, and trace elements if they comprise less than 0.1% of the sample. Trace elements are especially useful for identifying provenience (Andrefsky 1998:42) if a comparison sample is available. One of the greatest advantages for archaeological purposes is that most geochemical techniques are nondestructive or require the destruction of a very small sample. However the cost is significantly more than thin section analysis and, if a comparative sample is not available, their utility is limited.

Lithic Tool Manufacture

Reduction Techniques

Flaked stone tools are manufactured by a reductive process whereby flakes or chips of stone are removed from an objective piece by a hammer or percussor until a desired shape is attained. Fracture of brittle materials occurs under high tensile stress and is initiated at areas of weakness, such as micro-cracks or flaws, on the surface of the toolstone (Kooyman 2000:21). This is why homogeneous and isotropic materials are favored for controlled and predictable flaking (Cotterell and Kamminga 1987:678). In contrast, toolstone that contains flaws and bedding planes fractures in a more unpredictable manner.

Three techniques of percussion are employed to produce different sizes and types of flakes: direct percussion, indirect percussion, and bipolar technique (Crabtree 1972:10-17; Kooyman 2000:16-17). The raw material being worked and the stage of manufacture of the tool determine which technique is used (Crabtree 1972:8-9). Percussion is simply the delivery of a sudden, substantial blow to detach a flake. The resultant flake is detached through Hertzian initiation, bending initiation or wedging initiation (Cotterell and Kamminga 1987:685-691). The following provides a description of the three types of fracture initiation followed by a very brief summary of percussion techniques and their relationship to fracture initiation and flake morphology (For a detailed discussion of fracture mechanics see Cotterell and Kamminga 1987). Flake terminology (Figure 3.3) in this study follows Kooyman (2000).

Hertzian initiation is the formation of a partial Hertzian cone crack at the point where a hard percussor meets the lithic material (Cotterell and Kamminga 1987:685-686). A classic Hertzian cone is produced when a hard spherical indenter is pressed perpendicularly into the surface of an isotropic brittle solid. This is rarely the case in tool manufacture; instead, flakes are initiated near the edge of the objective piece resulting in outward force and the formation of conchoidal flakes. The most distinguishing characteristic of a conchoidal flake is a partial Hertzian cone that forms the bulb of percussion (Figure 3.3). Conchoidal flakes may also exhibit eraillure scars or small flakelets that detach from the face of the bulb.

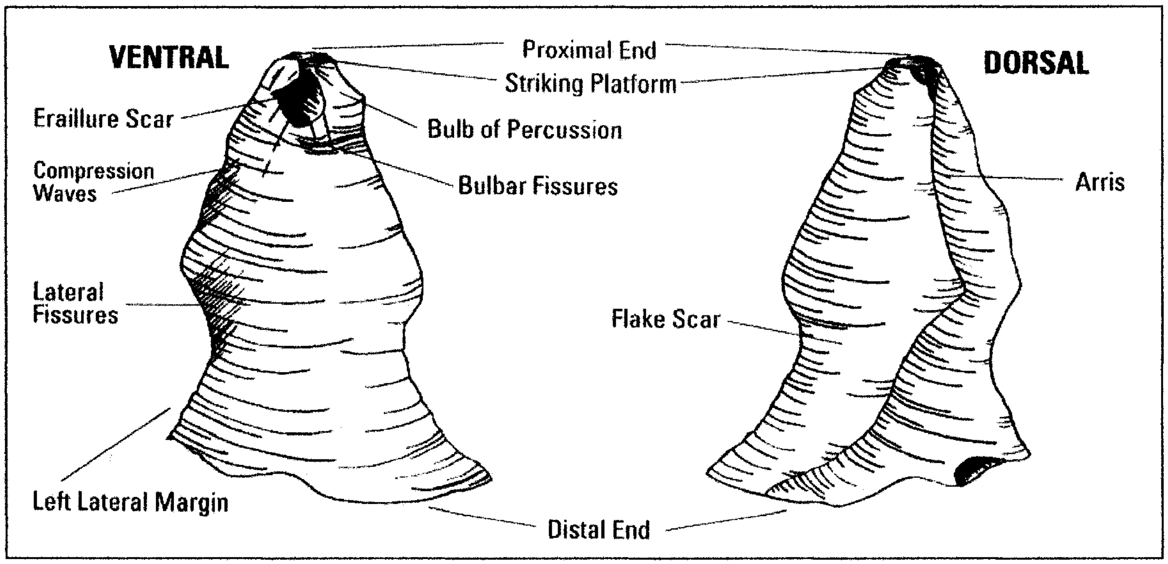


Figure 3.3 Conchoidal flake features (Kooyman 2000:12, figure used with permission from the author).

Bending initiation does not begin at the point of contact between the percussor and the lithic material. Instead, when force is applied by a soft percussor and contact stress is small, "fracture initiates under bending stresses away from the indenter" (Cotterell and Kamminga 1987:689). Flake characteristics include a waisted appearance and a sharp lip on the ventral surface at the proximal end. Though bending initiations do not produce a bulb of percussion, the ventral surface can appear to have a diffuse bulb due to the effects of the transition between bending initiation and propagation of the flake (Cotterell and Kamminga 1987:690).

Wedging initiation occurs under high pressure with a hard percussor when the lithic material immediately under the percussor flows plastically and initiates a median crack at the middle of the cone (Cotterell and Kamminga 1987:688). Flake characteristics include an absence of a bulb of percussion and crushing on the fracture surface near the point of initiation (Cotterell and Kamminga 1987:689).

Direct percussion is a technique of striking a hand-held objective piece with a percussor to remove a flake. Percussors may consist of a variety of lithic materials such as granite and basalt, or they may be wood, antler or bone. The yield and density of the percussor affects the force of the blow and must be appropriate for the size, quality, and density of the material being worked (Crabtree 1972:10). Very hard percussors, relative to the hardness of the toolstone, have a tendency to crush or shatter the flake so they have limited use. Hard hammer percussors are used to strike expanding conchoidal flakes off the margins of the objective piece. These flakes can be identified by their distinct bulb of percussion, thick transverse cross section and low frequency of intersecting flake scars on the dorsal face (Ahler 1989:211). Relatively soft percussors remain in contact with the objective piece for a longer time and over a larger surface than hard percussors, resulting in the formation of bending flakes (Cotterell and Kamminga 1987:690; Crabtree 1972:10). Soft hammer percussion is used to thin bifaces and to remove very small flakes from bifacial edges (Cotterell and Kamminga 1987:690). Bifacial thinning flakes are recognizable by their thin curved longitudinal cross section, feather termination, multiple dorsal flake scars and lipped platform (Ahler 1989:210). Though not as common, bifacial thinning flakes can be produced by hard hammer percussion on edges (Ahler 1989:211).

Pressure flaking, though not a percussion technique, also removes flakes through bending initiation and is commonly used to finish bifacial edges or rejuvenate worn edges. Fracture occurs when force is applied with a pointed flaking tool made of hardwood, bone or antler on the edge of the objective piece. The force is gradually increased until the elastic limit of the raw material is exceeded and small flakes with a lipped platform are removed (Kooyman 2000:17).

The indirect percussion technique uses a semi-pointed or blunt rod-like punch as an intermediate tool between a hammer and the objective piece. The punch may be made of a variety of materials including stone, bone, antler, or wood. One end of the punch is applied to the objective piece and the other is struck with a hammer to apply the force necessary to detach a flake (Kooyman 2000:17). There is no evidence this technique was used by Archaic peoples at West Burleigh Bay.

Bipolar percussion is a technique whereby the objective piece is placed on an anvil and struck with a hammerstone (Crabtree 1972:10). The hammerstone may be hand-held, hafted or thrown. Bipolar percussion has a tendency to shatter the objective piece into two or more orange-like segments, often with accompanying chunky debris. The anvil acts as a second hammerstone directing reflected force. All three types of fracture initiation may result from bipolar percussion, but wedging is the most common (Cotterell and Kamminga 1987:688). Bipolar flakes may show evidence of platform features, including crushing and bulbs of percussion, at both ends. Other distinguishing characteristics may include an angular polyhedral transverse cross section (orange-like segments) and lack of distinction between the dorsal and ventral faces (Ahler 1989:210). Bipolar reduction is often utilized when raw material is scarce or of poor quality (Honea 1965:259; Kujit et al 1995:117). As a result, the bipolar technique is often used to detach flakes from pebbles that are too small to work by other methods. Pebble cores may have flakes removed from a single end, from both ends, or from multiple margins (Honea 1965:263) and often exhibit major and minor negative bulbs of percussion as a result of reflected force. While identification of bipolar flakes and bipolar cores in association with stone anvils is indicative of bipolar reduction (Honea 1965), the absence of bipolar cores and stone anvils does not indicate this technique was not used. Instead, a debitage assemblage that is dominated by non-orientable and medial/distal fragments may be considered to be the result of bipolar reduction (Kujit et al 1995).

Stages of Biface Production

The process of producing a bifacial tool is a continuous operation that begins with core reduction and ends with a useable tool. A core in this context may be any piece of stone that acts as the starting point for a tool. It may be a flake, a cobble or a block of raw material. The core is methodically reduced through ever finer flake removal, layer by layer, until the desired shape is obtained (Sharrock 1966:40). Unfinished bifacial tools, often referred to as blanks (Callahan 1979; Muto 1971; Sharrock 1966), may function as useable tools such as knives and choppers (Sharrock 1966:41). While the term *unfinished biface* suggests the tool is not in its final form this is not always true. The term is not intended to place a narrow interpretation on the objective piece. Instead, for non-hafted bifaces the term is used in a relative sense to distinguish between diagnostic tools and non-diagnostic tools. The designation also recognizes that the biface could be further modified.

A number of experimental studies have been undertaken to identify and/or categorize stages of biface production (e.g. Callahan 1979; Magne 1985; Muto 1971). Muto (1971:3) notes that since lithic technology is a subtractive process it requires a great deal of control and foresight to produce a desired result. In his experiments on manufacturing Clovis-like bifaces he found that some characteristics were produced early in the production sequence and some were produced later. Muto (1971:47-48) avoids identifying explicit stages, preferring instead to recognize that tool manufacture is a continuum of operations that may be completed in a single event. Six artificially delineated operations are identified (Muto 1971:48).

1. selection of nodule or flake of adequate size to produce the finished implement
2. selection of fabricator
3. removal of cortex or rind from the nodule
4. thinning the objective piece to the approximate section and cross section
5. securing the final outline and sections
6. finishing the edge and hafting mechanism if any

Callahan (1979:9) has produced an exhaustive study of biface production including a comprehensive catalogue of the various stages of manufacture, and examples of rejected and failed pieces. In his study he recognizes five stages of production for biface preforms.

Stage 1 – Obtaining the blank
Stage 2 – Initial edging
Stage 3 – Primary thinning
Stage 4 – Secondary thinning
Stage 5 – Shaping

Callahan is very precise in defining stages. They are based on a number of attributes including width/thickness ratio, edge-angles, the plan or shape of the biface, the interval or space between flakes along the lateral edges and the offset or sinuosity of the lateral edge. Stage 2 bifaces have been flaked around the circumference resulting in thick, irregular pieces with widely spaced flake scars and very sinuous edges. Stage 3 bifaces are more lenticular in cross section with flake scars that are somewhat closely spaced and extend across to the center of the piece. The lateral edges of Stage 3 bifaces are moderately wavy. Stage 4 bifaces are regular in shape with closely spaced flake scars that extend beyond the center line. The lateral edges of Stage 4 bifaces are relatively straight.

Magne (1985:106-107) opts for very broad stages of production which he defines as early, middle and late stage reduction. Early stage reduction includes all core reduction events that result in flake blanks and encompasses both bipolar and direct percussion techniques. Middle stage reduction is defined as the primary trimming stages and includes all flaking except for marginal retouch (on tools with marginal retouch) or the first half of flaking events on unifacial or bifacial tools (on tools without marginal retouch). Its primary purpose is to straighten edges, and remove excess mass. Late stage reduction is defined as the second half of the flaking events on unifacial and bifacial tools and its purpose is to refine the final shape of the tool.

Indicators of Stage of Production

Experimental studies have provided valuable insight into the process of manufacturing bifaces and the characteristics of the resultant debitage. Additional studies have been undertaken to correlate debitage, including fragments of unfinished bifaces, to stages of production (e.g. Baumler and Downum 1989; Kooyman 2000; Magne 1985, 1989; Mauldin and Amick 1989; Muto 1971; Odell 1989). Magne (1985:111-129) tested the effectiveness of six flake scar attributes used to differentiate between bipolar reduction flakes and bifacial reduction flakes and also to identify the stage of manufacture. He tested weight, dorsal scar count, dorsal scar complexity, platform scar count, platform angle, and cortex cover. Magne (1985:118) concluded that flakes from early stages of production could be correctly identified more often than those from later stages. He also concluded that platform scar count and dorsal scar count were the most discriminating variables and could be used to identify the reduction stage as follows:

0-1 Scars = early stage (core reduction)
1-2 Scars = middle stage (primary trimming)
3 or more scars = late stage (finishing)

Mauldin and Amick (1989) tested the efficacy of cortex cover, dorsal scars and flake size as determinants of reduction stage and found the results were ambiguous and highly variable. They suggested variability may be the result of any number of factors including initial core size and shape, different raw materials or different knappers (Mauldin and Amick 1989:67,85). Though individual attributes did not conclusively identify stage of production, Mauldin and Amick (1989:73) determined that a combination of attributes, such as size grades and cortex cover, had the potential to provide conclusive results.

Sullivan and Rozen (1985) reject the method of analyzing debitage by assigning each to a stage of reduction. They assert that technological origins cannot be confidently inferred from key attributes on individual artifacts and it is more reliable to examine the assemblage in its entirety (Sullivan and Rozen 1985:755). They claim their model for determining reduction strategies from debitage is interpretation-free (Sullivan 1987; Sullivan and Rozen 1985; Rozen and Sullivan 1989). Debitage is categorized into mutually exclusive categories of complete flakes, broken flakes, split flakes, flake fragments and debris (Sullivan and Rozen 1985:755; Sullivan 1987:47). The advantages of this method are twofold. The first is the ease of assigning flakes to the defined categories which makes it replicable (Kelly 1994:134), and the second is the ability to statistically examine an assemblage for the presence of trends and patterns.

In a study comparing site assemblages from Arizona, Sullivan and Rozen (1985) identified proportional differences between respective debitage types that corresponded to technological strategies employed. They found that higher rates of core fragments and complete flakes along with lower rates of broken flakes and flake fragments were indicative of core reduction. Conversely, low rates of core fragments and complete flakes with higher rates of broken flakes and flake fragments indicated tool manufacture.

The Sullivan and Rozen technique has been criticized because a number of their results have not been verified by experimental research (Baumler and Downum 1989:108; Prentiss and Romanski 1989:89). Prentiss and Romanski (1989) evaluated the technique on debitage assemblages created from experimental biface, end scraper, block core and spheroid core reduction. Their results indicated that tool production assemblages could be differentiated from core reduction assemblages but the proportional differences contradicted those identified by Sullivan and Rozen. The Prentiss and Romanski study determined that tool production resulted in far more complete flakes than core reduction.

A second phase of the Prentiss and Romanski (1989:94-96) study evaluated the effects of trampling on the debitage assemblages. Though Sullivan and Rozen (1985:763) believed their assemblages had not suffered breakage from trampling the trampled assemblages from the Prentiss and Romanski study closely resembled the Sullivan and Rozen pattern.

A recent study by Pearce (2005) compared debitage analytical techniques on an Archaic assemblage excavated with the aid of brick hammers and picks from a heavy clay soil matrix at a ploughed site. In this context the prospect of breakage/trampling was great. Pearce compared the efficacy of the Sullivan Rozen (1985) technique against the traditional typological analysis. Pearce's (2005:10,12) results indicate that the two techniques were complementary and identified the technologies employed at the site as both tool production and core reduction. In this case, post-depositional processes may have altered the assemblage in a manner similar to Prentiss and Romanski's (1989) trampling experiment.

Indicators of Retooling Activities

Study of small-sized debitage (1 to 20 mm) is critical for identifying lithic retouching and resharpening behavior (Baumler and Downum 1989:113). Baumler and Downum's (1989) mass analysis of experimentally produced lithic debris identified distinctive debitage assemblages for core reduction and tool retouch. The study looked at flaking debris of 2 to 4 mm in maximum dimension produced by experimental core reduction and the manufacture of scrapers. Their analysis categorized small-sized debitage as complete flakes, split flakes and shatter in a manner similar to the model developed by Sullivan and Rozen (1985:758-759) and Sullivan (1987:47). They found that small-sized debitage is produced in large amounts by both tool manufacture and core reduction, but that core reduction resulted in a greater proportion of shatter and a lower proportion of complete flakes than tool manufacture (Baumler and Downum 1989:105-106). This indicates that the mere presence of small-sized debitage is not sufficient to signify resharpening or retouching activity. However, analysis of small-sized debitage within an assemblage may help to identify site patterning of activity areas.

The greatest limitation to analyzing small-sized debitage is the small quantities collected in the field. This is a direct result of using 6 mm mesh screens where debitage under 5 mm slips through the mesh and is not recovered.

Indicators of Expertise

Technological features, specifically flake scars, may be examined to investigate flint-knapping expertise. Since lithic tools are manufactured by a reductive process, errors that result from raw material flaws or knapper inexperience are preserved (Deetz 1967:48). Examination of these features on flakes, unfinished bifaces and even finished bifacial tools shows how individual knappers resolved knapping problems.

Central to this study is the examination of the lithic material to determine if the chunky appearance of Archaic tools is the result of poor quality material or novice flint-knapping ability. Crabtree (1972:5) cautions against using the term “crude” to describe workmanship when material quality is poor. As experiments in lithic technology have shown, a novice can produce a reasonable tool with superior material (e.g. Magne 1985) but superior workmanship is required to overcome the limitations of poor material (Crabtree 1972:5). Ideally, experimental knapping of the metasedimentary lithic material used at the West Burleigh Bay site would enable assessment of the frequency of adverse flaking events and help to determine the quality of the material. However, discovery of the source of the metasedimentary material very late in the process of this research, combined with very limited quantities of the material, made experimentation impossible.

Lithic tool production requires both cognitive and physical skill. It requires forethought and planning as well as manual dexterity (Muto 1971:102; Pigeot 1990:130). A knapper needs to be able to envision the steps required to modify the core, choose the appropriate tools to detach required flakes and be able to overcome problems as they arise. Not all flint-knappers are equally skilled and we should expect to see variation in skill levels, from novice to expert, in an archaeological assemblage. A study by Pigeot (1990) examined lithic production attributed to apprentice flint-knappers. Through refitting debitage struck from large flint nodules she was able to reconstruct flake removal events. Eleven clusters were studied presenting a range of competencies. Some nodules could be almost entirely refitted suggesting that no useable flakes were manufactured and the debitage was produced by children imitating adult behavior. Others reflected a gradation of technical abilities that may suggest an apprenticeship program that gradually incorporated new skills.

Flint-knapping is a learned skill and requires substantial practice and observation to gain full competency. Skill is largely unconscious and is the ability to regulate required gestures, such as degree of force and patterns of movement, based on visual cues (Chazan 1997:723). Beginners produce repetitive errors and more frequent errors than experts (Shelley 1990:187). Shelley (1990) studied core and flake samples from expert and novice flint-knappers and determined that variation was patterned and identifiable. Novice flint-knappers were more likely to discard cores as a result of repeated unsuccessful attempts at flake removal. Stacked step terminations were indicative of repeated unsuccessful attempts. Expert flint-knappers rarely discarded bifaces prior to completion but when they did it was due to the discovery of a flaw in the material, or the result of perverse or end shock fracture. Shelley (1990) computed relative frequencies of combined hinge and step fractures and used these to identify the flint-knapper as novice or expert. Occurrence of stacked hinge and step fractures ranged from 54 to 61 % for beginners and only 2 to 4% for experts. This suggests that a high frequency of stepped fractures in an assemblage indicates the presence of novice flint-knappers. The opposite may also be inferred. An absence or very low frequency of stepped fractures in an assemblage, consisting of manufacturing debris from all stages of production, would indicate the presence of expert flint-knappers.

Documentation of the Archaic Lithic Assemblage: A Typological Analysis

Typological analysis stems from a culture-historical perspective and was originally developed as a means of classifying artifacts based on morphological characteristics (e.g. Kidder 1924; McKern 1939). Shared traits were assumed to be the result of diffusion and therefore indicated shared origins, history and ethnicity. This assumption enabled the construction of regional cultural chronologies based on shared traits (Trigger 1989:191-192). William Ritchie's (1944) PhD dissertation on pre-Iroquoian occupations in New York State followed McKern's (1939) Midwestern Taxonomic Method and set the precedent for lithic typologies in the Northeast.

Projectile point names are ingrained in archaeology and are useful for communicating technological, morphological and chronological information in a single recognizable term (Morrow 1999:220). The corresponding projectile point styles are considered indicators of cultural, spatial and temporal variation (Justice 1987:6; Ritchie 1971:7; Willey and Sabloff 1993:119). Differences in the morphology of projectile points are attributed to two factors, style and function (Sackett 1977:370). Form relates to the function of a tool, but cultural ideas of how a tool should look are termed style. According to Dunnell (1978:199) stylistic similarity is the direct result of cultural transmission of tool design and may be used to infer cultural or spatial interaction. Published typologies (e.g. Justice 1987; Ritchie 1971) seem to support this view because they indicate that tool types cluster regionally and temporally. However, they should not be interpreted simply as evidence for different ethnic identities because the meanings behind similarities and differences in projectile point styles are not clear. They may represent ethnic boundaries, cultural interaction, and/or expression of personal or social identity (Wiessner 1985:163) or alternatively, they may reflect social distance (Morrow 1999:222). Morrow (1999:220-221) also notes that tools exhibit a great degree of variation and can not always be assigned to a specific type. For example, resharpening activities change the dimensions of a tool over its use-life and gradual changes in design over time result in a blending of traits representative of multiple types. Therefore, interpretation of artifact assemblages based on stylistic variability must be flexible. Tool styles overlap culturally, temporally and spatially.

In the archaeological literature, lithic tools are usually named according to their perceived function. This has been a largely intuitive process since stone tools are often morphologically similar to historic and even contemporary tools. However, form does not always correlate to function (Andrefsky 1998:190). Microwear studies (eg. Ahler 1971; Greiser 1977) have shown that hafted bifaces were multifunctional tools, and though they were often solely used as projectile points, at times they were used for a number of other functions including cutting, butchering, piercing and scraping. Bifaces were also a portable toolkit. Large bifaces were used as cores to produce sharp, undamaged flakes when needed, and when exhausted they could be recycled and used for other functions such as scrapers (Kelly 1988:718). This multifunctionality is important to keep in mind when assessing any lithic assemblage for interpretation of the activities that took place at a site.

A high frequency of curated, bifacial tools on a site is indicative of a mobile hunting and gathering population. The frequency and style of bifaces can provide insight into the activities that took place at the site and the time of year the site was occupied. Throughout the Northeast during the Archaic there was a trend towards increased stability and intensive exploitation of abundant food resources, leading to increased efficiencies (Caldwell 1958:13). Thus, exploitation of nuts in mast forest environments, shellfish in coastal environments, fish in riverine environments and game in forest environments led to the development of specialized tools to capture and process the resources. For example, lithic projectile point styles developed for atlatls during the Archaic were usually barbed. Barbed points were especially well suited to ambush hunting in a forested environment. When struck with an atlatl dart the barbs would stick into the game and impede their flight from the hunter (Caldwell 1958:13).

Seasonal availability of scattered and varied food resources affected mobility patterns and the time of year sites were occupied. Southeastern Ontario is characterized by two distinct seasons that affected the mobility patterns and tool use of the people who resided there. The spring and summer season was a time of plentiful resources when Archaic peoples would congregate at prime fishing locations and harvest large quantities of fish. This was also a time for bands to interact and engage in a variety of social, political and religious events (Hamilton et al. 1994:5). The combined effects of repeated seasonal occupation and larger population resulted in increased visibility of these types of sites in the archaeological record (Cleland 1976:64). Conversely, during the fall and winter season when resource availability declined, the group would divide and disperse into well sheltered uplands to hunt and gather a range of diffuse resources (Hamilton et al. 1994:5). Short term camps used during the fall/winter season as well as in-transit camps used when moving between seasonal locations have very low archaeological visibility due to their limited duration of use as well as the small number of people inhabiting them.

Discrete occupations at a multicomponent site are difficult to discern. Through statistical analysis Sullivan (1992) was able to identify short duration occupations, of a few days or less, from artifact scatters that included lithic tools and debitage. Clines of artifact density variation were identified representing subsite areas. Analysis of the flaking debris by subsite area indicated that six of the seven areas represented bifacial lithic reduction techniques, the seventh did not. When weight and dimension attributes were statistically compared, the subsite areas were interpreted as distinct occupations at the site. Plotting of temporally diagnostic point styles to the subsite areas resulted in the development of a chronological model for the site. Since the study was of a multicomponent site it was expected that variation between subsite areas would be limited (Sullivan 1992:105). Consequently, any strong differences between subsite areas strengthened the interpretation of distinct occupations.

Summary

The use of multiple approaches to interpret lithic assemblages provides several avenues for inferring aspects of ancient culture. Technological approaches are used to study the raw material and manufacturing processes for making stone tools. Studies have shown that organization of technology is related to subsistence strategies. Though both curated and expedient technologies were commonly used throughout antiquity, curated technologies were more frequently used by mobile populations and expedient technologies were more commonly used by sedentary populations. Identification of raw materials and their provenience indicates the raw materials that were available and where they originated. This can provide clues to regional interaction through seasonal rounds or through trade and exchange. Raw material properties may also be studied to identify manufacturing limitations which, key to this particular study, can aid in identifying flintknapper expertise. Lithic reduction techniques can be studied to identify the activities performed at the site. By analyzing the entire assemblage of finished tools, unfinished tools, and lithic debris, manufacturing and rejuvenating activities performed at the site may be identified. Presence of manufacturing debris from all stages of manufacture implies that tools were being made and not just repaired. In addition, the skill level of flintknappers may be identified by looking at unfinished bifaces and observing knapping problems that occurred and the steps taken to resolve them. Typological approaches to studying lithic assemblages allows for identification of the time period when the site was inhabited and indicates cultural or spatial interaction. The types of tools present can indicate the season of occupation as well as the food resources exploited. Though no study can ever produce a complete profile of cultures of great antiquity, such as those of the Archaic peoples, many reasonable inferences can be made and are considerably strengthened when multiple approaches are used.

Chapter 4

Research Methods

The previous chapter outlined the variety of methods that may be used to analyze lithic assemblages. In this chapter the methods chosen for this study and the reasons for their selection are examined in detail. The chapter begins with an overview of the sampling strategies used during excavation, followed by an explanation of the methods used to identify and separate for analysis the Archaic artifacts from the total assemblage. Next, the methods used to organize the artifact assemblage into an appropriate analytical framework are described. This is followed by an examination of analytical methods used to study the organization of lithic technology by examining evidence of raw material provenience and lithic production techniques. The chapter concludes with a summary of the methods used for data analyses and statistical testing.

Excavation of the West Burleigh Bay Site

The use of probability sampling and statistical reasoning provides the basis for objective evaluation and analysis of archaeological sites and the artifacts recovered (Binford 1964:435; Thomas 1976:2). Research design that utilizes probability sampling in all phases of the archaeological project provides "adequate and representative data useful in the study of cultural process" while limiting the biases of the investigator (Binford 1964:435,440). Excavation of the West Burleigh Bay site was conducted in accordance with these methods.

The Trent University field school, led by Professor Susan Jamieson, excavated the West Burleigh Bay site over four six-week sessions from 2002 to 2005. As noted in the introductory chapter, West Burleigh Bay is located on the north shore of Stony Lake, approximately thirty kilometers north of Peterborough, on the edge of the Canadian Shield. The landscape is typical of the Shield with a mixed forest growing on thin, rocky soil. The site itself is situated on a low-lying point of land that juts into Stony Lake and is bisected by a steep, ancient terrace about sixty meters north of the current shoreline (Figure 4.1).

Prior to excavations by the field school, York North Archaeological Services completed Stage 1 and Stage 2 research of the site as defined by Redman (1973:64). Their survey of the site resulted in the recovery of a significant number of Archaic and Woodland artifacts. The first task performed by the Trent field crew, during the 2002 season, was to survey the entire site by shovel testing at three-meter intervals. This intensive systematic sampling of the site is equivalent to the Stage 3 collection recommended by Redman (1973:64). The survey provided important information that was later used to select loci for excavation. First, the data confirmed that no consistent, discernable stratigraphy exists at the West Burleigh Bay site (Jamieson 2002:30). Second, the recovered artifact clusters indicated repeated occupation of temporary camps at various locations within the site (Jamieson 2002:30). Some camps overlapped previous ones, and some were discrete. The majority of artifacts, representing multiple cultural periods, were recovered from a level area positioned between two ancient terraces. Woodland material appeared closer to the lower terrace with a small quantity of artifacts located between the terrace and the shoreline. Very few artifacts were recovered

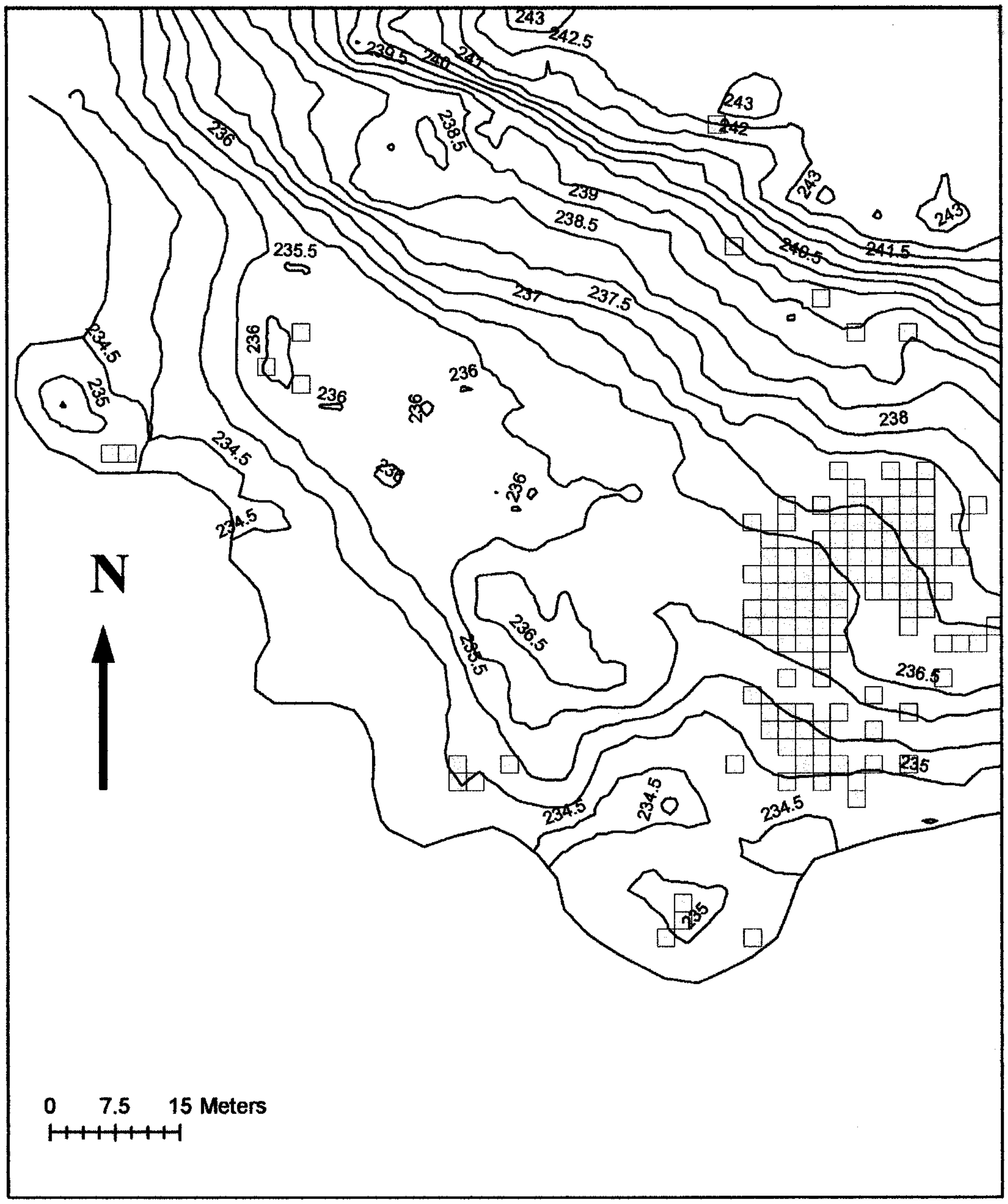


Figure 4.1 Contour map of West Burleigh Bay (BdGn-12) site with $2m^2$ excavation units identified
Contour interval = 0.5 m

from above the higher terrace. The result of the sampling confirmed a lack of vertical stratigraphy but the distribution of artifact clusters suggested intra-site variability that could be used for relative dating based on variations in the water level over time.

Excavations during the 2002 field season concentrated on areas of artifact clusters discovered during the survey. Units excavated along the shoreline contained Middle and Late Woodland artifacts but units excavated along the eastern portion of the site produced a range of artifacts spanning the entire 12,500 year range of occupation at this site (Jamieson 2002:31). The bulk of the artifacts were recovered from a low-lying area that floods after every heavy rain. This natural hollow collects water released from a gully just north of the terrace that channels water down the hill. Artifacts recovered from this area appear to be deposited by two distinct methods. Small pieces of bone and lithic flakes are abundant in the topmost layer of the soil and are likely the result of down slope wash. Artifacts recovered from deeper in the units are more likely to be primary deposits.

Each successive field season at West Burleigh Bay had a clear focus based on the results of the previous seasons. Binford (1964) and Redman (1987) recommend this approach and it was used with considerable success at the site. While the first season was dedicated to providing a chronology of occupation at the site, subsequent seasons were devoted to expanding the knowledge of the Archaic and Paleoindian occupations. These earliest occupations are not well-documented in Ontario (Wright 1995:64). Selection of units for excavation during the first field season was based on the positive results from the York North survey and from the Trent University Stage 3 survey. Unit selections for the 2003, 2004 and 2005 seasons were based on results from all previous work at the site.

Two meter by two meter units were excavated by individual students. As a part of their training, students were required to meticulously excavate their first two meter unit by trowel. The advantage of this method was that students often identified and removed artifacts, including flaking debris, from their unit prior to screening. This resulted in the recovery of a significant quantity of small-sized debitage that would otherwise have fallen through the quarter inch mesh of the screens. Subsequent units were excavated by shovel, when possible, but the stony nature of the soil required extensive excavation by trowel. It is expected that recovery of small-sized debitage from these units was somewhat reduced.

One of the early limitations that was later resolved at the West Burleigh Bay site concerned the boundaries for excavation set by the landowner. The bulk of the Archaic artifacts appeared adjacent to the eastern edge of the site and it was expected that additional Archaic artifacts were buried *in situ* beyond the boundary. Permission was granted by the landowner for excavation beyond the boundary in the final two years of the field school. This enabled an enhanced sampling of the Archaic components of the site.

Identification of the Archaic Sample

For the purpose of this study it was necessary to attempt to separate all Archaic period lithic artifacts from the multicomponent collection. The West Burleigh Bay collection consisted of all artifacts recovered during the four seasons of Trent University field schools. Artifacts recovered by York North Archaeological Services were not available for study. Two issues affected the identification of the Archaic component. The first related to taphonomy and the characteristics of the soil. The second issue concerned the shortage of comparative material in Ontario.

Highly acidic soil, thin soil profiles, and intermittent water flow/seepage combine to significantly limit temporal identification of artifacts at the site. The presence of highly acidic soil destroys most traces of organic material, making radiocarbon dating methods impossible (Wright 1995:126). Relative dating through stratigraphic methods is also difficult because this is a high-energy site where artifacts move vertically within the soil as well as horizontally across the surface of the site. The thin soil profile, typical of the Canadian Shield, combined with disturbances from seasonal freeze-thaw cycles, rodent activity, and tree roots, result in the intermixing of artifacts (Wright 1999:709). In addition, water flowing through the site moves artifacts from higher elevations to lower elevations, both on the surface and below it.

