Late Paleoindian Biface Manufacture: A Case Study from the Mackenzie I Site (DdJf-9) near Thunder Bay, Ontario

Gjende Bennett

Northern Environments and Cultures

Lakehead University

Thunder Bay, Ontario

Submitted to the Faculty of Graduate Studies in Partial Fulfillment of the
Requirements for the Degree of Masters of Environmental Studies in
Northern Environments and Cultures

PERMISSION OF USE

In presenting this thesis in partial fulfillment of the requirements for a Masters of environmental Studies in Northern Environments and Cultures degree from Lakehead University, i agree that copies of this thesis shall be deposited in the Institute Library and the department of Anthropology to be freely available for public use. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor Dr. Scott Hamilton, the Graduate Coordinator, or in their absence, by the chair of the Department of Anthropology or the Dean of the Faculty of Science and Environmental Studies. It is understood that any copying or publication of this thesis, or parts thereof for financial gain shall not be allowed without my written permission. Also it is understood that due recognition will be given to me and Lakehead university in any scholarly use which may be made of any material in this thesis.

ABSTRACT

The Mackenzie Sites appear to form part of the Late Paleoindian Lakehead Complex that occupied the unglaciated peninsula between Glacial Lakes Agassiz and Minong during the terminal Pleistocene. A number of sites and isolated projectile point finds have been discovered throughout the region. Most excavated collections consist of quarry workshops, yielding vast lithic assemblages snapshots of the reduction sequence and very few diagnostic tools. In contrast Mackenzie I (DdJf-9) appears to be an extensive and repeatedly used stream mouth habitation site. Its vast lithic assemblage includes specimens attributable to the full range of the lithic reduction sequence and a large number of diagnostic tools. Biface assemblages from other sites within the Lakehead Complex have been analyzed in an attempt to determine the lithic reduction sequence. These sites have provided partial insight in understanding the middle stages of the Lakehead Complex reduction sequence. Mackenzie I offered the chance to observe the complete sequence of lithic reduction. The biface assemblage consists of 667 bifaces that could be placed in Stage 1-5 reduction. Am additional 223 bifaces were unstageable, 21 anomalous bifaces fell outside the normal range of variation, and 532 were classed as formal tools.

The biface stages were determined using metric and non-metric attributes in an attempt to further define the Lakehead Complex reduction sequence as previously established. Bifaces from Mackenzie I include Stage 1 through to Stage 6 (the last stage representing formal and diagnostic tools). It also became apparent that there were two trajectories of manufacture used in the production of the Mackenzie I assemblage. Large tabular blanks were reduced by systematic removal of flakes using direct percussion techniques, termed the Biface Trajectory. Where thin narrow flakes were reduced using refined methods of flake removal using either indirect percussion or directed pressure flaking, this was termed the the Flake/Blade Trajectory. It also became apparent that there was a selection of flake blanks, reduced for the specific purpose of manufacturing projectile points. Many of the projectiles at Mackenzie I exhibit a slight twist and/or curvature. Such attributes can be attributed to the nature of the blank and the subsequent methods of flake removal. Since the initial identification of the Lakehead Complex

projectiles, they have been characterized by their refined parallel oblique flaking pattern. It was not until the excavation of Mackenzie I that the prevelance of this manner of flaking (99%) became apparent. This analysis has revealed that parallel oblique flaking enters the lithic reduction sequence at Stage 3, but with significantly wider flake scars. It is hypothesized that this was a result of the preferred lithic raw material. The Gunflint Formation cherts that were heavily utilized at Lakehead Complex sites are very hard, yet brittle and contain joint plane faults and iron-oxide inclusions. The Mackenzie I assemblage also indicates the presence of a blade technology being used alongside the bifacial toolkit. These blades are easily producible on high quality tabular blocks of the Gunflint Formation chert. It appears that blades, blade/flakes and large tabular blocks were all utilized in order to produce the Mackenzie I toolkit. These were all nearly exclusively finished using parallel oblique flaking techniques.

ACKNOWLEDGMENTS

First and foremost I would like to thank my supervisor, Dr. Scott Hamilton (Dept. of Anthropology, Lakehead University) for all his time, hard work and dedication producing nothing less than perfection. I know I could be difficult and my writing wasn't always average but without your dedication to fixing my writing this never would have been completed. Also, thank you to my committee members, Dr. Matthew Boyd (Dept. of Anthropology, Lakehead University), Dr. Terry Gibson (Senior Manager and Founding Partner of Western Heritage) and my external reviewer, Dr. Michael Shott (Dept. of Anthropology, University of Akron, Ohio) for their time, guidance, support and input. I would also like to sincerely thank Bill Ross for his time and effort in reading through my work, and his tireless dedication to ensuring all site reports and other local knowledge was made available.

A sincere thank you goes out to Western Heritage for the use of the artifacts, software and support in the completion of this thesis, a heartfelt thank you goes out to Peggy McKeand, Terry Gibson and Jim Finnigan for their aid and support. A huge thank you goes out to the knappers who aided me in understanding the mechanics of biface reduction and tool manufacture, thank you Bill Ross, Gary Wowchuck, Dan Wendt, Mark Paxton-MacRae and Ernie Reichert.

I also would like to send a heartfelt thank you to the field crews of the Mackenzie I excavations of 2010 and 2011. Special thanks go out to friends and colleagues, who without your aid and support this thesis never would have been possible, Dave Norris, Samantha Markham, Christine Shultis, Breana McCulloch, Dale Langford, Sylvia Szymczak and Mark Paxton-MacRae. Thank you does not even begin to describe what I owe you.

Finally a huge thank-you to my family and friends back home in Saskatchewan. Thank-you all for your patience and tolerating my insanity. Mom, Dad, thank you so much this never would have been possible without your support (both financial and emotional). It is because of all of you that this was possible. I would also like to extend my sincerest apologies to anyone I left out.

TABLE OF CONTENTS

APPENDICES

*Excel Spreadsheets of the supplemental information is located on the attached disc

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This thesis addresses the lithic analysis of the biface assemblage recovered during the salvage excavations at the Mackenzie I (DdJf-9) site near Thunder Bay, Ontario. These excavations were carried out prior to the construction of the new highway infrastructure along an ancient shoreline north of the current shores of Lake Superior. The site has been assigned to the Lakehead Complex, the regional manifestation of the Late Paleoindian culture that may represent the earliest post-glacial settlement of the area. Lakehead Complex sites are thought to span a 1500 to 2000 year period shortly after the Marquette Advance with the earliest possible dates being between 9900 – 9500 years ago (Fox, 1975; Julig, 1984, 1991, 1994; Ross, 1995) (see Chapter 3).

Previous sites in the area that have been assigned to the Lakehead Complex are often found along ancient beach ridges deriving from Glacial Lake Minong. The best known sites in the Thunder Bay area are noted for their large yield of core material, debitage, and failed biface preforms, and are interpreted to represent quarrying (Julig, 1994; Hinshelwood and Webber, 1987) and lithic reduction activities (Hinshelwood, 1990; Adams, 1995; Halverson, 1992). Although there have been relatively few diagnostic tools found at these sites, those in the Thunder Bay region considered collectively can be compared to the assemblage from Mackenzie I.

The assemblage recovered from Mackenzie I is unique because it includes a significant number of tools and tool preforms. This enables the study of tool production sequences, and comparison to the generally much smaller assemblages recovered from other Lakehead Complex sites in the Thunder Bay region. This site not only yielded a large number of diagnostic tools, but also surprisingly large amounts of lithic reduction waste material. The waste material includes large cores and core fragments, substantial numbers of bifaces in each stage of production, and corresponding types of debitage. This suggests that the site was repeatedly used perhaps over several generations as an encampment along the Lake Minong strandline. The large numbers of formal tools, including many failed bifaces offers an opportunity to gain insight into the methods and practices used to create those tools, especially the large numbers of projectile points that were recovered during excavation.

1.2 THE MACKENZIE I SITE

The Mackenzie I site (DdJf-9) is located approximately 40 km east of Thunder Bay, Ontario on Highway 11/17, and occupied an ancient strandline of glacial Lake Minong. Immediately following the retreat of the Superior Lobe during the Marquette Advance the lake levels were controlled by a morainal sill at Nadoway Point, near Sault Ste. Marie. There were frequent fluctuations in lake levels throughout this period in response to meltwater influx, differential isostatic rebound and other factors (Boyd et al., 2012; Farrand and Drexler, 1985; Teller and Mahnic, 1988; Yu et al., 2010). Due to this complexity the Minong phase of Lake Superior remains poorly understood (Chapter 2).

Mackenzie I was discovered during the environmental assessment prior to the proposed lane twinning of Highway 11/17. The site was only one of eight Paleoindian sites investigated as part of the preparations for road work; other sites include (heading east from Thunder Bay) Naomi (DcJh-42), Hodder East (DcJh-44), Electric Woodpecker I (DdJf-11), Electric Woodpecker II (DdJf-12), Electric Woodpecker III (DdJf-14), RLF (DdJf-13), Mackenzie I (DdJf-9) and Mackenzie II (DdJf-10). These sites were all excavated by Western Heritage during the 2010 to 2012 field seasons (Figure 1.1 and 1.2). A ninth site, Neenookasi (DdJe-7) was discovered in the fall of 2012 during a Stage 2 assessment at Blende Lake (Lints, 2012; Figure 1.1 and 3.11).

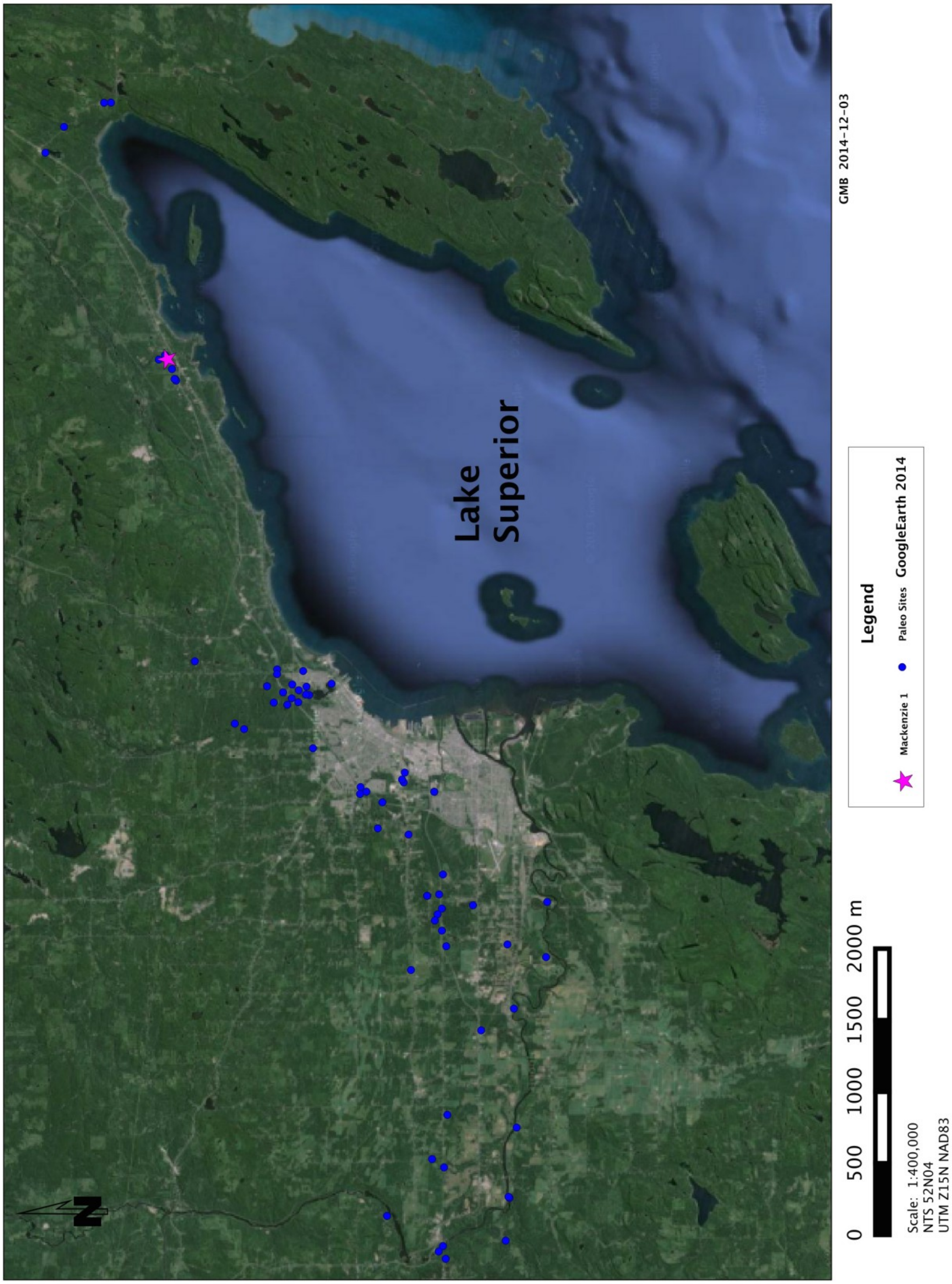


Figure 1.1: Map of the Lakehead Complex sites, inset map of the Mackenzie cluster of sites, which includes Mackenzie, I.

Figure 1.2: Map of the Mackenzie cluster of Paleoindian sites associated with the Lakehead Complex, including from west to east, Electric Woodpecker I and II (DdJf-11 and 12), DdJf-14, RLF (DdJf-13), Mackenzie I (DdJf-9) and Mackenzie II (DdJf-10).