The depth of the soil varies across the site and affects the degree of intermixture. There are three natural strata observed at the site (Jamieson 2003:11) and the first two range in thickness from about 1 cm to approximately 30 cm. The upper most stratum (Stratum I) consists of coarse black humic loam, and the second stratum (Stratum II) is a gravel and cobble packed, brown to dark yellowish brown sandy loam layer. The second stratum overlies a sterile sandy clay layer. Units located close to the shoreline are sandier, contain fewer rocks and have a thinner profile than units located up-slope. Intermixing of artifacts is most pronounced in these units with Paleoindian, Middle Woodland, and contemporary items recovered from a single stratum. Units located up-slope, away from the shoreline, tend to have deeper strata and intermixing of artifacts is somewhat less extreme. In these units, artifacts recovered from the deepest levels of

Stratum II were older, often of Paleoindian origin, than those recovered closer to the surface. This observation indicates that the stratigraphy may be used to interpret the relative age of lithic artifacts when combined with other factors such as location of the unit, style of the artifact, degree of patination, and degree of flake scar smoothing from environmental factors.

Since there is no way to confidently delineate time periods through stratigraphy and the absence of organic material makes dating by radiocarbon methods impossible, dating of artifacts must be made by comparison to published typologies. Typologies used for classifying artifacts in Ontario are based on collections from the northeastern United States (Ritchie 1971; Justice 1987). A few single component sites do exist in Ontario but most have not been dated by absolute methods (see Johnston 1984; and Ramsden 1990; for undated single component sites, also Lennox et al. 1995 for a Middle Archaic site C-14 dated to 6732 B.P.). Wright (1995:65) notes that serious identification problems occur because some Early Archaic types resemble later types. This problem has also been addressed by Ellis et al. (1990:71) in their discussion of the confusion between Early Archaic side-notched points and Middle Archaic Otter Creek points, which are also side-notched forms. They note there has been a tendency in Ontario to lump the early forms in with the later, thereby under-representing Early Archaic artifacts. Furthermore, we have such poor knowledge of Early Archaic and Late Paleoindian assemblages from Ontario, that we cannot reliably assign non-projectile tool types to either period with any degree of confidence (eg., Lennox 2002).

For identification of Archaic period flaked stone artifacts at the West Burleigh Bay site, three primary sources of regional typologies were referenced: *A Typology and*

Nomenclature for New York Projectile Points (Ritchie 1971); *The Archaic* (Ellis et al. 1990); and *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States* (Justice 1987). The primary sources for identification of ground stone artifacts were: *An Attribute and Spatial Analysis of Several Ground Stone Artifact Types from Southern Ontario, in Relation to their Patterning and Context in the Northeast* (Lackowicz 1996); and *The Archaic* (Ellis et al. 1990). Additional regional sources were consulted when further clarification was required and included regional summaries for the Great Lakes Region (Mason 1981; Quimby 1960), New York State (Funk 1988; Ritchie 1994), the northeastern United States (Snow 1980; Willoughby 1935), the Canadian Maritimes (Tuck 1976), and Ontario (Wright 1972a, 1972b, 1995, 1999), as well as site reports from Quebec (Chapdelaine et al 2001; Kennedy 1967), and Ontario (Ross et al. 1997, 1998; Ross and D'Annibale 2000; Williamson and MacDonald 1997).

In some reference books flaked stone projectile point styles overlap multiple periods. For example, Justice (1987:46) identifies the Hi-Lo complex as Late Paleoindian/Early Archaic but Ellis et al. (1990) omit it from the Archaic and instead identify it as Late Paleoindian (Ellis and Deller 1990:57). Susquehanna Broad points and Perkiomen points are identified by Justice (1987:167-168) as Late Archaic/Early Woodland but Ellis et al. (1990:100) include them in the Late Archaic. To provide consistency when discrepancies occurred, the Ellis et al. (1990) publication was followed. It was chosen because it takes into consideration sites, styles and dates from Ontario, making it the most relevant for this study. (Refer to Appendix A: Attribute 13 for further information regarding the identification process of flaked stone bifaces.)

Stylistic and temporal identification of ground stone artifacts proved to be problematic. Comprehensive typologies for ground stone artifacts do not exist. Lackowicz (1996:3) attributes this to lack of study due to the rarity of recovered ground stone artifacts and the absence of secure-context recoveries (see also Wright 1962). Complicating the issue is the absence of stylistic variability for some celts. Similar styles span thousands of years from the Archaic to the Woodland periods (Teal et al. 2003:20). However, a number of celt and gouge styles have been recovered from Archaic contexts and are included in site reports and regional syntheses. These sources have been used to approximate time periods for the various styles recovered at West Burleigh Bay. For this reason, only descriptive attributes were recorded and no detailed study of the ground stone artifacts was undertaken.

Once Archaic projectile points were identified, Archaic period toolstone was examined and compared to toolstone represented in the remainder of the West Burleigh Bay assemblage. It was determined that varieties of chert, quartz and quartzite were used during multiple periods of occupation, but two distinctive types of raw material were temporally limited to the Archaic. These were a fine-grained, black, metasedimentary material, and a coarse-grained grey-brown sedimentary material. This discovery allowed for the expansion of the sample to include non-diagnostic tools and manufacturing detritus for both of these types of rocks.

In summary, the Archaic lithic sample analyzed in this study consists of:

- diagnostic flaked stone tools
- diagnostic ground stone tools

- non-diagnostic tools made on non-chert sedimentary and metasedimentary materials
- lithic manufacturing remains on non-chert sedimentary and metasedimentary materials

Metric attributes and raw material identification were recorded for all artifacts. Flaked stone artifacts were further analyzed to identify raw material quality and manufacturing technique.

Organization of the Archaic Assemblage

The framework used to organize the flaked lithic assemblage for analysis was adapted from the research of Andrefsky (1994), and Sullivan and Rozen (1985; Sullivan 1987; Rozen and Sullivan 1989) on debitage analysis and from the research of Muto (1971) on biface production. The material is categorized in this manner to facilitate data manipulation and the ability to answer predetermined research questions. Assignment of maximal artifact categories (debitage, tool, and core) is based on the presence or absence of visible percussion features, and the presence or absence of retouch (Figure 4.2). (Refer to Appendix A for a detailed description of the features used to assign categories.)

Assignment of debitage categories followed the method developed by Sullivan and Rozen (1985; Sullivan 1987; Rozen and Sullivan 1989) (Figure 4.3). Alternatively, debitage could have been categorized by traditional flake typology, but the benefit of the Sullivan and Rozen method is its replicability and ease of use. The features used to sort debitage using the Sullivan and Rozen technique are explicitly defined and readily

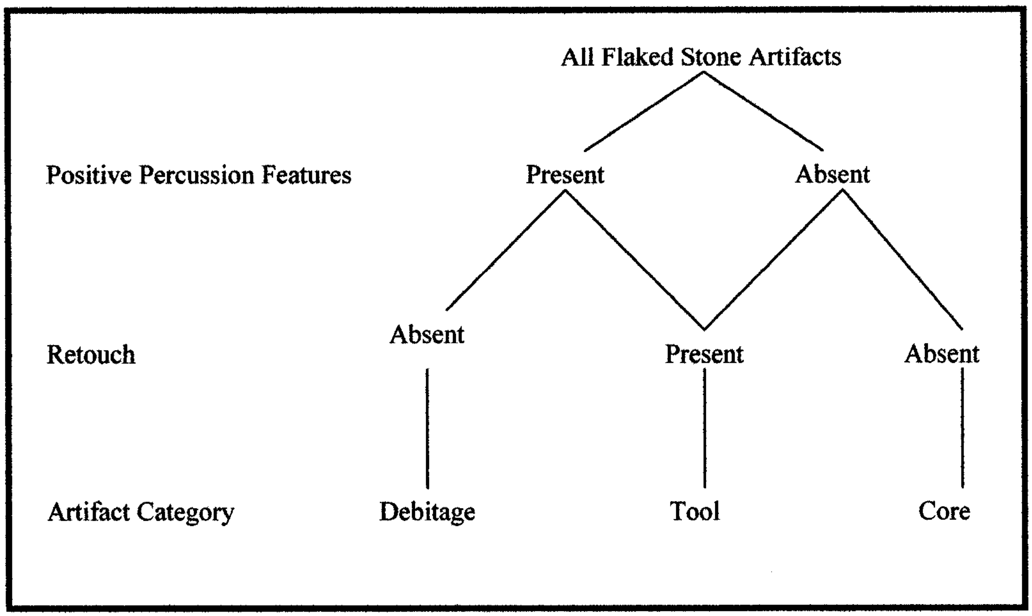


Figure 4.2 Maximal Artifact Categories (adapted from Rozen and Sullivan [1989:181] and Sullivan [1987:48])

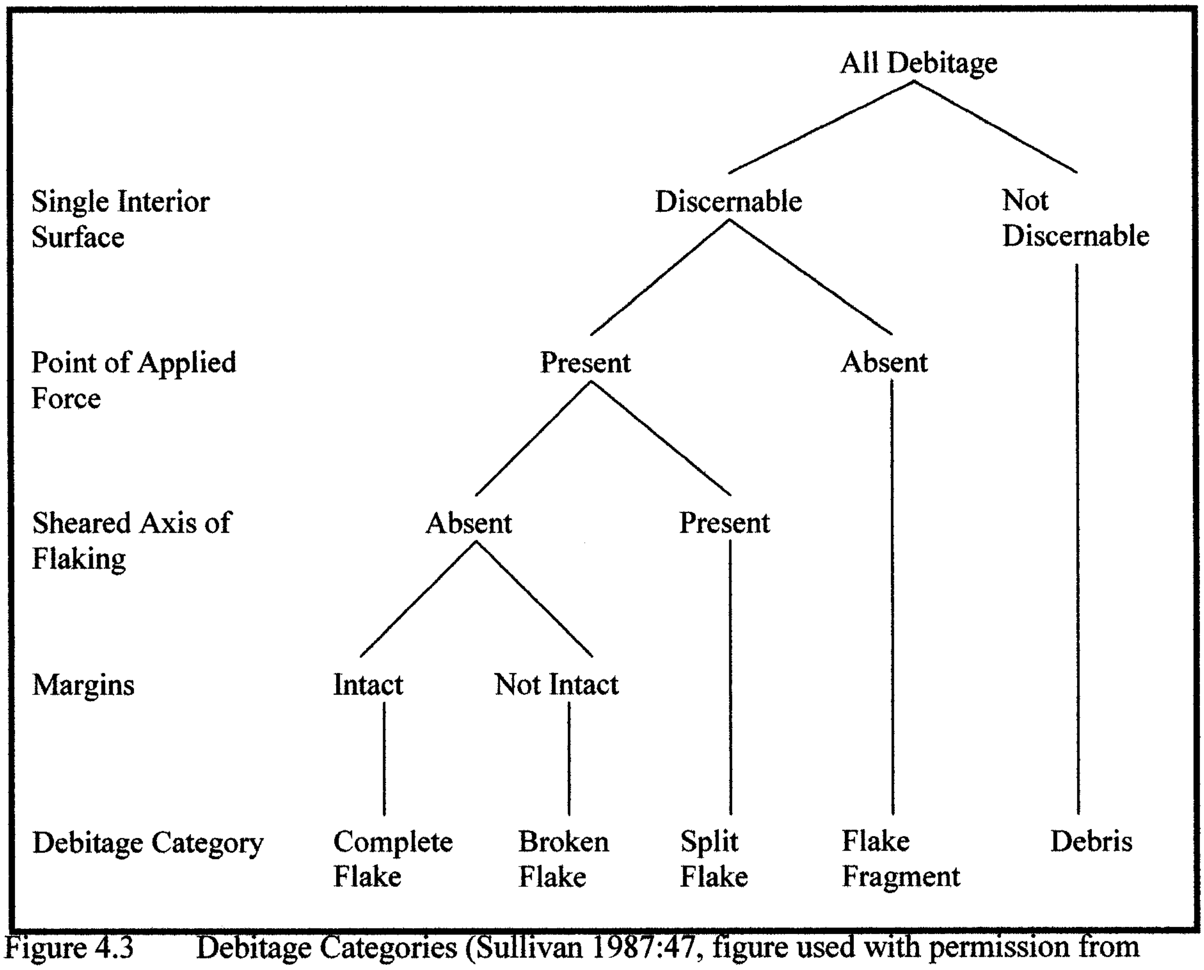


Figure 4.3 Debitage Categories (Sullivan 1987:47, figure used with permission from the author).

discernable (refer to Appendix A). The only modification made to the criteria set out by Sullivan and Rozen (1985:758-759) was to include outrepassé flakes within the definition of complete flakes.

Complete flakes are those with intact platforms and margins from the original flaking event. The distal margin of a complete flake detached through direct percussion will exhibit one of four methods of termination: feather, step, hinge, or outrepassé (Cotterell and Kamminga 1987:699-702) (Figure 4.4). Feather terminations are preferred as they have edges with minimal margins (Crabtree 1972:64). The remaining three methods are not ideal and are caused either by knapper error or by less than ideal toolstone. Step terminations end abruptly at right angles to the flake. They are caused by crack arrest due to the application of insufficient energy, or because the material is too brittle, or the crack intersected a flaw in the material. Step terminations may or may not exhibit finials, which are thin fragile extensions on the distal margin of the flake (Figure 4.4). Hinge terminations exhibit a blunt, rounded distal margin in cross section. They are caused by excessive outward pressure on bending flakes and, like step terminations, they may also exhibit finials. Outrepassé terminations occur when the crack plunges into, and detaches, the distal end of the objective piece. This type of termination is common when percussion flaking into a sharp corner or when pressure flaking too far from the face of the objective piece.

Feather terminations, hinge terminations and outrepassé terminations were deemed to be the result of the original flaking event and were categorized as complete flakes. On the other hand, step terminations may occur during flaking or they may be the

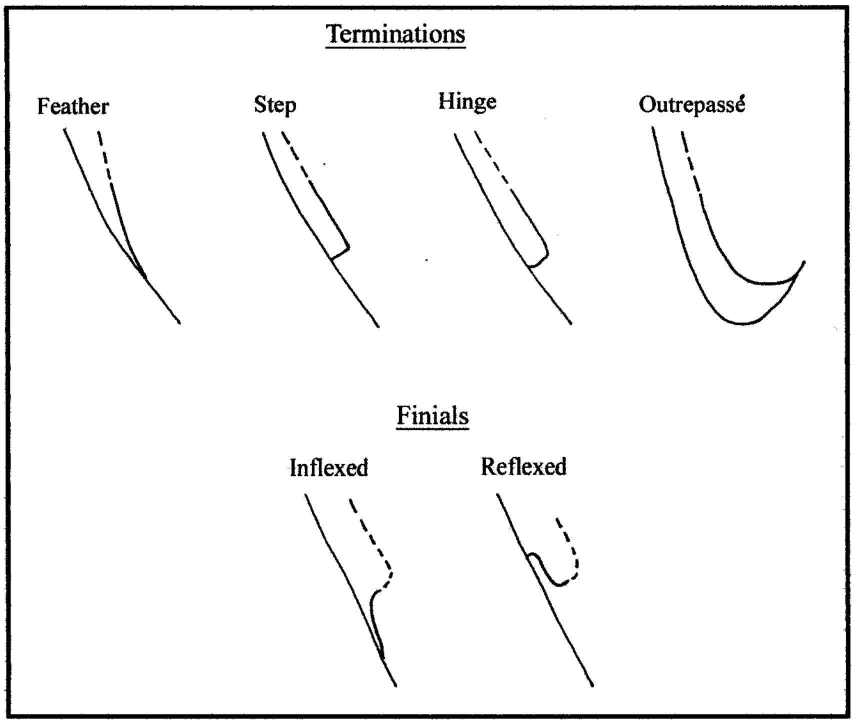


Figure 4.4 Flake Terminations (following Cotterell and Kamminga 1987:684)

result of post depositional damage. Trampling causes breakage of complete flakes along margins and ends (Prentiss and Romanski 1989:95) that can mimic the appearance of step terminations. Bending fracture initiated by force applied to the middle of the flake while it is lying on the ground or within the soil matrix can cause the flake to snap in two (Cotterell and Kamminga 1987:691). The crack formed in snap fractures travels through the flake meeting the opposite surface at right angles, and causes the flake to break transversely (Cotterell and Kamminga 1987:699-700). Inflexed and reflexed finials can occur on snap fractures. Since there is often no way to differentiate between step terminations and snap fractures these types of flakes were not considered complete flakes.

The remaining debitage was sorted according to the following definitions. Broken flakes are proximal flakes with missing margins. Split flakes are defined as flakes that retain a portion of the striking platform but are split longitudinally. Flake fragments are medial-distal fragments with no striking platform evident. Debris is defined as debitage that exhibits no flaking characteristics and is commonly referred to as shatter or blocky fragments.

The flaked stone tools in the assemblage were sorted into categories based on the presence or absence of bifacial flaking, the degree of retouch and the presence or absence of hafting elements (Figure 4.5). A finished biface is defined as a hafted, bifacial tool that has been extensively retouched, such as a projectile point or drill. An unfinished biface represents all stages of biface production up to but not including the addition of

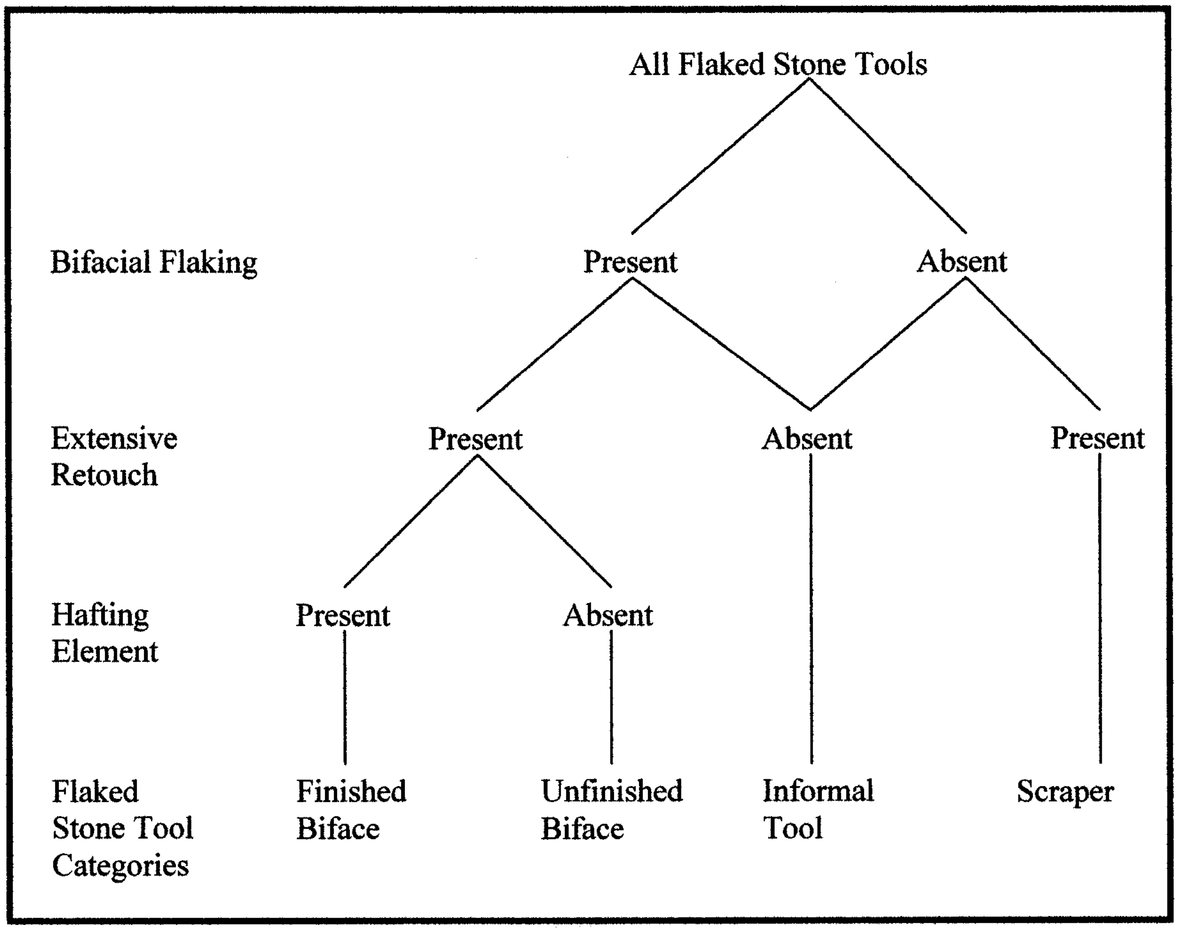


Figure 4.5 Flaked Stone Tool Categories (adapted from Andrefsky (1994:22), Muto (1971) and Sullivan (1987:48-49))

hafting elements. As stated in Chapter 3 the use of the term *unfinished* does not imply the tool was unusable, only that it could have undergone additional modification. An informal tool is defined as a unifacial or bifacial tool that is not extensively retouched but does have one to three invasive retouch scars (Sullivan 1987:49), and a scraper is a unifacial tool with more than three invasive retouch scars.

The Archaic lithic sample separated from the West Burleigh Bay assemblage was categorized as follows:

Table 4.1 Archaic Lithic Assemblage

Maximal Artifact Category	Category	Number of Artifacts
Flaked Stone Debitage	Complete Flakes	367
	Broken Flakes	539
	Split Flakes	97
	Flake Fragments	725
	Debris	160
Total Flaked Stone Debitage		1888
Total Flaked Stone Cores		8
Flaked Stone Tools	Finished Bifaces	73
	Unfinished Bifaces	48
	Informal Tools	20
	Scrapers	3
Total Flaked Stone Tools		144
Ground Stone Tools	Celts	9
	Gouges	7
	Bifaces	14
Total Ground Stone Tools		30
Total Number of Artifacts		2070

Raw Material

The Physiography of the Middle Trent Valley

The analysis conducted on the artifacts varied by category but all artifacts were examined for toolstone type. Some of the toolstones are documented in published reference books (e.g. Eley and von Bitter 1989) but others are not. Sourcing toolstone when its provenience is not documented requires knowledge of local geological landforms to isolate prospective locations. The following is a brief overview of the physiography of the middle Trent Valley and the area immediately surrounding Stony Lake (for more detail, refer to Chapman and Putnam [1966] and Eyles [2002]). It explains the formation of the geology in the area and the differences in the types of rocks found in each region.

The province of Ontario is divided into two physiographic regions: the Canadian Shield in the north and the Interior Platform in the south (Figure 4.6) with each further divided into smaller ecoregions (Eyles 2002:7-8). The northern margin of the Kawartha Lakes runs parallel to the boundary between the two regions, and Stony Lake is located at the contact. The Grenville Province of the Canadian Shield lies to the north of the lake and the Manitoulin – Lake Simcoe region of the Interior Platform lies to the south.

The Grenville Province is the eroded remains of the Precambrian age Grenville Mountains, formed over a billion years ago during continental collision (Eyles 2002:103-105). The rock of the Canadian Shield forms the bedrock of much of Ontario. In southern Ontario it has been overlain with sedimentary rock and thick glacial sediments but in the north very thin soils leave much of the rock exposed. The Grenville province is divided into two major belts: the Central Gneiss Belt (CGB) and the Central Metasedimentary Belt (CMB) with a fault line separating the two (Eyles 2002:103). The CBG consists primarily of gneisses intruded by granite, and the CMB is composed of marbles, volcanic rocks and highly metamorphosed sediments.

The geological stratigraphy of the Manitoulin – Lake Simcoe region of the Interior Platform consists of Canadian Shield bedrock overlain by Middle to Late Ordovician limestones and well drained glacial sediments (Eyles 2002:9,127). Geologically, the limestone formations have been subdivided into five separate formations including two that are chert bearing: Gull River, and Bobcaygeon.

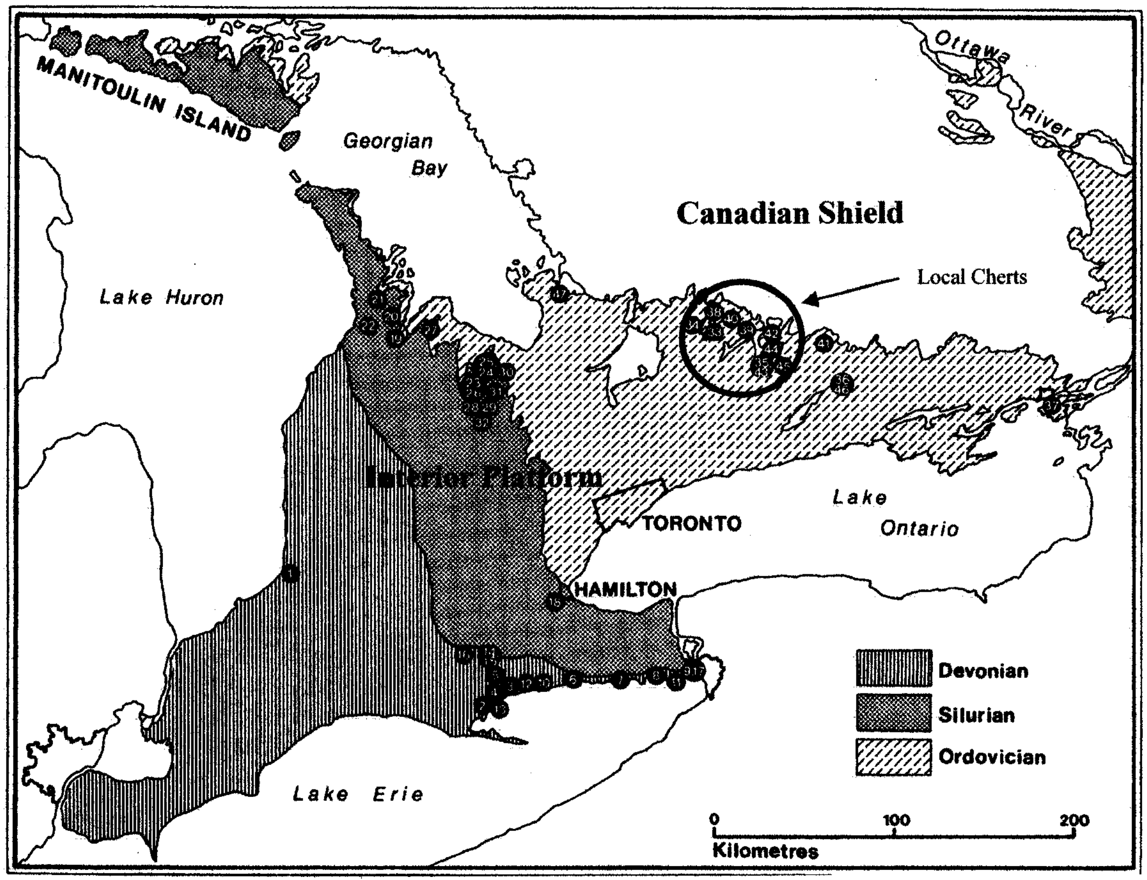


Figure 4.6 Physiography of Southern Ontario with location of chert sources (Eley and von Bitter 1989:4; used with permission)

Raw Material Identification and Provenience

Differentiation between chert and non-chert toolstone in the West Burleigh Bay assemblage was not always macroscopically possible. On the basis of simple visual examination the metasedimentary material closely resembles black cherts from the Gull

River and Bobcaygeon formations. The visual similarity is attested to by the misidentification of a significant number of metasedimentary artifacts as chert in the West Burleigh Bay catalogue. To differentiate between the chert and non-chert materials it was necessary to view the toolstone under 40x magnification to look at grain size, inclusions, and degree of silicification. Cherts are highly siliceous and exhibit a smooth translucent texture under magnification. Metasediments appear glossy, but with discrete, fine grains cemented together. Silica is not always discernable in these rocks at this magnification.

Macroscopic methods were used to identify cherts and their geological source (Figure 4.6). Colour, patina, luster and fracture of the toolstone was compared to published descriptions (Eley and von Bitter 1989; Miles 2005) as well as to comparative samples held at the Royal Ontario Museum and in the Ontario Archaeology lab at Trent University. Visual identification is quick and inexpensive but prone to error because cherts from different formations can look similar (Eley and von Bitter 1989:3). While the use of petrographic or palynological analysis would provide a more definitive identification of the cherts, and might allow for differentiation between cherts from different locations within a single formation, they are time consuming and costly. The level of accuracy required for this study did not warrant the expense or time investment required for microscopic analysis. Macroscopic identification provides sufficient accuracy to identify approximately 78% of the cherts (Miles 2005), and identification of Gull River and Bobcaygeon cherts likely attain higher rates of accuracy since they are either distinctively darker than other southern Ontario cherts (Upper Gull and

Lower/Middle Bobcaygeon) or distinctively peloidal (Upper Bobcaygeon) (Eley and von Bitter 1989:10-11).

Raw material sources have been classified as either local or non-local for this study. There is disagreement in the literature as to what constitutes a local source. Some define local as being within 10 km of the site (e.g. Carr 1994; Meltzer 1984), some define 30 km as the cut-off (e.g. Tankersley 1989), while others use 40 km (e.g. Gould and Saggars 1985; Meltzer 1989). Meltzer (1989:31) expanded his earlier 10km (Meltzer 1984) definition of a local area to 40 km based on ethnographic evidence of contemporary hunter-gatherers. He concluded that 10 km was "too conservative" (Meltzer 1989:31). Site reports from southern Ontario tend to support, though do not explicitly state, this larger area (e.g. Teal et al. 2003:27). Consequently, instead of defining "local" and "non-local" by using an arbitrary distance, I have defined local as toolstone that is located within the middle Trent Valley. This includes cherts from the upper and lower/middle members of the Bobcaygeon formation and from the upper member of the Gull River formation. It takes into account that these materials are found in the middle Trent Valley in both primary and secondary contexts.

Non-chert toolstone was identified through macroscopic and petrographic analysis. As noted in Chapter 3, rocks intergrade making source identification difficult in cases where rocks originate from a single source but look different. Alternatively, there are rocks that are visually similar but originate from different sources. To get assistance with this issue I met with Dr. Peter von Bitter, Invertebrate Paleontologist, and Dr. Vince Vertolli, Precambrian Geologist, at the Royal Ontario Museum. Vertolli, who mapped the geology of the Grenville province (Lumbers and Vertolli 2000), examined samples of the non-chert toolstone from West Burleigh Bay and certified that they were not Precambrian in age and therefore were not from the Grenville province. Neither he nor von Bitter could confidently identify the raw material or its source, but were able to say that it is a fine grained, lightly metamorphosed metasedimentary material. It was their opinion that the samples represent several different materials that look similar macroscopically. Both recommended thin sections be made and petrographic analysis be performed to identify the rock types and their mineral compositions. The results of thin sectioning would indicate whether the samples were from a single source or multiple sources and would also delimit the geographical sources of the toolstones. In order to positively correlate archaeological samples to a specific source, petrographic analysis would be required for both artifacts and samples from the suspected source. This presumes that: 1) permission is granted for destruction of artifacts; 2) the artifacts are all made from the same material; 3) the source(s) of the toolstone can be located; and 4) the source(s) are homogeneous enough to permit a positive correlation.

On the recommendation, and with the advice of, von Bitter and Vertolli, I went in search of the source of the metasediment. Vertolli recommended that I begin my search south of Stony Lake where the rocks were younger. Von Bitter concurred but thought it would be prudent to also look at sedimentary outcrops along the north shore of the lake. With a geological map (Lumbers and Vertolli 2000) in hand that identified sedimentary outcrops, Susan Jamieson and I searched rock cuts along road sides, and at the waters edge, on all sides of Stony Lake. Extensive construction and landscaping by cottage owners has altered the lakefront properties and removed any possibility of locating toolstone sources along the shoreline. Even though the source of the toolstone was not identified during this excursion we were able to determine that finer grained rocks occurred at the contact between the gneiss and granite of the Canadian Shield and the limestone of the Interior Platform. A second attempt to locate the source of the toolstone was undertaken after the petrographic analysis of lithic samples was completed. The identification of rock types, including the mineral compositions, further narrowed the possible source locations to several locales on the north shore of Stony Lake and within the immediate vicinity of the West Burleigh Bay site. A visit to Frasers Island, approximately one kilometer east of the site and situated within view of Burleigh Falls, proved successful. Samples were removed from rock outcrops on the island and were macroscopically compared to archaeological samples from West Burleigh Bay. Macroscopic analysis included comparison of the Frasers Island and West Burleigh Bay samples under 40x magnification to look at grain size, inclusions, and silicification. The Frasers Island samples were not submitted for petrographic analysis due to time and financial constraints.

Petrographic analysis was performed on a stratified random sample, without replacement, of fifteen pieces of debitage from the Archaic assemblage (Table 4.2). The sample was stratified by visually seriating the diagnostic non-chert toolstone artifacts. This is an informal method used by geologists to look for variation and similarities in a collection of rocks (Peter von Bitter, personal communication 2005). Once the artifacts were seriated it was clear the collection represented a fairly narrow spectrum of metasedimentary material. The next

Table 4.2 Petrographic Sample

Subset	**No. in Subset**	**Sample Size**
1	11	3
2	23	3
3	20	3
4	13	3
5	22	3
Total	89	15

step involved dividing the seriated diagnostic tools into five subsets based on visual characteristics. The first subset consisted of toolstone that was dark black and contained few inclusions. Subset 2 was also very dark black but contained more inclusions, striations and variations of colour. The third subset was fairly homogeneous but had significantly more brown variations within the stone. Subset 4 was more grey-brown and the fifth subset consisted of larger grained, brown stone.

Thin section preparation requires a minimum sample width of 5mm (Stephanie Downing, personal communication 2005). To ensure that valid samples were selected, only non-chert debitage greater than 5mm wide was sorted into the subset categories. Three samples from each subset were selected and sent to SGS Lakefield Research Limited in Lakefield, Ontario, for thin sectioning and petrographic analysis.

Identification of Raw Material Quality

Toolstone was examined for the presence or absence of flaws and inclusions as well as the presence or absence of bedding planes. Bedding planes were examined two ways. The first was a simple examination of the raw material to determine if sedimentary layers could be observed. The second was to determine if the material had fractured along a bedding plane during a flaking event.

Lithic Production

Analysis of Debitage

A combination of the Sullivan and Rozen technique (Sullivan 1987) for analyzing debitage, and the traditional stage of reduction identification method, were used to infer the methods of lithic production at the West Burleigh Bay site. As stated earlier in the chapter, the debitage was sorted into five mutually exclusive, interpretation-free categories according to definitions set by Sullivan (1987:47). All debitage was then sorted into size grades, with all complete flakes larger than 20 mm in diameter further analyzed to infer stage of reduction. Thirteen ordinal categories were used to sort the debitage into size grades. The first category represented debitage with a maximum dimension of less than 5 mm. Each successive category was set to 5 mm increments with the final category representing artifacts larger than 61 mm in diameter.

The information recorded for the additional analysis of complete flakes was adapted from Magne's (1985:113-114) experimental tool reduction research and the attributes he determined were most indicative of stage of reduction. Attributes recorded for this study included: weight in grams; the presence or absence of cortex; the number of scars present on the dorsal surface of the flake; and the number of scars present on the striking platform of the flake. Mauldin and Amick (1989) suggest combining attributes to strengthen the accuracy of identification of the stage of reduction. They caution against using single attributes since they can be the result of multiple factors. For example, flake size is a product of stage of reduction but it is also conditioned by core size and shape, raw material type, and the individual knapper (Mauldin and Amick 1989:67,79). Large flakes are indicative of early stages of reduction, but small flakes can be detached during any stage of reduction. However, when cortex cover is examined along with flake size Mauldin and Amick (1989) determined a more accurate assessment may be made. As a result, examination of the four additional attributes enabled a more accurate assessment of stage of reduction.

Analysis of Bifaces

The analysis of technological features on bifaces was undertaken to investigate: knapper expertise; the degree of effort expended in the production of finished bifaces; and to identify stages of production on unfinished bifaces. Metric attributes, which included maximum length, width, and thickness, were recorded to enable comparison of length-to-thickness and width-to-thickness ratios. The number of step and hinge terminations as well as the presence or absence of stacked step or hinge terminations were examined to determine frequency of flake failures. Discarded unfinished bifaces were examined for perverse and end shock breakage which result from excessive force or from flaws in the raw material and also for evidence of face battering. Morphological attributes were recorded to evaluate the symmetry and overall esthetic refinement of the bifaces. The morphological attributes were selected as a way to objectively compare differences in biface form, specifically on the "hastily" made bifaces. These attributes included, the shape of the transverse section, and the degree of sinuosity along the lateral margins for both finished and unfinished bifaces, and also blade symmetry, patterning and number of flake scars, form and degree of retouch along the lateral edges, and degree of preparation of the base for finished bifaces. The attributes used to infer stage of production, effort expended, and knapper expertise are summarized in Table 4.3.

Width-to-thickness ratios, the shape of the transverse section, degree of sinuosity and number of flake scars were used to identify the stage of production on unfinished bifaces following Callahan (1979:10-11). The frequency of flake failures, the presence of face battering, and the presence of perverse and end shock breakage were used to evaluate knapper expertise, following Shelly (1990). All of the attributes, with the exception of biface breakage and face battering were used to evaluate the amount of effort expended in the production of the biface. The data collected for each of these attributes and the results of the interpretations are discussed in Chapter 5.