Archaeological Services Inc. (ASI) who conducted the preliminary Stage 2 and 3 investigations of the area in 2009 initially investigated the Mackenzie I site. These investigations framed the planning and subsequent salvage excavation conducted by Western Heritage. These excavations resulted in 2539 m^2 being investigated, yielding a variety of tools that included projectile points, scrapers, drills, perforators, knives, bifaces and adzes. A large amount of debitage representing all stages of tool manufacture, cores and core fragments, rejected biface blanks, and large numbers of informal tools were discovered as well. Local Gunflint Formation cherts (Taconites and Gunflint Silica) represented the dominant raw material used for tool manufacture, as well as locally sourced siltstones from certain outcrops of the Gunflint Formation. The site also yielded tools manufactured from Knife Lake Siltstone, Hixton Silicified Sandstone, Hudson's Bay Lowland chert, Dog Lake Mudstone and various Rhyoltic materials.

1.3 PRESENT ENVIRONMENTAL CONDITIONS

At present, the study area contains the northern portion of the mixed conifer-hardwood forest and the southern boreal forest regions. The modern mixed forest is primarily jackpine, poplar and black spruce, with some maple, white pine, red pine, yellow and white birch, balsam fir and white spruce. In the low wetlands, stands of willow and alder can be found. The boreal forest portion consists of spruce dominated closed forest with smaller amounts of white birch, larch and balsam fir. Mosses are abundant and diverse across the forest floor. There is no clear boundary between these different forest types since their expression varies with the soil conditions, drainage and topography (Julig, 1994; Hinshelwood, 1990; Hinshelwood, 2004).

1.4 PREVIOUS ARCHAEOLOGICAL WORK WITHIN THE STUDY AREA

An understanding of the Late Paleoindian occupation of the region began with the efforts of avocational archeologists. The first professional work was done by R.S. MacNeish at the Brohm Site (DdJe-1) in 1950 and 1951 (MacNeish, 1952). Bill Fox (1975; 1980) defined the Lakehead Complex based on the Plano-like assemblages recovered from the Brohm and Cummins sites (DcJi-1) (see Chapter 3 and 7). Sites related to the Lakehead Complex are associated with ancient strandlines of Lake Minong, and are characterized by the predominant use of Gunflint Formation chert, and the production of generally lanceolate projectile points. Bill Ross (1995) proposed a higher conceptual framework for the Lakehead Complex called the Interlakes Composite, which encompassed the complete Lake Superior basin west to the strandlines of Glacial Lake Agassiz (see Chapter 3).

Our current understanding of the lithic reduction sequence employed by the Lakehead Complex is based on a small number of sites that have been subjected to large-scale excavations and more intensive analysis. The initial attempts at understanding how the tools were manufactured were offered by MacNeish (1952) and Fox (1975) but were poorly understood at the time. Based on the recovery of larger biface preforms resembling other Paleoindian assemblages throughout North America, they proposed that the Lakehead Complex was primarily a biface tool technology. However, Fox (1975) also noted that the recoveries included evidence of the possibility of a rudimentary blade technology.

1.5 RESEARCH CONTEXT AND BIFACE ASSEMBLAGE ANALYSIS

Lithics are the primary source of information about pre-contact, aceramic, archaeological cultures in the region. Methods have been developed over the years to better understand the nature and function of lithic assemblages and the human behaviors that lead to the accumulation of this material (Andrefsky, 1997, 1998, 2001, 2007; Hall and Larson, 2004; Callahan, 1979; Crabtree, 1966; Frison and Stanford, 1982; Bamforth, 2007; Bradley, 2009; 2010; Bradley et al., 2010; Odell, 2003; Young and Bonnichsen, 1984; Surovell, 2009). Generally, the focus of most lithic studies has been on creating typologies for diagnostic projectile points found in site assemblages. This focus has led to an incomplete understanding of a sites lithic assemblage as a purposely-organized production sequence. Research addressing Mackenzie I is taking a somewhat different course, with Markham (2013) offering a morphological approach to the analysis of the projectile points, and with the research presented here, that offers a reduction stage analysis of the bifaces to help comprehend the tool production sequence as a whole.

Reduction sequence studies first began before the turn of the century with Holmes (1890), but for a long time thereafter, this approach to understanding lithic assemblages was set aside. Instead, attention shifted to typological analysis of the diagnostic projectile points. It was not until the processual period that a return to the lithic reduction studies resulted in the establishment of the Stage Reduction Sequence in North American archaeologists (Crabtree, 1966; Callahan, 1979; Flenniken, 1978; Bradley, 2009, 2010; Bradley et al., 2010; Bamforth, 2007; Whittaker, 1994; Andrefsky, 1998; Frison and Stanford, 1982; Johnson, 1993; Waldorf, 1984), while European archaeologists employed the *Chaîne Opératoire* approach to describe what they believed to be a more fluid less structured approach to tool manufacture (Leroi-Gourhan, 1964. This idea saw a resurgance in the 1990s (Bleed, 2001; Carr and Bradbury, 2011, Stout, 2011; Boëda et al., 1990; Bourguignon et al., 2004) but has fallen under critique as it is essentially just a fancy French expression for reduction sequence (Shott, 2003; 2007). Utilizing these methods of describing how stone tools were manufactured leads to an understanding of the cognitive processes underlying the manufacturing process. Observations can be made on when there is a shift in manufacture process (percussion to pressure flaking), the sequence of flake removals, shifts in process to mitigate a potential problem or fix an existing problem, and the level of understanding of the fracture mechanics of the raw material. In effect, both approaches view the lithic reduction sequences as a culturally learned and objective-driven process designed to achieve specific tool forms.

Crabtree (1966) and Callahan (1979) employed the Stage Reduction Sequence to understand the manufacture of Folsom and Clovis projectile points respectively. Their methods involved both the analysis of an archaeological assemblage, and attempts at replication. Callahan (1979) not only attempted to replicate the finished Clovis projectile points but also to replicate errors observed in the earlier stages of manufacture to better understand what caused some bifaces to fracture. These methods were replicated and refined to describe technical variation evident within Folsom and Clovis specimens (Bradley 2009, 2010; Bradley et al., 2010; Frison and Stanford, 1982; Johnson, 1993) and explain the finishing stages of the subsequent Paleoindian groups (Bradley, 2009, 2010; Frison and Stanford, 1982; Bamforth, 2007). Other researchers have attempted to standardize the reduction sequences allowing them to be directly applied to any biface tool technology (Waldorf, 1984; Whittaker, 1994; Andrefsky, 1998; Odell, 2003).

This thesis employs a methodological and conceptual approach that is consistent with this analytic approach. The Mackenzie I site consists of a large formal tool assemblage that includes over 380 projectile points in various stages of curation (complete, reworked, discarded following use), as well as a large number of bifaces in all stages of manufacture. Hinshelwood and Webber (1987) were the first to explicitly attempt to describe the Stage Reduction Sequence of the Lakehead Complex using the Biloski Site (DcJh-9) assemblage. Previously, Julig (1994) analyzed the Cummins lithic assemblage but did not use the same methods of analysis later used by Hinshelwood and Webber (1987). The methods adapted from Callahan (1979) and Crabtree (1966) were subsequently applied to Brohm (Hinshelwood, 1990), Simmonds (Halverson, 1992), Naomi (Adams, 1995) and the Crane Cache (Hinshelwood and Ross, 1992). Mackenzie I offers a unique perspective on the Lakehead Complex reduction sequence due to the large number of both formal tools and fractured bifaces. The bifacial tool assemblage from Mackenzie I as a whole is far greater than at any other site within the region. More projectile points were found at this site alone than from all other Lakehead Complex sites combined.

1.6 OBJECTIVES

The primary goal of this thesis is to apply the staged reduction sequence analytic method formerly employed on Lakehead Complex collections to the biface assemblage from Mackenzie I. This analysis follows the methodology of Hinshelwood and Webber (1987) as adapted from Callahan (1979) and Crabtree (1966), with the realization that the metric attributes do not fully capture the variation within the assemblage. Hinshelwood and Ross (1992) determined that, due to the nature of the raw material and/or the skill of the knapper, the metric attributes alone could result in incorrect stage identification. It is contended in this thesis that use of non-metric attributes as part of lithic analysis, will enable the actual stage of manufacture to be more accurately determined. Once the bifaces were staged within the Lakehead Complex reduction scheme the results are compared to other sites to aid in determination of the nature and function of the Mackenzie I assemblage. All bifaces were anayzed and staged using the metric attributes of Callahan (1979). These bifaces were then re-analyzed using non-metric attributes which resulted in a number of mid-stage bifaces (Stages 2-4) being shifted either up or down in the reduction sequence. A secondary objective is to observe when the parallel oblique flaking technique first enters the reduction sequence. Regardless of the morphological variation in the overall shape the majority of projectile points and several other formal tool types recovered from Mackenzie I exhibit a carefully executed parallel oblique flaking pattern.

This was done to understand the entire manufacture sequence associated with the Lakehead Complex. Since most other Lakehead Complex sites reflect early stages of biface reduction little is understood about the final manufacture stages, resulting in uncertainty about many aspects of the reduction sequence as a whole. The large Mackenzie I biface assemblage offers the opportunity to understand the finishing stages as well as to address questions arising from previous studies. As part of this analysis and due to the uncertainty of the timing of settlement, the Mackenzie I assemblage was compared to early lithic reduction sequences (Clovis and Folsom) as well as an Early Archaic lithic reduction sequence (Kirk Corner Notched) and an Archaic biface assemblage from the Thunder Bay region (Chapter 7).

The subsequent chapters provide important cultural and environmental context to aid the lithic reduction analysis. Chapter 2 provides a general overview of the deglaciation sequence, lake level fluctuations and the paleoenvironment. Chapter 3 introduces the prehistory of North America and human migration into the continent as affected by the glaciers and subsequent glacial lakes. It also offers a more detailed discussion of the prehistory of northwestern Ontario, including trends observed within the Thunder Bay region. This culminates in a summary of the Lakehead Complex (Fox, 1975) and a brief discussion of the Interlakes Composite (Ross, 1995). The reduction sequences of the various Paleoindian culture groups are briefly discussed, with more detail following in Chapter 4.

The theoretical framework for lithic analyses is provided in Chapter 4. This is followed by a more detailed discussion of the reduction sequences observed in both fluted and non-fluted traditions. This chapter concludes with a discussion of the Lakehead Complex reduction sequence as defined by Hinshelwood and Webber (1987) and missing portions of the sequence and problems identified as needing further analysis by Hinshelwood and Ross (1992).

Chapter 5 offers the methodological framework for the analysis conducted in this thesis. It outlines and defines the metric attributes and how these measurements were obtained. This is followed by an identification of the non-metric biface attributes used to more completely describe the level of work conducted on each biface. The attributes are illustrated along with the generalized understanding of the fracture patterns observed within biface assemblages.

The results of this analysis are presented in Chapter 6, which includes a metric and non-metric summary. The bifaces are divided into stages of manufacture, and observed trends are presented regarding the flaking pattern, degree of platform preparation and nature of the fracture. These results are then discussed in greater detail in Chapter 7, specifically to relate the lithic reduction sequence observed at Mackenzie I to the Lakehead Complex as it is currently understood, and also more broadly to Paleoindian biface technological organization in general. The chapter concludes with a discussion of site functionality based on the nature of the biface assemblage. As part of this thesis a rudimentary spatial analysis was undertaken using the biface refit data. This data is presented in Chapter 8 with a brief discussion about the implications of the distance and directionality of the refitted bifaces. This was conducted in an attempt to determine what, if any, taphonomic events altered the intactness of the site and to identify if human behavior at the time of manufacture can explain the location of the refits.

Chapter 9 summarizes the outcomes of the research and offers conclusions about the lithic reduction strategy associated with the Lakehead Complex. This features definition of distinct manufacturing trajectories, where parallel oblique flaking first enters the sequence, and more fully explores the presence of blade technology within the Lakehead Complex. Finally it offers cautions about the complications of relying too fully on metric attributes to define the bifaces and their stage(s) of production.

CHAPTER 2

NORTH AMERICAN DEGLACIATION AND PALEOENVIRONMENT

2.1 INTRODUCTION

The Mackenzie I Site (DdJf-9) is located approximately 25 km east of Thunder Bay Ontario. The site is immediately to the west of the Mackenzie River gorge, and just over 1 km north of the modern shoreline of Lake Superior (See Figure 1.1 and 1.2). Its locale is characterized by closed boreal forest with both till-mantled and exposed Precambrian Shield. Glacial activity heavily impacted the formation of the modern landscape and deglaciation was the primary determining factor of initial human habitation of the region. The site is situated approximately 230 m above sea level (asl), an elevation that has been associated with relic beach ridges of proglacial Lake Minong. However, it is not clear whether the Minong level beach was active at the time of occupation, and whether or not periodic flooding by the nearby Mackenzie River had any effect on the site. For these reasons an understanding of the deglaciation events of the area is integral to site interpretation.

This chapter briefly discusses dramatic changes that occurred during the shift from the Pleistocene to the Holocene epoch. This includes the effects of climate change in the Superior basin and its effect on post-glacial biotic recovery and human occupation. This is followed by a brief discussion about the proposed subsistence base of this newly deglaciated area.

2.2 GLACIATION AND GEOMORPHOLOGY

The Last Glacial Maximum (LGM) occurred during the Wisconsinan period of the terminal Pleistocene, and is characterized by dramatic climate shifts that resulted in dynamically shifting ice fronts (Figure 2.1). This affected the immediate environment as well as the newly deglaciated landscape. The time of interest marks the transition to the Holocene epoch and eventual climatic stabilization and biotic recovery. The glaciers profoundly affected the Great Lakes watershed. The upper Great Lakes region, more specifically the Lake Superior Basin, is the area where the glacial maximum had a lasting effect. The Superior lobe remained in the basin far longer than the surrounding area and was also prone to re-advances that constrained possibilities for human occupation.