Table 4.3 Biface Attributes

Attribute:	Used to Infer:		
	Stage of Production	Effort Expended	Knapper Expertise
Width-to-thickness ratio	■	■	
Shape of the transverse section	■	■	
Sinuosity along the lateral margins	■	■	
Patterning and number of flake scars	■	■	
Blade symmetry		■	
Retouch along the lateral edges		■	
Preparation of the base		■	
Frequency of flake failures		■	■
Perverse and end shock breakage			■
Face Battering			■

Data Analysis and Statistical Testing

A variety of tools have been used to summarize, visualize, and analyze the data collected during this research. Appendix B contains tables of artifact summaries with values collected for the various attributes. These 11 tables constitute the raw data used to create graphs and bar charts, comparative summaries, distribution maps, and used to organize data for statistical testing. All tables and associated bar charts and graphs were produced using Microsoft Excel.

Statistical testing revolved around testing for differences and similarities between flaked stone artifacts manufactured on metasediment and those manufactured on other materials such as chert. In other words, was metasediment of inferior quality to chert, was it used at particular times or for particular functions, and did it contribute to the chunky appearance of the tools recovered at the site? Three different statistical tests were utilized based on the format of the attribute tested; chi-square distribution, Mann-Whitney and Kolmogorov-Smirnov. All three of these tests are nonparametric tests meaning they require no assumptions regarding population parameters (Lapin 1973:405).

The chi-square test (χ^2) is used to determine if two variables or attributes are statistically independent (Lapin 1973:339-345). It compares the observed distribution of values between two attributes to a computed theoretical distribution for those values (Thomas 1976:264-272). In this particular study chi-square was used to test the distribution of biface toolstone by Archaic period to determine if there was any temporal relationship. It was also used to test for differences between the qualities of toolstones at the site. The CHITEST function in Excel was used to generate the results for these tests. CHITEST computes a p-value (p_2) indicating the probability of independence using appropriate degrees of freedom based on the number of rows and columns of data being compared. A p-value less than .05 is indicative of independence with 95% confidence.

The simplicity of the chi-square test makes it a popular statistical test even though it has limitations. The way the test works is that computed values of the expected distribution are derived from the observed values and this theoretical binomial distribution is used in place of the normal distribution. If the sample is not sufficiently large the computed distribution may be inadequate for the test (Lapin 1973:396). For this reason, sample sizes used in the tests were restricted to more than 5.

The Mann-Whitney (M-W) and Kolmogorov-Smirnov (K-S) tests were used to test attributes with ordinal values and ratios and focused on comparison of biface morphology between different raw materials. SPSS 12 software was used to perform these statistical tests. The Mann-Whitney test (also known as the Wilcoxon rank-sum test) is used to analyze independent samples and does not require the populations to be normally distributed (Lapin 1973:407). The test assumes the two samples come from identical populations. It assesses the degree of overlap between two observed distributions to determine whether the overlap is less than would be expected by chance. The two sample Kolmogorov-Smirnov test tests deviation between two samples. It compares the observed cumulative frequency distribution of the two samples and determines the maximum deviation between them (Thomas 1976:322). For this study two-tailed tests were selected and p-values (p_2) represent the probability that the samples overlap. P-values less than .05 are indicative of separate populations with 95% accuracy.

Summary

The methods used for the analysis of the Archaic component of the West Burleigh Bay assemblage were chosen to address the specific research questions of this study. Equally important, it was necessary that they be feasible within the time and financial constraints of the research. The structure of the Sullivan and Rozen Technique provided the basic framework for organizing the artifacts into a manageable format. Raw material identification and provenience comprises a large part of this study and both macroscopic and microscopic techniques were utilized to improve the accuracy of the results. Artifacts were also examined to determine the methods of lithic production performed at the West Burleigh Bay site. The presence of different stages of manufacture may be used to make inferences regarding the occupation of the site and the source of the raw materials used during the Archaic. These inferences will be discussed in more detail in the next chapter as will the analysis of the collected data.

Chapter 5

Research Results and Analysis

The Archaic assemblage from West Burleigh Bay consists of 2,070 lithic artifacts, divided into four maximal categories; flaked stone tools (N=144), ground stone tools (N=30), debitage (N=1,888) and cores (N=8) (see Table B.1 Appendix B). Selected attributes were recorded for each maximal category depending on analysis requirements. These requirements can be summarized into three broad categories: raw material usage; method of lithic production; and flint-knapper expertise. Raw material identification, provenience, and quality were assessed for all artifacts. These attributes were selected in order to determine the breakdown of raw material usage by horizon within the Archaic period, evaluate links between raw material and functional tool types, assess the quality of raw materials and their affect on fracture, determine the proportions of local and non-local materials represented in the assemblage, and assess changes in raw material usage over time. Unfinished bifaces, debitage, and cores were analyzed to infer methods of manufacture performed at the site. Analysis of debitage followed the Sullivan and Rozen technique and included sorting the flakes into size grades. Large complete flakes (greater than 20 mm in diameter) were further analyzed using traditional techniques of counting flake scars on dorsal surfaces and on striking platforms. Attributes used to interpret flint-knapper expertise included the frequency of hinge and step terminations on finished and unfinished bifaces, and the presence of adverse breakage on unfinished bifaces. These attributes were selected in order to compare the frequency of fracture problems to the quality of the raw material.

Raw Material Usage

Raw Material Identification and Provenience

Raw material was identified and assessed for all artifacts. As noted previously, diagnostic artifacts included in the analysis were manufactured on a variety of raw materials but non-diagnostic artifacts were only included if they were of metasedimentary or sedimentary material linked to use in the Archaic. For this reason comparison of raw material frequency is restricted to the assemblage's diagnostic tools. Diagnostic artifacts are defined as tools that can be typologically identified as Archaic. In this assemblage diagnostic tools include finished bifaces from the flaked stone category and all ground stone tools (see Table B.2, Appendix B).

When raw material usage is compared to the functional type of diagnostic tools, it is evident that there is a relationship between the type of tool manufactured and the knapping properties of the raw material selected. Figure 5.1 illustrates the raw materials identified for functional tool types from the West Burleigh Bay site. This bar chart shows that chert, metasediment and quartzite were used only for manufacturing flaked stone tools. These are all fine-grained, isotropic, hard, and brittle materials that fracture conchoidally permitting them to be flaked in a controlled manner. Slate, chlorite schist, schist, gneiss, and pyroxene were used for ground stone celts and gouges. The properties of these toolstones are such that they cannot be readily flaked or can be flaked only with difficulty. Though very hard, all of these materials, with the exception of pyroxene, are foliated, metamorphic rocks in which the process of metamorphism has realigned minerals to form parallel cleavage planes similar to sedimentary rock (Andrefsky 1998:54). Slate was the only material identified that was used for bifaces as well as for celts and gouges. In all instances the slate bifaces were ground. The process of making ground stone tools includes flaking to a rough shape and then finishing by grinding (Cesare D'Annibale, personal communication 2006). This is likely due to increased fracture along cleavage planes and a lack of controlled fracture capability. Though ground stone celt and gouge use is assumed to have originated during the Archaic, classification is notoriously difficult since style and raw material selection have very great time depth with some styles remaining in use up to the proto-historic period (Teal et al. 2003:20). The remainder of raw material comparisons concentrates on finished bifaces.

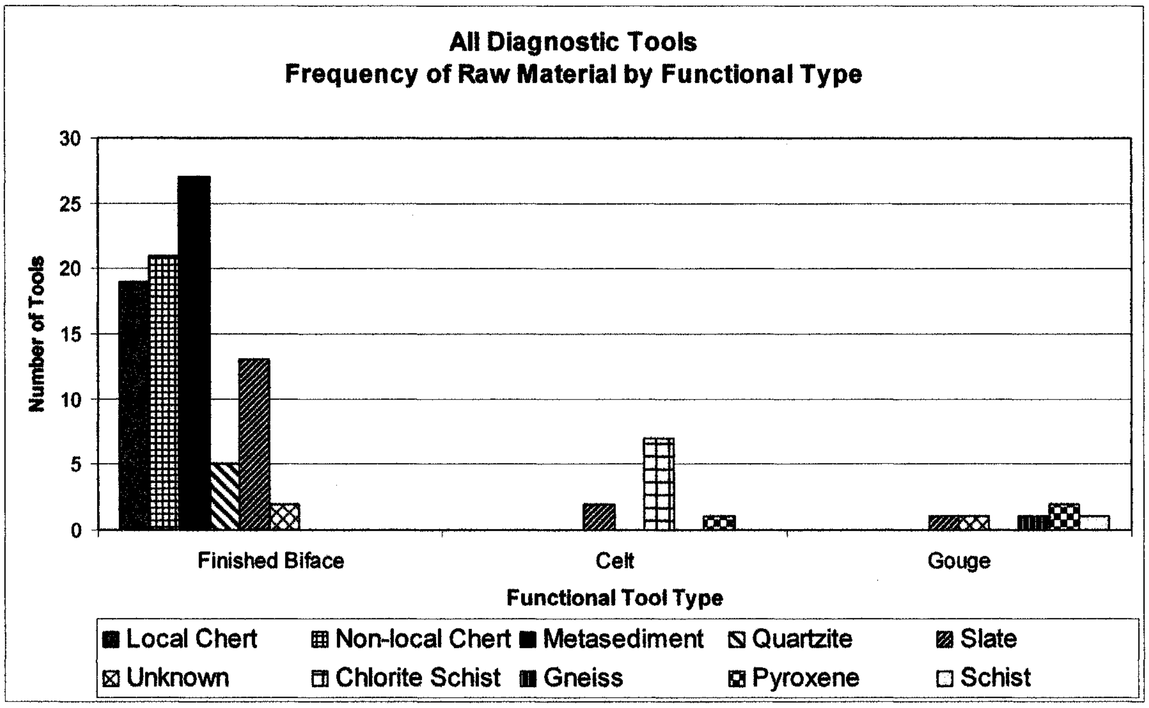


Figure 5.1 Frequency of raw material by functional tool type

Typological classifications for flaked and ground stone bifaces (Table 5.1, see Table B.3, Appendix B) provided the basis for determining trends of raw material usage during the Archaic at the West Burleigh Bay site. The following bar chart (Figure 5.2) depicts the raw material identification for the finished bifaces in the assemblage.

Table 5.1 Typological Classification of Flaked and Ground Stone Bifaces

	Horizon	Type	No. of Bifaces
Early Archaic	Side Notched	Un-typed Side Notched	1
	Corner Notched	Kirk Corner-Notched or Kirk-like	1
		Nettling or Nettling-like	2
		Un-typed Corner Notched	2
	Bifurcate	Kanawha Stemmed	1
		LeCroy	1
Total Early Archaic			8
Middle Archaic	Stemmed	Stanly/Neville-like	1
	Side-Notched	Otter Creek	4
		Raddatz Side-Notched	2
	Laurentian	Brewerton Corner-Notched	3
		Brewerton Side-Notched	14
		Eva II	1
		Ground Slate Point	3
		Ground Slate Bayonet	2
		Un-typed Ground Biface	9
Total Middle Archaic			39
Late Archaic	Narrow Point	Lamoka	6
		Normanskill	11
		Un-typed Narrow Point	4
	Broad Point	Adder Orchard	2
		Genesee	3
		Perkiomen	1
		Rossville	1
		Snook Kill	5
		Susquehanna	1
	Small Point	Ace of Spades	3
		Crawford Knoll	1
		Innes	2
Total Late Archaic			40
Total Archaic			87

The distribution of raw material between biface types on this bar chart implies that raw material correlates to typological classification in some cases. However, the majority of types consist of only one or two examples making statistical testing

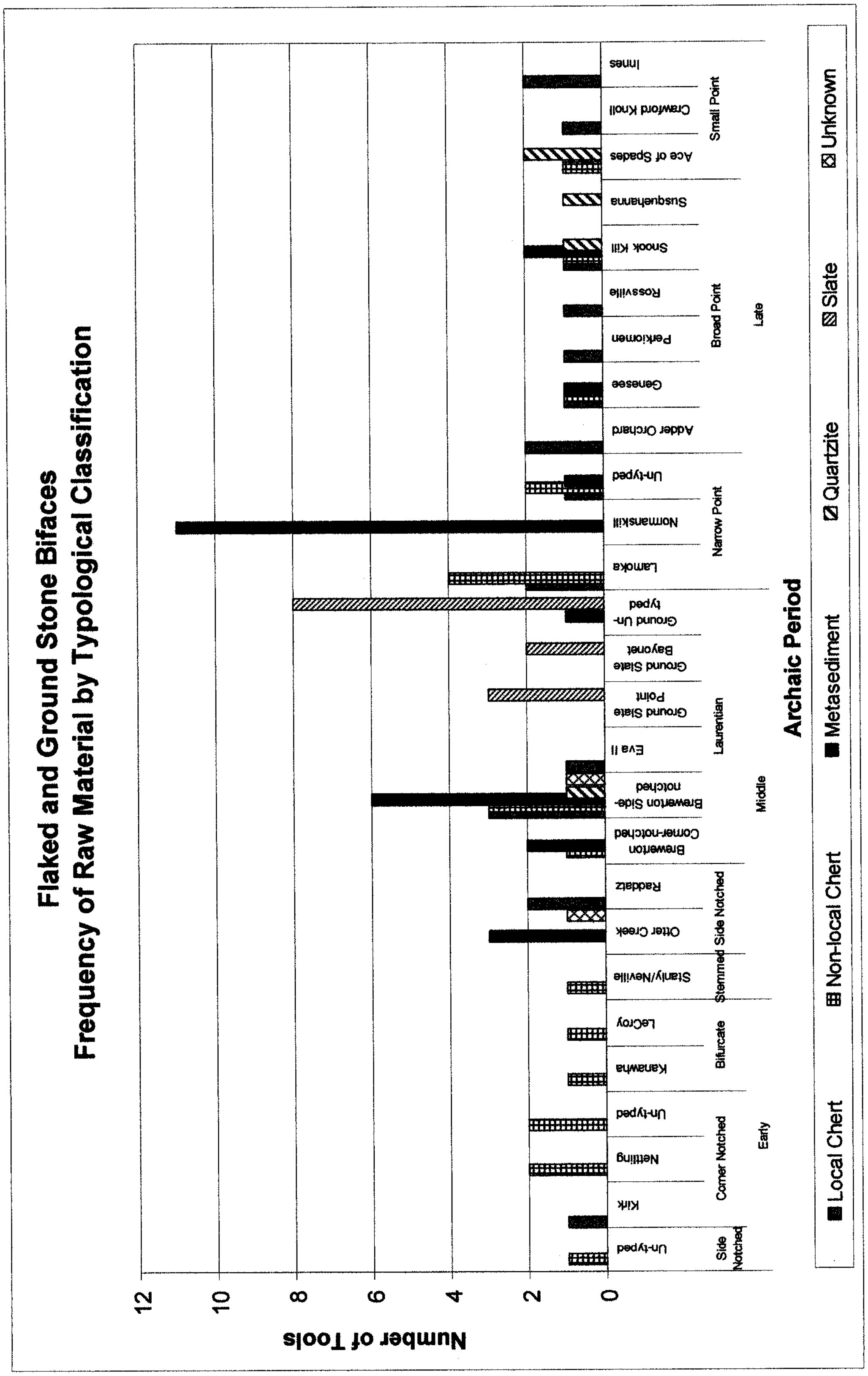
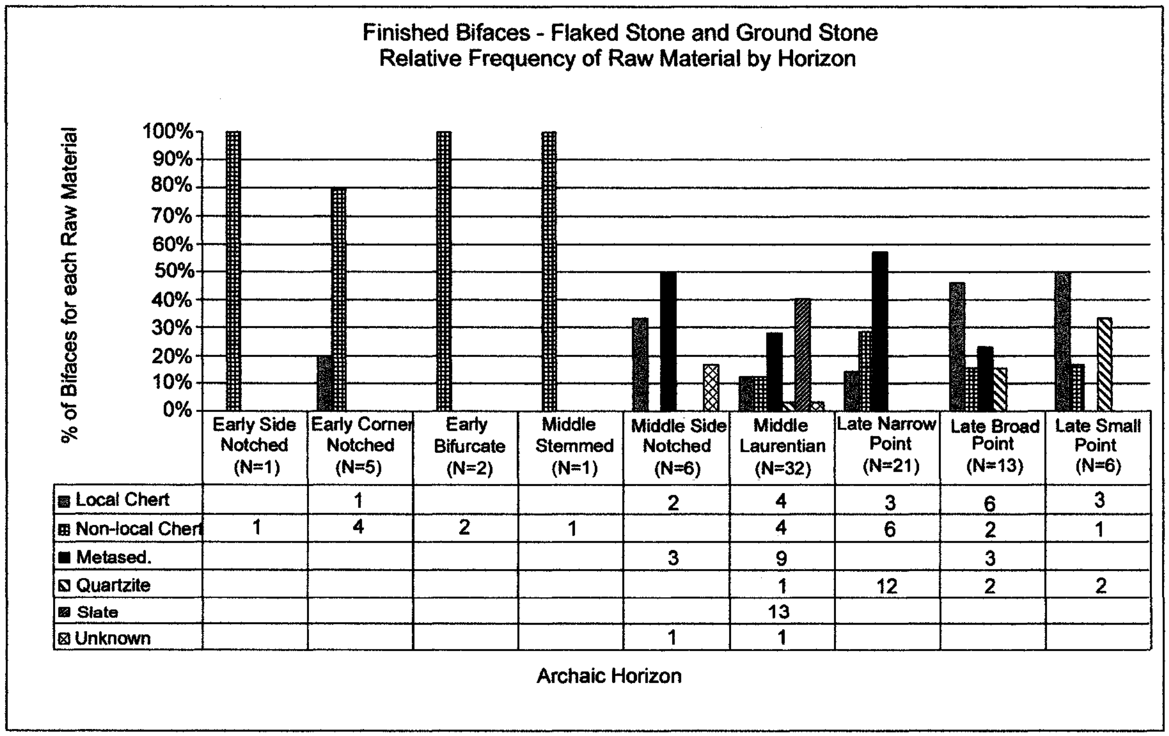


Figure 5.2 Frequency of raw material by typological classification

unfeasible. Anecdotally, it appears that metasedimentary material was commonly used for Otter Creek, Brewerton, and Normanskill bifaces, and slate was the overwhelming choice for making ground bifaces, though one example of ground metasediment was identified. Quartzite appears sporadically in the assemblage beginning in the Middle Archaic but makes up a very minor part of the finished biface assemblage (only 5.75%). Chert, from both local and non-local sources, is used consistently throughout the Archaic and accounts for nearly half (45.98%) of the finished biface assemblage.

When raw material usage is compared at a horizon level (Figure 5.3) there is no significant difference in temporal distribution of metasedimentary material compared to the distribution of all other raw materials combined (χ^2, $p_2 = 0.06$), nor when compared to the distribution of chert (χ^2, $p_2 = 0.095$). However, when chert and metasedimentary raw

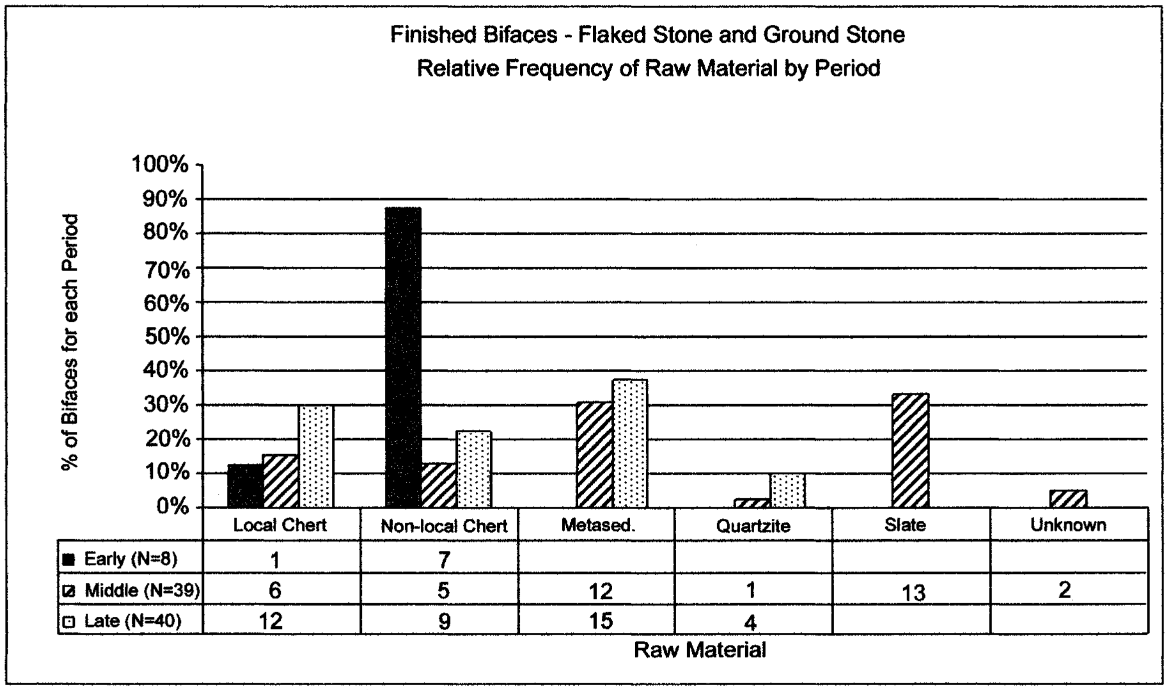


	Early Side Notched (N=1)	Early Corner Notched (N=5)	Early Bifurcate (N=2)	Middle Stemmed (N=1)	Middle Side Notched (N=6)	Middle Laurentian (N=32)	Late Narrow Point (N=21)	Late Broad Point (N=13)	Late Small Point (N=6)
▩ Local Chert		1			2	4	3	6	3
⊞ Non-local Chert	1	4	2	1		4	6	2	1
■ Metased.					3	9		3	
▧ Quartzite						1	12	2	2
▨ Slate						13			
⊠ Unknown					1	1			

Figure 5.3 Frequency of raw material by horizon

material distributions are compared between Early, Middle and Late Archaic periods (Figure 5.4) metasediment distribution differs significantly (χ^2, $p_2 = 0.043$). These are contradictory results that indicate a rather tenuous relationship between raw material types and their temporal distribution. Even so, Figure 5.3 illustrates that metasedimentary material is temporally limited to the Middle and Late Archaic periods. It first appears during the Side Notched horizon (ca. 6500 to 5000 BP) of the Middle Archaic, reaches its peak during the Narrow Point horizon (ca. 4500 to 4000/3800 BP) of the Late Archaic (57.14%) and declines in use during the Broad Point horizon (ca. 4000/3800 to 3500 BP).

The bar graph Figure 5.4 provides a summary of raw material usage for Early, Middle and Late Archaic periods. This shows that chert is the only raw material used during the Early Archaic and it is predominantly non-local (87.5%). Statistically there is no significant difference in the use of local versus non-local chert over the span of the

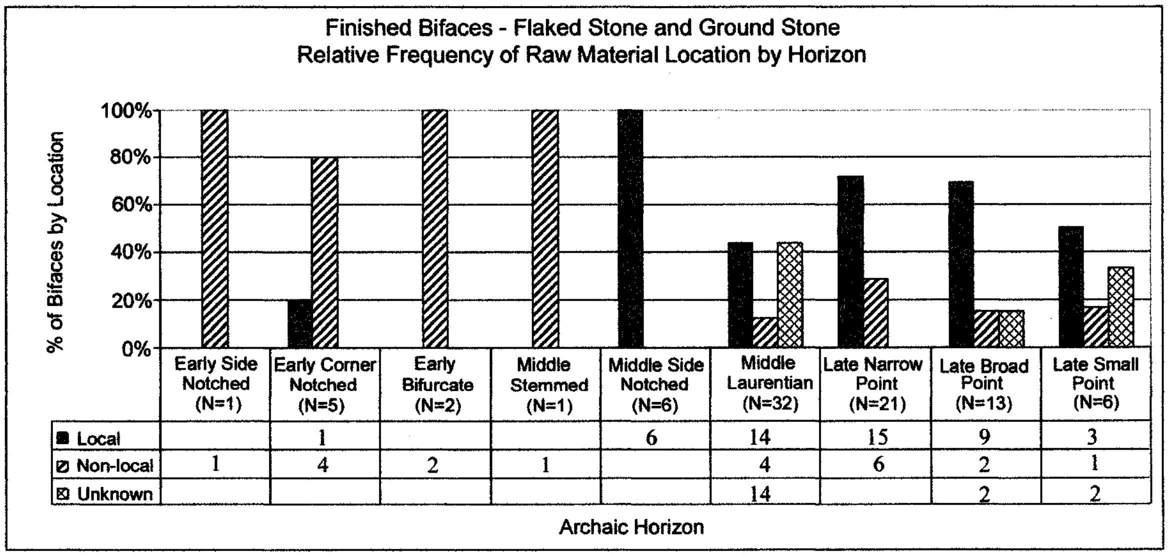


	Local Chert	Non-local Chert	Metased.	Quartzite	Slate	Unknown
■ Early (N=8)	1	7				
▨ Middle (N=39)	6	5	12	1	13	2
□ Late (N=40)	12	9	15	4		

Figure 5.4 Frequency of raw material by period

Archaic, even when the apparent preference for non-local chert during the Early Archaic is taken into consideration (χ^2, $p_2 = 0.13$). This result is unexpected and is likely due to the small number of Early Archaic chert bifaces (N=7) versus 11 Middle Archaic and 21 Late Archaic chert bifaces in the assemblage. By the Middle Archaic there is increased variety in raw material selection. Chert remains important with the frequency of local chert appearing slightly greater than non-local chert. Overall, the distribution of raw material for biface production is split relatively evenly between chert (28.2%), metasediment (30.77%) and slate (33.33%). During the Late Archaic raw materials continue to be diverse but chert accounts for over half of the bifaces (52.5%), and metasediment increases slightly to just over a third (37.5%). As indicated by the raw material distribution in Figure 5.3, metasediment use declined to zero by the Small Point horizon at the end of the Late Archaic.

Raw material provenience is used to compare the frequency of local and non-local toolstones. The following bar graph (Figure 5.5) depicts raw material source by period.



	Early Side Notched (N=1)	Early Corner Notched (N=5)	Early Bifurcate (N=2)	Middle Stemmed (N=1)	Middle Side Notched (N=6)	Middle Laurentian (N=32)	Late Narrow Point (N=21)	Late Broad Point (N=13)	Late Small Point (N=6)
■ Local		1			6	14	15	9	3
▨ Non-local	1	4	2	1		4	6	2	1
⊠ Unknown						14		2	2

Figure 5.5 Frequency of raw material location by horizon

The use of local raw materials increased dramatically and significantly (x^2, $p_2 = 0.02$) during the Middle and Late Archaic with a pattern of local raw material acquisition combined with some non-local material use.

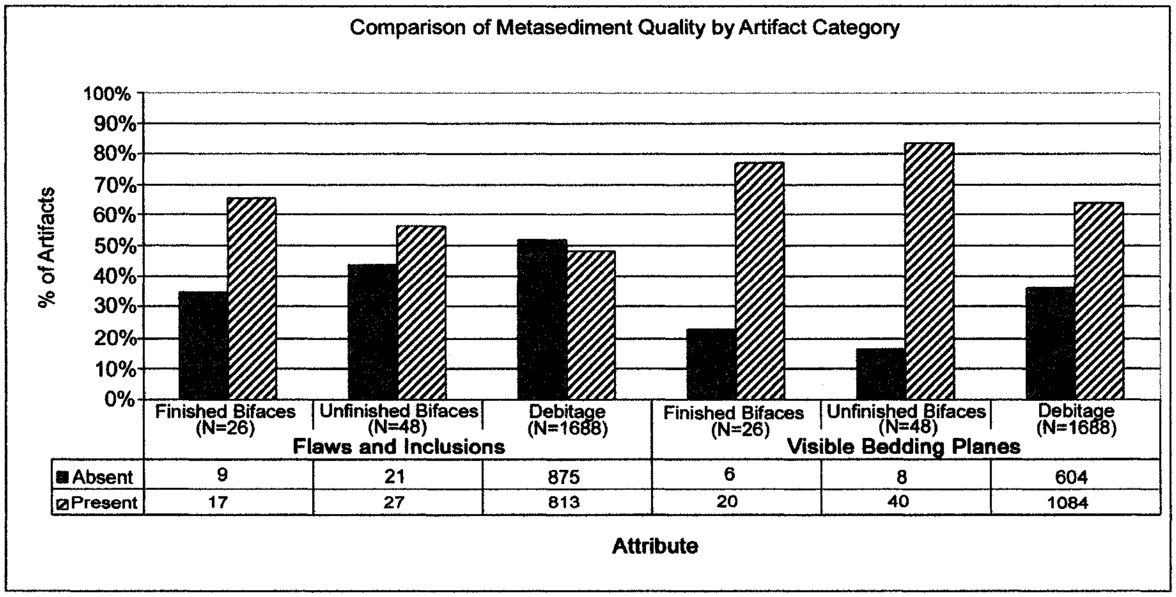
Raw Material Quality

The quality of toolstone used to manufacture finished bifaces was compared by observing the frequency of flaws and inclusions, the presence of visible bedding planes and the frequency of bifaces with fracture along bedding planes (see Table B.5, Table B.6, and Table B.7 Appendix B). The presence of flaws and inclusions is nearly identical for all raw materials utilized. Sixty-five percent of chert bifaces contained visible flaws and inclusions, 66% of all non-metasediment materials, including chert, contained flaws and inclusions and 65% of metasedimentary materials contained flaws and inclusions. Statistical comparison of chert and metasediment indicated no significant difference in the presence of flaws and inclusions (χ^2, $p_2 = 0.97$), and comparison of metasediment to all other raw materials also indicated no significant difference (χ^2, $p_2 = 0.96$).

The presence of visible bedding planes in the raw materials varies by raw material. Only 10% of chert bifaces exhibited visible bedding planes, whereas 77% of metasedimentary bifaces had visible bedding planes. This difference is statistically significant (χ^2, $p_2 < 0.01$). A comparison of metasediment to all other raw materials combined also indicates a significant difference in the presence of bedding planes (χ^2, $p_2 < 0.01$).

Fracture along bedding planes also varies by raw material type. A nominal 5% of chert bifaces in the assemblage exhibited fracture along bedding planes, whereas 62% of metasedimentary bifaces exhibited fracture along bedding planes. This difference is statistically significant (χ^2, $p_2 < 0.01$). A comparison of metasediment to all other raw materials combined also indicates a significant difference in the presence of fracture along bedding planes (χ^2, $p_2 < 0.01$).

Manufacturing debris, including unfinished bifaces was assessed for raw material quality as well (see Table B.8, Appendix B). Flaws and inclusions and observable bedding planes were recorded for each of these artifacts. The frequency of flaws and inclusions and visible bedding planes on unfinished bifaces and on debitage were compared to the frequencies of these attributes on finished bifaces manufactured of the same material (Figure 5.6). The frequency of flaws and inclusions ranged from 48% to 65%. Statistically, the frequency of flaws and inclusions for unfinished bifaces (χ^2, $p_2 = 0.44$) and debitage (χ^2, $p_2 = 0.08$) falls within the assemblage range for finished bifaces manufactured on metasediment. Visible bedding planes range from 64% to 83% for the



	Flaws and Inclusions			Visible Bedding Planes		
	Finished Bifaces (N=26)	Unfinished Bifaces (N=48)	Debitage (N=1688)	Finished Bifaces (N=26)	Unfinished Bifaces (N=48)	Debitage (N=1688)
■ Absent	9	21	875	6	8	604
▨ Present	17	27	813	20	40	1084

Figure 5.6 Comparison of metasediment quality

three artifact categories and like the previous attribute, the difference is statistically insignificant. Comparison of bedding plane frequency on unfinished bifaces (χ^2, $p_2 = 0.5$) and debitage (χ^2, $p_2 = 0.18$) to bedding plane frequency on finished bifaces indicates they also fall within the range for bifaces manufactured on metasediment. The frequency of flaws and inclusions (6%) and bedding planes (25%) were also computed for debitage on the unknown sedimentary material. However there were only two finished bifaces and no unfinished bifaces of this material present in the assemblage rendering statistical comparisons unfeasible.

Method of Lithic Production

Unfinished Bifaces

Unfinished bifaces recovered from the West Burleigh Bay site represented various stages of completion. Following Callahan (1979:10-11) unfinished bifaces were assigned stages of production (see Table B.8, Appendix B). Of the 48 unfinished bifaces, 9 are stage-2 bifaces that have been roughly flaked around the circumference, 23 are stage-3 bifaces indicating they have undergone primary thinning, and 16 are stage-4 bifaces indicating they have undergone secondary thinning. The presence of all stages of production indicates that bifaces were manufactured at the site and not simply rejuvenated or re-sharpened there. Assignment of stages of production was slightly problematic because width/thickness ratios of the metasediment bifaces did not correlate very well to the width/thickness ratios developed by Callahan (1979:18). Callahan's (1979:24-25) biface experiments predominantly utilized good quality toolstone such as chert and quartzite to manufacture reproductions of Paleoindian bifaces resulting in width/thickness ratios that increased with each stage of production and were considerably larger than those calculated for the West Burleigh Bay assemblage. For example, the width/thickness ratios for Callahan's finished bifaces ranged between 4.00 and 6.00+. The finished bifaces in the West Burleigh Bay assemblage more closely correlated to Callahan's Stage 2 through Stage 4 bifaces which had width-thickness ratios between 2.00 and 5.00 (Table 5.2). Though edge retouch can account for a decrease in width/thickness ratios to below 4.00 (Callahan 1979:18) this does not explain the very low width/thickness ratios for finished bifaces nor the wide variation in values for unfinished bifaces in this assemblage. Instead, the overall thickness and low width/thickness ratios are likely a morphological characteristic of Archaic points that may be linked to durability (Chesier and Kelly 2006). The wide variation in width/thickness ratios may also be a reflection of multiple knappers and of differences in knapper ability and motor variability, in contrast with Callahan's experiments that were performed by a single knapper.

Table 5.2 Metasediment Biface Width/Thickness Ratio Comparison

	Range	Mean	Median	N
Stage 2	2.08 to 5.56	3.77	4.00	9
Stage 3	2.86 to 6.20	3.75	3.42	23
Stage 4	1.82 to 5.33	3.14	4.18	16
Finished Bifaces	2.00 to 4.33	3.01	2.95	26

Debitage

Debitage was analyzed to determine the methods of manufacture utilized at the West Burleigh Bay site by following the method outlined by Sullivan and Rozen (1985; Sullivan 1987). The relative frequencies of debitage by category (see Table B.9, Appendix B) were computed for each of the raw material types in the debitage assemblage and also for combined raw materials. The purpose was to enable comparison of manufacturing methods by raw material type. The percentages calculated and included in Tables 5.3 and 5.4 indicate that the metasedimentary debitage assemblage and the unknown sedimentary debitage are virtually identical (χ^2, $p_2 = 0$) and therefore represent the same manufacturing methods.

Comparison of the West Burleigh Bay debitage to Sullivan and Rozen's (1985) published results from their Arizona assemblages includes debitage, cores and retouched pieces. When the West Burleigh Bay assemblage is compared (Table 5.3) it appears to be most similar to Assemblage II which represents debitage from a tool manufacturing site (Sullivan and Rozen 1985:762). This apparent similarity is supported by statistical comparison of the debitage category percentages between the West Burleigh Bay assemblage and each of the Sullivan and Rozen assemblages (IA(χ^2, $p_2 < 0.01$), IB1(χ^2, $p_2 < 0.01$), IB2(χ^2, $p_2 < 0.01$), II(χ^2, $p_2 = 0.08$)).

Table 5.3 Comparison of Debitage Category Percentages to Sullivan and Rozen Data

	West Burleigh Bay			Sullivan and Rozen (1985:763)			
	Metasediment	Unknown Sedimentary	Total	IA	IB1	IB2	II
Complete Flakes	19.17	19.40	19.19	53.40	32.90	30.20	21.00
Broken Flakes	28.70	23.88	28.19	6.70	13.40	8.10	16.80
Split Flakes	5.14	4.48	5.07				
Flake Fragments	37.35	42.79	37.92	16.00	35.30	34.70	51.30
Debris	8.30	8.96	8.37	6.10	7.90	23.00	7.30
Cores	0.47	0.00	0.42	14.70	2.80	2.00	0.60
Retouched Pieces	0.88	0.50	0.84	3.10	7.50	2.00	3.10
Total	100.00	100.00	100.00	100.00	99.80	100.00	100.10

The West Burleigh Bay assemblage was also compared to the experimental data published by Prentiss and Romanski (1989). Their study evaluated the effects of trampling on an assemblage and both trampled and untrampled results are recorded in Table 5.4. At first glance the West Burleigh Bay assemblage appears to resemble the trampled biface results. However, in this case there appears to be statistical similarity to all of the trampled assemblages as well as the untrampled biface and end scraper assemblages. (Untrampled assemblages: Biface (χ^2, $p_2 = 0.16$), End Scraper (χ^2, $p_2 = 0.38$), Block Core (χ^2, $p_2 < 0.01$), Spheroid Core (χ^2, $p_2 < 0.01$), Trampled assemblages: Biface (χ^2, $p_2 = 0.30$), End Scraper (χ^2, $p_2 = 0.17$), Block Core (χ^2, $p_2 = 0.04$), Spheroid Core (χ^2, $p_2 = 0.53$)).