Late Wisconsinan glaciation reached its maximum during the LGM, which ranged from 21,000 to 18,000 ^{14}C years BP (~25,100 to 21,700 cal years BP) and was characterized by a relatively stable climate and low global sea levels (Dyke et al., 2002). After 18,000 ^{14}C years BP (21,700 cal years BP) the glaciers began the slow retreat northwards; this resulted in the formation of a number of glacial lakes. The glacial lakes profoundly impacted the climate and also the biotic character of the landscape (Teller, 1995 Teller et al., 2002; Teller et al., 2005; Teller and Thorleifson, 1983; Yu et al., 2010; Saarnisto, 1974; 1975; Dyke, 2004). Unequivocal evidence for the earliest human occupation of unglaciated parts of North America occurred as early as 12,650 to 14,700 ^{14}C years BP (15,000 and 18,000 cal years BP). The appearance of the most recognizable fluted projectile point tradition began at 11,050 to 10,800 ^{14}C (~12,900 to 12,700 cal years BP; Waters and Stafford, 2007). By approximately 10,000 ^{14}C years BP (11,500 cal years BP), the late Paleoindian traditions dominated North America. It was during this time period that the ice sheets had retreated far enough north for biotic recovery and human occupation to occur in the study area (Kornfeld et al., 2010; Stanford and Bradley, 2012; Dixon, 1985; Dixon, 1999; Dixon, 2001; Meltzer, 1997; Meltzer et al., 1997).

Figure 2.1: Image demonstrating the extent of the North America ice sheets during the Last Glacial Maximum (modified after Shultis, 2012: Figure 2.2).

A series of re-advances occurred along the ice front; the Marquette re-advance was the last major glacial re-advance to affect the Lake Superior basin. The Superior Lobe advanced south to the northern upper peninsula of Michigan, effectively filling the Superior basin with ice. This occurred at 10,000 ^{14}C years BP (11,500 cal years BP; Drexler et al., 1983; Lowell et al., 1999; Figure 2.2) and split the lake into ancestral Lake Minong to the east and Lakes Duluth and Beaver Bay to the northwest (Farrand and Drexler, 1985; Shultis, 2012). By approximately 9,300 ^{14}C years BP (10,500 cal years BP), the smaller lakes coalesced during the final glacial retreat to form Lake Minong (Figure 2.3; 2.3). At its height, glacial Lake Minong reached an elevation of approximately 230 m asl, roughly 47 m above the modern water plane. A radiocarbon date from the base of the Rosslyn beach indicates that Minong beaches date to after 9,500 ^{14}C years BP (10,700 cal years BP). Following the retreat of the Superior Lobe, the outlets that facilitated the drainage of Lake Agassiz into the Great Lakes Watershed opened (Leverington and Teller, 2003; Teller and Thorleifson, 1983; Boyd et al., 2012; Kingsmill, 2011; Lowell et al., 2005; Murton et al., 2010). The peninsula between Lakes Agassiz and Minong has been termed the Interlakes Region (Figure 2.6; Ross, 1995). These outlets between Agassiz and the Great Lakes were located northwest of Lake Nipigon (Figure 2.4). The outlets demonstrate flood plains littered with boulders, indicating episodes of catastrophic influx (Broecker, 2007).

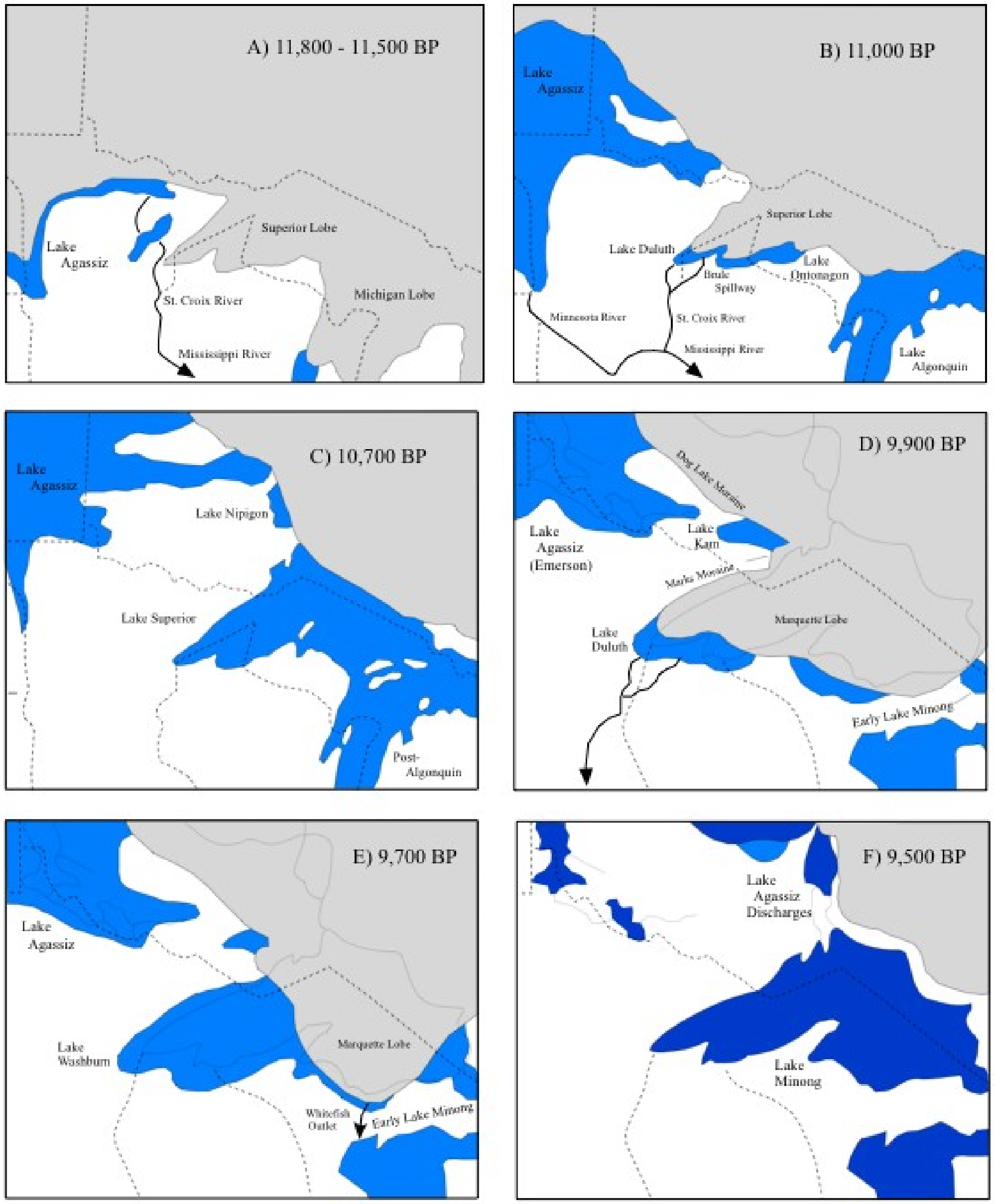


Figure 2.2: Deglaciation sequence of the Laurentide Ice Sheet in the Lake Superior basin A) from approximately 11,800 – 9,500 BP, with reference to the Glacial lakes, the Marquette re-advance is demonstrated in panel D (modified after Markham, 2013: Figure 3.1; A, B, and C modified after Farrand and Drexler, 1985: 21; D, E, and F modified after Phillips, 1993: 95).

Prior to the Marquette re-advance evidence suggests that a portion of the Lake Superior basin was ice-free and became an early glacial lake (Figure 2.3). Following the Marquette re-advance the basin was overridden, burying a forest at Lake Gribben 10,040 ± 55 ^{14}C years BP (11,404 – 11,738 cal years BP) and laying down the Grand Marais 1 moraine (Lowell et al., 1999). The retreat of the Superior Lobe allowed a series of small proglacial lakes to form, and these lakes gradually increased in size, eventually coalescing into Lake Minong once the entire basin was ice free, by around 9,500 ^{14}C years BP (10,700 cal years BP; Farrand and Drexler, 1985; Phillips and Fralick, 1994; Booth et al., 2002; Saarnisto, 1974; 1975).

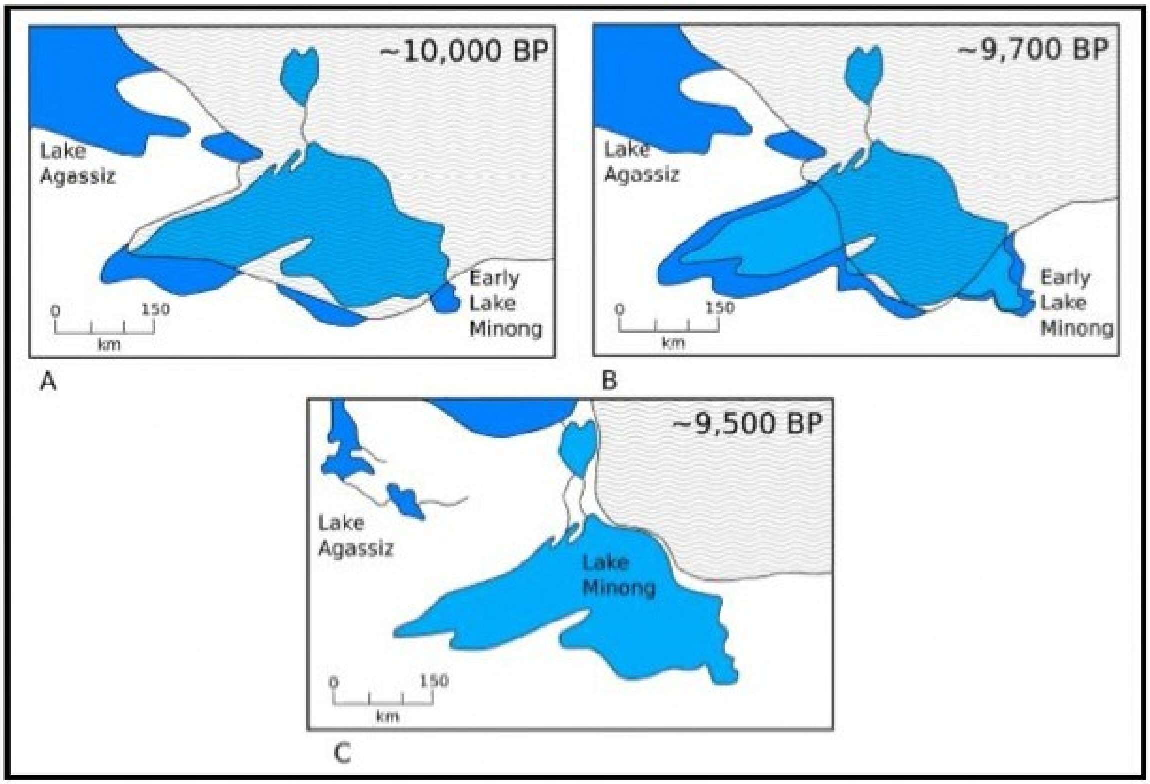


Figure 2.3: Time progressive maps of the Marquette re-advance and the formation of Lake Minong (Image from Shultis, 2013: Figure 2.9; modified after Phillips and Fralick, 1994a and 1994b).

Between 9,150 – 8,000 ^{14}C years BP (10,300 – 9,000 cal years BP) several water level fluctuations occurred in the Superior basin. The change in water elevation was the result, in part, of inflow from Lake Agassiz. Other factors contributing to these fluctuations include differential isostatic rebound, the location of the LIS margin, and the location and elevation of the Lake Minong outlet.

Sometime around 8,300^{14}C years BP (9,300 cal years BP) there was a significant drop in water level (Yu et al., 2010; Broecker et al., 2010). This has been attributed to the erosion of the Nadoway sill that previously controlled the level of Lake Minong. Around 8,000 ^{14}C years BP (8,900 cal years BP) Lake Agassiz drainage shifted to the Ottawa River valley through Lake Ojibway to the north, cutting the Superior Basin off from glacial melt water. This made it susceptible to significant drawdown compounded by widespread warming and drying (Teller and Thorleifson, 1983; Shultis, 2012; Boyd, 2007; Teller and Mahnic, 1988; Dyke and Prest, 1987; Mothersill, 1988).

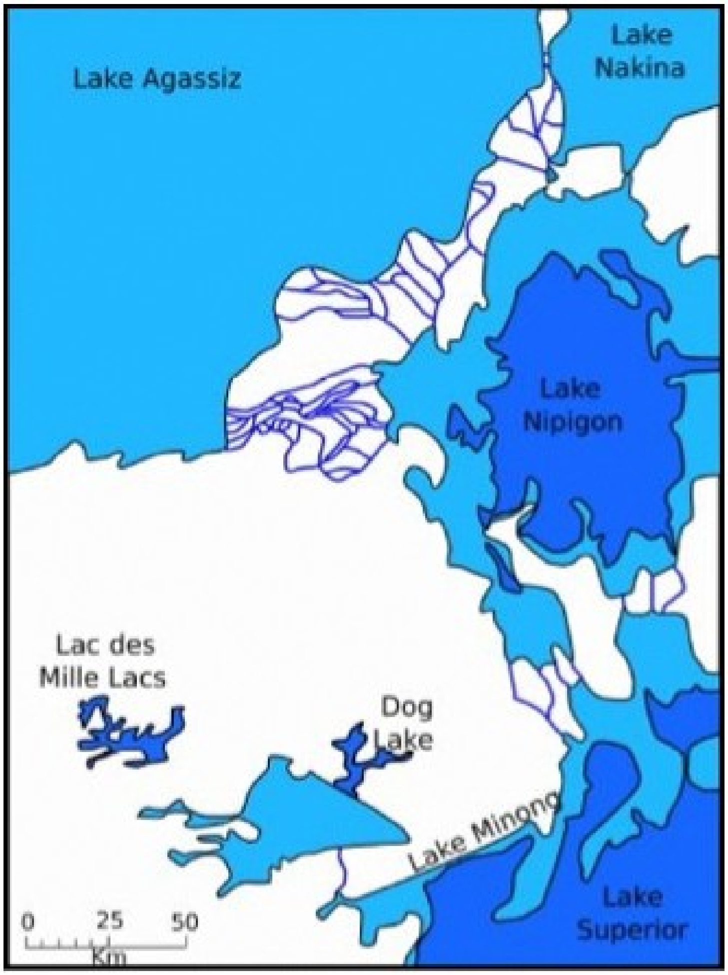


Figure 2.4: Meltwater connections between Lakes Agassiz and Lake Minong (Image from Shultis, 2012: Figure 2.7; modified after Teller and Thorleifson, 1983).

The final retreat of the LIS initiated the process that saw both lake levels and the climate begin to regularize. By around 8,000 ^{14}C years BP (8,900 cal years BP) lake levels had dropped to 183 m asl during the Houghton Low phase (Figure 205; Hunter et al., 2006; Lewis et al. 2007; Yu et al., 2010; Boyd et al., 2012; Kingsmill, 2011; O'Shea and Meadows, 2009; O'Shea et al., 2013). Lake levels then rose to near-Minong levels at around 213-216 m asl during the Nipissing transgression between 6000 – 4050 ^{14}C years BP (6,800 – 4,500 cal years BP; Fisher and Whitman, 1999; Teller, 1985; Farrand and Drexler, 1985; Kingsmill, 2011). There were fluctuations in both the climate and lake levels until the climate stabilized to near-modern conditions sometime around 4050 ^{14}C years BP (4,500 cal yrs BP).

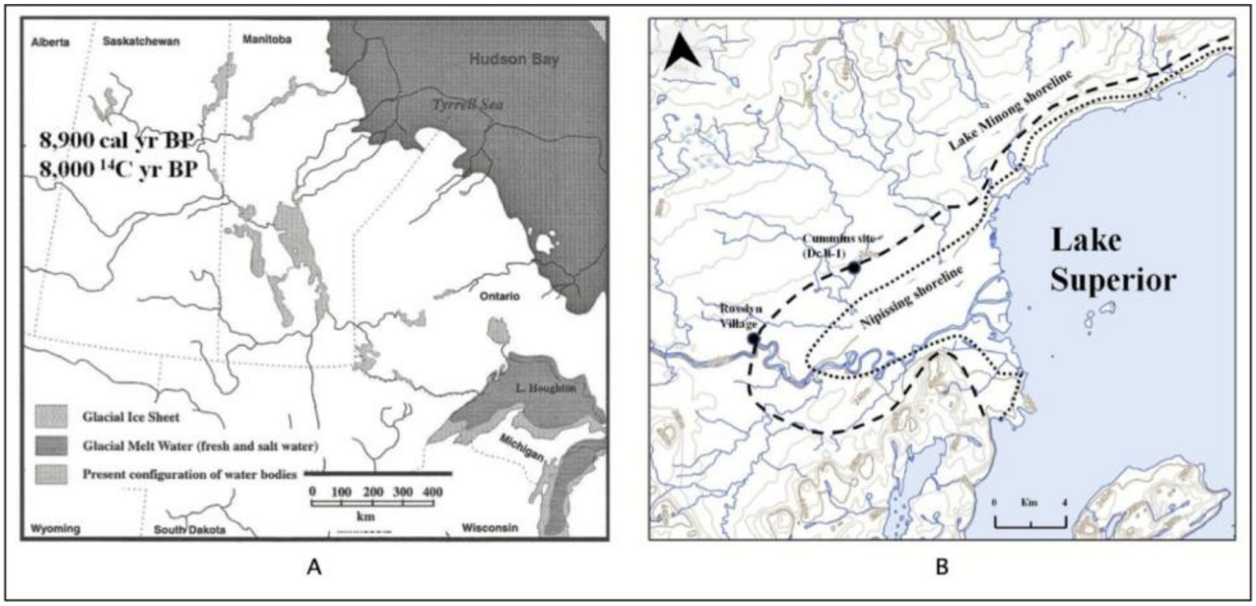


Figure 2.5: Lake level fluctuations in the Lake Superior basin. Panel A: the Houghton Low Phase; Panel B: the Nipissing Lake levels in the Thunder Bay region (Modified from Kingsmill, 2011: Figure 2.13 and 2.9; A after Hamilton 1995, B Modified after Zoltai, 1963; and Julig et al., 1990).

2.3 DEGLACIATION AND MIGRATION

Deglaciation and the resulting proglacial lakes that formed during the early period of the Holocene transition had a profound effect on the environment of the Great Lakes watershed (Dyke, 2004; Larson and Schaetzl, 2001; Leverington and Teller, 2003; Lowell et al, 2009; Teller, 1995; Zoltai, 1965; Farrand and Drexler, 1985; Slattery et al., 2007; Phillips, 1993; Brekenridge, 2007; Lowell et al., 1999; Boyd, 2003; 2007; Julig et al., 1990; Lewis and Anderson, 1989; Lewis et al., 2007; Phillips, 1988; Shultis, 2012). The retreat of the ice sheets, isostatic rebound and shifting drainages of the proglacial lakes affected the topography which in turn effected the distribution of archaeological sites in the Great Lakes watershed.

2.4 PALEOENVIRONMENTS AND THE PALEOINDIAN SUBSISTENCE BASE

During the early Holocene, fluctuating climate, lake levels and glacial ice profoundly affected the ecosystem. There is some debate regarding how fast the ecosystem recovered following deglaciation, but some estimates suggest colonization of tundra species within five years of being ice free (Björck, 1985; Boyd, 2007; Flakne, 2003; Phillips, 1988). This was not synchronous across the northern Great lakes, with events like the Marquette re-advance halting any vegetative expansion (Lowell et al., 1999). There have been several pollen coring programs carried out on the lakes surrounding the Superior basin (Phillips, 1982; Julig, 1994; Jackson and Thompson, 2002; Fisher and Whitman, 1999; Fisher, et al, 2007, Fries, 1962, Bjorck, 1985). These offer baseline data regarding the timing and relative abundance of pollen-producing plants in the area. These studies focused on small lakes that may have been embayments of Lake Minong. Coring programs not only resulted in vegetation reconstructions but also brought up datable organic gyttya. As the water levels receded, depositional processes reverted to those of smaller more isolated bodies of water. These and other studies have been used as indicators for the paleoenvironment of the Upper Great Lakes basin (Breckenridge, 2007; Fisher and Whitman, 1999; Fisher et al., 2007; Flakne, 2003).

2.4.1 Biotic Recovery Following Deglaciation

The evidence suggests that biotic recovery in the Superior basin region was asynchronous. In northeastern Minnesota vegetation began to colonize the newly deglaciated landscape by around 14,000 ^{14}C years BP (17, 200 cal years BP). In this area the sequence began with tundra immediately after deglaciation. This was followed by the expansion of open parkland forest mixed with tundra. A more closed mixed forest environment followed that was in turn replaced by pine dominated closed forest with some hardwoods (Björck, 1985). The transition from tundra to forest was not simultaneous across the northern fringes of the upper great lakes. This is especially true later on when spruce and white pine began migrating northward (Björck, 1985; Fries, 1962; Julig, 1994).

Pollen cores from central and northern parts of Lake Agassiz in Manitoba suggest that between 13,000 and 10,000 ^{14}C years BP (15,800 and 11,500 cal years BP) spruce was abundant in well drained areas with willow and poplar in poorly drained areas. In more arid areas typical prairie vegetation was present with grasses, shrubs and sage, while in central and eastern areas spruce fully replaced tundra which was in turn replaced by pine around 10,000 ^{14}C years BP (11,500 cal years BP). Spruce to pine transition did not occur in the immediate Thunder Bay area until around 9,400 ^{14}C years BP (10,600 cal years BP), gradually increasing by around 8,500 ^{14}C years BP (9,500 cal years BP) (Flakne, 2003; Bjork, 1985). Climate began to warm rapidly following the Marquette retreat and from 10,000 to 6,500 ^{14}C years BP (11,500 to 7,400 cal years BP) the climate was warmer and dryer with less precipitation. There was a period of more intense dune formation and loess distribution between 8,000 and 9,000 ^{14}C years BP (8,900 and 10, 200 cal years BP) (Julig, 1994; Björck, 1985; McAndrews 1982; Phillips, 1993; Anderson and Lewis, 1992; Karrow, 2004).

2.4.2 Paleoindian Subsistence Base

The subsistence base for Lakehead Complex sites is not well known as little to no faunal material has been recovered. Thus, researchers often will extrapolate from other late Paleoindian sites in order to interpret the Lakehead Complex subsistence economy. To the south and west at the Itasca and Sinnock sites bison remains have been found in association with Paleoindian materials (Shay, 1971; Pettipas and Buchner, 1983; Buchner, 1981; Julig, 1994). The people represented by these remains are believed to have lived in small, highly mobile, hunting groups that were economically self-sufficient and heavily reliant on big game hunting (Grayson and Meltzer, 2002; Hill, 2007; Kornfeld et al., 2010; Mason, 1997; Peers, 1985; Pettipas and Buchner, 1983). Fox (1975) hypothesized heavy reliance on caribou, supplemented with fish and smaller game. Dawson (1983c) also suggested major reliance on caribou, but that the diverse toolkits indicate a more generalized hunting, fishing and gathering economy. Paleoindian subsistence strategies are now believed to be far more generalized as evidence from sites in the west have revealed that small game hunting and plant processing practices were common (Kornfeld et al., 2010; Haynes, 1980; Adovasio et al., 1978; Adovasio et al., 1990). In the Interlakes Region between Lakes Agassiz and Minong (Figure 2.6) the subsistence base has been extrapolated based on the environmental conditions, the position of the glacial front, lake levels, and climate. Based on these factors, a likely suite of plant and animal resources are hypothesized to have been available to Paleoindian groups in the area. Evidence from sites in the area includes bone that was identified as caribou at the Cummins site and has since been positively identified as belonging to a white tail deer (Julig, 1994). Another bone fragment from Cummins has been identified as belonging to a large cervid (moose, caribou or elk). At the Holcombe site in Michigan caribou remains have been identified. It is possible that bison could have been available during the Hypsithermal ca. 9200-3600 ^{14}C years BP (10,300 – 3,900 cal years BP) (Julig, 1994; Buchner, 1980).

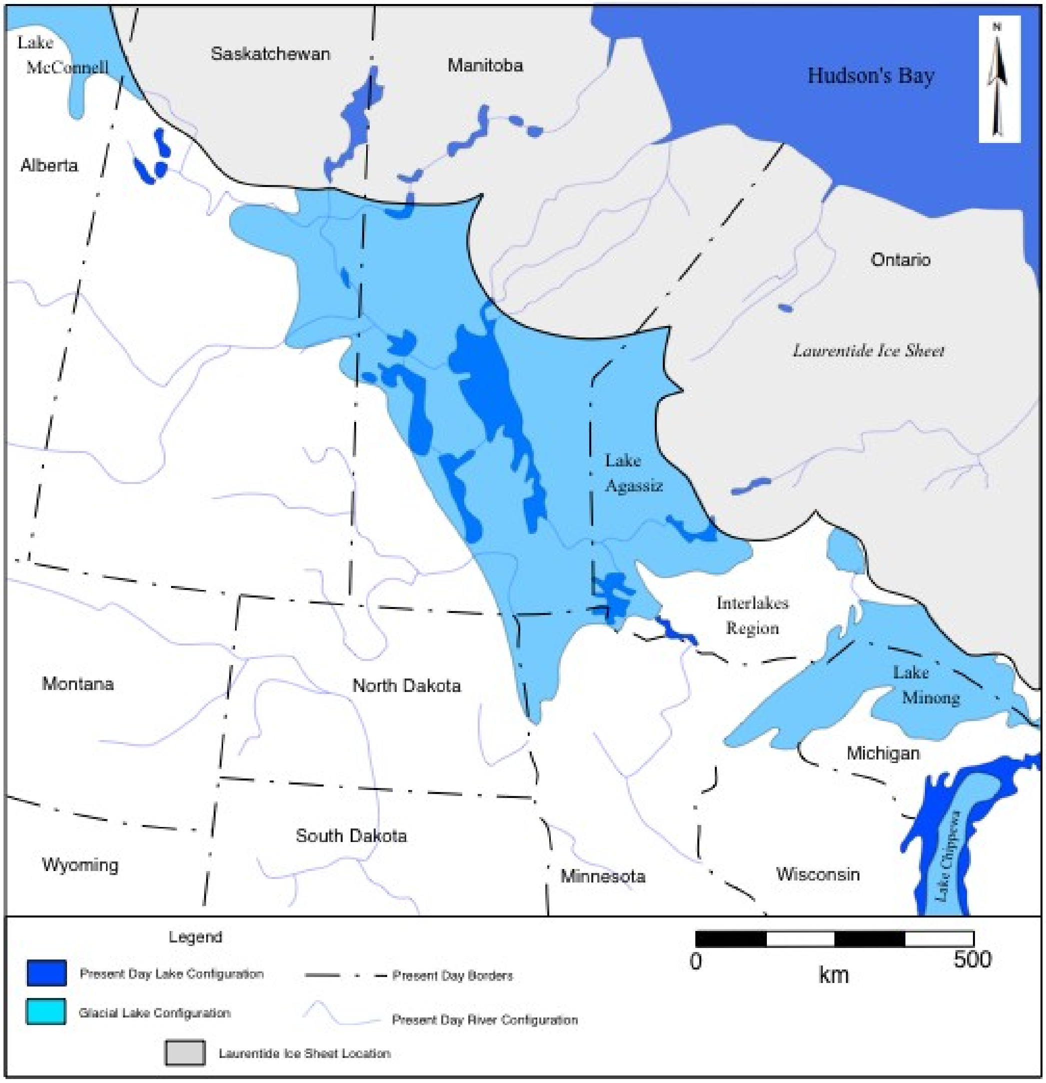


Figure 2.6: Map of the Interlakes Region circa 9500 BP (modified after Ross, 1995: Figure 1 pg 245).