Table 5.4 Comparison of Debitage Category Percentages to Prentiss and Romanski Data

	West Burleigh Bay			Prentiss and Romanski (1989:91)							
				Untrampled				Trampled			
	Metasediment	Unknown Sedimentary	Total	Biface	End Scraper	Block Core	Spheroid Core	Biface	End Scraper	Block Core	Spheroid Core
Complete Flakes	19.43	19.50	19.44	34.10	30.10	25.40	16.30	15.70	17.10	12.50	18.90
Broken Flakes	29.09	24.00	28.55	22.20	22.50	15.90	18.60	28.70	37.10	17.90	18.90
Split Flakes	5.21	4.50	5.14	4.00	2.50	4.80	7.00	1.70	0.00	5.40	8.10
Flake Fragments	37.86	43.00	38.40	35.70	35.00	22.20	25.60	49.60	37.10	42.90	43.20
Debris	8.41	9.00	8.47	4.00	10.00	31.70	32.60	4.30	8.60	21.40	10.80
Total	100.00	100.00	100.00	100.00	100.10	100.00	100.10	100.00	99.90	100.10	99.90

The results of the statistical tests are unclear and it is likely that the chi-square test is inappropriate for testing this particular data. In order to clarify the relationship between the various debitage assemblages and provide a more confident analysis, each was plotted on a graph to determine which provided the closest fit to the West Burleigh Bay data. Figure 5.7 depicts the two assemblages that are most similar.

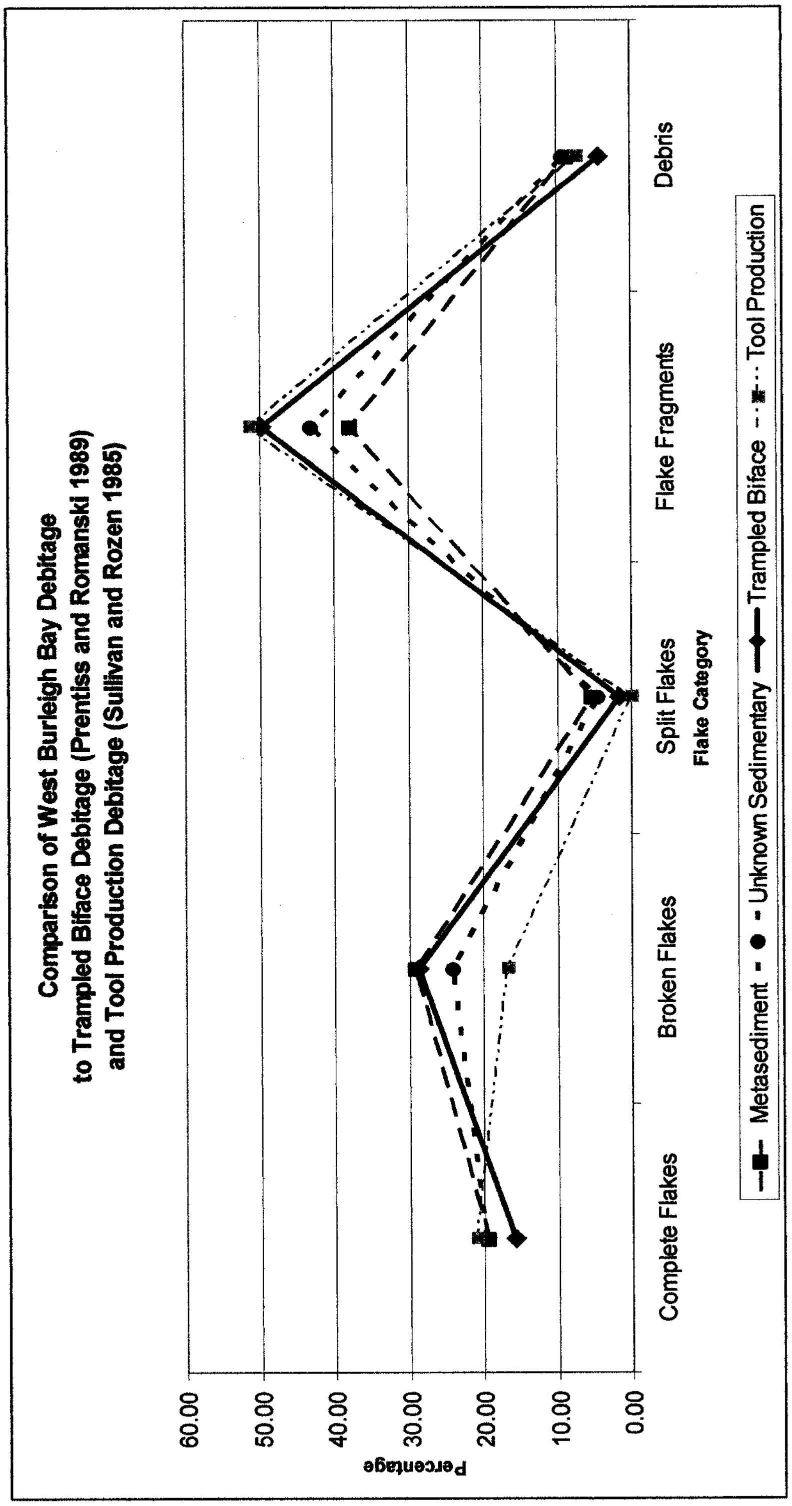


Figure 5.7 Comparison of West Burleigh Bay debitage to published debitage assemblages

The graphic representation (Figure 5.7) comparing the raw material types in the West Burleigh Bay debitage assemblage to the published trampled biface and tool production assemblages suggests that both types of raw material debitage in the West Burleigh Bay assemblage may be attributed to biface production. However, without clear statistical evidence to support this, additional means of validating biface production as the method of manufacture must be used.

The debitage categories were sorted into size grades (Figure 5.8; Table B.9, Appendix B). No flakes less than 5mm were recovered, thus preventing analysis of small-sized debitage outlined by Baumler and Downum (1989) to infer retouching and resharpening behavior. However, the range and variation in flake size suggests that all stages of tool manufacture took place at the site.

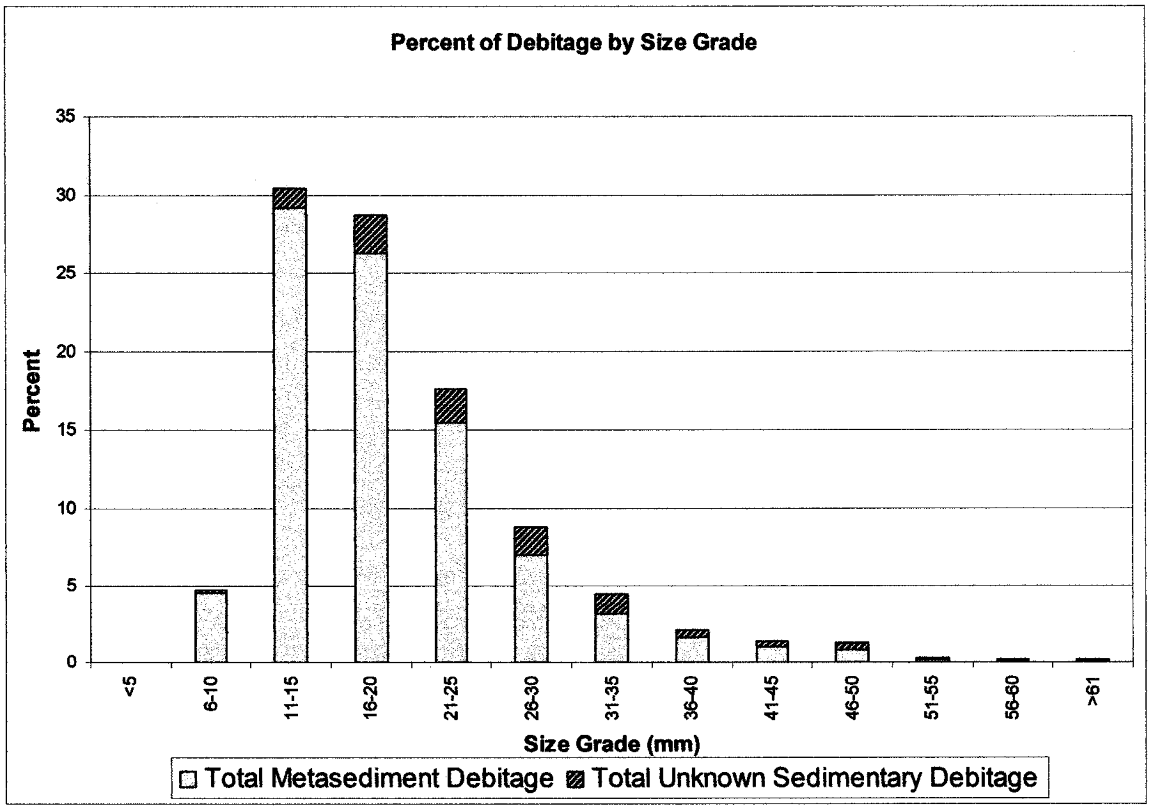


Figure 5.8 Percent of debitage by size grade

Large Complete Flakes

Analysis of large complete flakes (> 20 mm) was undertaken as another means of identifying methods of lithic production at the West Burleigh Bay site. Stage of reduction was determined for the flakes following Magne (1985:113-114). In total 171 flakes were examined, 138 of metasedimentary material (see Table B.10, Appendix B) and 33 of unknown sedimentary material (see Table B.11, Appendix B). Early, middle and late stage reduction flakes were identified for both types of raw material (Figure 5.9) indicating that the complete sequence of biface production was undertaken at the site.

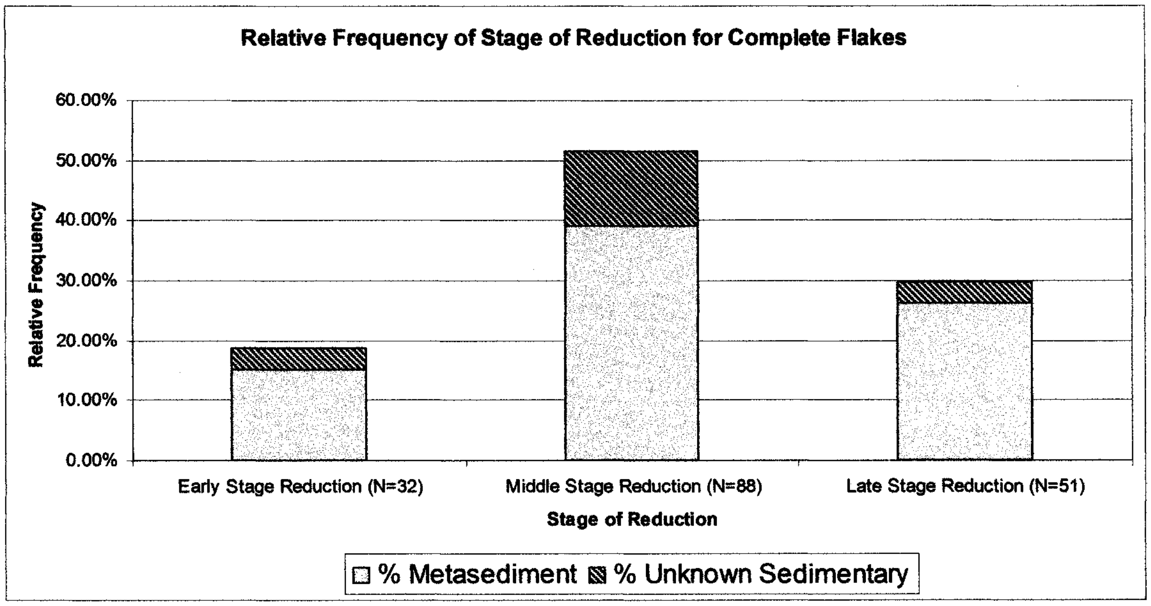


Figure 5.9 Frequency of stage of reduction for complete flakes

Flint-knapper Expertise

Attributes were examined on finished and unfinished bifaces to examine variations in effort expended for biface manufacture by raw material type and ultimately to infer flint-knapper expertise. Finished bifaces manufactured on metasedimentary material (N=26) (see Table B.6, Appendix B) and chert (N=40) (see Table B.5, Appendix

B) were compared to determine if there were any statistical differences in their morphology. Quartzite bifaces (see Table B.7, Appendix B) and unknown sedimentary bifaces (see Table B6, Appendix B) were not used for comparative purposes due to the small sample sizes (N=5 and N=2 respectively). Seven attributes were compared and five indicted no significant difference. Length/thickness ratio (M-W, $p_2=0.91$; K-S, $p_2=0.94$), width/thickness ratio (M-W, $p_2=0.10$; K-S, $p_2=0.20$), blade symmetry (M-W, $p_2=0.89$; K-S, $p_2=0.88$), flake scar patterning (M-W, $p_2=0.61$; K-S, $p_2=0.98$) and the relative frequency of hinge and step terminations (M-W, $p_2=0.73$; K-S, $p_2=0.61$) all indicate morphological similarity between chert and metasediment bifaces. Statistical analysis of two attributes, basal preparation and number of flake scars, was not conclusive. The Kolmogorov-Smirnov test indicated similarity and the Mann-Whitney test indicated a significant difference. The results for the basal preparation attribute were M-W, $p_2=0.02$; K-S, $p_2=0.12$ and the results for the number of flake scars attribute were M-W, $p_2=0.04$; K-S, $p_2=0.61$. In conclusion, when all attributes are taken into consideration there is no significant difference in the morphology of finished Archaic bifaces regardless of the raw material used.

Hinge and step terminations (Table 5.5) and adverse breakage on unfinished bifaces (Table 5.6) were the attributes selected to assess novice and expert flint-knapping ability. Sixty-five percent of finished bifaces exhibited at least one hinge or step termination, whereas nearly all (92%) unfinished bifaces had one or more hinge and/or step terminations. The rate of hinge and step terminations to flake density was correspondingly dissimilar with .24 terminations per flake for finished bifaces and .57 terminations per flake for unfinished bifaces. Seventy-seven percent of the unfinished

Table 5.5 Flint-knapper Expertise Comparison

		Hinge & Step Terminations					
	N	No. with Hinge/Step Terminations	% with Hinge/Step Terminations	Range of Hinge/Step per Flake Frequency	Average Frequency	No. with Stacked Terminations	% with Stacked Terminations
Finished Biface - Metasediment	26	17	65.38	0 to 0.67	0.24	7	26.92
Finished Biface -Chert	40	26	65.00	0 to 0.67	0.22	10	25.00
Finished Biface - Quartzite	5	3	60.00	0 to 0.5	0.25	0	0.00
Unfinished Biface - Metasediment	48	44	91.67	0 to 1	0.57	18	37.50

Table 5.6 Adverse Breakage on Unfinished Bifaces

N	Perverse	% Perverse	End Shock	% End Shock	Total	% Total	Face Battering
26	16	33.33	21	43.75	37	77.08	0

bifaces showed evidence of adverse breakage and of the 23% that were not broken transversely, 63% had stacked hinge and/or step terminations. In comparison, stacked hinge and step terminations appeared on just 26.92% of finished bifaces and 37.50% of unfinished bifaces.

A frequency of stacked hinge and step fractures of 54 to 61% is suggestive of novice flint-knappers and a frequency of 2 to 4% is indicative of expert flint-knappers according to Shelley's (1990:188) experiments with cryptocrystalline silicates (cherts, silicified woods, and chalcedonies) and vitreous silicates (obsidians and tachylyte). All bifaces in the West Burleigh Bay assemblage fall between these two ranges and are likely the result of poorer quality toolstone. Roughly two-thirds of all finished bifaces were manufactured on toolstone that contained flaws and inclusions. Though flaws and inclusions on unfinished bifaces of metasedimentary material were slightly lower at 56%, 83% of the same artifacts had visible bedding planes. As noted previously, toolstone with flaws, inclusions or bedding planes tends to break prematurely resulting in a higher proportion of hinge and step fractures, and fractures along bedding planes and flaws (Andrefsky 1998:50; Cotterell and Kamminga 1987:678; Crabtree 1972:5). This is certainly true of the West Burleigh Bay assemblage. Shelley (1990) noted that expert flint-knappers only discarded incomplete bifaces if a flaw was discovered in the toolstone or as a result of adverse breakage. The very high incidence of perverse (33%) and end shock (44%) breakage coupled with stacked terminations on the remainder of discarded unfinished bifaces is indicative of inherent flaws in the material. A complete absence of face battering on any of the artifacts suggests these tools were manufactured by expert flint-knappers and the problems observed were the result of the quality of the toolstone. It is a testament to the skill of the knappers that even though unfinished metasediment bifaces exhibit a high degree of failure, finished metasediment bifaces show no appreciable difference in morphology from chert bifaces.

Artifact Distribution

The majority of Archaic artifacts recovered from the West Burleigh Bay site were distributed in a 120 m^2 area of the easternmost portion of the site situated at an elevation above 235 m asl. This area corresponds to the grid coordinates E00 to E30 and N10 to N50 (see Figures C.1, C.2 and C.3, Appendix C; Figures 5.12, 5.13 and 5.14). One exception is a Late Archaic Ace of Spades point recovered by York North Archaeological Services Inc. from the western side of the site (Dibb 2001). Of the Archaic artifacts excavated by Trent University, 97% were recovered above 236 m asl or north of the N30 grid line. Only one Early Archaic and two Late Archaic artifacts were recovered from between 235 and 236 m asl. The location of artifacts suggests that water levels during the Archaic were no higher than modern levels of approximately 234 m asl to 235 m asl.

Presently, the area of Archaic artifact concentration floods after every heavy rain (Figure 5.10). If this was the case during the Archaic it would make for an unsuitable camp site. However, the presence of large numbers of artifacts attests to the repeated use of the area throughout the Archaic and the overall pattern of artifact distribution is one of overlapping clusters that form an arc with an apparent void of artifacts in the middle. This absence of artifacts corresponds to the location of a group of boulders that bisect the area (Figure 5.11). As indicated on Figure 4.1 this was an area that was not fully

Figure 5.10 Flooded area of the site (looking south from grid coordinates N50 E20)

Figure 5.11 Large rocks along N30 grid line (236.5 m asl)

excavated. The mass of boulders made excavation extremely difficult and time consuming and thus not ideally suited to a field school project that was also responsible for mitigating the area prior to development. Also taken into consideration was the expectation that the boulders would protect any underlying artifacts during the development and subsequent use of this property. In summary, artifact distribution (depicted in Figures C.1, C.2 and C.3, Appendix C; Figures 5.12, 5.13 and 5.14) follows the natural landforms in the area with some disturbance due to water flow that causes artifacts to move on the surface and within the soil matrix.

Regardless of the limitations caused by taphonomic processes and limited stratigraphy at the site, there remains a largely constrained distribution of Archaic artifacts. A number of diagrams were produced to identify broad temporal clusters (see Figures C.1, C.2 and C.3, Appendix C) and to correlate debitage to metasedimentary bifaces for inference of horizon clusters (Figures 5.12, 5.13 and 5.14). The results indicate considerable overlap and repeated use of the same general space over several thousands of years. The distribution of metasediment bifaces (Figure 5.12) follows the

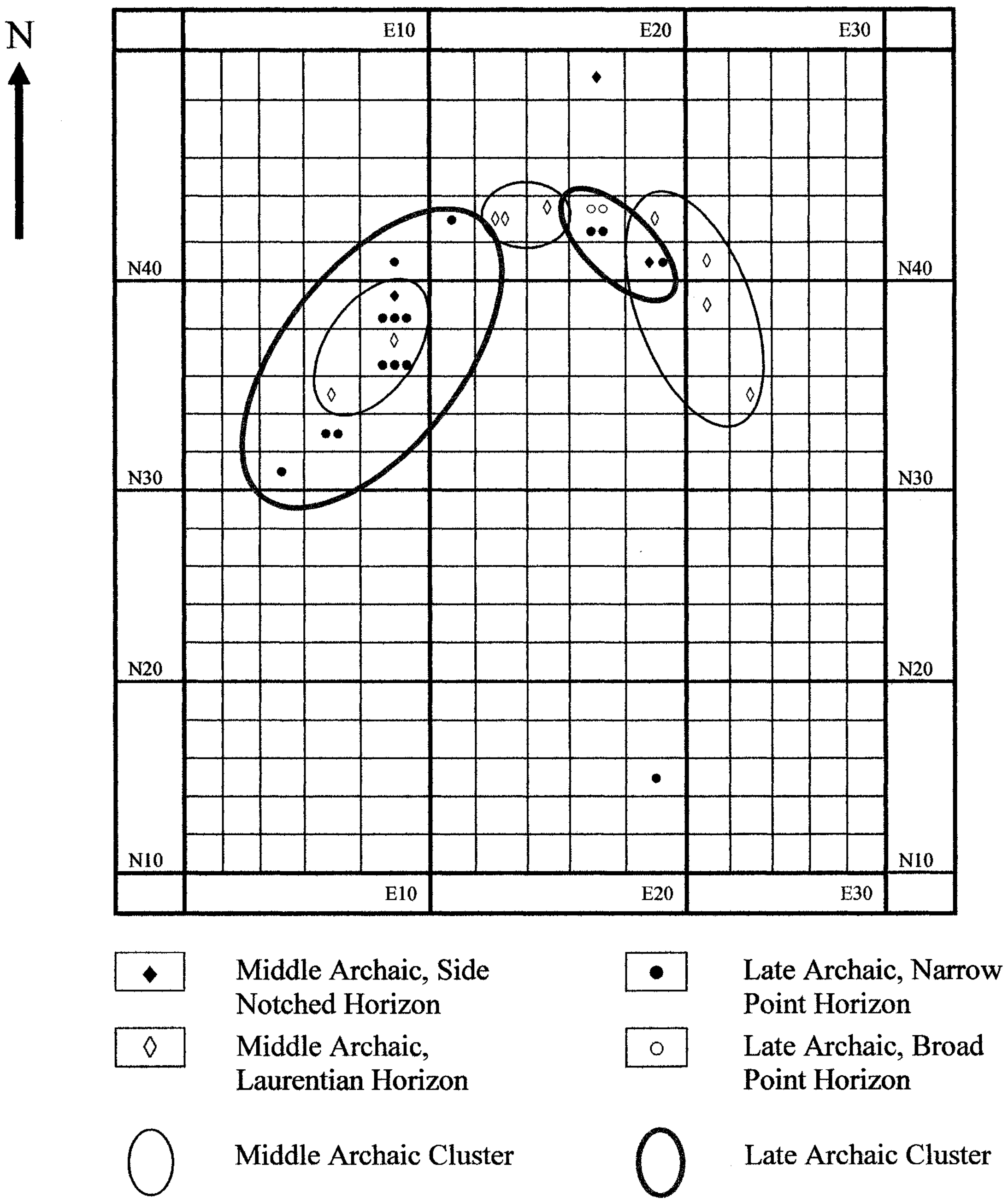


Figure 5.12 (not to scale) Distribution of Metasediment Bifaces

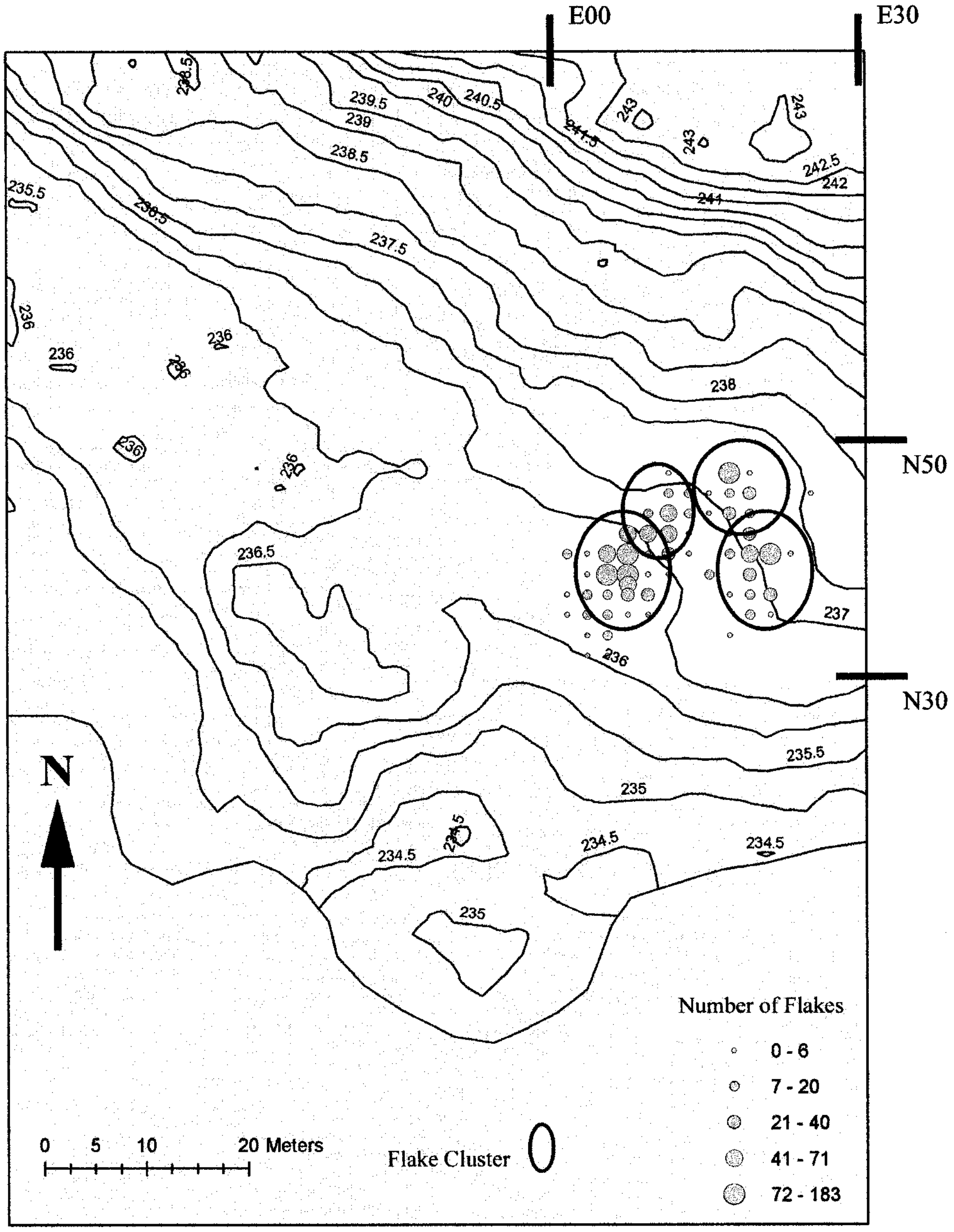


Figure 5.13 Distribution of metasediment flakes at BdGn-12

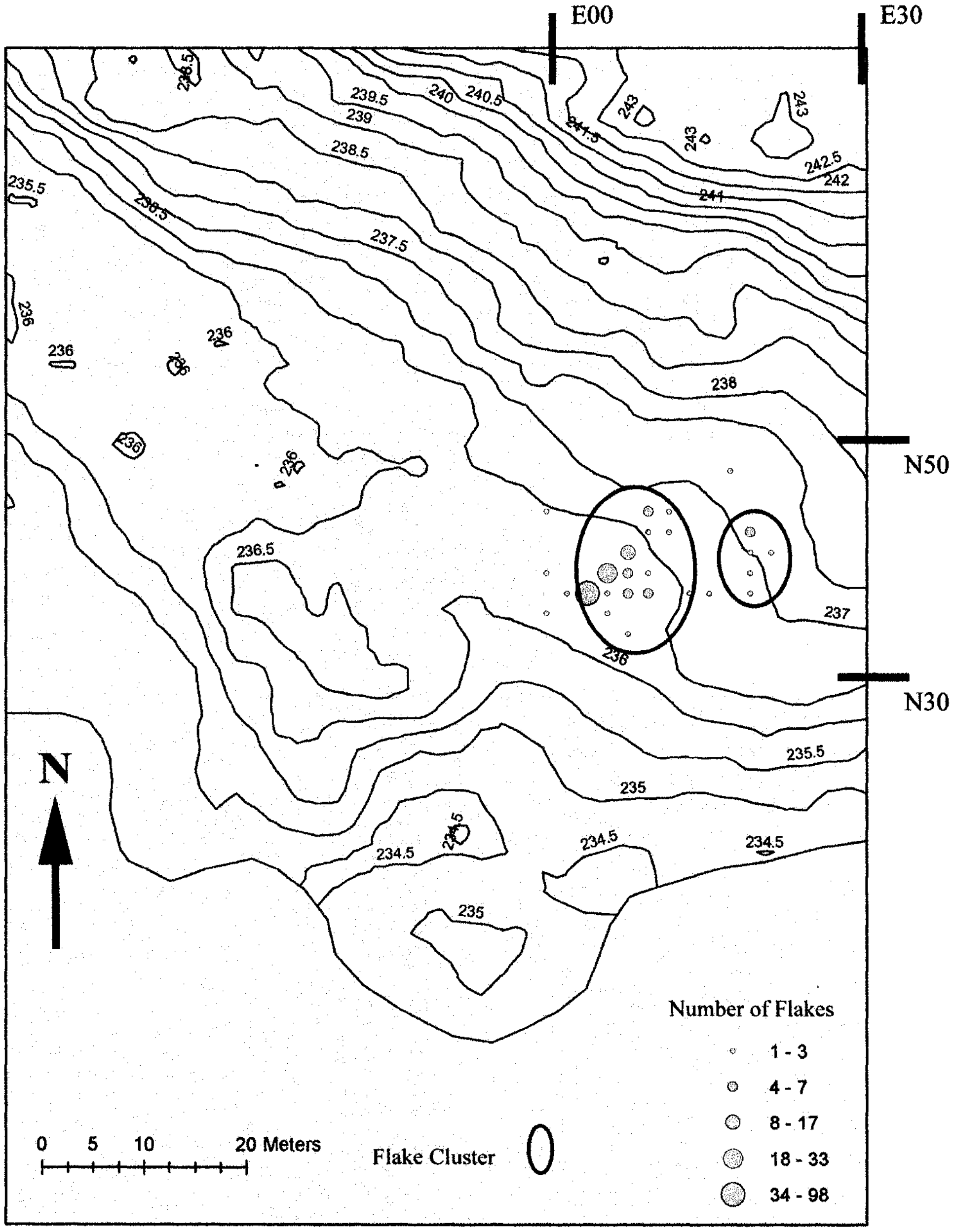


Figure 5.14 Distribution of unknown sedimentary flakes at BdGn-12

patterns of distribution identified for Middle (see Figure C.2, Appendix C) and Late Archaic (see Figure C.3, Appendix C) artifacts indicating no discernable difference in site occupation. Figure 5.12 itemizes the diagnostic metasedimentary artifacts recovered from each 2m unit and the horizon to which each is assigned. Although there is overlap there are clusters that are predominantly Middle or Late Archaic. When compared to clusters of metasedimentary debitage (Figure 5.13) a very tenuous relationship is suggested. Unfortunately, water flow through the site affects movement of smaller artifacts, such as flaking debris, to a greater degree than larger artifacts and further lessens the strength of any relationship between debitage and discarded bifaces. Clusters of debitage from the unknown sedimentary material (Figure 5.14) were also identified and they also overlap the previously discussed clusters. In addition, the two diagnostic Middle Archaic points made on the unknown sedimentary material were recovered from units included in the westernmost debitage cluster (Figure 5.14). Movement of artifacts via taphonomic processes means that defined artifact clusters are tenuous. Nevertheless, the ability to discern any clusters at all in an area that appears so disturbed suggests that movement within, and on, the soil is quite limited. For example, Laurentian Archaic artifacts tend to be very tightly clustered with multiple artifacts recovered from adjacent units.

Warm weather use of the site by small groups of Archaic period hunter-gathers taking advantage of abundant fresh water resources certainly contributed to the clustering of the artifacts. However, the physical layout of the site as well as taphonomic processes likely contributed to the close proximity of artifact clusters and their predominance within a small area of the site. If the shoreline during the Archaic was as high as the present level there would have been limited choices for situating domestic shelters. The area of artifact concentration is relatively flat and though it represents a less than ideal location at the present time, due to its tendency to flood, it may have been perfectly suitable during the Archaic when the environment was drier. Therefore, the artifact clusters may represent multiple domestic areas, repeated use of the area as a midden, or lithic manufacturing sites. With no hearth features recovered it is difficult to conclusively identify activity areas within the site.

Hunter-gatherer camps tend to be organized around a central area for domestic activities that includes shelters and hearths (Bamforth et al 2005:571). At camps occupied for more than a few days it is common for debris to be removed to an area outside of the central area. In addition, particularly messy or dangerous activities tend to be performed outside the domestic zone. Bamforth et al. (2005) posit that a Paleoindian site located in southwestern Nebraska shows evidence of trash disposal into a common midden over a period of 3000 years and that visible signs of previous midden use encouraged this repeated use. In the Nebraska case, flaking debris was scattered horizontally, but not vertically, within the strata with no evidence of *in situ* flaking, indicating disposal of flaking debris that originated at another location on the site. The clustering of flaking debris at the West Burleigh Bay site suggests that it is relatively *in situ* and because flaking debris is very sharp and can be considered a dangerous activity it may represent flint-knapping episodes that occurred away from the central domestic area. Alternatively, the clusters may simply represent flaking episodes that occurred around domestic hearths.

As noted in the diagrams of artifact distribution artifact densities increase over time. This suggests a trend towards larger populations and/or increasing intensification of site use. Large numbers of Archiac bifaces and accompanying debitage indicates this site was a longer term camp and not merely a temporary or transient stop en route to another location.

Petrographic Analysis

Fifteen artifacts were sent to SGS Lakefield Research Limited for petrographic analysis (see Figures D.1, D.2, D.3, D.4, and D.5, Appendix D). Though the original request was for thin section petrography the Project Mineralogist determined that X-ray diffraction (XRD) analysis of the samples would provide added accuracy to the classification procedure due to the very fine grain size (< 4 μm) of most of the samples (Downing 2006). As a result, rock classification was based on optical examination and XRD. Of the fifteen artifacts examined, two were classified as varieties of chert and the remainder were sedimentary rocks classified as mudstone with differing mineral components (Table 5.7, see Table D.1, Appendix D). Of the two chert samples, the first (sample 1), included in Subset 1, was defined petrographically as calcareous chert. Based on the inclusion of black pyrite crystals the source of this sample can be traced to the Upper Gull River formation (Eley and von Bitter 1989:26,46). The second (sample 11), included in Subset 4, was defined petrographically as ferruginous chert. Based on the peloidal appearance and organic inclusions the source of this sample can be traced to the Lower and Middle Bobcaygeon formation (Eley and von Bitter 1989:25). The mudstone samples were predominantly composed of "K-feldspar (microcline), with or without:

carbonates, Fe- and Ti-oxides (magnetite, hematite, rutile), minor quartz, clay material (consisting of possible zeolites and/or clay minerals), phyllosilicates, plagioclase-feldspar, amphibole, and amorphous cryptocrystalline material" (Downing 2006:1-2). The petrography confirms much of the macroscopic analysis discussed in Chapter 4.

The mudstone samples meet most of the criteria of useable toolstone for clastic sedimentary rocks as defined by Andrefsky (1998:56). All of the samples are fine-grained, hard and brittle, and though none is silicified they all contain high quantities of silicates including feldspar and quartz providing the ability to fracture conchoidally. Most of these rocks exhibit lamination or bedding planes and therefore do not meet Andrefsky's characteristic of uniform composition. This is the single characteristic that does not meet the definition of ideal toolstone. Additionally, evidence of zeolites in some of the samples indicates low grade or contact metamorphism.