Climatic and environmental data suggest that there was a wide range of food resources available to Paleoindian groups in the area. Due to poor organic preservation and/or because of excavation methods, little to no subsistence data has been found in many of the sites in the Upper Great Lakes region. Soils in the region are highly acidic which has a profound effect on organic materials. Analysis of organic residue found on tools may be the only way such evidence can be found. Until a datable, stratified site with good organic preservation is found within the Upper Great Lakes it can only be speculated as to what Paleoindian and Early Archaic people were utilizing as their subsistence base.

2.5 SUMMARY

The retreat of the glaciers had a profound effect on the environment and was a limiting factor on biotic recovery and human occupation and migration. The presence of the glaciers and the subsequent glacial and pro-glacial lakes affected the climate as well. It is believed that biotic recovery could have occurred as soon as 5-10 years after land masses becoming ice free (Björck, 1985; Boyd, 2007; Flakne, 2003; Phillips, 1988). Once the environment had recovered it was possible for fauna and human occupation to occur. The terminal dates for glaciers combined with the lake level fluctuations provide dates for when migration and occupation by both fauna and humans was possible. The fluctuations of lake levels post-Minong gives rise to the possibility that transitional Paleo-Archaic sites are submerged below Lake Superior.

CHAPTER 3

PALEOINDIAN CULTURE HISTORY SEQUENCE

3.1 INTRODUCTION

This chapter offers a synthesis of the Paleoindian culture history for North America. It begins with a brief description of the initial peopling of the Americas and what is understood about Paleoindian subsistence practices. This is followed by a discussion of the Paleoindian occupation of the study region. Also included, is a discussion of the preferred local raw material and its fracture mechanics. The chapter also includes a review of the exotic materials usually associated with Lakehead Complex assemblages, and concludes with a synthesis of the identified archaeological complexes.

3.2 THE PEOPLING OF THE NEW WORLD

The initial peopling of the Americas occurred sometime between 12,650 and 14,700 ^{14}C years BP (15,000 and 18,000 cal years BP). This coincided with the timing of the last glacial maximum, thereby constraining the lands available for occupation. A drop in global sea levels exposed much of the continental shelves as well as the Bering Land Bridge or Beringia. Berinigia connected Siberia and the Americas allowing the transfer of fauna and opening up new lands for human settlement (Figure 3.1). The rise in sea levels is believed to have obscured evidence for human movement and settlement in Beringia and along the continental shelf. Nevertheless there is evidence in both Alaska and Siberia of an Arctic-adapted people making use of an Upper Paleolithic microblade technology (Stanford and Bradley, 2012), although, there is no evidence for a bifacial tool technology that would explain the presence of Clovis lithic technology. This suggests that something influenced tool technology that has not yet been determined (Bever, 2001; 2006; Dixon, 1985; Dumond, 2001; Hoffecker, 2002; Meltzer, 2009; Stanford and Bradley, 2012)

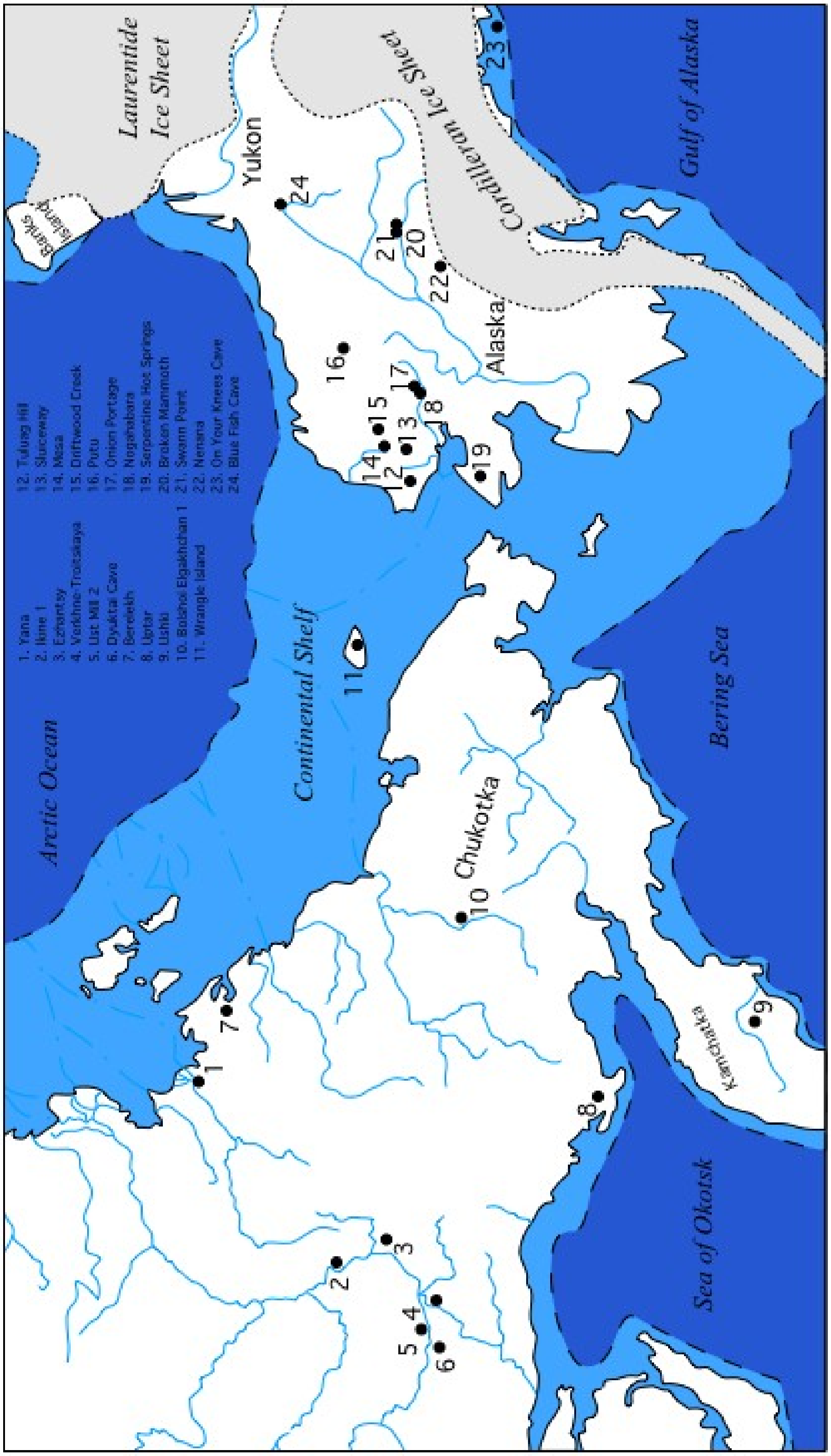


Figure 3.1: Map of Beringia with known sites (modified after Stanford and Bradley 2012)

The most widely accepted interpretation for the peopling of the Americas revolved around the 'Clovis first' hypothesis. This idea held that Clovis groups 11,050 to 10,800 ^{14}C years BP (13,125 to 12,925 cal years BP) crossed Beringia at some time prior to 12,500 ^{14}C years BP (14,800 cal years BP) to occupy deglaciated parts of Alaska and the Yukon. As deglaciation proceeded, the so-called "ice free corridor" opened between the Laurentide and Cordilleran Ice Sheets, allowing people to migrate southward to the deglaciated parts of North America (Martin, 1973; Hamilton and Buchannan, 2007; Whitley and Dorn, 1993). Recent studies have revealed that, at times, the ice free corridor would have been closed, although it is possible that it was actually open later than previous estimates (Dyke, 2004; Dyke et al., 2002; Jackson et al., 2000). As an alternative, other researchers proposed the "Northwest Coast Route" whereby populations might have moved south along the exposed continental shelf to populate the Americas long before the opening of the Ice Free Corridor (Dixon, 1999; Fedje and Christensen, 1999; Fladmark, 1979; Mandryk et al., 2001; Whitley and Dorn, 1993). The third hypothesis attempts to address the older sites found in South America that date prior to the earliest Clovis sites. These older sites discovered are also used as evidence explaining the coastal migration route hypothesis (Dillehay et al., 1982; Waters et al., 2011; Anderson and Gillam, 2000; Hamilton and Buchanan, 2007). Sites such as Meadowcroft Rockshelter in Pennsylvania (Adovasio et al., 1978) and Monte Verde in Chile (Dillehay et al., 1982; Fiedel, 1999; Waters et al., 2011) appear to support the presence of a pre-Clovis occupation of the Americas, as does the recent discovery of a complex underlying the Clovis levels at the Debra L. Friedkin Site in Texas. This has been identified as the Buttermilk Complex (Waters et al., 2011). See Figure 3.2 for the proposed migration routes for these various hypotheses.

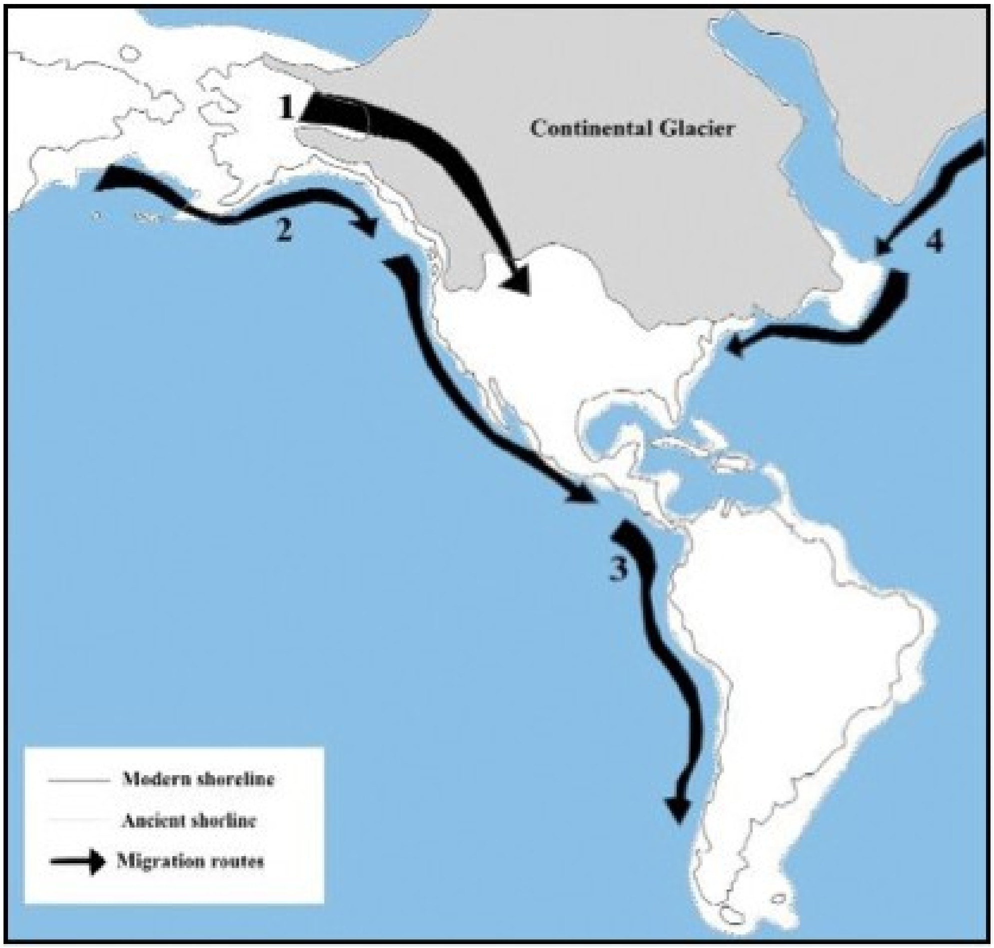


Figure 3.2: Map of the proposed migration routes, Ice Free Corridor (1), Northwest Coast Route (2) Pacific Coastal Route (2 and 3), Atlantic Ice Edge Route (4), (Image from Markham, 2013: Figure 2.3; modified after Stanford and Bradley 2012).

Stanford and Bradley (2004; 2012) have argued for an Atlantic coast ice margin migration. They propose that this was undertaken by a marine-adapted group of Solutrean people from the coastal regions of France, Spain and Portugal. This argument is circumstantially supported by the lack of evidence for a specialized bifacial technology present in Siberia and Alaska to explain the unique fluted point traditions that marked the early Paleoindian period in North America. Their argument is based on the discovery of early sites in the eastern United States that suggest a pre-Clovis occupation, the discovery of bifaces from the submerged continental shelf and the similarity in manufacture techniques between Clovis and Solutrean bifacial reduction strategies (Stanford and Bradley, 2004; 2012).

Current research has been focused on seeking evidence regarding the Northwest Coast and the Atlantic Ice Edge migration hypotheses. Explorations of the east and west coast shorelines include mapping of the continental shelf, dredging the coastal margins, dating of the coastal landforms and searching for inland sites with preserved stratigraphy and datable material (Stanford and Bradley, 2012; Fiedel, 1999; Hamilton and Buchannan, 2007).

3.3 PALEOINDIAN SUBSISTENCE PATTERNS

Paleoindian people are generally interpreted to have been organized in small mobile hunter-gatherer groups that were highly self-sufficient (Mason, 1997). Much of the information about subsistence and economy derives from sites located on the high plains and in the Rocky Mountains, and this has led to assumptions that these groups were primarily Pleistocene big game hunters (Grayson and Meltzer, 2002; Hill, 2007; Kornfeld et al., 2010; Mason, 1997; Peers, 1985; Pettipas and Buchner, 1983). This idea has begun to shift, as investigations have revealed that plants and smaller fauna were exploited as well (Kornfeld et al., 2010; Haynes, 1980, Julig, 1994; Adovasio et al., 1978, Dixon, 1999; Morlan, 2003; Wilson and Burns, 1999).

In the Plains region, the extinction of mammoth and other Pleistocene megafauna caused a shift to the more intense exploitation of bison. This perpetuated the idea that Paleoindians were specialized big game hunters, as the large kill sites on the plains appeared to support the idea they placed a heavy reliance on bison for subsistence (Hill, 2007; Kornfeld and Larson, 2008; Frison, 1996, Frison and Stanford, 1982; Frison, 1974; Kornfeld et al., 2010; Mason, 1997). This idea is often inappropriately applied to other Paleoindian sites with similar diagnostic tools. Evidence for a broad spectrum subsistence economy centered on the acquisition of both large game (mammoth, bison, caribou, and elk) and small game mammals (deer, hare, and beaver), as well as birds fish and plants, is increasing. The diverse subsistence economy is revealed at sites such as Meadowcroft Rockshelter in Pennsylvania and Bluefish Cave in the

Yukon (Adovasio et al., 1978; Hill, 2007; Kornfeld et al., 2010; Kornfeld and Larson, 2008; Peers, 1985; Julig, 1994; Dixon, 1999; Morlan, 2003; Wilson and Burns, 1999).

3.4 THE PALEOINDIAN TRADITION

The initial peopling of the Americas resulted in the appearance and spread of hunter-gatherer groups into newly deglaciated areas. Many sites documenting this appearance have little to no organic preservation and interpretation of cultural traditions is based on diagnostic artifact types (fossil-markers). Diagnostics from the Paleoindian period include specially worked lithic tools such as projectile points and/or knives. Cultural affiliation is often assumed between sites based on similarities in diagnostic projectile point forms. The Paleoindian period is divided into the Fluted and Non-Fluted traditions. However, debates continue as to how the Clovis culture arose and when the Paleo-Archaic transition occurred.

3.4.1 Fluted Point Traditions

Clovis lithic assemblages are defined by fluted lanceolate points with parallel or slightly convex edges and a concave base defined by lateral and basal grinding. The flute is present on both faces and extends to at least half the length of the point (Wormington 1957; Bradley, 1982; Callahan, 1979; Witthoft, 1952; Fitting, 1963; Stork, 1983; Justice, 1987; Fagan, 2005; Irwin and Wormington, 1970; Kornfeld et al., 2010; Kooyman, 2000; Howard, 1990) (Figure 3.3). Clovis sites have been dated from 11,050 to 10,800 ^{14}C years BP (13,125 to 12,925 cal years BP) (Waters and Stafford, 2007). Clovis age range is constantly shifting with the discovery of new sites and the application of new dating methods (Haynes et al, 1984; Haynes, 2008; Haynes, Jr., 1991; Ferring, 2001). The range extends across much of North America with geographical restrictions in the north as a result of the ice front and the pro-glacial lakes (Justice, 1987, Waters and Stafford, 2007; Kornfeld et al., 2010).

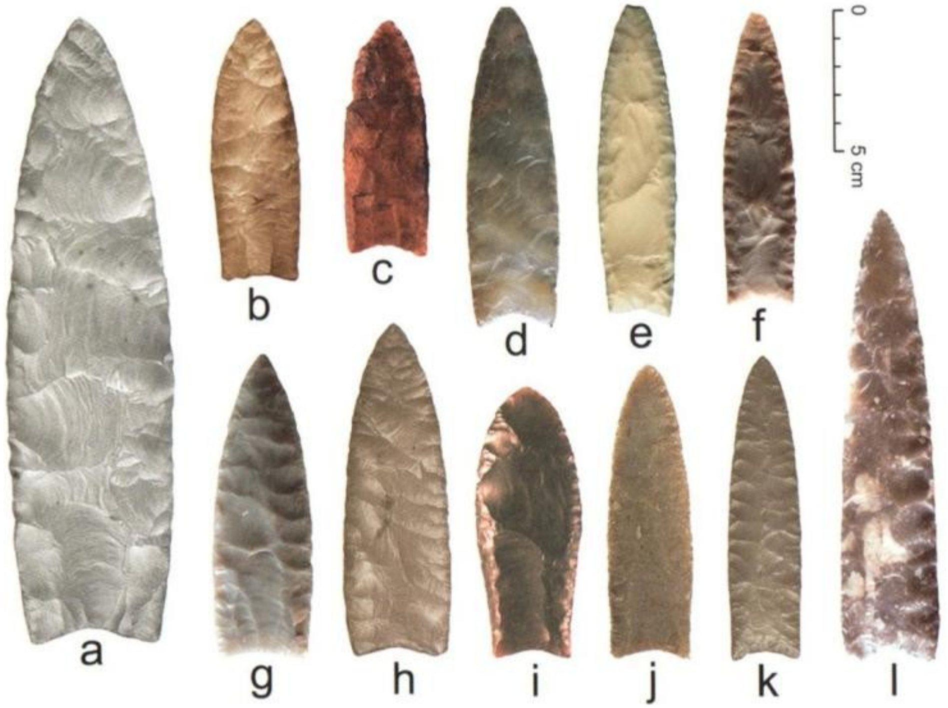


Figure 3.3: Variation of Clovis points (modified after Bradley et al, 2010: Plate 3).

Clovis manufacture methods have been widely studied due, in part, to the flutes found on both faces. Many of the Clovis age lithic assemblages have been extensively studied and the reduction sequence for Clovis projectiles has been determined (Callahan, 1979; Bradley et al., 2010; Waters et al., 2011). Callahan (1979) studied two large Clovis assemblages and defined the reduction sequence using the materials present and by replicating the assemblage. Callahan's interpretation of the Clovis manufacture method has been the basis of all subsequent conceptual models of tool production applied to Paleoindian groups. Another important aspect of Clovis lithic technology is the use of blade technology alongside bifacial tool technology (Collins, 2002; Waters et al., 2011). The conceptual model as first observed by Callahan (1979) will be discussed in greater detail in Chapter 4).

The Folsom tradition is defined with reference to projectile points that are lanceolate with parallel to slightly convex sides and a concave base. The major difference between Clovis and Folsom projectiles is the flute which, on Folsom points, was usually a single large channel flake which extended nearly to the tip on both faces. The edges were then finely worked using pressure flaking techniques. Folsom points are thin with small straight edges, may have ears present on the basal edges and a snub-nosed tip (Crabtree, 1966; Flenniken, 1978; Fagan, 2005; Irwin-Williams et al., 1973; Irwin and Wormington, 1970; Justice, 1987; Kornfeld et al., 2010; Wormington, 1957) (Figure 3.4). Folsom occupations have been dated to between 10,900 and 10,000 ^{14}C years BP (12,800 to 11,500 cal years BP), mainly from sites located in the western United States (Fagan, 2005; Frison, 1991; Justice, 1987; Kooyman, 2000; Kornfeld et al., 2010; Roosa, 1965; Wormington, 1957). The Folsom tradition is considered to be a regional phenomenon largely limited to the Southwest, Central Plains and parts of the upper Mississippi Valley while Clovis sites have been found across North America (Frison, 1991; Justice, 1987; Kornfeld et al., 2010)

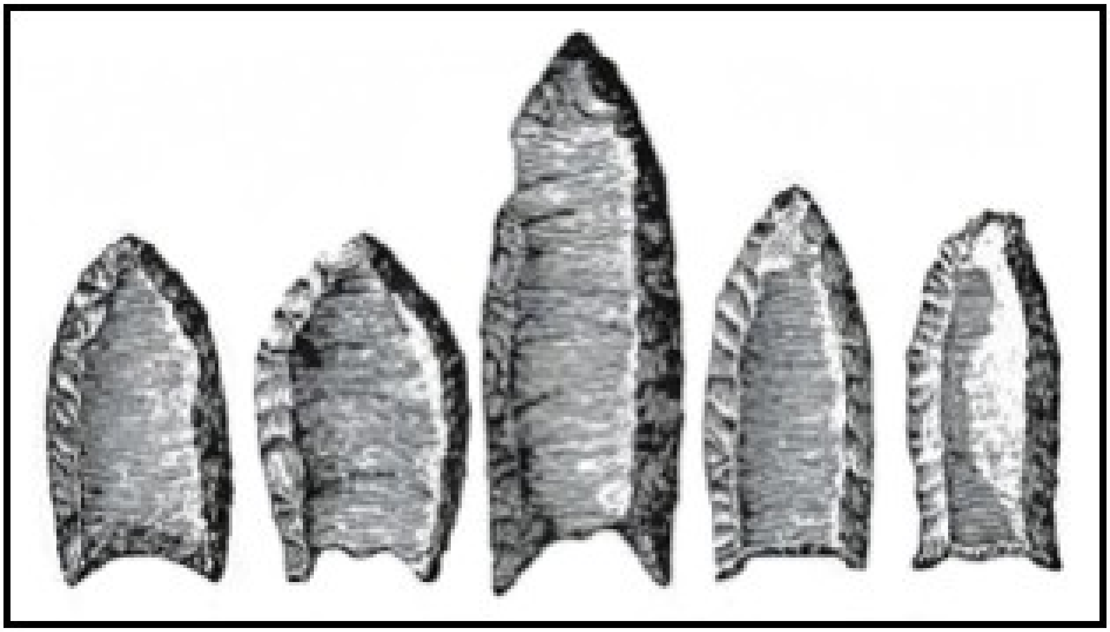


Figure 3.4: Variability in Folsom projectile points from the Lindenmeir Site. (Image from Markham, 2013: Figure 2.8; modified after Wilmsen and Roberts Jr., 1979: 114, 115).

Reduction sequence studies have been undertaken for Folsom points as well. Crabtree (1966) examined the finely made Folsom points recovered from the Lindenmeir site, and sought to explain how they were produced. Using Crabtree's conclusions, Flenniken (1978) revisited the Lindenmeir assemblage and made some changes to the sequence of events. These were centered, like much of the Clovis reduction studies, on how the final shape was achieved and the sequence of the fluting. The conceptual model (Crabtree, 1966; Flenniken, 1978; Frison, 1991; Bradley and Frison, 1987; Bradley, 2009; 2010) has been determined and will be discussed in greater detail in Chapter 4.

The fluting observed on the early Paleoindian Traditions creates very distinct tool types readily distinguishable from each other as well as from the subsequent non-fluted traditions. The purpose of the flute may have been to facilitate hafting or it may have simply been favoured for the aesthetic effect (Wormington, 1957; Justice, 1987; Howard, 1990; Frison, 1991; Mason, 1997; Kooyman, 2000; Kornfeld et al., 2010). Eastern variants such as Cumberland (Figure 3.5: A; Justice, 1987; Roosa, 1965) and Barnes are present and are lumped by some into the Clovis tradition (Stanford and Bradley, 2012). Other eastern variants of the fluted tradition include Holcombe (Figure 3.5: D; Fitting, 1966; Mason, 1963; MacNeish, 1952; Deller, 1983; Storck, 1984; Justice, 1987), Debert (Figure 3.5: B; Bradford, 1976; Justice, 1987; Macdonald, 1966), and Hi-Lo (Figure 3.5: E; Justice, 1987; Fitting, 1966; Ellis and Deller, 1982; Smith et al., 2010). Other variants include Gainey, Barnes and Crowfield (Figure 3.5: C; Deller, 1979; 1983; Ellis and Deller, 1982; Ellis et al., 1998; Wright and Roosa, 1966; Roberts, 1984; Simons et al., 1984). The points identified as variations are addressed more completely by Markham (2013), Stanford and Bradley (2012), Kornfeld et al. (2010), and Justice (1987). The subsequent non-fluted or Plano traditions are classified into several competing typologies that overlap geographically and temporally.

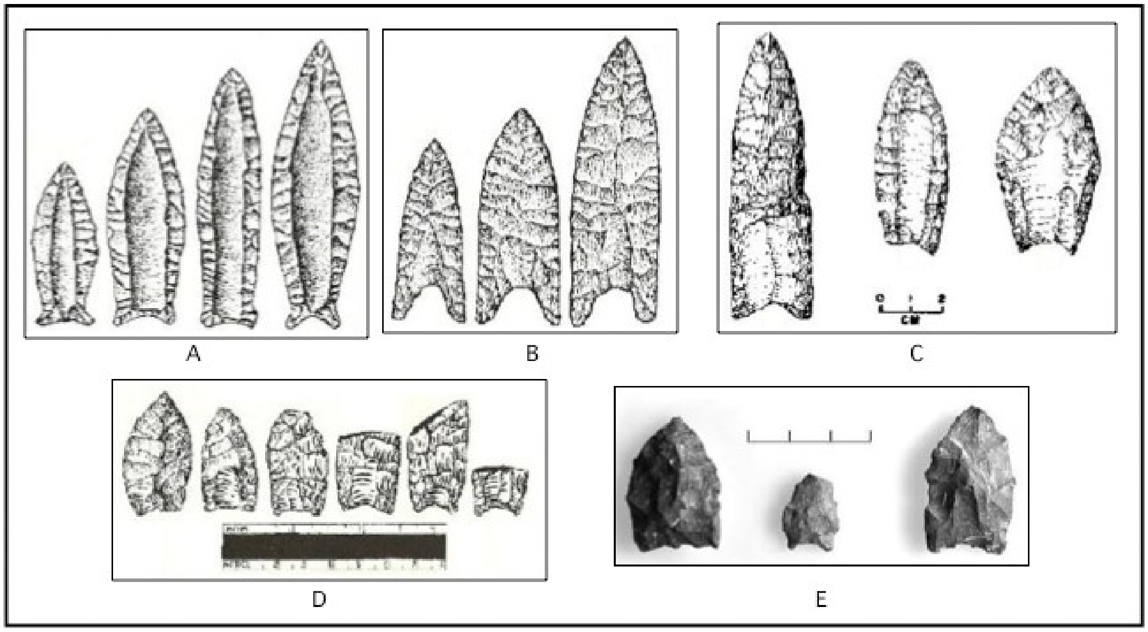


Figure 3.5: Regional variability of the fluted traditions A) Cumberland Projectiles B) Debert Projectiles C) left to right: Gainey, Barnes, and Crowfield D) Holcombe, E) Hi-Lo projectile points (Image from Markham, 2013: Figure 2.10-2.14; A Modified after Bradford, 1976 B Modified after Bradford, 1976; Justice, 1986; MacDonald, 1966 C Modified after Ellis et al., 1998 Figure 4: 155 D Modified after Fitting et al., 1966: 42 E Modified after Smith et al., 2010).