Table 5.7 Summary of Lithic Sample Classifications

Subset	Sample No.	Sedimentary Classification
1	1	Calcareous chert
1	2	Feldspathic, calcareous, ferruginous mudstone (marl)
1	3	Feldspathic, calcareous, ferruginous mudstone (marl)
2	4	Feldspathic cherty mudstone
2	5	Feldspathic, ferruginous mudstone
2	6	Feldspathic, calcareous, ferruginous mudstone (marl)
3	7	Feldspathic, calcareous, ferruginous mudstone (marl)
3	8	Feldspathic, calcareous, ferruginous mudstone (marl)
3	9	Feldspathic, calcareous, ferruginous mudstone (marl)
4	10	Feldspathic, ferruginous, argillaceous mudstone
4	11	Ferruginous chert
4	12	Ferruginous, argillaceous mudstone
5	13	Feldspathic, ferruginous, argillaceous mudstone
5	14	Feldspathic, ferruginous, argillaceous mudstone
5	15	Feldspathic, ferruginous, argillaceous mudstone

Macroscopic identification throughout this study has differentiated between clastic sedimentary rocks based predominantly on colour and grain size. All artifacts that met the visual characteristics of the samples in Subsets 1, 2 and 3 were classified as *metasedimentary* and all artifacts that looked similar to the samples in Subset 5 were classified as *unknown sedimentary* material. Based on the petrographic results, Subset 4 contains raw materials that do not fit easily into either macroscopic group. During the artifact identification process flakes visually similar to these were assigned to either *metasedimentary* or *unknown sedimentary* classifications. Based on this data (see Table D.1, Appendix D), all non-chert samples are feldspathic mudstones, with the previously defined metasedimentary classification distinguished by the presence of laminated beds, very fine grain size (< 80 μm), and dark grey colour, whereas the unknown sedimentary classification may be macroscopically identified by its absence of laminated beds, larger grain size (100 to 200 μm), and reddish brown colour.

Thirteen of the fifteen samples sent for petrographic analysis were sedimentary rock, an 87% rate of accuracy for macroscopically identifying artifacts as clastic sedimentary raw material. The identification of two chert samples from local sources is not unexpected. Macroscopically, Upper Gull River chert and Lower Middle Bobcaygeon chert can be difficult to differentiate from each other and their colour, fine-grained texture and sedimentary structure all fall within the range of characteristics identified for the clastic sedimentary materials analyzed.

The petrographic analysis of the lithic materials is consistent with amphibole – rich metasedimentary rocks defined as "metamorphosed calcareous mudstone and sandstone" with local phases rich in potassium feldspar (Lumbers and Vertolli 2000; Pam

Sangster personal communication 2006) located in the vicinity of the West Burleigh Bay site. A number of sources are accessible within 10 km of the site including a unit exposed immediately to the north and east of Burleigh Falls extending to adjacent islands such as Wood Island, Frasers Island, Horseshoe Island and Acton Island, and also at a unit exposed between Stony and Dummer Lakes. This material is also exposed along the shoreline of Jack Lake but at a distance of over 20 km (as the crow flies, and no direct water route) from the West Burleigh Bay site it is an unlikely source for the material recovered.

Summary

The results of the research on Archaic tools has been tailored to answer questions posed in Chapter 1 regarding raw material usage, method of lithic production, flint-knapper expertise, and the source of the metasedimentary raw material recovered at the West Burleigh Bay site. Multiple methods were used to obtain the results in an effort to strengthen the inferences made from the Archaic artifacts recovered at this multicomponent site.

Raw material usage at West Burleigh Bay generally follows the observed pattern of Archaic lithic use for flaked stone tools which notes increased use of locally available, lesser quality, toolstone over time. Statistical testing of temporal use of toolstones based on typological styles of flaked stone bifaces indicates only a tenuous relationship. However, there is a shift to using a greater proportion of local toolstones. Certainly there is a relationship between the properties of the toolstones used and the types of tools manufactured. Somewhat obviously, toolstone properties that permit controlled flaking were utilized for flaked stone tools though less flakable materials were often used for manufacturing ground stone tools. Selection of suitable raw material for flaked tools encompassed a fairly broad range of materials and qualities during the Archaic. High quality chert, poorer quality chert, and metasedimentary material with abundant bedding planes were used to produce bifaces of similar morphology at the West Burleigh Bay site.

Three methods were utilized to infer the method of lithic production on metasedimentary material at the site. Flaking debris was analyzed using the Sullivan and Rozen technique, large flakes were assigned to stages of reduction, and unfinished bifaces were assigned to stages of production. Each of these methods indicated that all stages of biface manufacture occurred at the site. Further analysis of the assemblage indicates the bulk of knapping problems were the result of inferior toolstone, specifically the presence of bedding planes, and not from a lack of flint-knapping experience. Thus, it can be concluded that expert knappers were manufacturing bifaces on local metasedimentary material at the West Burleigh Bay site.

This site was repeatedly occupied during warm weather months throughout the Archaic by small groups of hunter-gatherers. The proximity to prime fishing locations, and access to toolstone, as well as a number of intangible aspects, such as being sheltered by the ancient terraces yet open to cross breezes from the lake, combine to make this a suitable camp site. The close proximity of artifacts on the site suggests reuse of visible activity areas over many thousands of years.

Chapter 6

Summary and Conclusions

This study has confirmed that in many instances the lithic evidence from the West Burleigh Bay site conformed to trends recognized for Archaic tool use throughout the Northeast. Curated bifacial technology was the predominant mode of lithic production and together with the distribution of artifacts on the site supports the premise of small mobile bands using this locale as a spring-summer fishing and hunting camp. There is evidence of increased use of local toolstone and an increase in the variety and quality of toolstones used. Ground slate tools are present at the site and this also conforms to documented traits of the Archaic which note that ground slate is rarely found in southwestern Ontario but has been found in southeastern Ontario and points east.

The Archaic lithic assemblage was examined to better understand two documented traits of the Archaic period, namely; the increased diversity of toolstone including the use of less flakable material, and the appearance of thick, irregularly flaked, asymmetrical tools. The primary objective of the research was to identify the quality of archaeological toolstones used and the knapper's skill levels to determine if the tools were indeed made with less care and skill, as stated in the literature, or if the quality of the toolstone affected the appearance of the finished tools. A second objective was to augment the body of knowledge for the Archaic in Ontario and particularly in the southeast.

Quality and Source of Toolstones

There are a number of potential reasons for the increased use of local and less flakable toolstone, including; longer periods of time spent in areas and a corresponding greater familiarity with the resources available, a change in water levels that provided access to previously inaccessible materials, restricted access to chert quarries, a preference for toolstones from sources with symbolic importance such as spiritually or culturally significant areas, a change in technology or hunting practices that was less dependant on higher quality toolstone, or simply, convenient use of materials at hand. I suspect the impetus for the increased use of local toolstone was a combination of several reasons and not limited to a single one.

Evidence in the Northeast indicates that, on the whole, Archaic peoples traversed smaller territories than earlier Paleoindian peoples, likely due to changes in subsistence practices resulting from changes in the environment and a concomitant increase in the diversity of plants and animals in the region. It seems intuitive that more time spent in an area would result in a broader knowledge of resources, including toolstone availability. In the case of the West Burleigh Bay site, several presumed geological units of the metasedimentary toolstone are located within 5 km of the site including the shoreline of the site and 2 nearby islands. Though the present shoreline would have been inundated during the Paleoindian period, the toolstone locations would have been accessible during the low water phases of the Georgian Bay and Lake Huron basins, corresponding with the beginning of the Archaic. Flow rates in the Trent Valley fluctuated throughout the Archaic with the greatest changes occurring during the Nipissing transgression. A high water phase around 5000 BP may have temporarily restricted access to the local toolstone.

The use of local and non-local chert remains constant throughout the Archaic at the West Burleigh Bay site. There is no evidence that access to chert quarries was restricted.

The source of the metasedimentary toolstone, specifically the two islands, is directly across from Burleigh Falls. Waterfalls were spiritually significant to the historic Ojibwa and may have been important to Archaic peoples as well. *Misshepeshu,* the undisputed ruler of the lower world resided under the water and was both feared and revered for its ability to control turbulent waters and the force of storms (Brehm 1996:680-684). In addition, *Misshepeshu* controlled the supply of game and fish, and provided medicines and the knowledge for their use. It is possible that toolstone collected from nearby areas was favored for its associative power.

One of the more interesting, and often neglected, reasons for the change in toolstone selection is that local material was convenient, and was adequate for the types of tools being manufactured. As this study has shown, there is no statistical difference between the morphology of finished bifaces manufactured on chert or any other lithic material during the Middle and Late Archaic. Combined with evidence that these tools were manufactured by expert flintknappers, it infers the chunky appearance of the tools was planned and may be related to function. An experiment to test projectile point durability (Chesier and Kelly 2006) found that increasing relative thickness to length increased the likelihood of a point surviving its initial impact. It is possible that due to the force generated by atlatls, thicker more durable dart points could be used without significantly reducing hunting effectiveness. If this is so, less flakable material, such as metasediment, would be perfectly suitable for tool manufacture.

It is my contention that metasedimentary material was used at the West Burleigh Bay site because it was convenient, it met all of the properties required for controlled flaking except for the inherent bedding planes which could be overcome by knapper skill, it was adequate for the functional use of the tools, and its source location within sight of the Burleigh rapids and waterfalls provided an added spiritual incentive.

Skill Levels of Archaic period Flint-knappers

When the morphology of flaked Middle and Late Archaic bifaces from the Northeast are discussed they are generally described as thick, and asymmetrical, or sometimes even as crude. These traits have led researchers to surmise that they have been made by flint-knappers with less skill and/or care than the Paleoindian knappers who preceded them. While I would agree that many Archaic bifaces are less aesthetically pleasing than Paleoindian bifaces in general, I do not agree it is due to lack of skill. This study revealed that bedding planes in the metasedimentary raw material contributed to increased flaking failures, especially hinge and step fractures but also to end shock and perverse fracture during the manufacturing process. At the West Burleigh Bay site there is no indication of novice knappers. Instead, the debitage provides evidence of removed stacked hinge and step fractures (Figure 6.1), while finished bifaces have very few stacked hinge and step fractures, attesting to the skill of the knappers to overcome flaws in the material. The ability to work with flawed material and overcome knapping problems is indicative of expert flint-knapping ability that requires more skill than is required for superior quality isotropic toolstone.

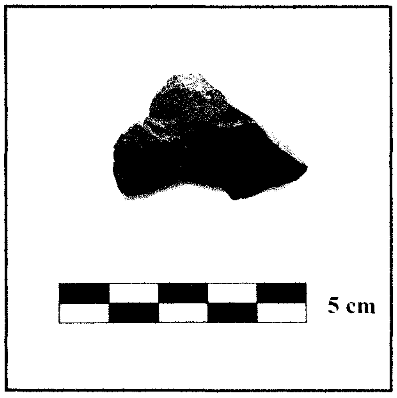


Figure 6.1 Removed flake with stacked step fractures

The Archaic in Southeastern Ontario

While no discrepancies were discovered between the artifacts recovered from the site and published accounts of the Archaic this study has expanded on the selection, use, and manufacture of flaked bifacial tools during the Middle and Late Archaic. Information from this site also expands the knowledge base of Archaic sites in southeastern Ontario and provides much needed documentation for a period that is anecdotally ubiquitous but rarely published.

Several strands of evidence indicate that the West Burleigh Bay site likely represents a number of warm weather camps that, based on its proximity to Burleigh Falls, were reliant on fishing. Other aquatic resources, such as fowl, would also have been a part of their subsistence as would game such as deer and seasonal berries and other plants. The presence of axes, adzes, and gouges suggests that Archaic peoples were involved in woodworking activities at the site. A large number of drills are also indicative of craft work. Each of these lends credence to the assumption that Archaic peoples occupied this site for extended periods during the warm months of the year.

Evidence of interaction between West Burleigh Bay and sites in Southeastern Ontario and regions in the greater Northeast are inferred from the presence of artifacts that are stylistically associated with other regions or manufactured on non-local material. Aside from the use of non-local cherts, there is a perceptible increase in the variety of artifacts at the site that may be considered non-local starting around 5000 years ago. Items such as ground slate points, a copper point, a Susquehanna broad point, and a fragment of a steatite bowl suggest broad but infrequent networks of interaction to the east and southwest. Coincident with the appearance of these artifacts is the probable rise in water levels in the Trent Valley due to the Nipissing transgression. This may have contributed to faster more efficient travel routes during the late Middle Archaic and the early Late Archaic resulting in the expansion of interaction networks in the region.

Evidence of interaction, along the Trent-Severn system to the east, is seen in the complementary artifact assemblages of the West Burleigh Bay site and the Healey Falls site, located north of Campbellford. Chlorite schist celts, metasedimentary bifaces, as well as fragments of steatite bowls recovered at both sites provide fairly robust evidence of similar interaction networks sometime after the late Middle Archaic. Travel between these two sites on the Trent-Severn system, by way of Rice Lake, would likely have been straightforward. Since both are interpreted as warm weather sites it is unlikely that the same people occupied both sites during a single season. There is ample evidence of lithic tool manufacture, with all stages of production identified for their respective tools, at both sites. Chlorite schist celts were manufactured at Healy Falls and metasedimentary bifaces were produced at Burleigh Falls. Though a number of chlorite schist celts were recovered at Burleigh Falls there was neither manufacturing debris nor any other evidence of manufacture. The opposite scenario appeared at Healy Falls for metasedimentary tools, with a large number of bifaces recovered but no accompanying manufacturing debris. This suggests that Archaic peoples in the vicinities of Burleigh Falls and Healy Falls were exchanging a variety of items, including finished bifaces and celts, either directly or through "down the line" trade.

The recovery of several ground slate artifacts at the site have been noted in this thesis but have not been studied in detail. However, of special note is the recovery of two intact ground slate points (Figure 6.2) from a single unit suggesting contemporaneity and the possibility of purposeful, and/or symbolic placement. A third intact ground slate point discussed in the previous chapter was engraved with a cross-hatch design that may be of spiritual or symbolic importance. Additionally, broken pieces of ground slate bifaces were recovered including one that had its proximal end purposely sawed and snapped off suggesting the point had been rejuvenated.

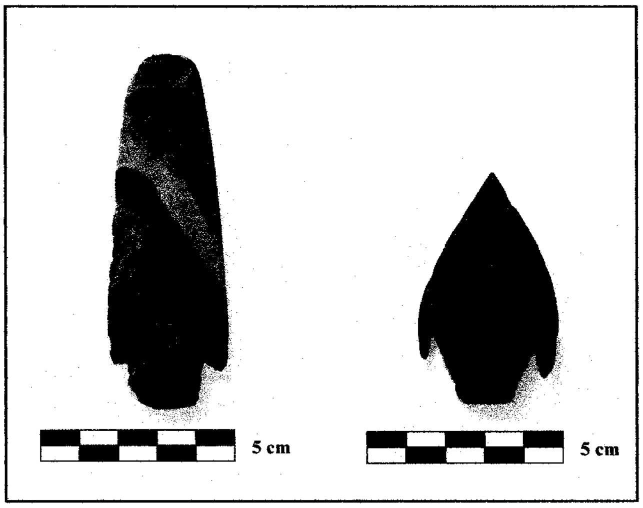


Figure 6.2 Pair of ground slate projectile points

A number of the artifacts recovered from the West Burleigh Bay site indicate an increase in the expression of ideology through material culture. Paired projectile points, portions of gorgets, a copper point, evidence of red ochre nodules, and the discovery of a fully ground chlorite schist axe adjacent to the bottom of a suspected 'empty' burial pit all infer ceremonial burial practices and inhumation of at least some band members late in the Archaic. In addition, a miniature projectile point (Figure 6.3) may have been carried in a medicine bag as a personal talisman.

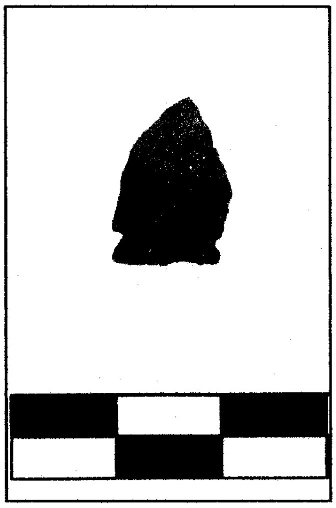


Figure 6.3 Miniature projectile point

In summary, this study has endeavored to document both flaked and ground stone tools attributed to the Archaic at the West Burleigh Bay site and situate them within the broader context of the Northeast. Though not the primary focus of this research, the ground stone tools aid in interpreting and contextualizing the site.

Suggestions for Future Research

In the process of this study it became clear that there were gaping holes in the research and publication of Archaic sites and artifacts. Though Archaic sites are common in Ontario, they tend to be messy. Most often they are disturbed, multi-component sites with an array of lithic tools that do not always fit published typologies and are made on local, difficult to identify, raw materials. I hope that this study inspires others to attempt to extract meaningful data from chaotic assemblages and expand and enhance our understanding of the Archaic. With this in mind the following suggestions highlight a number of topics that I believe expand on the research presented in this thesis and would contribute to our understanding of the period.

1. Recent experimentation of projectile point thickness by Chesier and Kelly (2006) indicates that relative thickness of bifaces contributes to the durability of the tools. Further examination of Archaic bifaces and additional experimentation may shed light on the possibility of functional reasons for the trend towards thicker points during the Archaic.
2. As discussed at length in this present study, the Archaic peoples utilized many varieties of lithic material, much of it confined to discrete localized areas. As a result local toolstone can easily be misidentified. A comprehensive examination resulting in a reference document of non-chert toolstones would be invaluable. This may already have been completed. Adrian Burke, a professor of anthropology at the University of Montreal, has a publication in press entitled *Stone Tool Raw Materials and Sources of the Archaic Period in the Northeast*, in Proceedings of the Archaic Conference held at University of Maine, October 13-14, 2001. David Sanger is the editor. This publication has the potential to provide increased consistency and accuracy in the identification of non-chert toolstones in the Northeast.
3. There is scant literature on the study of ground stone bifaces. From the evidence at West Burleigh Bay it appears that these tools served dual purposes: as functional tools, and as cultural and/or spiritual symbols. I believe the use of decorative elements such as cross-hatching and the incorporation of distinctive bands of colour are integral elements of the bifaces and were significant to the maker. Study of the symbolic elements of these bifaces would aid in understanding and interpreting the Laurentian horizon of the Archaic. In addition,

evidence of symbol systems could be studied for possible continuity through to historic populations.

4. An area of study that was excluded in this thesis was the functional use of tool types at the West Burleigh Bay site. A large number of drills were recovered as were a number of gouges, axes, and adzes. These tools, associated with activities that likely took place at the site, may provide more detail regarding Archaic daily lives.

There is much we do not know about the Archaic and further research of this period will contribute to our understanding and interpretation.

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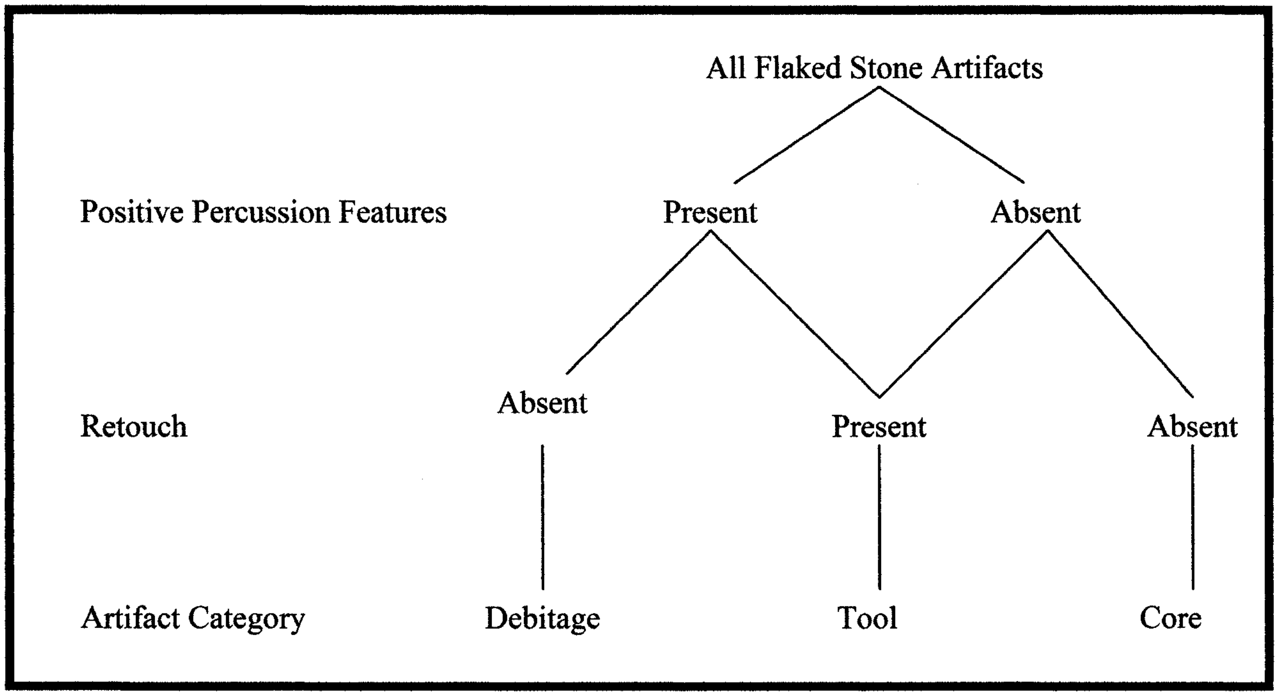
Appendix A

Lithic Attributes

Artifact Categories

The artifacts are categorized on the basis of their flaking characteristics. Since West Burleigh Bay is a multicomponent site, the separation of the Archaic artifacts from the complete assemblage proceeded in several steps. The categories presented here are the final result. Two objectives were accomplished during this process. First, diagnostic Archaic artifacts from the collection were identified and selected, and second, metasedimentary manufacturing debris was selected and sorted. Analysis of the diagnostic artifacts in the multicomponent assemblage indicates that black metasediment was used as a lithic raw material only during the Archaic period. For this reason, the selected Archaic assemblage consists of diagnostic flaked stone tools, diagnostic ground stone tools, and all metasedimentary non-diagnostic tools and flaking debris.

Maximal Artifact Categories



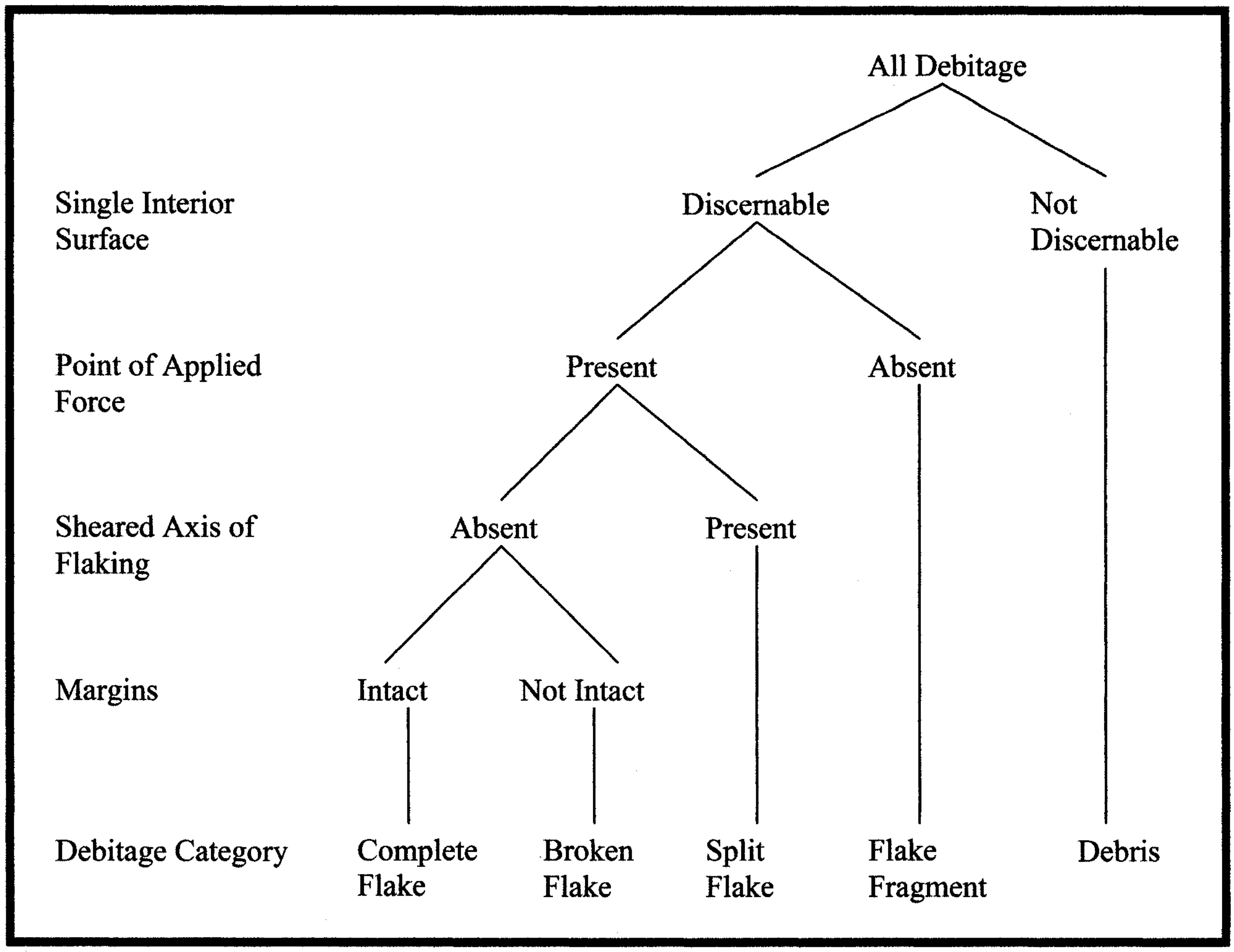
Each artifact is assigned to a broad category based on visible flake scars. The categories in this figure were developed by Rozen and Sullivan (1989:181), and Sullivan (1987:48).

(1) Debitage – an artifact that exhibits positive percussion features but lacks any evidence of retouch or use-wear.

(2) Tool – an artifact that exhibits positive percussion features, or alternatively, negative percussion features with continuous bifacial retouch of at least 3.0 mm on at least one non-platform margin.
In addition, all ground stone artifacts are considered tools based on the considerable effort required for their manufacture.

(3) Core – an artifact that exhibits only negative percussion features and does not exhibit continuous bifacial retouch of at least 3.0 mm on any margin.

Debitage Categories



Each artifact defined as debitage is further categorized according to the characteristics indicated in the above figure (Sullivan 1987:47, figure used with permission from the author).

(1) Complete Flake – debitage that exhibits a single interior surface, an intact striking platform, and retains all margins. Included in this category are flakes with hinge terminations. A cursory examination of the collection suggests a large number of flakes have aborted terminations and it is surmised that this is due to the

limitations of the raw material. Flakes that exhibit step terminations are not considered complete since this is a common result of taphonomic processes.

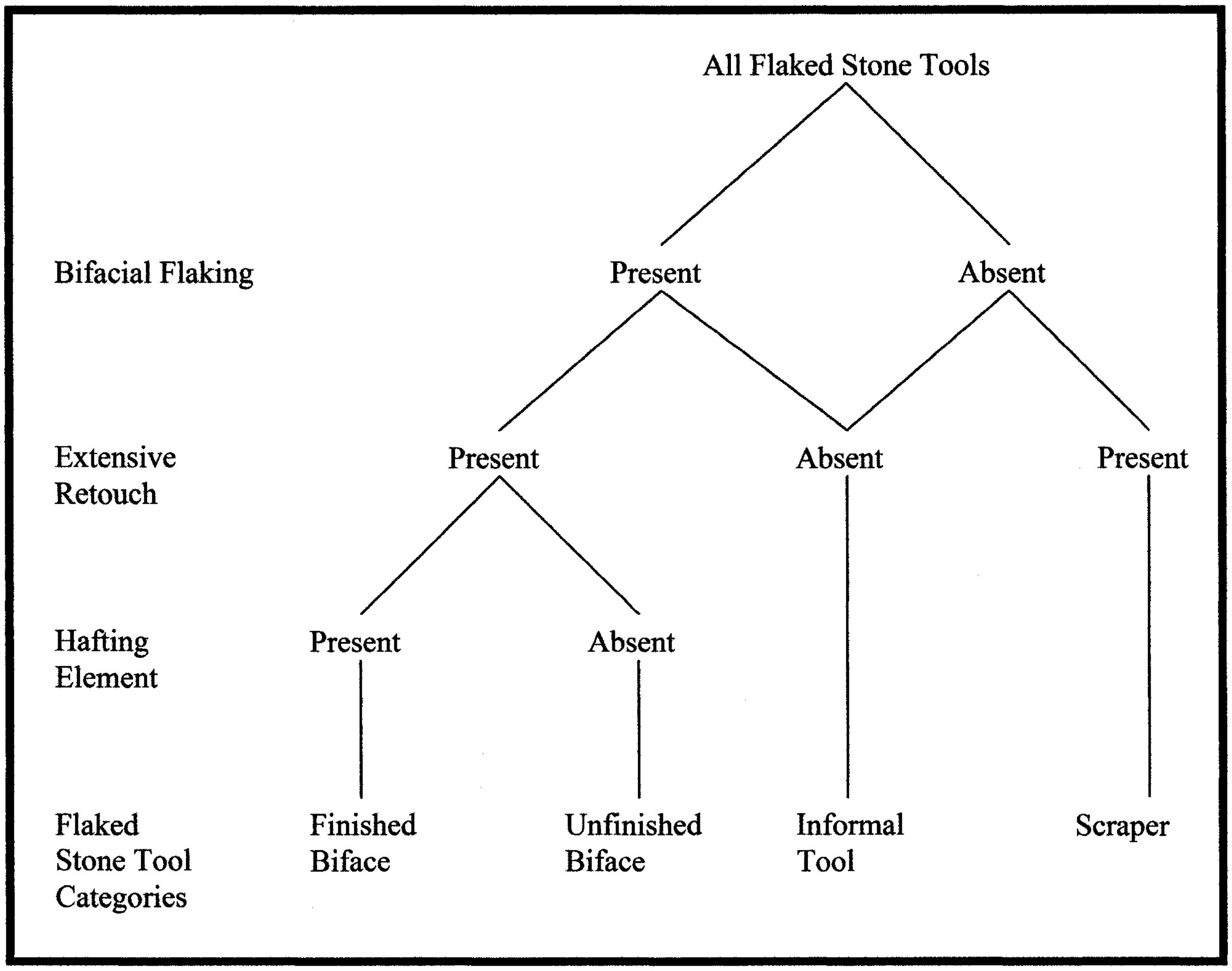
(2) Broken Flake – debitage that exhibits a single interior surface and an intact striking platform, but does not retain all margins.

(3) Split Flake – debitage that exhibits a single interior surface and an intact striking platform, but is split longitudinally along the flaking axis.

(4) Flake Fragment – debitage that exhibits a single interior surface, but the striking platform is missing.

(5) Debris – debitage that exhibits no flake characteristics, such including material commonly referred to as shatter or blocky fragments.

Tool Categories



Each artifact categorized as a flaked stone tool is further categorized according to the characteristics indicated in the above figure. These categories are adapted from Andrefsky (1994:22), Muto (1971) and Sullivan (1987:48-49).

(1) Finished Biface – a hafted, bifacial tool that is extensively retouched. This category includes a variety of tool types traditionally categorized on the basis of their presumed function, for example, projectile points and drills as well as scrapers made from reworked points.
(2) Unfinished Biface – a bifacial tool that exhibits extensive retouch but is not hafted.
(3) Informal Tool – a unifacial or bifacial tool that is not extensively retouched but exhibits between one and three invasive retouch scars greater than 3.0 mm on a non-platform margin.
(4) Scraper – a unifacial tool that exhibits more that three invasive retouch scars greater than 3.0 mm on a non-platform margin.

Ground stone tools are categorized using archaeologically recognized functional names (Lackowicz 1996; Ritchie 1994; Snow 1980; Tuck 1976; Wright 1962).

(5) Celt – a generalized designation for axes and adzes.
(6) Gouge – a ground stone implement similar to a celt with a pronounced groove on the bit end.
(7) Biface – this includes ground stone projectile points, bayonets and all unidentified bifacially worked ground stone tools.

Attributes Recorded for All Artifacts:

1. Identification Number

Each tool and complete flake larger than 10 mm in diameter is assigned a unique identification number corresponding to the catalogue number from the West Burleigh Bay site. The catalogue number indicates the unit and stratigraphic provenience of each artifact. In cases where artifacts were grouped together under one number in the catalogue, a lowercase alphabetic character is appended, beginning with "a" and progressing through the alphabet as required, for each additional artifact.
All debitage other than complete flakes are identified by excavation unit number.

The following five attributes are examined to identify the probable source and quality of toolstone used. Raw material properties are examined to infer the fracture capability of the toolstone. Ideal toolstone is isotropic, is hard, has a fine crystal structure and has an absence of flaws, cracks, inclusions or cleavage planes (Bordaz 1970:9; Callahan 1979:16; Crabtree 1972:5; Moffat 1981:205).

2. Raw Material

This attribute indicates the type of material used in the manufacture of the artifact. Identification is made by macroscopic identification with the aid of reference books by Eley and von Bitter (1989) and Bishop et al. (2005).

(1) Chert
(2) Chlorite Schist
(3) Gneiss

(4) Metasediment
(5) Pyroxene
(6) Quartzite
(7) Schist
(8) Slate
(9) Unknown Sedimentary

3. Raw Material Source

This attribute indicates the geographical and geological source of chert used as lithic raw material. The sources of ten southern Ontario chert types have been documented and mapped to geological formations and members (Eley and von Bitter 1989). Eight of these southern Ontario chert types have been identified in the West Burleigh Bay collection. Locations are divided into local, non-local and unknown sources. Sources located in the Middle Trent Valley are considered local. Source location is not known for non-chert toolstones.

Local Source
(1) Bobcaygeon Formation – lower/middle member
(2) Gull River Formation – upper member
(4) Bobcaygeon Formation – upper member

Non-Local Source
(3) Amabel Formation
(5) Bois Blanc Formation
(6) Fossil Hill Formation
(7) Gull River Formation – lower member
(8) Kettle Point Formation
(9) Lockport Formation
(10) Onondaga Formation

Unknown Source
(11) Unknown

4. Presence of flaws or inclusions at a macroscopic level – artifacts are examined with a hand lens of 10x power or less.
(0) Absent
(1) Present

5. Presence of cleavage planes at a macroscopic level – artifacts are examined with a hand lens of 10x power or less.
(0) Absent
(1) Present

6. Lithic Grade Scale (adapted from Callahan 1979:16; and Eley and von Bitter 1989:10).

(1) Coarse tough igneous materials – includes materials identified by Callahan as grade 5.0 on his workability scale, such as coarse rhyolites, felsites and common basalt.
(2) Coarse, tough sedimentary materials – includes materials identified by Callahan as grade 4.5 on his workability scale, such as silicified slate, and argillite.
(3) Soft, chalky cherts – includes the group 1 cherts identified by Eley and von Bitter as being soft and fracturing in an irregular manner. These cherts correspond to grade 4.0 on Callahan's workability scale. This grade also includes quartz and quartzite.
(4) Hard, fine grained cherts – includes the group 2 cherts identified by Eley and von Bitter as being hard and fracturing in a conchoidal or subconchoidal manner. These cherts correspond to grade 3.5 on Callahan's workability scale.

Attributes Recorded for Debitage, Cores, Informal Tools, and Scrapers:

7. Size Grade

This attribute refers to the maximum dimension of an artifact in millimeters. All debitage, cores, informal tools and scrapers are measured, by comparing to circles of varying diameters in 5mm increments.

(1) < 5 mm
(2) 6 to 10 mm
(3) 11 to 15 mm
(4) 16 to 20 mm
(5) 21 to 25 mm
(6) 26 to 30 mm
(7) 31 to 35 mm
(8) 36 to 40 mm
(9) 41 to 45 mm
(10) 46 to 50 mm
(11) 51 to 56 mm
(12) 57 to 60 mm
(13) > 61 mm

8. Weight

This attribute refers to the weight of the artifact in grams. All cores, informal tools, and scrapers are weighed. In addition, debitage larger than 20 mm in diameter is weighed.

The remaining attributes in this section are recorded only for Complete Flakes larger than 20 mm in diameter. These attributes were selected to determine the stages of production performed at the West Burleigh Bay site. They are adapted from key attributes identified through experimental tool reduction by Magne (1985:113-114). The 20 mm size demarcation was selected based on Baumler and Downum's (1989) definition of small-sized debitage. Study of small-sized debitage is a key criterion for identifying lithic retouching and resharpening behavior (Baumler and Downum 1989:113), and mass analysis through identification of debitage category and size grade provides sufficient information for interpretation (Baumler and Downum 1989:106).

9. Cortex

This attribute refers to the (0) absence or (1) presence of cortical surface on the artifact.

10. Bedding Plane

This attribute refers to the (0) absence or (1) presence of bedding plane surface on the artifact.

11. Dorsal Scar Count

Following Magne (1985) and Kooyman (2000:52), this attribute refers to the number of scars, greater than 5 mm in length, on the dorsal surface of the flake.