3.4.2 Non-Fluted/Plano Traditions

The Plano traditions are more diverse from a morphological perspective, but they also overlap with each other temporally and geographically. A number of the fluted traditions following Folsom overlap with the earliest Plano traditions as well. Large multi-component sites with well defined and dated occupation layers (often found on the Great Plains) have been widely used to define a projectile sequence and then apply it to similar recoveries found in other regions that less frequently yield stratigraphically ordered sequences. It is not always clear whether the temporal ordering observed on the Plains has relevance in other regions far removed from the type site. These extrapolations can be challenged in circumstances of morphological ambiguity. For much of the mid-continental United States the accepted Late Paleoindian cultural sequence is as follows: Plainview/Goshen, Agate Basin, Hell Gap, Dalton, Cody (Scotsbluff/Eden), and Frederick (Frison and Stanford, 1982; Irwin-Williams, 1973; Wormington, 1957; Justice, 1987; Howard, 1990; Frison, 1991; Mason, 1997; Kooyman, 2000; Kornfeld et al., 2010).

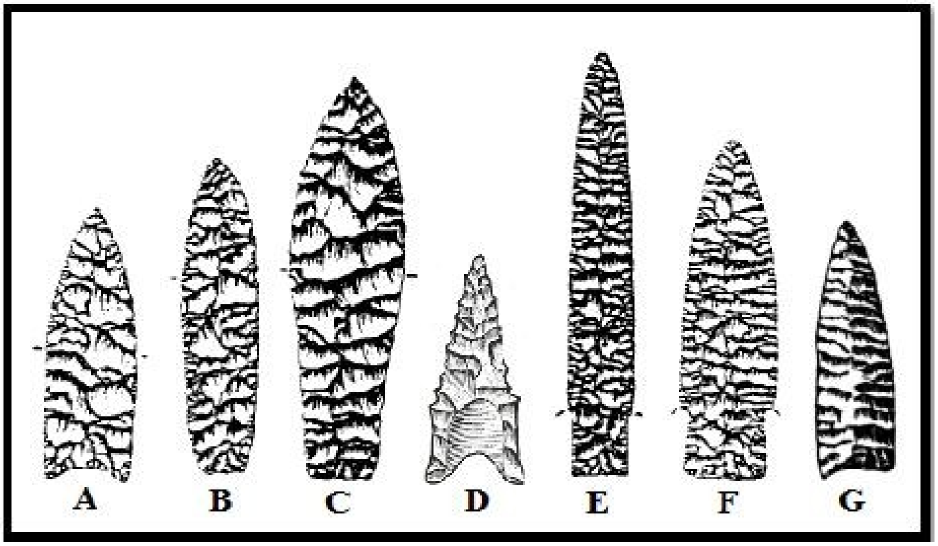


Figure 3.6: Demonstrating the Late Paleoindian projectile point styles A) Plainview/Goshen B) Agate Basin C) Hell Gap D) Dalton E) Eden/Cody F) Scotsbluff/Cody G) Frederick/James Allen (Image from Markham, 2013: Figure 2.9; modified after Frison, 1998; Sellet, 2001).

Plainview and Goshen are two names for the same cultural horizon. The modal form of these projectiles is parallel to slightly convex, with concave bases, basal thinning and lateral and basal grinding (Figure 3.6: A). Finishing flakes were removed at right angles to the long axis of the projectile. They exhibit fine edge work using pressure flaking techniques not observed on Clovis points, but which is observed on Folsom points. Plainview/Goshen artifacts exhibit similar reduction strategies as Clovis and blades have also been found in association (Kornfeld et al., 2010; Sellet, 2001; Holliday et al., 1999). Dates for Plainview horizons range from 10,170 to 10,660 ^{14}C years BP (11,800 to 12,600 cal years BP) (Holliday et al., 1999) while Goshen horizons from the Hell Gap Site date between 10,900 to 10,000 ^{14}C years BP (12,900 to 11,500 cal years BP) and occur with fluted points (Sellet, 2001).

Agate Basin points have an elongated lanceolate shape with a thick lenticular cross-section. They exhibit parallel to constricting sides and often have a flat to slightly convex base (Figure 3.6: B). They exhibit little to no basal thinning and have near-perfect bilateral symmetry of the edges. Agate Basin points exhibit fine pressure flaking on the edges while overshot flaking has been observed in the early stages of the production sequence (Wormington, 1957; Irwin and Wormington, 1970; Irwin-Williams et al., 1973; Frison and Stanford, 1982; Shelley and Agogino, 1983; Justice, 1987; Mason, 1997; Morrow and Morrow, 1999; Kornfeld et al., 2010; Kooyman, 2000; Fagan, 2000, Larson et al., 2009). The Agate Basin assemblages are said to date between 10,500 and 9,400 ^{14}C years BP (12,400 and 10,600 cal years BP) (Kornfeld et al., 2010; Justice, 1987; Fagan, 2000; Wormington, 1957; Frison and Stanford 1982). Bradley (2009; 2010) describes the Agate Basin reduction sequence, and it will be discussed in greater detail in Chapter 4.

Hell Gap points are defined by the stem which is created by basal constriction below the shoulders defining the blade portion. The basally constricted portion generally accounts for half the length of the point. The bases are again flat to slightly convex and the edges exhibit fine edge retouch and lateral grinding of the stemmed portion (Figure 3.6: C). Hell Gap points typically display co-medial to random flaking patterns resulting in a thick lenticular to diamond cross-section. (Justice, 1987; Agogino, 1961; Larson et al., 2009; Irwin-Williams et al., 1973; Irwin and Wormington, 1970) The Hell Gap complex dates to between 10,000 and 9,500 ^{14}C years BP (11,500 and 10,700 cal years BP) (Kornfeld et al., 2010), Larson et al., (2009) report a date of 10,240 ± 300 ^{14}C years BP (11,450 to 12,441 cal years BP) for the Hell Gap/Alberta layer. Bradley (2009; 2010) discusses the Hell Gap reduction sequence which will be discussed in greater detail in Chapter 4.

Dalton projectile points are characterized by parallel to slightly incurvate lateral edges, a deep basal concavity, basal and lateral grinding, extended basal thinning scars and basal ears and an emphasis on lateral edge re-sharpening to create a serrated blade (Figure 3.6: D) (Goodyear, 1982; Justice, 1987). Dalton horizons have been identified and dated at Graham Cave (Logan, 1952; Klippel, 1971), Modoc Rock Shelter (Fowler, 1959a; 1959b) and Rogers Rock Shelter (Goodyear, 1982). These sites indicate Dalton ranges from between 10,500 and 9,900 ^{14}C years BP (12,400 and 11,300 cal years BP). There is some confusion about this complex as there are significant traits which indicate early Paleoindian (the near fluting of the base) and others which indicate Archaic (serrated triangular blade). Despite the relatively early absolute dates, these and other traits have led some to assign Dalton a late Paleoindian affiliation (Kornfeld et al., 2010; Justice, 1987; Goodyear, 1982; Wormington, 1957), or a transitional Paleo/Archaic designation (Tuck, 1974; Logan, 1952).

The Cody Complex consists of a cluster of diagnostic projectile points including Alberta, Eden and Scotsbluff points, all of which are found in association with the Cody knife (Hafted). This complex is divided into Alberta-Cody I and Alberta-Cody II based on technological differences in manufacture. Overall, these points are all large and parallel sided, with a stemmed base and well-defined shoulders. They all exhibit co-medial flaking patterns that result in a diamond cross-section, with the primary difference being the width of the blade portion. Alberta and Cody points generally have a broad blade with a lenticular cross-section, while the Eden and Scotsbluff points are long and narrow, resulting in a more well-defined diamond cross-section (Figure 3.6: E,F) (Wormington, 1957; Justice, 1987; Mason and Irwin, 1960; Kooyman, 2000; Kornfeld et al., 2010). Biface reduction dominates with very little evidence of blade or flake reduction. According to Knudson (1982) this demonstrates a marked technological shift away from that of the early Plano and fluted traditions. Minocqua points have been placed by Mason (1963) and Salzer (1974) into this complex, but Knudson (1982) does not think that these points bear any resemblance to plain-derived artifacts. Cody Complex materials are often found in association with *Bison antiquus* giving a date range of between 9,000 to 8,000 ^{14}C years BP (10,200 to 8,900 cal years BP) (Wormington, 1957; Mason and Irwin, 1960; Irwin and Wormington, 1970; Justice, 1987; Kornfeld et al., 2010; Kooyman, 2000, Larson et al., 2009). Bradley (2009; 2010) discusses the Cody Complex reduction sequence that is discussed in greater detail in Chapter 4.

Frederick/James Allen complex projectiles are considered to be a related suite of points dating from the terminal Paleoindian period. There is a range of names given to these projectiles, but they are all lanceolate with concave bases, basal thinning and narrow parallel oblique pressure flaking (Figure 3.6: G). The pattern is so fine that in most cases it has been determined that the flaking was directed from upper left to lower right (Julig, 1994). The similarity observed in the Lakehead Complex points has led some researchers to include them in the Frederick and/or James Allan Complex (Kornfeld et al., 2010).

Julig (1994) includes Frederick, James Allen, Lusk, Angostura and Brown Valley points within this complex. This complex is still not well defined with dates ranging from 8,400 – 8,000 ^{14}C years BP (9,400 – 8,900 cal years BP) at the Hell Gap site, and to approximately 9,080 $^{14}C \pm 50$ years BP (10,214 – 10,276 cal years BP) at the Norton site (Kornfeld et al., 2010). Dates from Mummy Cave range from 9,200 to 8,100 ^{14}C years BP (10,300 to 9,000 cal years BP) (Frison, 1978).

These points show an abrupt shift back to the lanceolate style points seen prior to Cody complex materials. The parallel oblique pressure flaking is considered by Frison (1978) to be a very significant change as well. The James Allan points exhibit similar flaking patterns and morphology to the Frederick points with a date of 8,405 $\pm$ 25 ^{14}C years BP (9,438 – 9,472 cal years BP) from the type site. Lusk projectile points are described on the basis of a small assemblage from the Betty Greene site. These points are lanceolate with parallel oblique flaking that is similar to Frederick points, but are narrower and thicker. This results in a smaller width to thickness ratio, and they tend to have a D-shaped cross-section. Lusk points date slightly later than James Allan types, 7,900 ^{14}C years BP (8600 cal years BP). The flaking pattern is also slightly more irregular, and the D-shaped cross-section likely derives from their production from blades and flakes (Julig, 1994; Bradley, 2009; 2010). Bradley (2009; 2010) discusses the Frederick/Lusk reduction sequence that will be discussed in greater detail in Chapter 4.

3.5 PALEOINDIAN PERIOD IN NORTHWESTERN ONTARIO

The synthesis of the understanding of the Paleoindian occupation of the Thunder Bay region began with the identification of the Lakehead Complex (Fox, 1975; 1980), with later contributions by Bill Ross (1979; 1995; 2011). Fox (1975; 1980) proposed that the Paleoindian occupation began around 9500 years ago and was associated with strandlines of proglacial Lake Minong and exposed outcrops of Gunflint Formation material. It was assumed that occupation occurred during active beach formation (Fox, 1975; Ross, 1979). The subsequent research by Ross (1995) focused on considering the similarities between Lakehead Complex and other nearby complexes, leading to the formation of the Interlakes

Composite as an integrative taxonomic category. The primary information sources are reports submitted as part of Cultural Resource Management investigations. Fox and Ross have attempted to synthesize these data combining them with the earlier works of Dawson (1983), Wright (1963), and MacNeish (1952). Ross (1995; 2011) later added the work of Julig (1994).

3.5.1 Lakehead Complex

The initial identification of the Lakehead Complex (Fox 1975) was based upon data from the Brohm (DdJe-1), Catherine (DcJh-11), Cummins (DcJi-1), Rocky Point (DeJj-6), Knife Lake (DeJj-6), Narrows (DaJn-7), and Sturgeon Sand Spit (Dcjv-1) sites in Canada and from the South Fowl II site in the United States (Figure 3.7). Settlement patterns were observed showing a preference for Lake Minong strandlines (Fox, 1975; 1980). These spatial associations led to the discovery of the Newton (DdJf-1), Simmonds (DcJh-4), MacDaid (DcJh-16), Boulevard Lake (DcJh-2) and Harstone Hill (DcJj-11) sites. Fox (1980) also included a number of smaller sites discovered inland, but located along waterways and include, Rocky Point (DeJj-6), South Fowl Lake I and II and the Narrows (DaJn-7).