(1) 0 to 1 scars
(2) 2 to 3 scars
(3) > 3 scars

12. Platform Scar Count

Following Magne (1985) and Kooyman (2000:52), this attribute refers to the number of scars on the striking platform of the flake.

(1) 0 to 1 scars
(2) 2 to 3 scars
(3) > 3 scars

Attributes Recorded for Finished Bifaces and Ground Stone Tools:

13. Typological Classification - for Finished Bifaces

This attribute pertains primarily to projectile points and drills, but may also be used to identify scrapers that have been remanufactured from pre-existing projectile points. It indicates the style of artifact based on published typologies (Ellis et al. 1990; Justice 1987; Kenyon 1980; Ritchie1971; Roberts 1980; Wright 1978). Characteristics examined include, but are not limited to; blade and stem shapes, notching characteristics, flake scar patterning, basal grinding, and presence of cortex (Justice 1987:6-9). Whenever possible the artifact is identified as a particular point type but in some cases it is only possible to identify the artifact as belonging to a particular horizon. The following chart summarizes the diagnostic styles identified in this collection and the period to which they pertain:

Early Archaic (ca. 10,000 to 8000 BP)
    Side-Notched Horizon (ca. 10,000 to 9800 BP)
        (1) Un-typed Early Side Notched

    Corner-Notched Horizon (ca. 9800 to 8900 BP)
        (2) Kirk Corner-Notched or Kirk-like

- (3) Nettling or Nettling-like
- (4) Un-typed Early Corner-Notched

Bifurcate Horizon (ca. 8900 to 8000 BP)

- (5) Kanawha Stemmed
- (6) LeCroy

Middle Archaic (ca. 8000 to 4500 BP)

Stemmed Horizon (ca. 8000 to 7000 BP)

- (7) Stanly/Neville-like

Side-Notched Horizon (ca. 6500 to 5000 BP)

- (8) Otter Creek
- (9) Raddatz Side-Notched

Laurentian Archaic and Other Developments (ca. 5000 to 4500 BP)

- (10) Brewerton Corner-Notched
- (11) Brewerton Side-Notched
- (12) Eva II
- (13) Ground Slate Point
- (14) Ground Slate Bayonet
- (15) Un-typed Ground Biface

Late Archaic (ca. 4500 to 2800 BP)

Narrow Point (ca. 4500 to 4000/3800 BP)

- (16) Lamoka
- (17) Normanskill
- (18) Un-typed Narrow Point

Broad Point (ca. 4000/3800 to 3500 BP)

- (19) Adder Orchard
- (20) Genesee
- (21) Lanceolate
- (22) Perkiomen
- (23) Rossville
- (24) Snook Kill
- (25) Susquehanna
- (26) Un-typed Broad Point

Small Point (ca. 3500 to 2800 BP)

- (27) Ace of Spades
- (28) Crawford Knoll
- (29) Innes

14. Typological Classification - for Celts and Gouges

This attribute pertains to ground stone celts (axes and adzes), and gouges. Typological classifications for ground stone celts and gouges do not approach the precision of typologies for flaked stone projectile points. Absence of provenience in studies of museum collections of Archaic ground stone artifacts in Ontario has precluded the definition of chronologies for many of these artifacts (Lackowicz 1996; Wright 1962). However, a number of celt and gouge styles have been recovered from Archaic contexts and thus have been used to approximate time periods for the various styles recovered at West Burleigh Bay. Site reports and regional syntheses were the primary resources used for identifying celt styles and their respective approximate time period (Ritchie 1994; Ross et al. 1997; Snow 1980; Tuck 1976). Lackowicz's (1996) MA Thesis contained a detailed study of gouges and it was the primary resource for classifying gouges from the West Burleigh Bay collection. A number of characteristics were examined including, but not limited to; raw material type, general shape, poll and bit shapes and metric dimensions adapted from Lackowicz (1996). Whenever possible the artifact is identified as being similar to an artifact from another collection but when it is not possible, it is included in the *Unknown Period* category. The following chart summarizes the diagnostic styles identified in this collection and the period to which they pertain:
Early Archaic (ca. 10,000 to 8000 BP)

Middle Archaic (ca. 8000 to 4500 BP)
(1) Celt – Hardaway I or Hardaway I-like
(2) Gouge – Fully Grooved
(3) Gouge – Other than Fully Grooved

Late Archaic (ca. 4500 to 2800 BP)
(4) Celt – Ground Chlorite Schist
(5) Celt – Lamoka or Lamoka-like

Unknown Period
(6) Celt or Gouge of Indeterminate period

15. Period

This attribute indicates which period of the Archaic the artifact is associated with, based on the typological classifications above.
(1) Early Archaic (ca. 10,000 to 8000 BP)
(2) Middle Archaic (ca. 8000 to 4500 BP)
(3) Late Archaic (ca. 4500 to 2800 BP)

16. Completeness of Tool

This attribute indicates the completeness of each formal tool.
(1) Complete

For Projectile Points and Drills:
(2) Missing Tip
(3) Missing Basal Ear(s) (basal style may still be observed)

(4) Missing Basal elements
(5) Missing Tip and Basal elements
(6) Missing Tip and Blade elements
(7) Longitudinal Split

For Celts and Gouges:
(8) Missing Poll elements
(9) Missing Bit elements
(10) Missing Poll and Bit elements

Attributes Recorded for Finished Bifaces:

Biface dimensions are collected and ratios are computed to compare the relative shape and thickness of tools made on fine quality raw material to those made on poorer quality material.

17. Length of Biface
This attribute represents the maximum length, centered on the longitudinal axis, of bifacial tools that retain both tip and basal elements. This measurement is rounded to the nearest mm.

18. Width of Biface
This attribute represents the maximum width of bifacial tools that retain both blade and basal elements. This measurement is taken at right angles to the tool length, and is rounded to the nearest mm.

19. Thickness of Biface
This attribute represents the maximum thickness of the bifacial tool. Measurement is rounded to the nearest mm.

20. Length to Thickness Ratio
This attribute computes the relative length to thickness ratio for each bifacial tool that can be measured longitudinally.
Length to Thickness Ratio = Length of Biface/ Thickness of Biface

21. Width to Thickness Ratio
This attribute computes the relative width to thickness ratio for each bifacial tool that can be measured horizontally.
Width to Thickness Ratio = Width of Biface/ Thickness of Biface

22. Transverse Section observed at the midpoint of the blade.
(1) Plano-convex
(2) Triangular
(3) Biplano
(4) Biconvex

Technological features are examined to investigate variability of effort in the manufacture of projectile points as outlined by Andrefsky (1994). These attributes and definitions are adapted from Binford (1963) and Crabtree (1972). Though Binford developed an attribute list for use in classifying projectile points, a number of the attributes are useful for identifying and comparing technological features on bifaces.

23. Cortex

This attribute refers to the (0) absence or (1) presence of cortical surface on the biface.

24. Bedding Plane

This attribute refers to the (0) absence or (1) presence of bedding plane surface on the biface.

25. Blade Symmetry

(0) Indeterminate
(1) Asymmetrical – the two lateral edges are not geometrically complementary, e.g. one edge excurvate, one edge incurvate.
(2) Symmetrical – both of the lateral edges are geometrically complementary.

26. Patterning of Flake Scars

This attribute records the observed symmetry of flake scars on both faces of the biface. They indicate the method of thinning the biface prior to edge retouch.

(0) Indeterminate
(1) Random, non-patterned – multi-directional, multiform flaking without any perceived order.
(2) Patterned – patterned or parallel flaking with obvious order.

27. Form of the Lateral Edge

This attribute records the method of retouch along the lateral edge of the biface.

(0) Indeterminate
(1) Serration – flakes removed so as to produce regular notches along the lateral edge.
(2) Even, continuous chipping – evenly spaced flake removal along the lateral edge.
(3) Irregular, discontinuous chipping – flake removal is random, clustered, or irregularly spaced along the lateral edge.

28. Edge Sinuosity

Sinuosity refers to the degree of wave exhibited on the lateral margins that results from removing alternate flakes (Crabtree 1972:92). This attribute represents the degree of sinuosity on the lateral edge of the biface when compared to a hypothetical straight line. The terminology follows Shelley (1990:189) and takes into account Callahan's (1979:11) definition of flake offset, or spacing between flakes, along the margin.

(0) Indeterminate

(1) Slight – edges appear relatively straight and flake offset is close
(2) Moderate – edges are moderately wavy and flake offset is moderate
(3) Extreme – edges are extremely wavy and flake offset is wide

29. Preparation of the Base
(0) Indeterminate
(1) Unprepared – cortex may be evident
(2) Thinned by Flaking
(3) Ground
(4) Thinned by Flaking and Ground
(5) Bifurcate

Relative frequency of hinge and step terminations is calculated to determine manufacturing expertise. Flake scars are recorded for a 1 cm square on the non-labeled side of Finished Bifaces that retain a portion of the blade. The 1 cm square selected is on the area of the blade with the greatest number of perceived hinge and step terminations.

30. Number of Flake Scars
This attribute records the total number of flake scars on the Finished Biface larger than 5 mm in a 1 cm square.

31. Number of Hinge and Step Terminations.
This attribute records the number of step and hinge terminations observed on the Finished Biface larger than 5 mm in a 1 cm square.

32. Relative Frequency of Hinge and Step Terminations.
This attribute computes the relative frequency of hinge and step terminations on the Finished Biface.
Relative Frequency = No. of Step & Hinge Terminations / No. of Flake Scars

33. Stacked Step or Hinge Terminations
This attribute refers to the (0) Absence or (1) Presence of stacked step or hinge terminations on the Finished Biface. Terminations are considered stacked if three or more step or hinge terminations appear together.

Attributes Recorded for Unfinished Bifaces:

Technological attributes for Unfinished Bifaces were examined to ascertain the level of manufacturing expertise exhibited by the flintknappers, following Shelley (1990) and to determine stages of reduction following Callahan (1979:30-31), and Sharrock (1966:43-46b).

34. Length of Unfinished Biface
This attribute represents the maximum length, centered on the longitudinal axis, of bifaces that are not broken transversely. This measurement is rounded to the nearest mm.

35. Width of Unfinished Biface
This attribute represents the maximum width of bifaces not broken longitudinally. The measurement is taken at right angles to the biface length and is rounded to the nearest mm.

36. Thickness of Unfinished Biface
This attribute represents the maximum thickness of the biface. Measurement is rounded to the nearest mm.

37. Length to Thickness Ratio
This attribute computes the relative length to thickness ratio for each biface that can be measured longitudinally.
Length to Thickness Ratio = Length of Biface / Thickness of Biface

38. Width to Thickness Ratio
This attribute computes the relative width to thickness ratio for each biface that can be measured horizontally.
Width to Thickness Ratio = Width of Biface / Thickness of Biface

39. Transverse Section observed at the midpoint of the biface.
   (1) Plano-convex
   (2) Triangular
   (3) Biplano
   (4) Biconvex

40. Edge Sinuosity
Sinuosity refers to the degree of wave exhibited on the lateral margins that results from removing alternate flakes (Crabtree 1972:92). This attribute represents the degree of sinuosity on the lateral edge of the tool when compared to a hypothetical straight line. The terminology follows Shelley (1990:189) and takes into account Callahan's (1979:11) definition of flake offset, or spacing between flakes, along the margin.
   (0) Indeterminate
   (1) Slight – edges appear relatively straight and flake offset is close
   (2) Moderate – edges are moderately wavy and flake offset is moderate
   (3) Extreme – edges are extremely wavy and flake offset is wide, or alternatively, edges are very thick.

Relative frequency of hinge and step terminations is calculated to determine manufacturing expertise. Flake scars are recorded for a 1 cm square on the non-labeled side of Unfinished Bifaces. The 1 cm square selected is on the area of the biface with the greatest number of perceived hinge and step terminations.

41. Number of Flake Scars
This attribute records the total number of flake scars on the Unfinished Biface larger than 5 mm.

42. Number of Hinge and Step Terminations.
This attribute records the total number of step and hinge terminations observed on the Unfinished Biface.

43. Relative Frequency of Hinge and Step Terminations.
This attribute computes the relative frequency of hinge and step terminations on the Unfinished Biface.
Relative Frequency = No. of Step and Hinge Terminations / No. of Flake Scars

44. Stacked Step or Hinge Terminations
This attribute refers to the (0) Absence or (1) Presence of stacked step or hinge terminations on the Unfinished Biface. Terminations are considered stacked if three or more step or hinge terminations appear together.

45. Breakage
This attribute refers to the type of breakage, due to excessive platform loading, observed on discarded Unfinished Bifaces. Definitions of types of breakage follow Crabtree (1972:60,82).

(0) Absent
(1) Perverse – a helical, spiral or twisting break initiated at the edge of the biface.
(2) End Shock – a transverse fracture resulting from the stone exceeding its elastic limits.

46. Face Battering
Face battering is indicative of novice manufacturing techniques (Shelley 1990:192). It appears as repetitive crushing and/or unsuccessful flaking on platforms and lateral edges of the biface. This attribute refers to the (0) Absence or (1) Presence of repetitive battering.

Appendix B

Data Collection Summaries

Table B.1 Summary of Artifact Categories

Maximal Artifact Category	Category	Number of Artifacts
Flaked Stone Debitage	Complete Flakes	367
	Broken Flakes	539
	Split Flakes	97
	Flake Fragments	725
	Debris	160
Total Flaked Stone Debitage		1888
Total Flaked Stone Cores		8
Flaked Stone Tools	Finished Bifaces	73
	Unfinished Bifaces	48
	Informal Tools	20
	Scrapers	3
Total Flaked Stone Tools		144
Ground Stone Tools	Celts	9
	Gouges	7
	Bifaces	14
Total Ground Stone Tools		30
Total Number of Artifacts		2070

Table B.2 Diagnostic Flaked and Ground Stone Tools; Typological Classification

Typological Classification			Completeness of Tool										
	Horizon	Type	Complete	Missing tip	Missing Basal Ear(s)	Missing Basal Elements	Missing Tip and Basal Elements	Missing Tip and Blade Elements	Longitudinal Split	Missing Poll Elements	Missing Bit Elements	Missing Poll and Bit Elements	Total
Flaked Stone Finished Bifaces													
Early Archaic	Side-Notched	Un-typed Side Notched						1					1
	Corner-Notched	Kirk Corner-Notched or Kirk-like	1										1
		Nettling or Nettling-like					1	1					2
		Un-typed Corner-Notched				1	1						2
	Bifurcate	Kanawha Stemmed	1										1
		LeCroy			1								1
Total Early Archaic													**8**
Middle Archaic	Stemmed	Stanly/Neville-like							1				1
	Side-Notched	Otter Creek	1		2			1					4
		Raddatz Side-Notched	1					1					2
	Laurentian	Brewerton Corner-Notched	2	1									3
		Brewerton Side-Notched	7	1	1	1	1	3					14
		Eva II	1										1
Total Middle Archaic													**25**
Late Archaic	Narrow Point	Lamoka	5			1							6
		Normanskill	7		2	2							11
		Un-typed Narrow Point	3			1							4
	Broad Point	Adder Orchard	2										2
		Genesee	1	2									3
		Perkiomen		1									1
		Rossville				1							1
		Snook Kill	3				1	1					5
		Susquehanna	1										1
	Small Point	Ace of Spades	1	1		1							3
		Crawford Knoll	1										1
		Innes	2										2
Total Late Archaic													**40**
Total Flaked Stone Finished Bifaces			**40**	**6**	**6**	**8**	**4**	**8**	**1**	**0**	**0**	**0**	**73**

Ground Stone Tools													
Middle Archaic		Celt - Hardaway I or Hardaway I-like	1										1
		Gouge - Fully Grooved	1								1		2
		Gouge - Other than Fully Grooved	1								2	1	4
	Laurentian	Ground Slate Point		1	1	1							3
		Ground Slate Bayonet					2						2
		Un-typed Ground Biface				1	2	2	4				9
Total Middle Archaic													**21**
Late Archaic		Celt - Ground Chlorite Schist								3	2		5
		Celt - Lamoka or Lamoka-like	1										1
Total Late Archaic													**6**
Unknown Period		Celt or Gouge of Indeterminate Period								2	1		3
Total Ground Stone Tools			**4**	**1**	**1**	**2**	**4**	**2**	**4**	**5**	**6**	**1**	**30**

Table B.3 Diagnostic Flaked and Ground Stone Tools; Raw Material Summary

Typological Classification			Raw Material											
	Horizon	Type	Local Chert	Non Local Chert	Unknown Chert	Chlorite Schist	Gneiss	Metasediment	Pyroxene	Quartzite	Schist	Slate	Unknown Sedimentary	**Total**
Flaked Stone Finished Bifaces														
Early Archaic	Side-Notched	Un-typed Side Notched		1										**1**
	Corner-Notched	Kirk Corner-Notched or Kirk-like	1											**1**
		Nettling or Nettling-like		2										**2**
		Un-typed Corner-Notched		1	1									**2**
	Bifurcate	Kanawha Stemmed		1										**1**
		LeCroy		1										**1**
Total Early Archaic			1	6	1	0	0	0	0	0	0	0	0	**8**
Middle Archaic	Stemmed	Stanly/Neville-like		1										**1**
	Side-Notched	Otter Creek						3					1	**4**
		Raddatz Side-Notched	2											**2**
	Laurentian	Brewerton Corner-Notched		1				2						**3**
		Brewerton Side-Notched	3	3				6		1			1	**14**
		Eva II	1											**1**
Total Middle Archaic			6	5	0	0	0	11	0	1	0	0	2	**25**
Late Archaic	Narrow Point	Lamoka	2	4										**6**
		Normanskill						11						**11**
		Un-typed Narrow Point	1	2				1						**4**
	Broad Point	Adder Orchard	2											**2**
		Genesee	1	1				1						**3**
		Perkiomen	1											**1**
		Rossville	1											**1**
		Snook Kill	1	1				2		1				**5**
		Susquehanna								1				**1**
	Small Point	Ace of Spades		1						2				**3**
		Crawford Knoll	1											**1**
		Innes	2											**2**
Total Late Archaic			12	9	0	0	0	15	0	4	0	0	0	**40**
Total Flaked Stone Finished Bifaces			**19**	**20**	**1**	**0**	**0**	**26**	**0**	**5**	**0**	**0**	**2**	**73**

Ground Stone Tools														
Middle Archaic		Celt - Hardaway I or Hardaway I-like				1								**1**
		Gouge - Fully Grooved							1			1		**2**
		Gouge - Other than Fully Grooved					1		1		1		1	**4**
	Laurentian	Ground Slate Point										3		**3**
		Ground Slate Bayonet										2		**2**
		Un-typed Ground Biface						1				8		**9**
Total Middle Archaic			0	0	0	1	1	1	2	0	1	14	1	**21**
Late Archaic		Celt - Ground Chlorite Schist				5								**5**
		Celt - Lamoka or Lamoka-like				1								**1**
Total Late Archaic			0	0	0	6	0	0	0	0	0	0	0	**6**
Unknown Period		Celt or Gouge of Indeterminate Period							1			2		**3**
Total Ground Stone Tools			**0**	**0**	**0**	**7**	**1**	**1**	**3**	**0**	**1**	**16**	**1**	**30**

Table B.4 **Maximal Artifact Category; Raw Material Summary**

		Raw Material											
Maximal Artifact Category	**Category**	Local Chert	Non Local Chert	Unknown Chert	Chlorite Schist	Gneiss	Metasediment	Pyroxene	Quartzite	Schist	Slate	Unknown	**Total**
Flaked Stone Debitage	Complete Flakes						328					39	**367**
	Broken Flakes						491					48	**539**
	Split Flakes						88					9	**97**
	Flake Fragments						639					86	**725**
	Debris						142					18	**160**
Total Flaked Stone Debitage		0	0	0	0	0	1688	0	0	0	0	200	**1888**
Total Flaked Stone Cores		0	0	0	0	0	8	0	0	0	0	0	**8**
Flaked Stone Tools	Finished Bifaces	19	20	1			26		5			2	**73**
	Unfinished Bifaces						48						**48**
	Informal Tools	1	1				15		2			1	**20**
	Scrapers						3						**3**
Total Flaked Stone Tools		20	21	1	0	0	92	0	7	0	0	3	**144**
Ground Stone Tools	Celts				7			1			1		**9**
	Gouges					1		2		1	2	1	**7**
	Bifaces						1				13		**14**
Total Ground Stone Tools		0	0	0	7	1	1	3	0	1	16	1	**30**
Total Number of Artifacts		20	21	1	7	1	1789	3	7	1	16	204	**2070**

Table B.5 Finished Biface Technology; Chert Bifaces

Typological Classification			Technological Attributes													
	Horizon	Type	Flaws or Inclusions	Visible Bedding Planes	Length/Thickness Ratio	Width/Thickness Ratio	Transverse Section	Cortex	Fracture along Bedding Plane	Blade Symmetry	Flake Scar Patterning	Lateral Edge Pattern	Basal Preparation	Rel. Freq. of Hinge & Step Terminations	Stacked Hinge & Step Terms.
Flaked Stone Finished Bifaces - Chert																
Early Archaic	Side-Notched	Un-typed Side Notched	1	1			4	0	0	0	0	0	5		
	Corner-Notched	Kirk Corner-Notched or Kirk-like	1	0	5.50	3.17	4	0	0	2	1	2	4	0.25	0
		Nettling or Nettling-like	0	0			4	0	0	2	1	2	0	0.50	0
			1	0		3.83	4	0	0	0	2	1	4	0.00	0
		Un-typed Corner-Notched	1	0		3.14	4	0	0	2	2	1	0	0.50	0
			1	0		4.00	4	0	0	0	1	1	0	0.25	0
	Bifurcate	Kanawha Stemmed	1	0	3.20	1.80	1	0	0	1	2	2	2	0.00	0
		LeCroy	1	0	5.00		1	0	0	0	1	2	5	0.33	0
Total Early Archaic		**(N=8)**	**7**	**1**				**0**	**0**						**0**
Middle Archaic	Stemmed	Stanly/Neville-like	0	0	3.38		4	0	0	0	1	3	2	0.00	0
		Raddatz Side-Notched	1	0	8.14	4.86	4	0	0	0	1	2	4	0.00	0
			0	0		4.71	3	0	0	0	1	3	2	0.33	0
	Laurentian	Brewerton Corner-Notched	0	0	3.29	4.71	1	0	0	2	0	0	2	0.00	0
		Brewerton Side-Notched	0	0	3.50	2.75	4	0	0	2	1	2	2	0.00	0
			0	0	4.20	3.40	1	0	0	2	1	3	1	0.67	1
			1	1	7.88	4.13	4	0	1	0	1	2	0	0.00	0
			0	0	6.00	3.71	4	0	0	1	1	2	4	0.00	0
			1	0	4.50	3.00	4	0	0	2	2	2	2	0.00	1
			1	0		3.71	4	0	0	2	1	2	0	0.13	0
		Eva II	1	0	7.00	3.75	1	0	0	2	2	2	2	0.40	0
Total Middle Archaic		**(N=11)**	**5**	**1**				**0**	**1**						**2**
Late Archaic	Narrow Point	Lamoka	1	0	6.67	2.33	1	1	0	1	1	3	1	0.50	1
			1	0		3.29	2	0	0	1	1	2	0	0.40	0
			0	0	6.20	4.20	1	1	0	1	1	3	2	0.25	1
			1	0	3.43	2.14	4	0	0	2	2	2	2	0.25	0
			0	0	6.33	3.00	4	1	0	1	1	3	1	0.00	0
			1	0	6.00	2.67	1	1	0	1	1	2	1	0.13	0
		Un-typed Narrow Point	0	0		0.89	1	0	0	2	2	2	0	0.25	0
			1	0	4.13	2.13	1	1	0	1	2	3	1	0.00	1
			1	0	5.57	0.86	2	1	0	1	2	2	1	0.14	1
	Broad Point	Adder Orchard	1	0	6.40	3.60	1	0	0	1	1	3	1	0.50	0
			0	0	5.00	2.71	4	0	0	1	1	3	2	0.14	1
		Genesee	0	0	4.71	3.29	4	0	0	2	1	3	1	0.20	0
			0	0		3.00	4	0	0	2	1	2	2	0.00	0
		Perkiomen	1	0		2.71	1	1	0	1	1	3	1	0.71	1
		Rossville	1	0		3.13	4	0	0	1	1	2	0	0.50	0
		Snook Kill	1	1	6.43	4.29	4	0	1	2	1	2	2	0.25	0
			0	0		4.40	4	0	0	0	0	2	2	0.00	0
	Small Point	Ace of Spades	1	0		3.80	4	0	0	2	2	2	2	0.22	0
		Crawford Knoll	1	0	5.29	2.86	4	0	0	1	2	2	4	0.29	1
		Innes	1	1	5.17	3.50	1	0	0	1	1	3	2	0.00	0
			1	0	4.57	3.14	4	0	0	1	1	3	2	0.57	1
Total Late		**(N=21)**	**14**	**2**				**7**	**1**						**8**
Total Flaked Stone Finished Bifaces - Chert (N=40)			**26**	**4**				**7**	**2**						**10**

Table B.6 Finished Biface Technology; Metasediment and Unknown Sedimentary Bifaces

Typological Classification			Technological Attributes												
	Horizon	Type	Flaws or Inclusions	Visible Bedding Planes	Length/Thickness Ratio	Width/Thickness Ratio	Transverse Section	Cortex	Fracture along Bedding Plane	Blade Symmetry	Flake Scar Patterning	Lateral Edge Pattern	Basal Preparation	Rel. Freq. of Hinge & Step Terminations	Stacked Hinge & Step Terms.
Flaked Stone Finished Bifaces - Metasediment & Unknown Sedimentary															
Middle Archaic	Side-Notched	Otter Creek	0	1	8.13	3.25	4	0	0	1	1	3	2	0.50	1
			0	1	8.13	3.25	4	0	1	2	1	3	4	0.67	0
			0	0	5.89	3.00	4	0	0	2	1	2	4	0.17	1
*			0	1		4.14	4	0	0	0	0	2	4	0.00	0
	Laurentian	Brewerton Corner-Notched	1	1	5.10	2.90	4	0	1	1	1	2	2	0.33	1
			1	1		3.75	4	0	1	2	1	3	2	0.57	1
		Brewerton Side-Notched	0	1	4.43	2.86	4	0	1	1	1	2	2	0.00	1
			1	1		3.50		0	1	0	1	0	2	0.50	0
			1	0	4.43	2.57	4	0	0	1	1	2	2	0.00	1
			0	1	3.36	2.09	4	1	0	1	1	3	4	0.40	1
			0	1		3.11	4	0	0	0	1	0	4	0.33	1
			1	1		3.10	4	0	0	1	1	3	4	0.00	1
*			1	0	4.30	2.90	4	0	0	1	1	3	2	0.00	0
Total Middle Archaic		**(N=13)**	**6**	**10**				**1**	**5**						**9**
Late Archaic	Narrow Point	Normanskill	0	1		2.50	4	0	1	1	1	3	0	0.00	0
			1	1	5.78	2.89	1	0	1	1	1	2	4	0.40	0
			0	1	5.43	2.71	4	0	1	2	1	3	4	0.00	0
			0	0	6.13	3.00	2	0	0	1	2	2	2	0.00	0
			0	0		2.14	4	0	0	1	2	3	0	0.33	1
			1	1	4.38	2.00	2	1	1	1	1	3	2	0.00	1
			0	1	4.25	2.50	4	0	1	1	1	3	4	0.00	1
			0	1	4.00	2.13	2	0	1	1	2	2	4	0.00	0
			1	1	4.14	2.29	4	0	1	1	1	3	4	0.25	1
			0	1		4.00	3	0	1	1	1	3	0	0.00	0
			0	1	6.88	3.50	4	0	1	1	1	3	4	0.33	1
		Un-typed Narrow Point	0	1	4.50	2.25	1	1	1	1	1	3	1	0.00	0
	Broad Point	Genesee	1	0		3.86	4	0	0	2	2	2	2	0.60	1
		Snook Kill	0	1	5.67	3.83	1	0	1	2	1	2	2	0.43	1
			0	0	5.83	4.33	1	0	0	1	1	3	2	0.50	0
Total Late Archaic		**(N=15)**	**4**	**11**				**2**	**11**						**7**
Total Flaked Stone Finished Bifaces - Metasediment & Unknown Sedimentary (N=28)			**10**	**21**				**3**	**16**						**16**

* - denotes bifaces on unknown sedimentary material

Table B.7 Finished Biface Technology; Quartzite Bifaces

Typological Classification			Technological Attributes												
	Horizon	Type	Flaws or Inclusions	Visible Bedding Planes	Length/Thickness Ratio	Width/Thickness Ratio	Transverse Section	Cortex	Fracture along Bedding Plane	Blade Symmetry	Flake Scar Patterning	Lateral Edge Pattern	Basal Preparation	Rel. Freq. of Hinge & Step Terminations	Stacked Hinge & Step Terms.
Flaked Stone Finished Bifaces - Quartzite															
Middle Archaic	Laurentian	Brewerton Side-Notched	0	0		3.13	4	0	0	2	2	2	2	0.25	0
Total Middle Archaic		**(N=1)**	**0**	**0**				**0**	**0**						**0**
Late Archaic	Broad Point	Snook Kill	1	0		6.60	1	0	0	1	1	2	0	0.50	0
		Susquehanna	1	0	5.63	3.00	4	0	0	1	1	2	2	0.00	0
	Small Point	Ace of Spades	1	1	9.67	6.00	3	0	0	1	1	3	2	0.50	0
			1	0		4.17	4	0	0	1	1	2	0	0.00	0
Total Late Archaic		**(N=4)**	**4**	**1**				**0**	**0**						**0**
Total Flaked Stone Finished Bifaces - Quartzite (N=5)			**4**	**1**				**0**	**0**						**0**

Table B.8 Unfinished Biface Technology; Stage of Production

Unfinished Bifaces	Raw Material and Technological Attributes									
Catalogue Number	Flaws or Inclusions	Visible Bedding Planes	Length/Thickness Ratio	Width/Thickness Ratio	Transverse Section	Edge Sinuosity	No. of Flake Scars (1 cm^2)	Rel. Freq. of Hinge & Step Terminations	Stacked Hinge & Step Terminations	Breakage	Face Battering
Stage 2 - Initial Edging											
TP43.6	0	0		2.64	1	3	3	0.33	1	1	0
N32E08.I.14	1	1		4.93	4	2	2	0.50	0	2	0
N38E22.I.18	0	1		2.40	2	2	4	0.25	1	1	0
N38E22.I.20	0	1		5.56	1	3	2	0.50	1	2	0
N40E10.I.40b	0	0		2.08	2	3	2	0.50	0	2	0
N38E12.NWBaulk.59	1	1		3.67	4	3	4	0.75	1	2	0
N40E12.I.55	1	1		5.88	3	3	3	0.67	1	0	0
N40E14.I.30	1	1		4.00	1	3	2	1.00	0	1	0
N40E20.I.II.91	1	1		4.23	1	3	2	0.00	0	2	0
Total Stage 2 (N=9)	5	7							5	8	0
Stage 3 - Primary Thinning											
N26E08.I.1	0	0		2.86	4	2	3	1.00	0	1	0
N34E18.I.45	0	0	6.45	2.09	4	2	3	0.33	1	0	0
N36E06.II.1	0	1	4.58	2.92	1	2	2	0.00	0	0	0
N36E20.II.7	1	1	3.07	3.79	3	3	4	1.00	1	0	0
N36E20.II.8	1	1		5.56	1	3	2	0.50	0	1	0
N38E06.II.88	0	0		3.31	4	2	5	0.60	0	1	0
N38E08.I.26	0	1		4.00	1	2	2	0.50	0	2	0
N38E20.II.7	0	1	5.44	3.56	1	2	4	0.50	1	0	0
N38E24.I.17	0	1		5.00	3	2	3	0.33	0	2	0
N40E10.I.16	0	1		4.13	3	3	3	1.00	1	2	0
N40E10.I.40a	1	1		6.20	4	2	3	0.33	0	1	0
N40E10.I.41	0	1	6.20	3.70	3	3	4	0.50	0	0	0
N40E14.I.29	1	1		3.40	1	3	3	0.67	0	1	0
N40E14.I.30	1	1		3.50	1	3	3	2.00	1	1	0
N40E14.I.30	1	1		4.25	1	3	3	1.50	0	1	0
N40E14.I.34	1	1		4.00	1	3	3	0.67	0	2	0
N40E14.I.37	1	1		3.88	1	3	3	0.33	0	2	0
N40E14.II.4	0	1		4.63	3	1	2	0.50	1	2	0
N40E20.I.II.96	1	1		3.29	1	3	3	0.33	0	2	0
N42E12.I.21	1	1		1.91	2	2	3	0.33	0	1	0
N42E12.I.53	0	1		3.22	1	2	5	0.80	1	2	0
N42E12.I.54	1	1		3.42	3	3	5	1.00	1	1	0
N42E20.I.11	0	1		3.38	3	3	6	0.67	1	1	0
Total Stage 3 (N=23)	11	20							9	18	0

Table B.8 (continued)

Unfinished Bifaces	**Raw Material and Technological Attributes**										
Catalogue Number	Flaws or Inclusions	Visible Bedding Planes	Length/Thickness Ratio	Width/Thickness Ratio	Transverse Section	Edge Sinuosity	No. of Flake Scars (1 cm²)	Rel. Freq. of Hinge & Step Terminations	Stacked Hinge & Step Terminations	Breakage	Face Battering
Stage 4 - Secondary Thinning											
N32E08.I.22	1	1		5.33	3	1	2	0.50	0	2	0
N32E08.I.25	1	0		2.44	4	2	5	0.00	0	1	0
N32E10.I.1	1	1		4.25	3	1	3	1.00	0	2	0
N34E08.II.4	1	1		2.75	4	1	6	0.17	0	2	0
N34E10.Baulk.55	0	0		3.67	4	3	4	0.50	0	2	0
N34E22.I.29	1	1		2.60		1	4	0.50	0	0	0
N36E08.I.44	0	1		4.33	3	1	2	0.50	0	1	0
N36E08.I.59	0	1		1.82	4	1	4	0.00	0	2	0
N36E10.I.11	1	1	6.82	2.36	4	1	4	0.50	1	0	0
N38E18.I.4	1	1	5.29	2.86	4	1	5	0.40	0	0	0
N38E24.I.16 (SS4)	0	1		4.33	3	3	5	0.60	1	1	0
N40E02.III.13	0	0		2.00	4	2	4	0.50	0	2	0
N40E14.I.32	1	1		2.90	1	1	5	0.40	0	2	0
N42E10.I.26	1	1		2.73	4	1	2	0.50	0	2	0
N44E12.I.11	1	1	4.87	2.53	1	3	6	0.83	1	0	0
N44E14.I.38	1	1	5.80	2.20	4	1	3	0.33	1	0	0
Total Stage 4 (N=16)	11	13							4	11	0
Total Unfinished Bifaces (N=48)	**27**	**40**							**18**	**37**	**0**

Table B.9 **Debitage Summary by Size Grades**

		Size Grade (mm)													
Raw Material	**Flaked Stone Debitage**	(1) <5	(2) 6-10	(3) 11-15	(4) 16-20	(5) 21-25	(6) 26-30	(7) 31-35	(8) 36-40	(9) 41-45	10) 46-50	(11) 51-55	(12) 56-60	(13) >61	**Total**
Metasediment	Complete Flakes		12	79	99	66	32	13	12	9	3	2		1	**328**
	Broken Flakes		29	169	139	85	39	18	6	6					**491**
	Split Flakes		2	26	38	10	9	1			2				**88**
	Flake Fragments		41	246	185	108	34	15	7	1	1	1			**639**
	Debris		3	31	35	23	18	12	5	2	10	1	1	1	**142**
Total Metasediment Debitage		0	87	551	496	292	132	59	30	18	16	4	1	2	**1688**
Unknown Sedimentary	Complete Flakes			3	3	9	4	6	3	5	3	1	2		**39**
	Broken Flakes			6	14	10	12	5	1						**48**
	Split Flakes		1	1	1	1	2	2	1						**9**
	Flake Fragments		2	11	23	14	15	12	4	2	3				**86**
	Debris			2	5	6	1	1		1	1			1	**18**
Total Unknown Sedimentary Debitage		0	3	23	46	40	34	26	9	8	7	1	2	1	**200**
Total Debitage		0	90	574	542	332	166	85	39	26	23	5	3	3	**1888**

Table B.10 Complete Flakes Summary; Stage of Reduction for Metasediment Flakes

				Cortex		Dorsal Scar Count			Platform Scar Count		
Stage of Reduction	**Size Grade (mm)**	**No. of Flakes**	**Avg. Weight (g)**	Absent	Present	0 to 1	2 to 3	> 3	0 to 1	2 to 3	>3
Metasedimentary Material											
Early Stage (core reduction)	(5) 21 - 25	10	0.91	4	6	10			10		
	(6) 26 - 30	8	1.53	2	6	2	4	2	8		
	(7) 31 - 35	1	2.60		1		1		1		
	(8) 36 - 40	2	2.20		2	1	1		2		
	(9) 41 - 45	3	5.10		3		3		3		
	(10) 46 - 50	0									
	(11) 51 - 55	1	23.00		1			1	1		
	(12) 56 - 60	0									
	(13) > 61	1	27.00		1			1	1		
Total Early Stage Reduction		26		6	20	13	9	4	26	0	0
Middle Stage (primary trimming)	(5) 21 - 25	32	0.80	30	2	4	28		13	19	
	(6) 26 - 30	8	1.14	6	2		7	1	2	6	
	(7) 31 - 35	9	2.63	7	2		5	4	2	7	
	(8) 36 - 40	10	3.89	10			5	5	4	6	
	(9) 41 - 45	5	4.94	5			1	4	3	2	
	(10) 46 - 50	2	6.70	2				2	1	1	
	(11) 51 - 55	1	5.30	1				1	1		
	(12) 56 - 60										
	(13) > 61										
Total Middle Stage Reduction		67		61	6	4	46	17	26	41	0
Late Stage (finishing)	(5) 21 - 25	24	0.99	24				24	7	15	2
	(6) 26 - 30	16	1.59	16				16	5	8	3
	(7) 31 - 35	3	1.50	3				3	3		
	(8) 36 - 40										
	(9) 41 - 45	1	3.90	1				1			1
	(10) 46 - 50	1	1.40	1				1		1	
	(11) 51 - 55										
	(12) 56 - 60										
	(13) > 61										
Total Late Stage Reduction		45		45	0	0	0	45	15	24	6
Total Metasedimentary Flakes		138		112	26	17	55	66	67	65	6

Table B.11 Complete Flakes Summary; Stage of Reduction for Unknown Sedimentary Flakes

				Cortex		Dorsal Scar Count			Platform Scar Count		
Stage of Reduction	**Size Grade (mm)**	**No. of Flakes**	**Avg. Weight (g)**	Absent	Present	0 to 1	2 to 3	> 3	0 to 1	2 to 3	>3
Unknown Sedimentary Material											
Early Stage (core reduction)	(5) 21 - 25	1	1.10	1		1			1		
	(6) 26 - 30										
	(7) 31 - 35	2	1.65	1	1	1	1		2		
	(8) 36 - 40										
	(9) 41 - 45	1	10.80		1			1	1		
	(10) 46 - 50										
	(11) 51 - 55	1	17.40	1				1	1		
	(12) 56 - 60	1	15.90	1				1	1		
	(13) > 61										
Total Early Stage Reduction		6		4	2	2	1	3	6	0	0
Middle Stage (primary trimming)	(5) 21 - 25	6	0.82	6			6		4	2	
	(6) 26 - 30	1	2.50	1			1		1		
	(7) 31 - 35	4	2.33	4			3	1	3	1	
	(8) 36 - 40	2	2.95	2			2			2	
	(9) 41 - 45	4	5.58	3	1		3	1	2	2	
	(10) 46 - 50	3	8.47	3			2	1		2	1
	(11) 51 - 55										
	(12) 56 - 60	1	7.70	1				1		1	
	(13) > 61										
Total Middle Stage Reduction		21		20	1	0	17	4	10	10	1
Late Stage (finishing)	(5) 21 - 25	2	1.20	2				2	1	1	
	(6) 26 - 30	3	1.63	3				3	1	2	
	(7) 31 - 35										
	(8) 36 - 40	1	4.10	1				1			1
	(9) 41 - 45										
	(10) 46 - 50										
	(11) 51 - 55										
	(12) 56 - 60										
	(13) > 61										
Total Late Stage Reduction		6		6	0	0	0	6	2	3	1
Total Unknown Sedimentary Flakes		33		30	3	2	18	13	18	13	2

Appendix C

Artifact Distribution

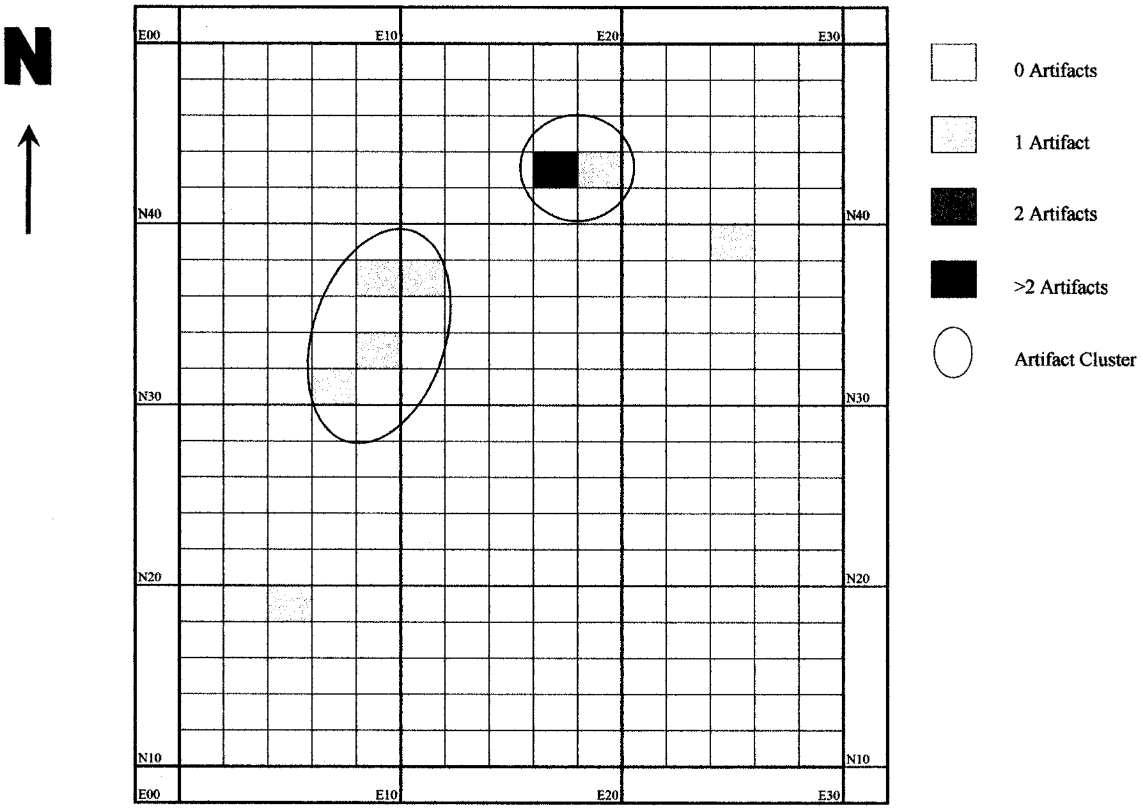


Figure C.1 Distribution of Diagnostic Early Archaic Lithic Artifacts

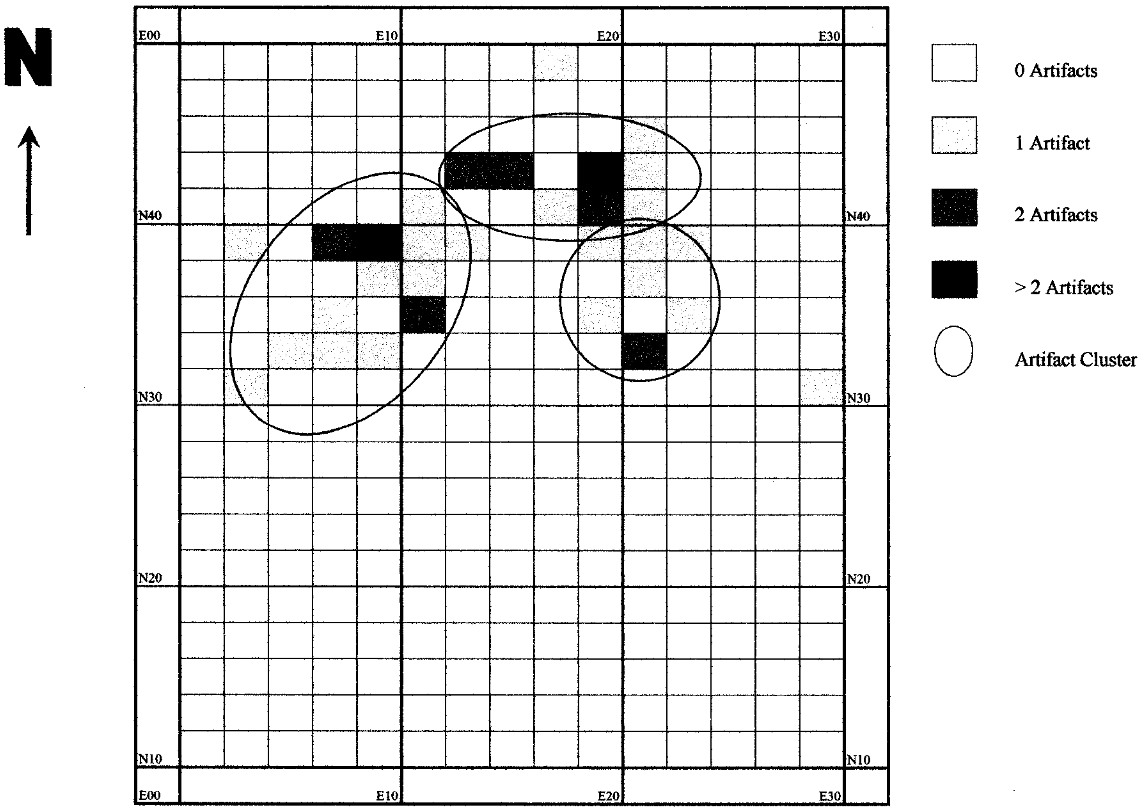


Figure C.2 Distribution of Diagnostic Middle Archaic Lithic Artifacts

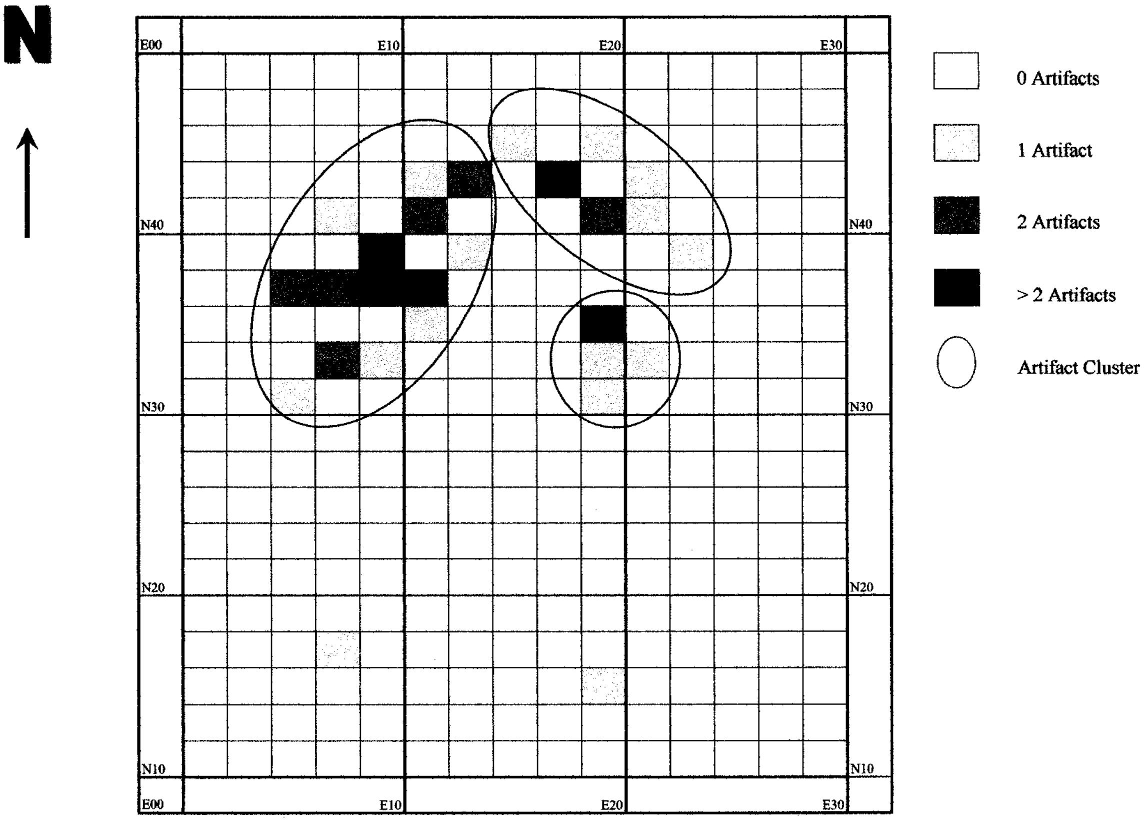


Figure C.3 Distribution of Diagnostic Late Archaic Lithic Artifacts

Appendix D

Petrographic Analysis

Petrographic Samples

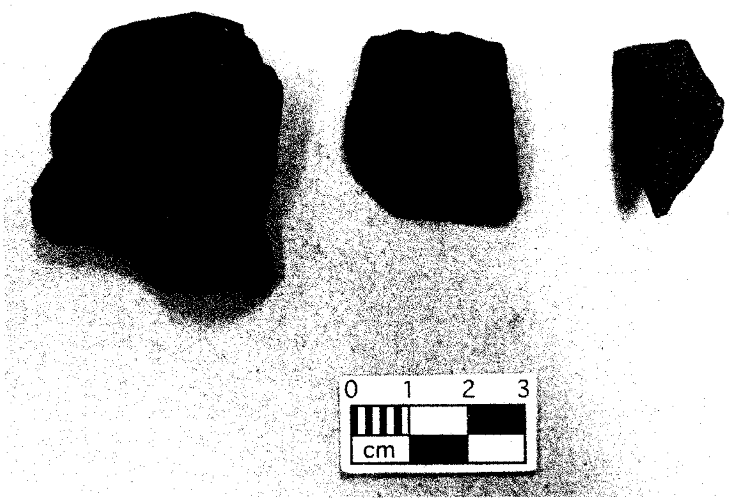


Figure D.1

Subset 1
(from left to right)

Sample 1

Sample 2

Sample 3

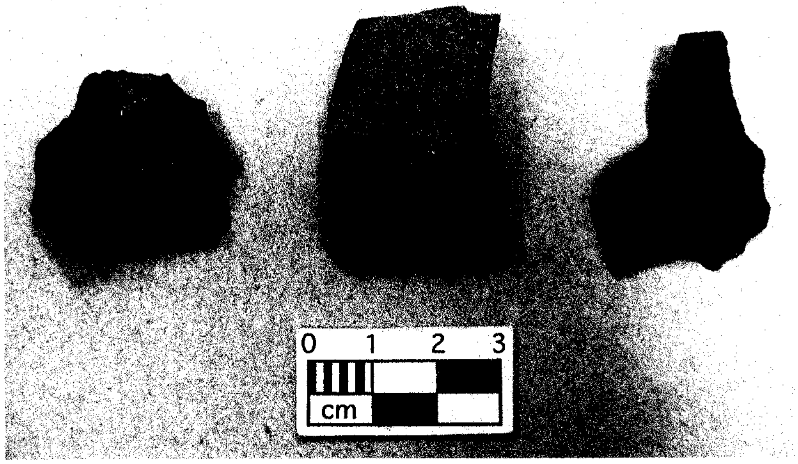


Figure D.2

Subset 2
(from left to right)

Sample 4

Sample 5

Sample 6

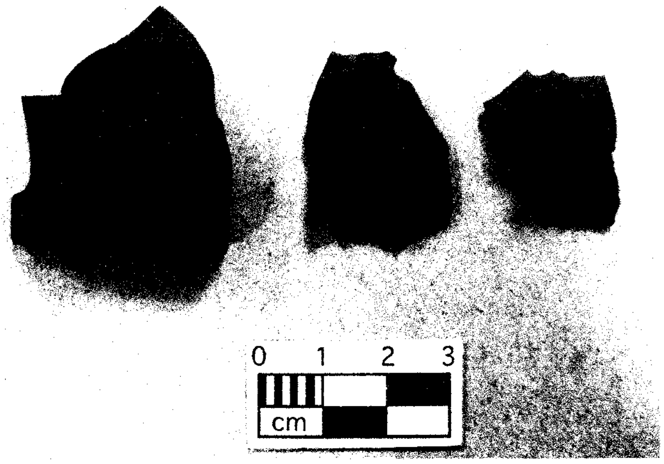


Figure D.3

Subset 3
(from left to right)

Sample 7

Sample 8

Sample 9

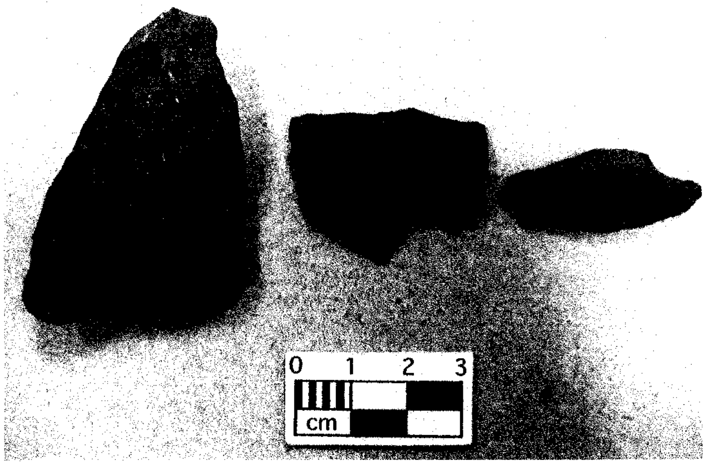


Figure D.4

Subset 4
(from left to right)

Sample 10

Sample 11

Sample 12

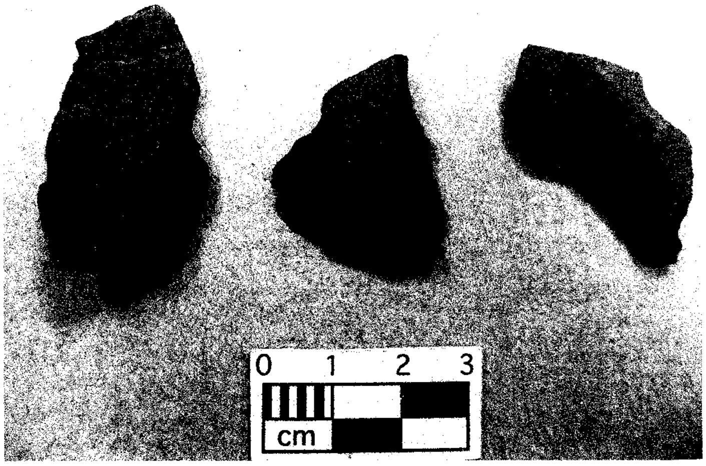


Figure D.5

Subset 5
(from left to right)

Sample 13

Sample 14

Sample 15

Table D.1 **Summary of Petrographic Analysis** (Downing 2006)

							Composititon/Modal Abundance - Relative Proportion (volume %) for Minerals ≥ 1%																
							Tectosilicates						Phyllosilicates		Inosilicate								
							Feldspar		Quartz							Fe- and Ti-oxides							
Subset	Sample No.	Catalogue Number	Sedimentary Classification	Colour	Grain Size	Sedimentary Structure	K-Feldspar	Plagioclase	Quartz	Quartz - Coarse	Quartz - Polycrystalline	Quartz - Cryptocrystalline	Biotite	Clay Material	Amphibole	Hematite	Magnetite	Rutile	Pyrite	Carbonates	Chlorite
1	1	N36E10.EBaulk.66	Calcareous chert	Dark grey	<2 to 80 µm	banded lamination with cross-bedding textures	5 - 10		75 - 80										2 - 5	5 - 10	
1	2	N36E06.I.52	Feldspathic, calcareous, ferruginous mudstone (marl)	Dark grey	<2 to 60 µm	faint banded lamination	50 - 60	1 - 5	1 - 5					1 - 5		20 -30				10 - 15	
1	3	N34E10.EBaulk.55	Feldspathic, calcareous, ferruginous mudstone (marl)	Dark grey	<2 to 60 µm	faint banded lamination	50 - 60		1 - 2				1 - 5	1 - 5		20 - 30				15 - 25	
2	4	N46E20.I.9	Feldspathic cherty mudstone	Pinkish Grey	<2 to 350 µm	laminated beds of variable thickness	70 - 80			5 - 10		5 - 10				1 - 5	1 - 5				1 - 5
2	5	N40E12.II.65	Feldspathic, ferruginous mudstone	Dark grey	<2 to 60 µm (up to 250 µm)	laminated bed with graded bedding	60 - 70							1 - 5	5 - 10	10 - 15	1 - 5			1 - 5	1 - 5
2	6	N34E06.I.46	Feldspathic, calcareous, ferruginous mudstone (marl)	Dark grey to black	<2 to 60 µm	laminated beds showing displacement	55 - 65							1 - 5		15 - 25				10 - 20	
3	7	N32E10.I.7	Feldspathic, calcareous, ferruginous mudstone (marl)	Dark grey	<2 to 60 µm	faint banded lamination with cross-cutting visible	40 - 50						1 - 5	5 - 10		15 - 20				25 - 35	
3	8	N38E22.II.31	Feldspathic, calcareous, ferruginous mudstone (marl)	Brownish grey	<2 to 80 µm	massive	60 - 70		1 - 5				1 - 5	1 - 5		15 - 20				5 - 10	
3	9	N34E18.I.1	Feldspathic, calcareous, ferruginous mudstone (marl)	Dark grey to black	<2 to 100 µm	massive	45 - 55		1 - 5					1 - 5		15 - 20				20 - 25	
4	10	N38E24.I.16	Feldspathic, ferruginous, argillaceous mudstone	Pinkish Grey	<2 to 60 µm	mottled and displacement lamination	50 - 60		1 - 5				1 - 5	5 - 10		20 - 30					5 - 10
4	11	N38E06.II.89	Ferruginous chert	Reddish brown	<2 to 150 µm	massive					20 - 30	60 - 70		1 - 5		1 - 5					1 - 5
4	12	N36E06.I.13	Ferruginous, argillaceous mudstone	Reddish brown	<2 to 120 µm	massive	50 - 60		5 - 10				1 - 5	10 - 15			5 - 10	1 - 5			1 - 5
5	13	N34E04.I.58	Feldspathic, ferruginous, argillaceous mudstone	Dark reddish brown	<2 to 150 µm	massive	45 - 55		1 - 5				1 - 5	20 - 30			5 - 10	1 - 5		1 - 5	1 - 5
5	14	N34E04.I.26	Feldspathic, ferruginous, argillaceous mudstone	Reddish brown	<2 to 200 µm	massive	50 - 60		1 - 5				1 - 5	15 - 20			5 - 10	1 - 5		1 - 5	5 - 10
5	15	N34E06.I.50	Feldspathic, ferruginous, argillaceous mudstone	Reddish brown	<2 to 200 µm	massive	45 - 55							15 - 25			10 -15			1 - 5	5 - 10

Appendix E

Photographic Catalogue

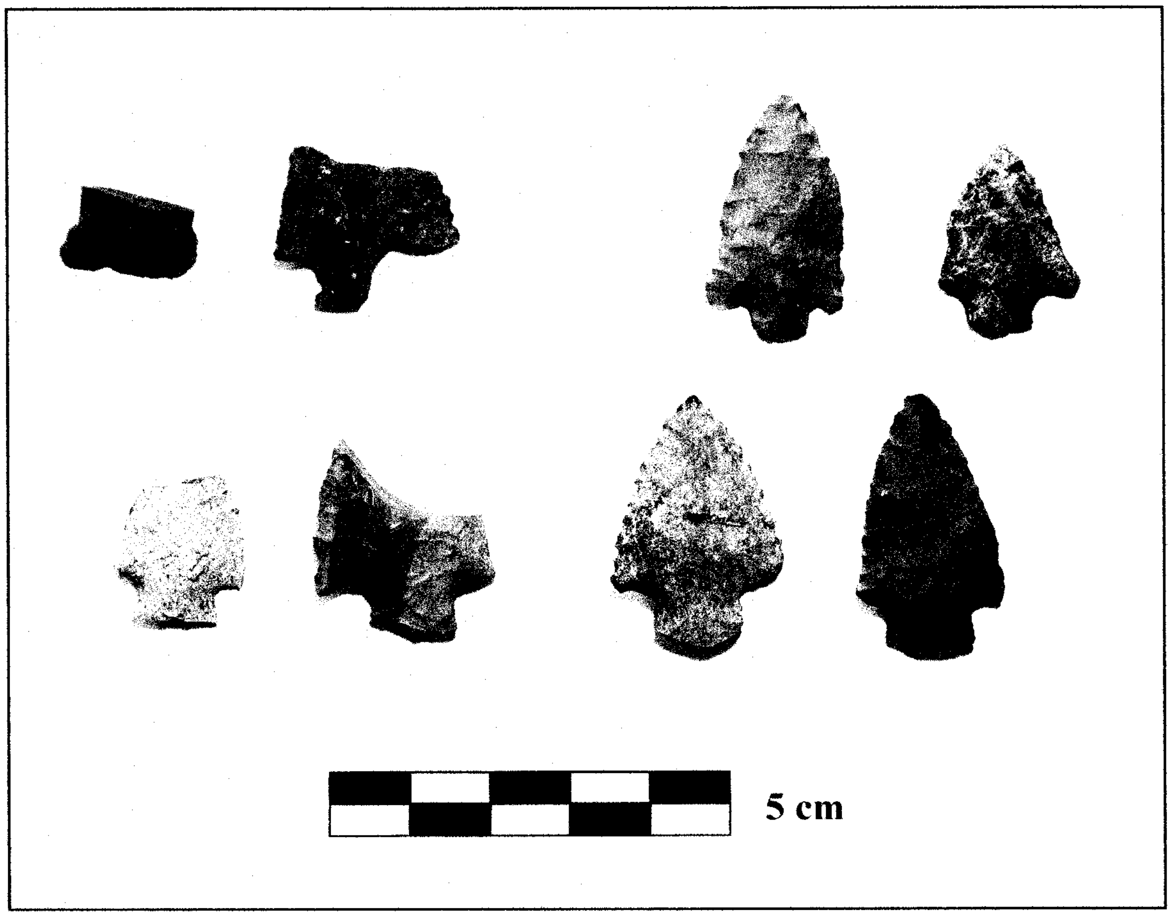


Figure E.1 Early Archaic Projectile Points

Top Row, left to right: Un-typed Early Side Notched, Un-typed Early Corner-Notched, Kanawha Stemmed, LeCroy
Bottom Row, left to right: Nettling or Nettling-like, Nettling or Nettling-like, Un-typed Early Corner-Notched, Kirk Corner-Notched or Kirk-like

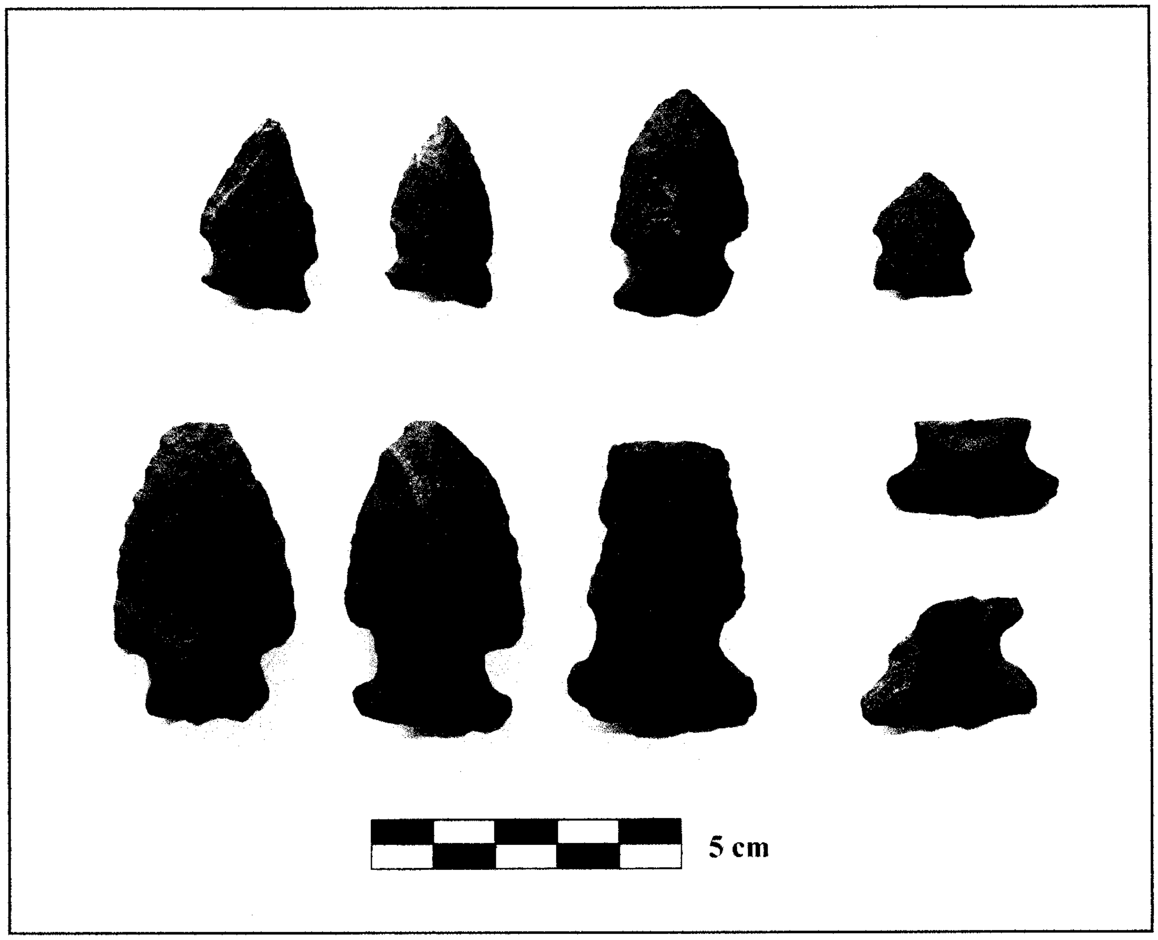


Figure E.2 Middle Archaic – Brewerton Side Notched and Corner Notched Points

Figure E.3 Middle Archaic – Otter Creek Projectile Points

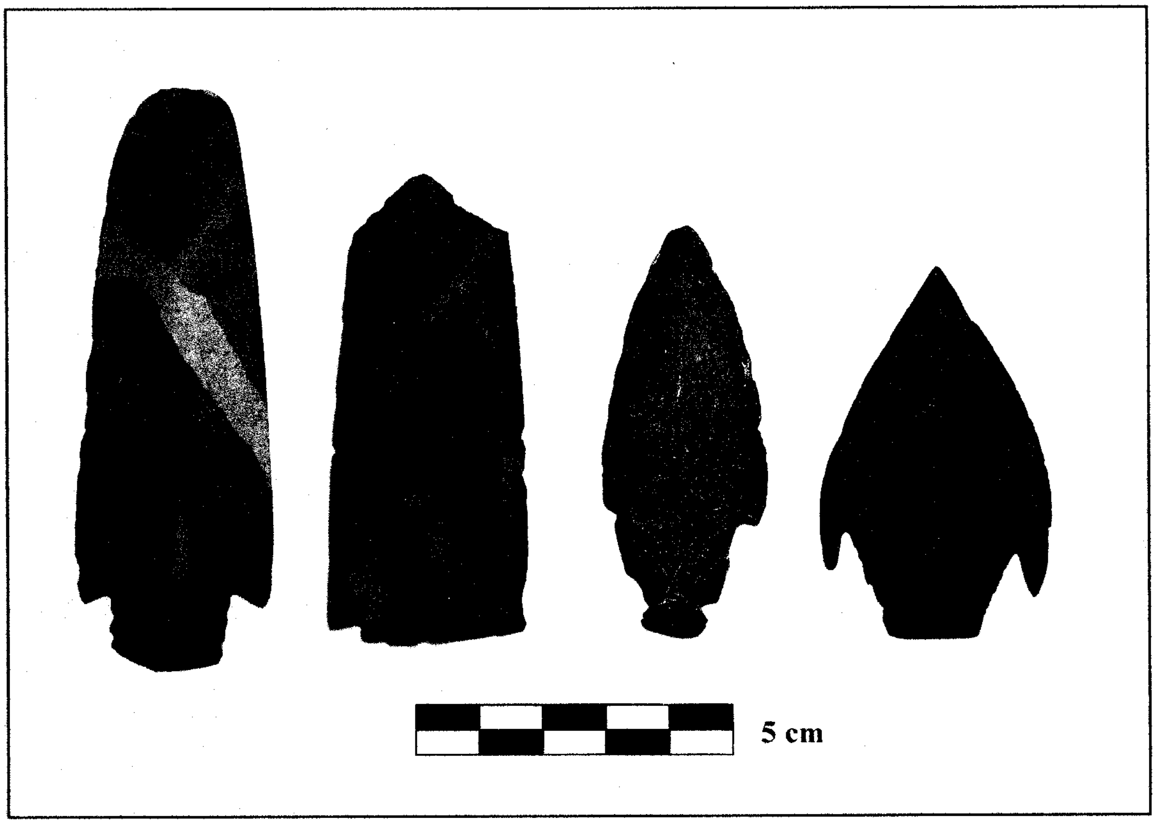


Figure E.4 Middle Archaic – Ground Slate Bifaces

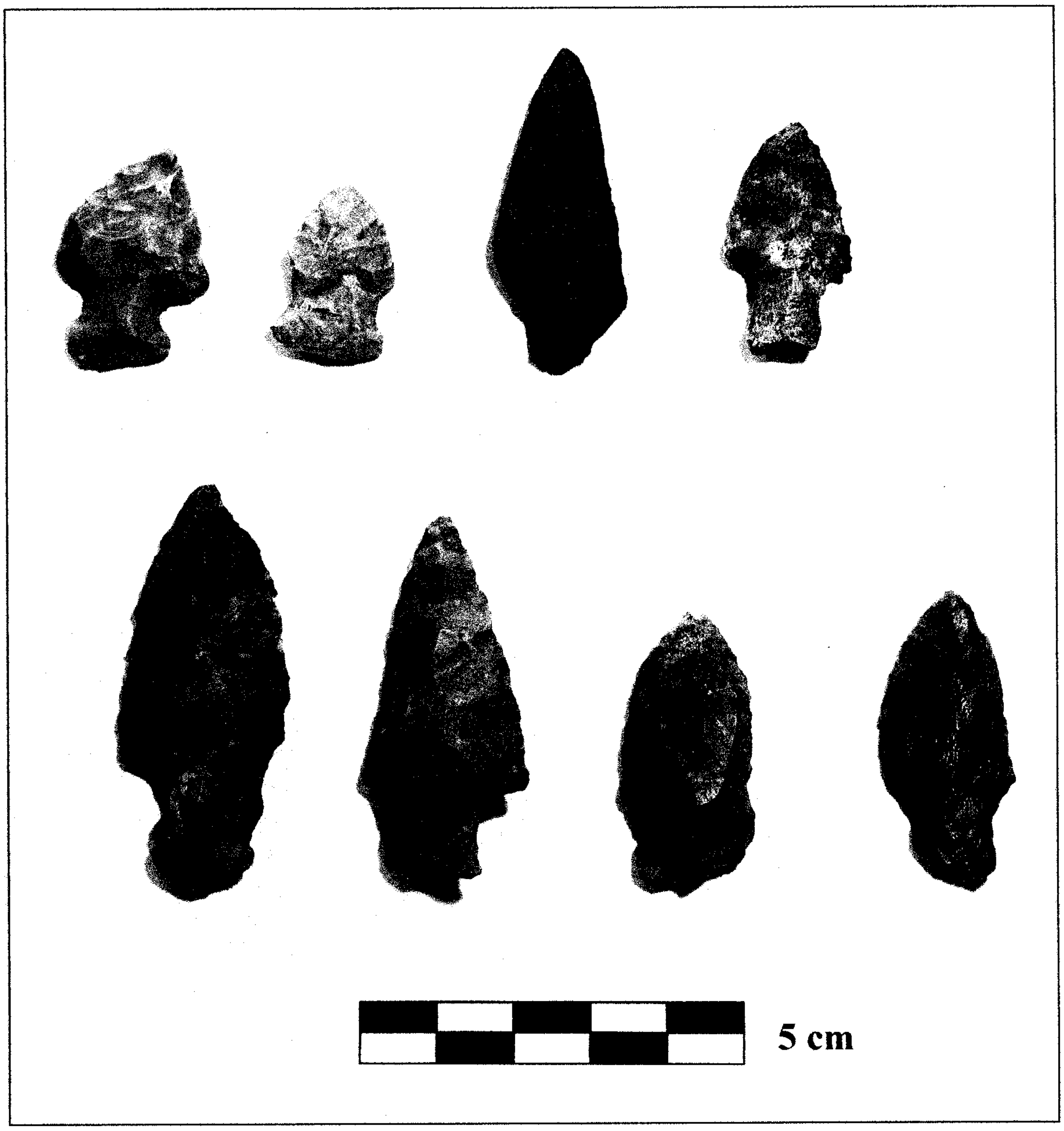


Figure E.5 Late Archaic – Narrow Point Projectile Points

Top Row, left to right: reworked Lamoka, Lamoka, two Un-typed Narrow Points
Bottom Row: all are Lamoka

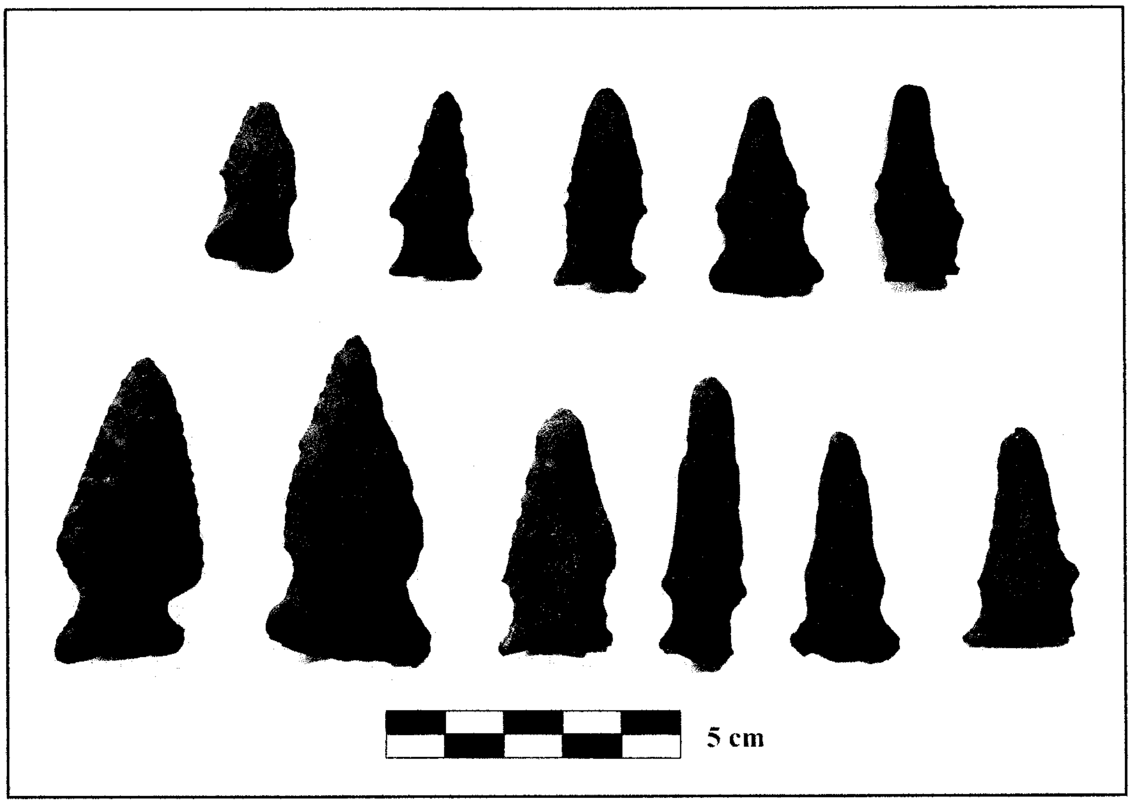


Figure E.6 Late Archaic – Normanskill Projectile Points and Drills

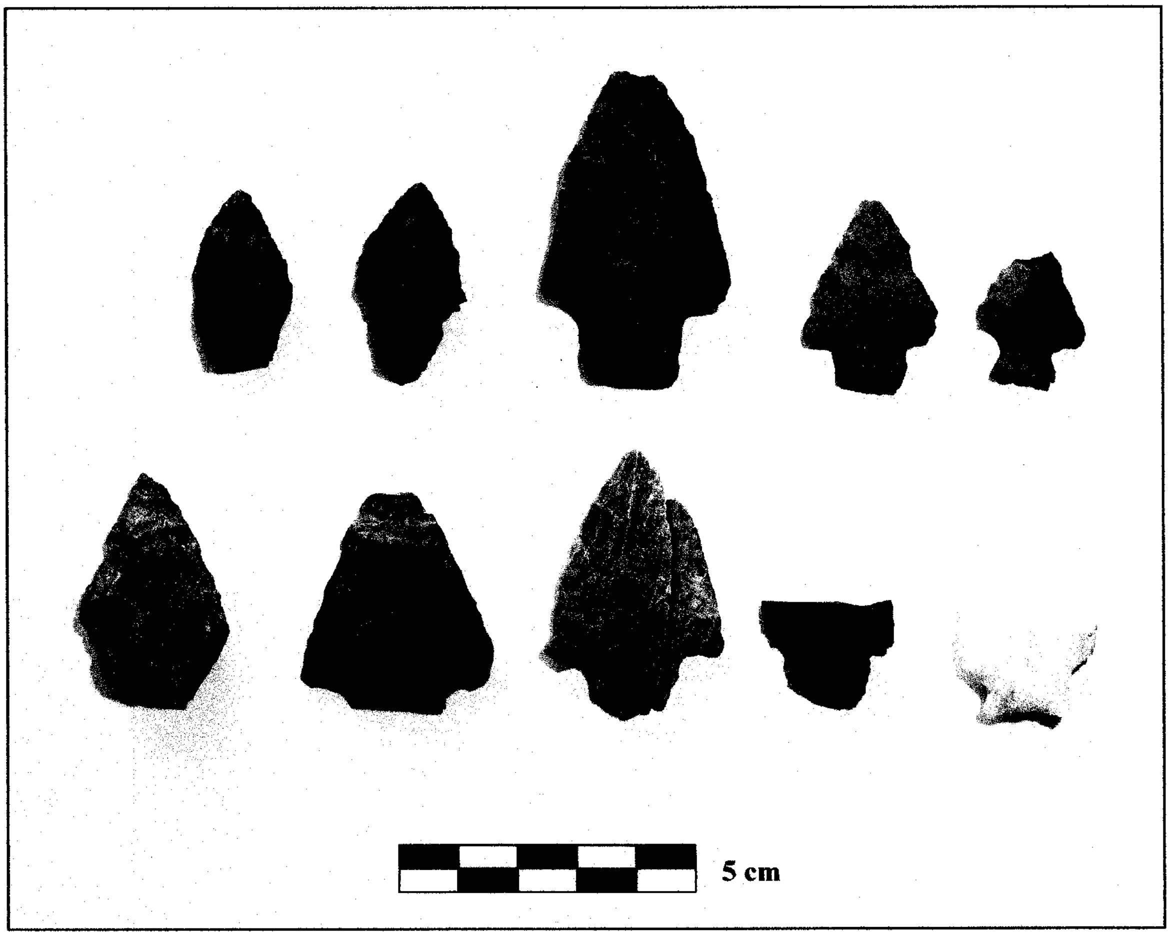


Figure E.7 Late Archaic – Broad Point Projectile Points

Top Row, left to right: Adder Orchard, Adder Orchard, Genesee, Genesee, Perkiomen
Bottom Row, left to right: Rossville, Snook Kill, Snook Kill, Snook Kill, Susquehanna

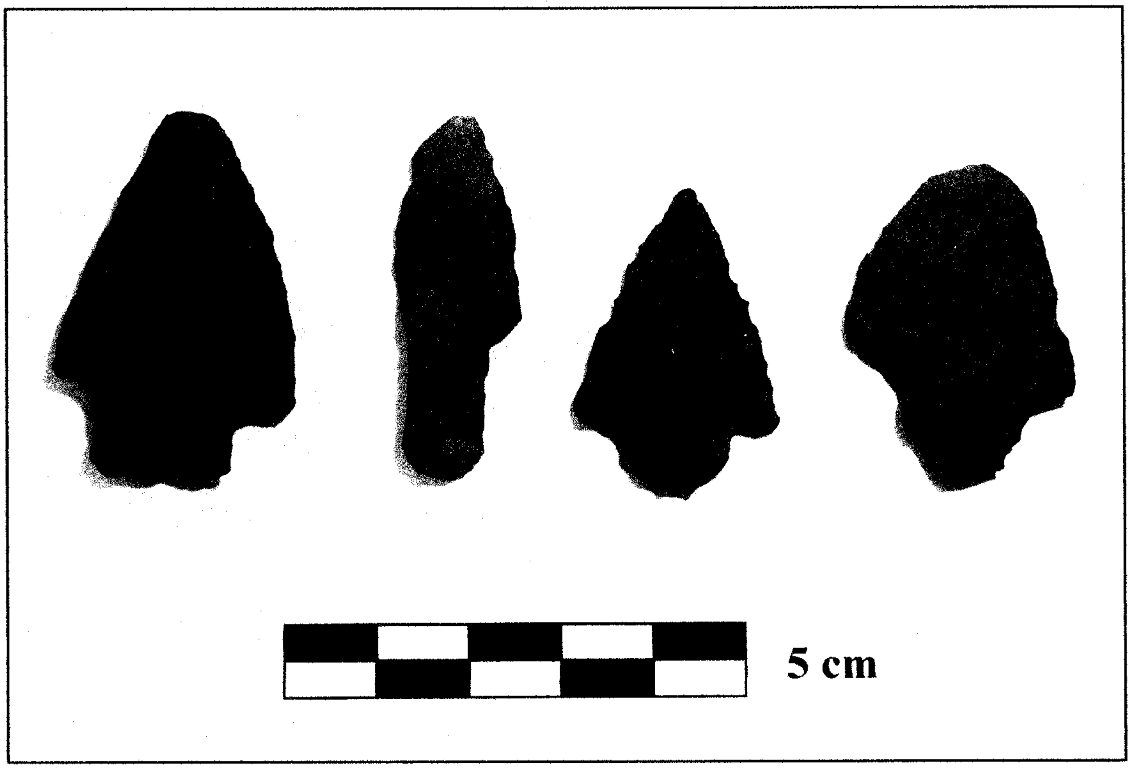


Figure E.8 Late Archaic – Projectile Points made on metasedimentary raw material

Left to Right: Genesee, Un-typed Narrow Point, Snook Kill, Snook Kill

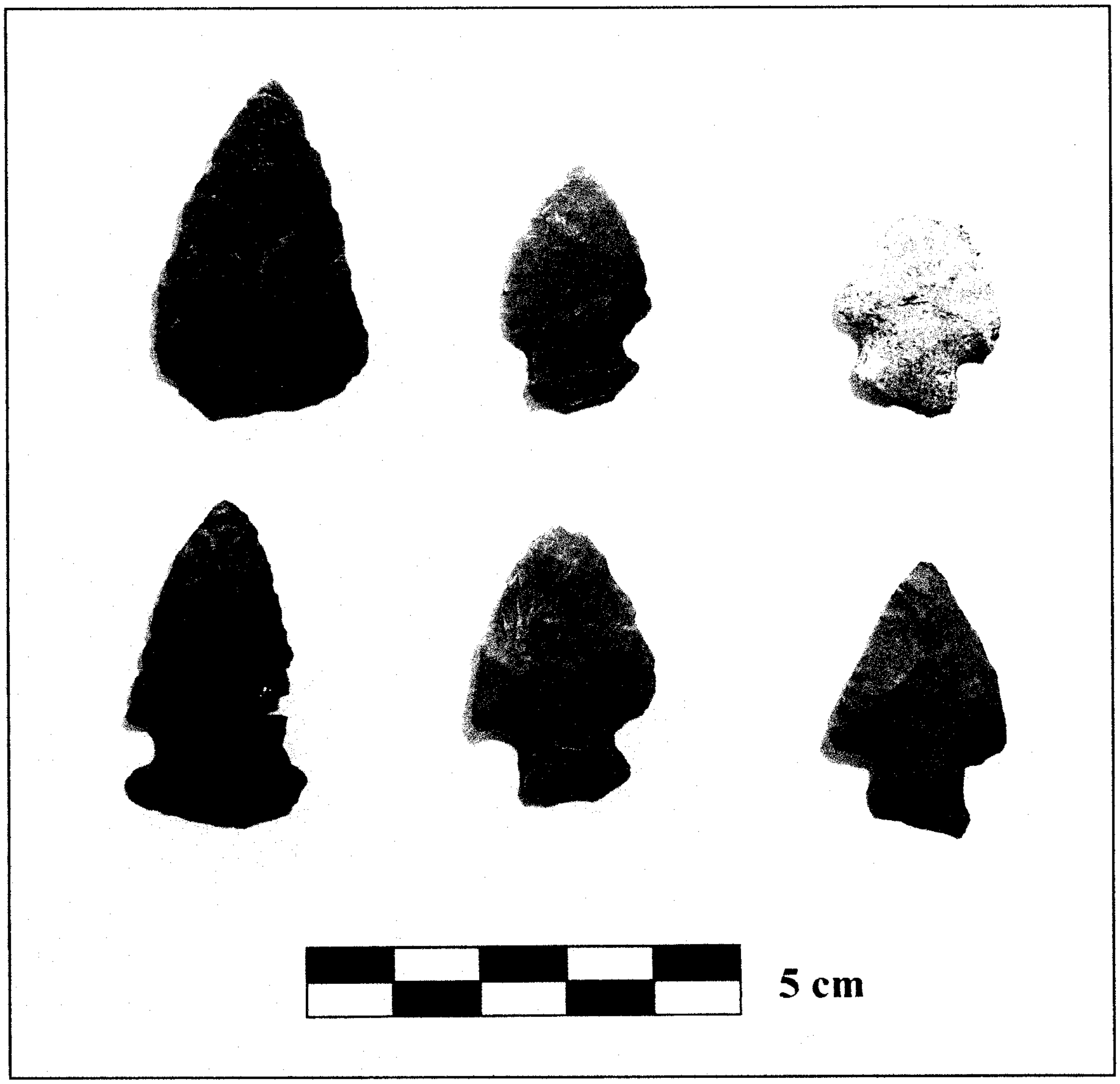


Figure E.9 Late Archaic – Small Point Projectile Points

Top Row: Ace of Spades points
Bottom Row, left to right: Crawford Knoll, Innes, Innes

Figure E.10 Unfinished Bifaces – Stage 2

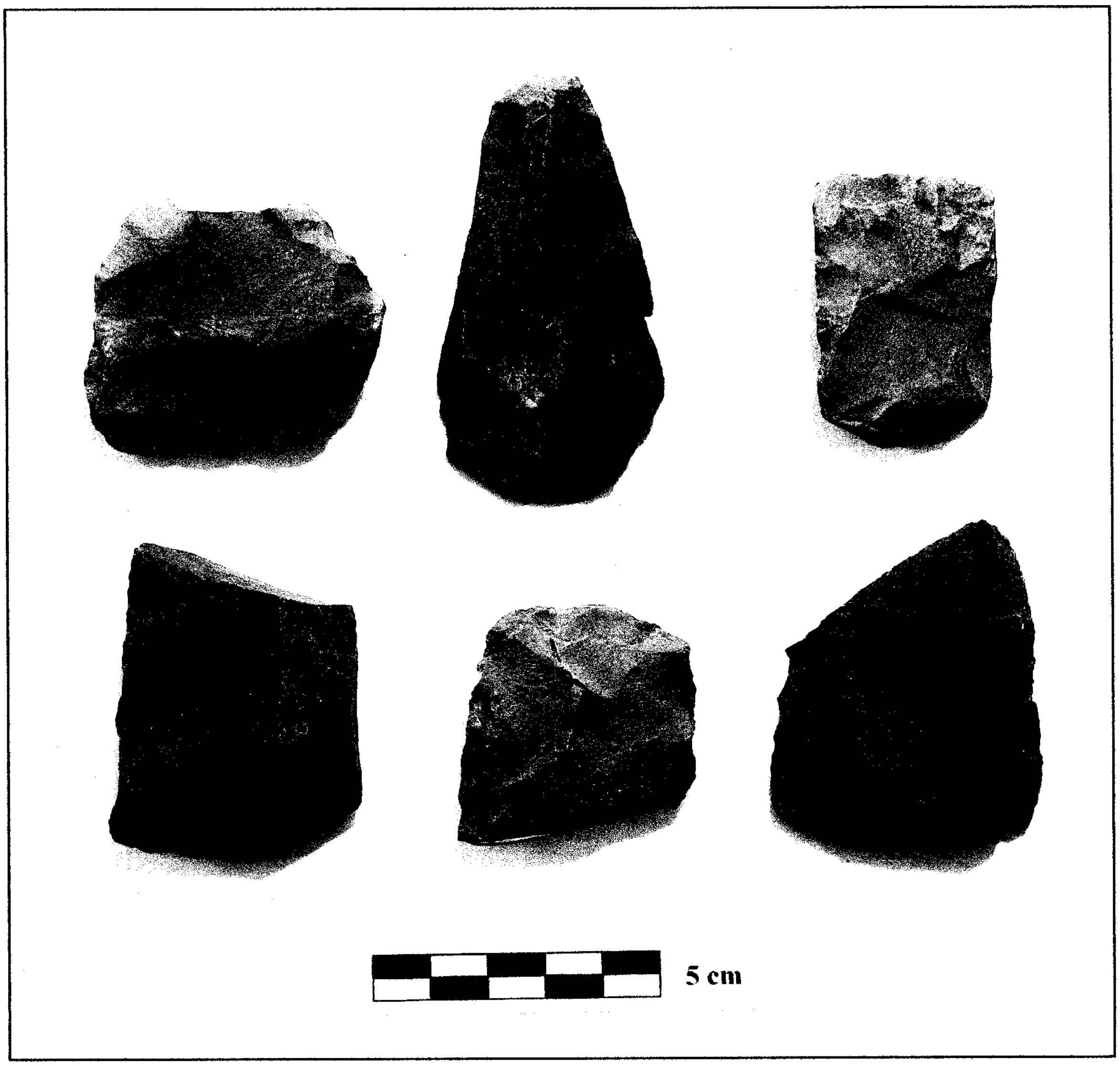


Figure E.11 Unfinished Bifaces – Stage 3

Figure E.12 Unfinished Bifaces – Stage 4

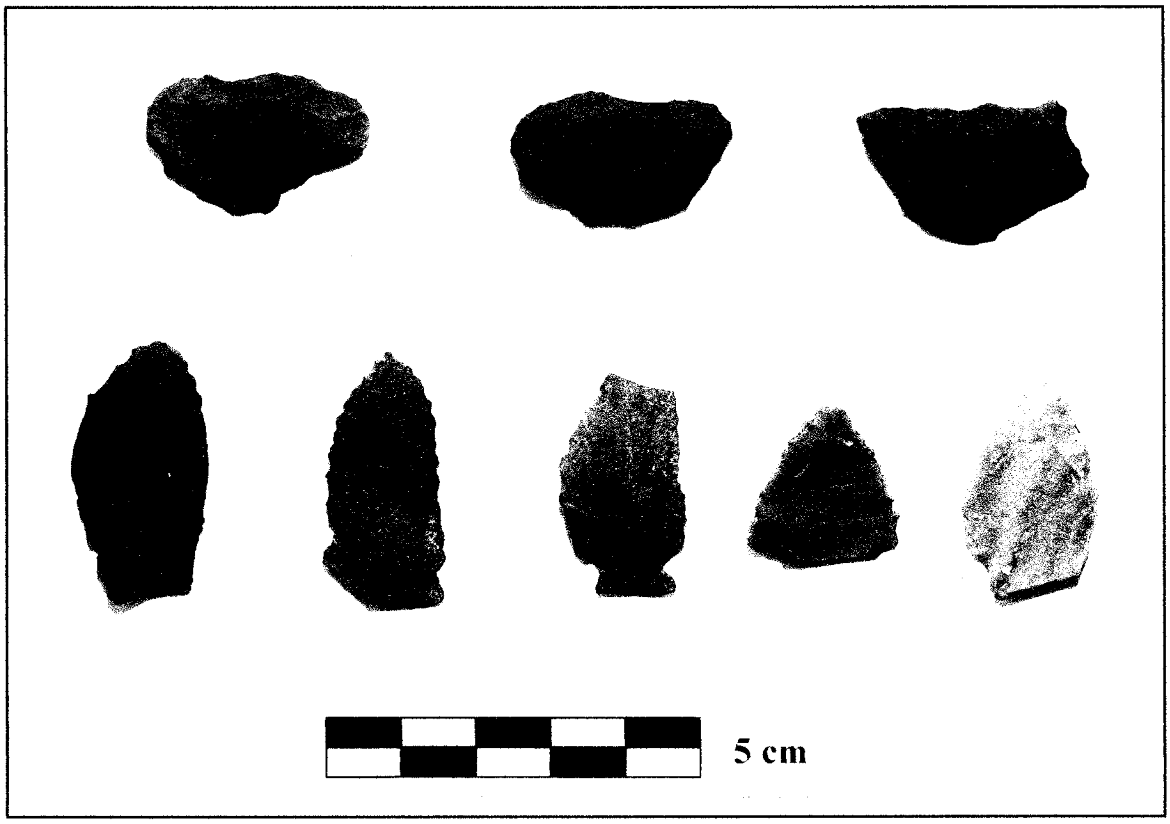


Figure E.13 Informal Tools

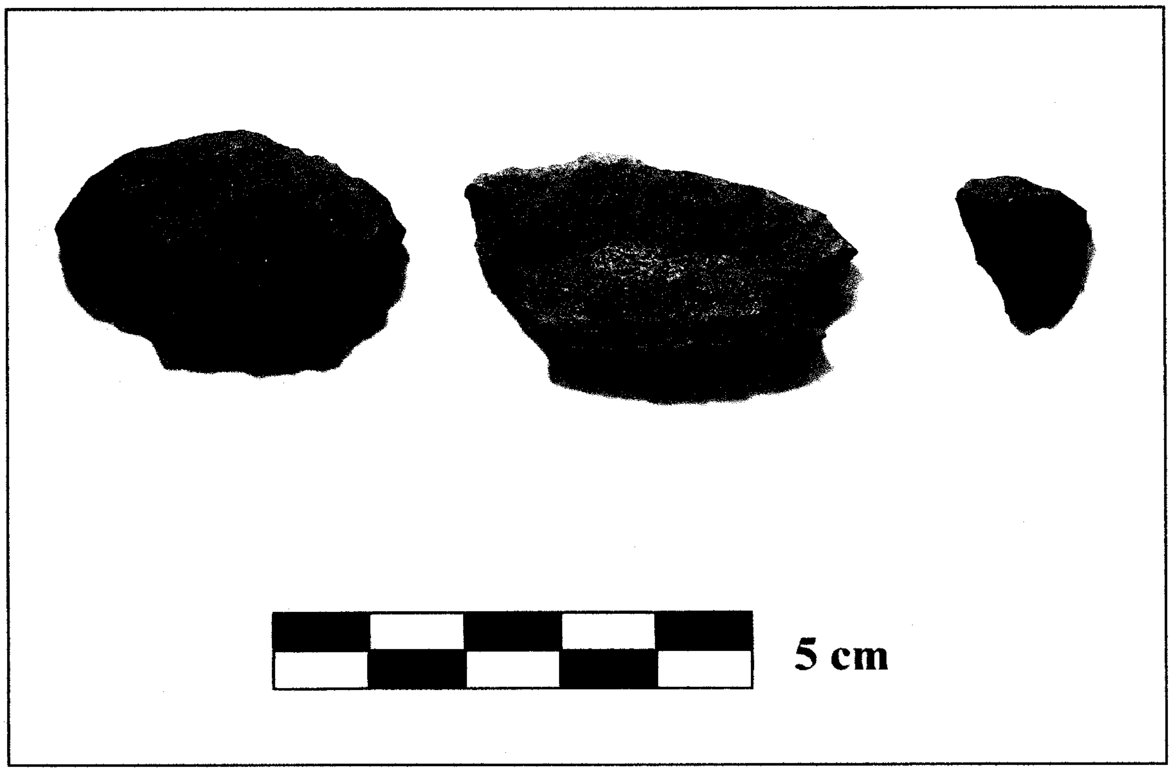


Figure E.14 Scrapers

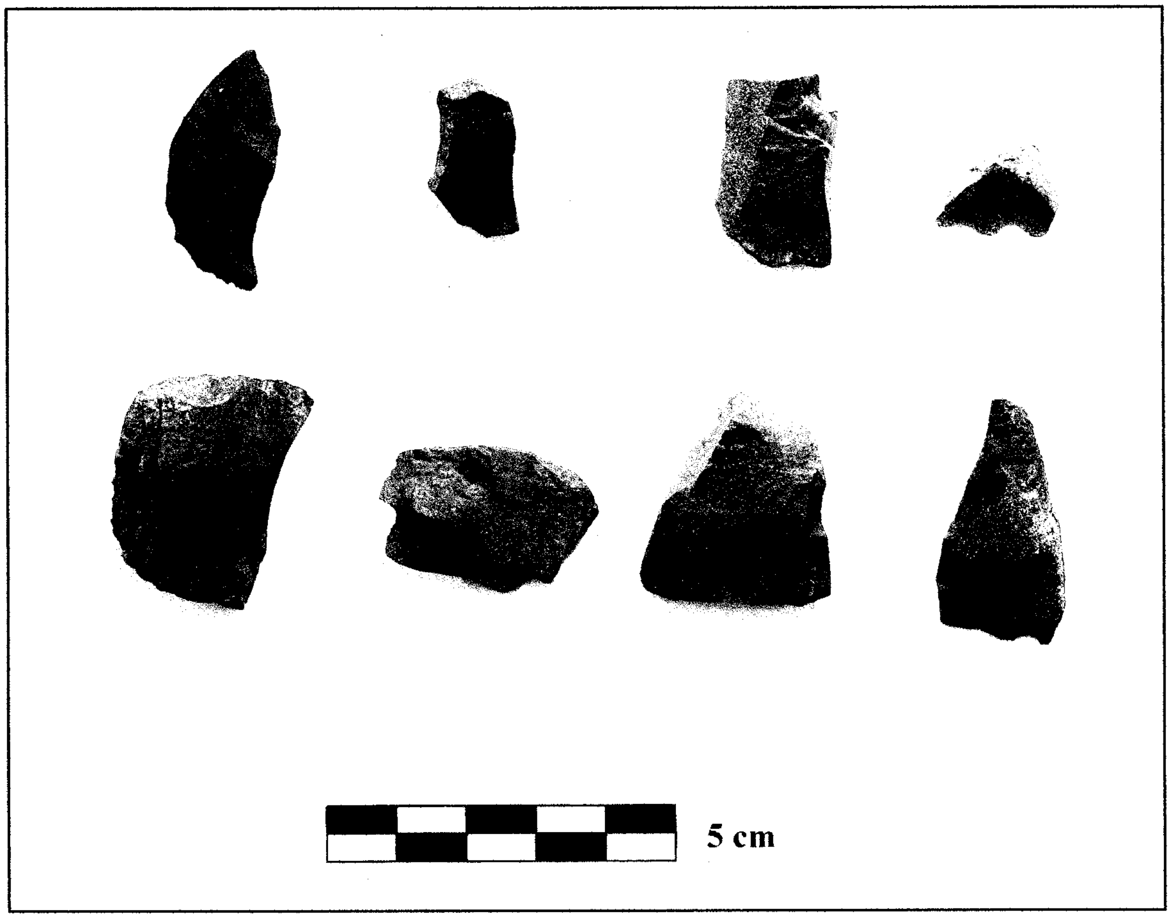


Figure E.15 Cores

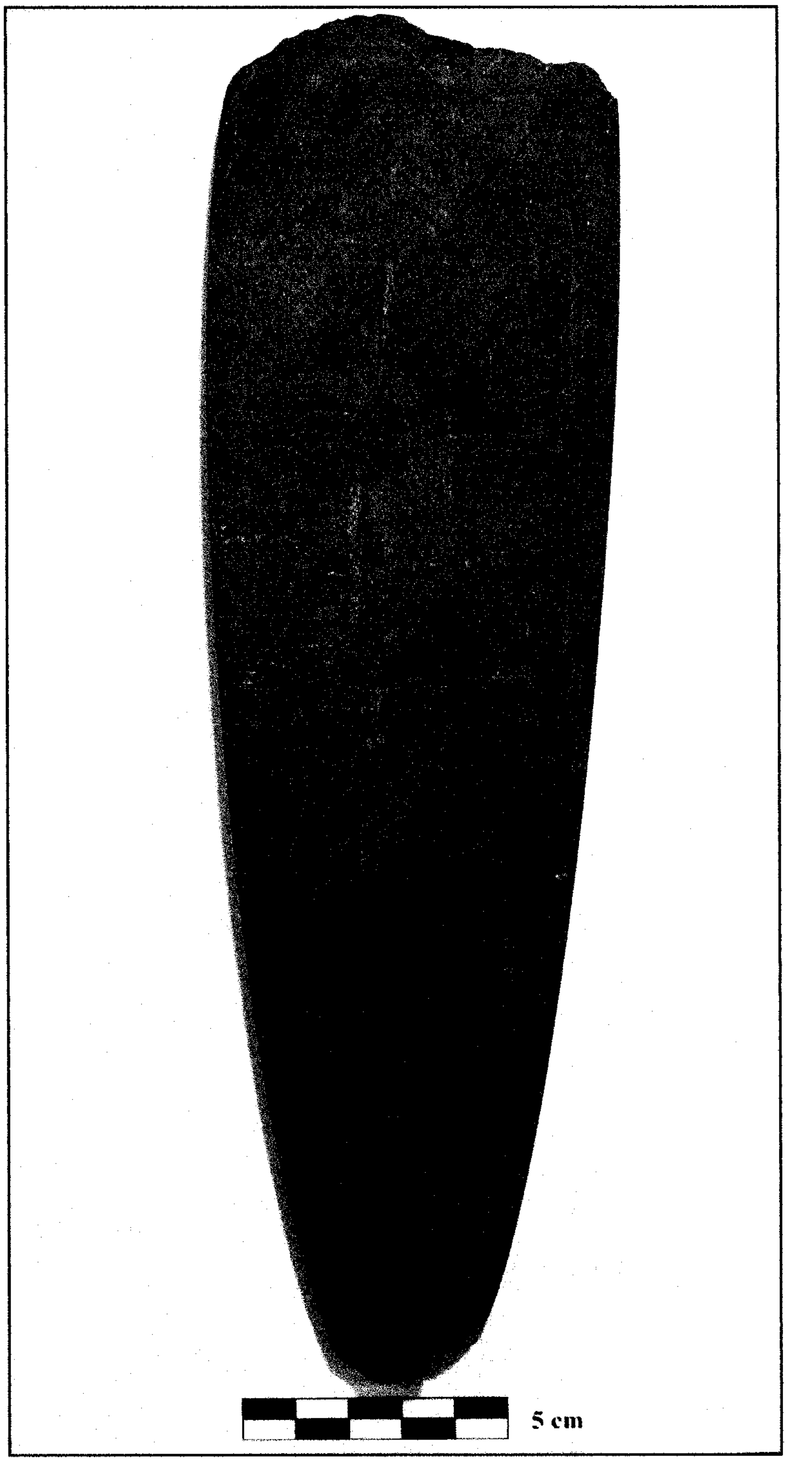


Figure E.16 Fully Ground Axe

Figure E.17 Chlorite Schist Axes

Figure E.18 Gouges

Figure E.19 Poll Ends of Celts

Figure E.20 Bit Ends of Celts

Appendix F

Permission for Use of Figures

1. Eley, Betty and Peter von Bitter
2. Eyles, Nick
3. Kooyman, Brian
4. Sullivan, Alan P.

Janice Teichroeb

From:	Glen Ellis [glene@rom.on.ca]
Sent:	Monday, March 27, 2006 4:57 PM
To:	jteichroeb@sympatico.ca
Cc:	Peter von Bitter
Subject:	Re: Request for Permission to use one of your published mapsin my MA thesis

Dear Ms. Teichroeb,

Permission is granted.

Glen Ellis
Manager, Royal Ontario Museum Publications

>>> Peter von Bitter 3/27/2006 11:14 AM >>>
Hi Janice:
Certainly its O.K. with me; however, it may require permission from our publications departement & I'll copy this to Glen Ellis.
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Best wishes.
Peter

Dr. Peter H. von Bitter,
Senior Curator in Charge, Palaeobiology Section,
Deputy Head, Department of Natural History,
Royal Ontario Museum, 100 Queen's Park,
Toronto, Ontario, Canada, M5S 2C6,
(416) 586-5592.

>>> "Janice Teichroeb" <jteichroeb@sympatico.ca> 3/20/2006 11:39 AM
>>>
Dear Dr. von Bitter,

As you may recall I am analyzing an Archaic lithic assemblage from a
site
located on the Trent-Severn Waterway. I would like to incorporate a
copy of
the map (Text-Fig. 2) that identifies chert localities in Southern
Ontario,
from your publication Cherts of Southern Ontario, in my thesis. May I
have
your permission to do so?

Sincerely,

Janice Teichroeb

Absolutely Janice, good luck with your project.
N

Janice Teichroeb wrote:

> Dear Professor Eyles,
>
> I am an Anthropology graduate student at Trent University in Peterborough. My MA thesis is an analysis of a lithic tool assemblage from a First Nations archaeological site on the Trent-Severn waterway. As part of the background information in my thesis I have included an overview of the importance of silicate minerals in archaeological toolstone. In order to add clarity to my summary I would like to include a copy of ***Figure 5-1 Building blocks of silicate minerals*** from your book ***Ontario Rocks***.
>
> May I have your permission to do so?
>
> Sincerely,
> Janice Teichroeb

Janice Teichroeb

From:	Janice Teichroeb [jteichroeb@sympatico.ca]
Sent:	Saturday, June 24, 2006 10:42 AM
To:	jteichroeb@sympatico.ca
Subject:	Fwd: Re: [Fwd: Request for Permission to use a published figure in my MA thesis]]
Attachments:	untitled-1.2; wstephen.vcf

untitled-1.2 (5 KB) wstephen.vcf (433 B)

Hi again Janice. You are good to go! Hope your research was sucessful and maybe even fun.
Brian

---------------------------- Original Message ----------------------------
Subject: Re: [Fwd: Request for Permission to use a published figure in my MA thesis] From: "Wendy Stephens" <wstephen@ucalgary.ca>
Date: Fri, June 23, 2006 9:35 am
To: bkooyman@ucalgary.ca

Yes it is fine - you can tell her.
Wendy

bkooyman@ucalgary.ca wrote:

>Hi Wendy,
>Would it be OK to give this student permission to use my Figure 6 in her MA thesis? Do you want to tell her or should I?
>Thanks,
>Brian Kooyman
>
>---------------------------- Original Message ----------------------------
Subject: Request for Permission to use a published figure in my MA thesis
From: "Janice Teichroeb" <jteichroeb@sympatico.ca>
>Date: Wed, June 21, 2006 7:23 pm
>To: bkooyman@ucalgary.ca
>--

>Dear Professor Kooyman,
>
>
>
>I am an Anthropology graduate student at Trent University in Peterborough,
> Ontario. My MA thesis is an analysis of an Archaic lithic assemblage from a
site on the Trent-Severn waterway in Ontario. As part of the background information in my thesis I have included definitions of various flake features. In order to add clarity to my summary I would like to include a copy of Figure 6: Flake features from your book Understanding Stone Tools and Archaeological Sites.
>
>
>
>May I have your permission to do so?

Janice Teichroeb

From: ALAN P SULLIVAN [sullivap@uc.edu]
Sent: Friday, January 06, 2006 9:48 AM
To: Janice Teichroeb
Subject: Fwd: Request for Permission to include one of your figures in my MA thesis

Dear Ms. Teichroeb:

No problem -- you have my permission to use the figure you need. For what it's worth, I think it is highly professional of you to request such permission. Good luck with your thesis -- it sounds very interesting.

Regards,
Alan P. Sullivan
Professor of Anthropology

> Dear Professor Sullivan,
>
>
>
> I am an Anthropology grad student at Trent
> University in Peterborough, Ontario. My MA thesis
> is an analysis of an Archaic lithic assemblage from
> a site on the Trent-Severn Waterway, in Ontario. I
> am following (with some modifications) the debitage
> analysis technique outlined in 1985 Sullivan and
> Rozen; Debitage Analysis and Archaeological
> Interpretation, and 1987 Sullivan; Probing the
> Sources of Lithic Assemblage Variability: A Regional
> Case Study Near the Homolovi Ruins, Arizona. I
> would like to include a copy of Figure 2
> Hierarchical attribute key used to define five
> debitage categories from Sullivan 1987 in the
> Appendix of my thesis.
>
>
>
> May I have your permission to do so?
>
>
>
> Sincerely,
>
> Janice Teichroeb