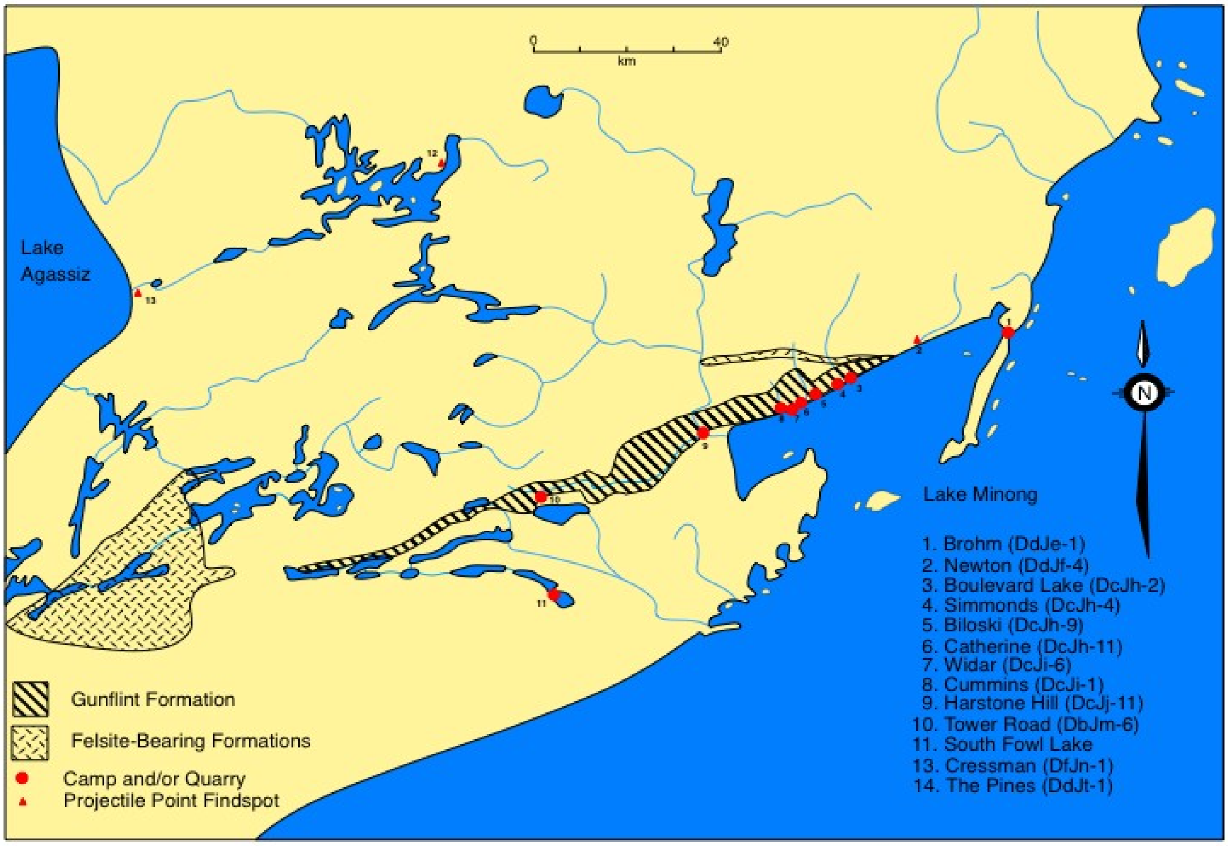


Figure 3.7 Map of the Lakehead Complex sites, (modified after Fox (1975).

At the time of Julig’s (1994) report on the Cummins Site, thirty-nine Paleoindian sites were reported within a 150 km radius of Thunder Bay (See Figure 3.11). Twenty-four yielded diagnostic Paleoindian projectile points, although only six of these had excavations undertaken. The remaining sites that did not yield diagnostic points were considered to be within the Lakehead Complex due to location, raw material preference and flaking traits observed within the lithic assemblage. The projectile points revealed a broad range of variability but were generally lanceolate, parallel sided to constricting, exhibit basal thinning, with lateral and basal grinding of the hafting portion and parallel oblique flaking patterns on the body (Fox, 1975; 1980; Ross, 1979; 1995; Markham, 2013). Nearly all the sites were located on Lake Minong strandlines, with many on or near outcrops of the Gunflint Formation. The lithic assemblages of these sites were nearly all taconite, from the Gunflint Formation outcrops, and consisted of large bifaces, debitage with ground platforms, unifacial tools, and the use of large flakes for reduction or as expedient tools (Julig 1994).

The lithic technology, as first described by Fox (1975), is based on biface reduction to obtain the more refined tools. There is also evidence for blade production methods (Hinshelwood and Webber, 1987; Hinshelwood, 1990; Hinshelwood and Ross, 1992). Using the natural fracture planes of Gunflint Formation cherts, long, thin, longitudinal flakes were driven off the blocks. This indicates an understanding of blade technology as well as biface reduction (Hinshelwood and Webber, 1987; Hinshelwood, 1990; Hinshelwood and Ross, 1992). Evidence exists for the use of bifacial and multi-directional cores and tabular blocks for biface reduction, and columnar cores for blade production. Refined biface blades are noted as well. These are largely ovate, but also range from rectangular to elongated bi-pointed shapes. The preforms for these refined blades are more angular and less well-defined (Hinshelwood and Webber, 1987; Hinshelwood, 1990; Hinshelwood and Ross, 1992). The projectiles are lanceolate in form with varying basal forms. Blade portion edges were largely all convex, while the hafting portion ranges from slightly convex, to straight, to slightly concave. The latter configuration caused a slight constriction that resulted in ears (Figure 3.8). Fox (1975) makes no mention of whether or not there is basal thinning or extensive grinding of the hafting portion. Two unique tool types were identified by Fox (1975) in the Cummins collection: the expanding base drill, and a biface endscraper. Unifacial endscrapers and sidescrapers have been noted as well. There is also a reliance on informal flake tools (Fox 1975). Fox (1975) notes a similarity in point morphology, material preference, and settlement patterns between the Lakehead Complex, Reservoir Lakes Phase (Harrison et al. 1995; Steinbring, 1974) and the Flambeau and Minoqua phases (Salzer, 1974).

Figure 3.8: Projectile point variation within the Lakehead Complex, Plate A: examples from various sites (Newton Site, Dog Lake Site, Catherine Site, Rocky Point Site at Dog Lake, Wiktoway Site (DfJg-1 at Hicks Lake, The Narrows Site), (modified after Markham 2013: Figure 3.12) and Plate B: examples from Mackenzie I (modified after Markham 2013).

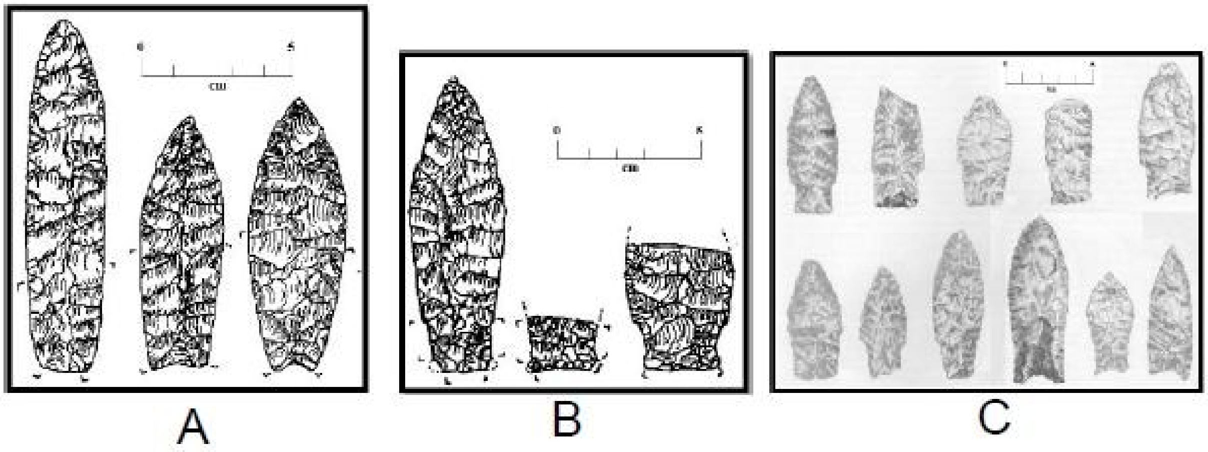


Figure 3.9: Projectile point examples of A) Flambeau (modified after Salzer, 1974: Fig. 1) B) Minocqua (modified after Salzer, 1974: Fig. 2) and C) Reservoir Lakes (modified after Steinbring, 1974: Fig. 1 and 2) phase projectiles (modified after Markham 2013: Figure 3.13-3.15).

The regional Paleoindian settlement pattern is not fully understood. However, some general inferences based on site settings can be made. In particular, many of the sites can be found along or near a permanent water source. There is often an exposure of the Gunflint Formation nearby. The initial settlement pattern description by Fox (1975) indicates heavy preference for Minong age strandlines, with limited evidence for inland sites (one exception being the Crane Cache). The beach ridges would have provided a high and dry camping area, as well as easy travel routes. The longshore routes of the strands would have allowed easy walking for both humans and prey species above the lacustrine plains as water levels receded (Julig 1994).

The Flambeau and Minocqua phases have been identified from northern Wisconsin and Minnesota. They differ in the detail of the point styles said to be part of them, but the toolkit remains generally the same. This includes scrapers, lanceolate projectiles, utilized flakes, wedges, large bifaces and bifacial knives (Salzer, 1974). Flambeau points (see Figure 3.9 plate A) are identified as small Agate Basin lanceolate points with lateral grinding (Salzer, 1974). Minocqua points (see Figure 3.9 plate B) are stemmed lanceolates considered by Mason (1963) to be a regional variant of Scotsbluff. They generally have small projections or ears on the base, with ground stems and poorly to irregularly executed collateral flaking (Salzer, 1974).

The Reservoir Lakes Phase (see Figure 3.9 plate C) is a provisional designation by Steinbring from the western Lake Superior basin in the Reservoir Lakes area (Steinbring, 1974). Steinbring (1974) identified this phase as containing a number of Late Paleoindian point styles (Scotsbluff, Agate Basin, Hell Gap and Plainview). The rest of the toolkit includes large bifaces, crude choppers, crescent blades, adzes, and a variety of unifacial tools with no evidence of ground stone tools (Steinbring 1974).

3.5.2 The Interlakes Composite

Bill Ross (1995) considered the various Paleoindian phases and complexes reported within the Lake Superior basin (including the Lakehead Complex), and proposed their integration within the Interlakes Composite to better synthesize the late Paleoindian occupation of the Interlakes Region (Figure 2.6 and 3.10). The occupation of the Minong Age strandlines remains as an important factor in determining site location in the peninsula located between Lake Agassiz to the west and north, and Lake Minong in the Superior Basin. It is unclear whether occupation of many of these sites occurred during active beach formation, although there is some evidence to suggest this possibility: water-worn artifacts identified from both the Cummins and Catherine sites that indicate the possibility of occupation during the period of beach formation (Fox, 1975; Julig, 1994; Ross, 1995).

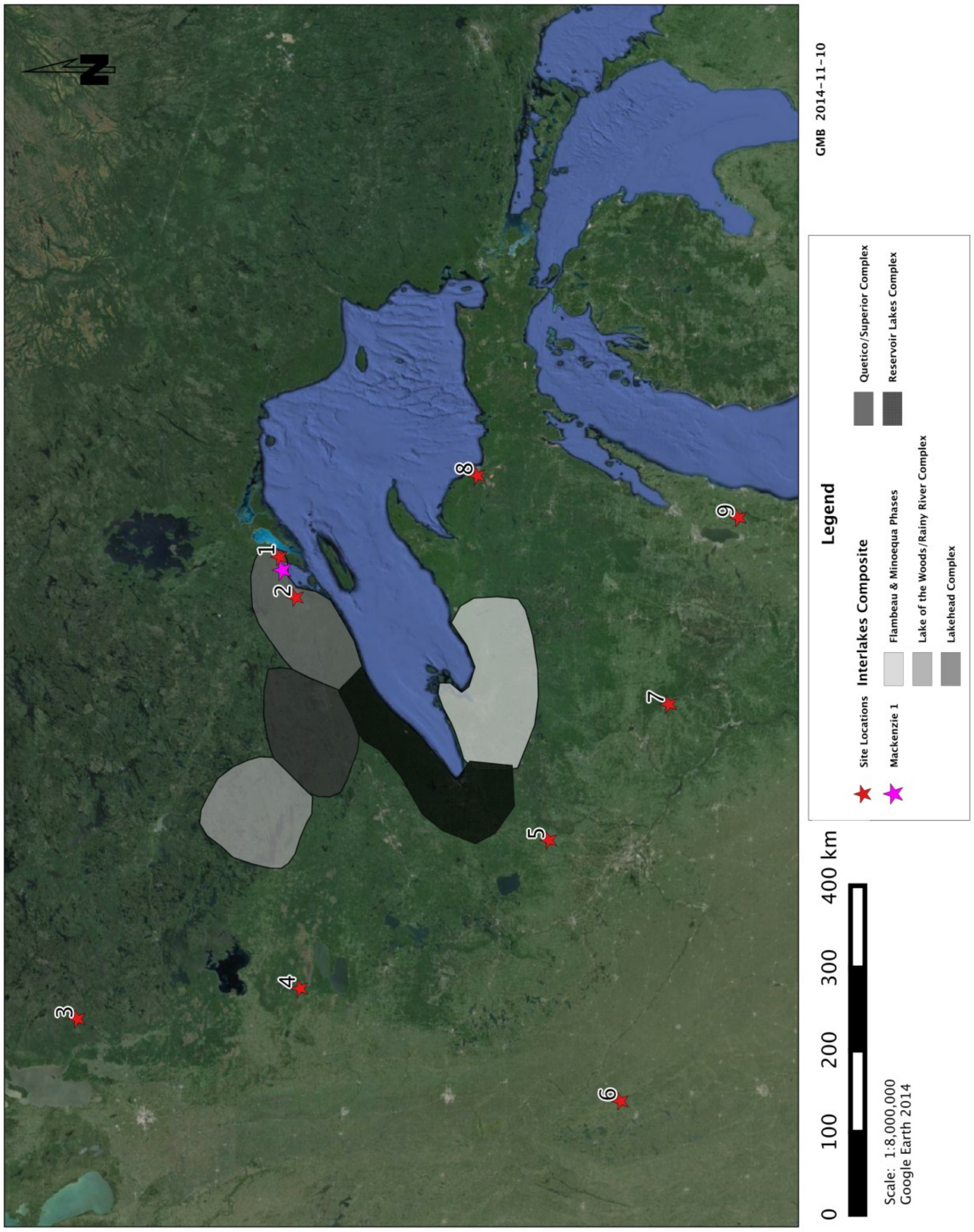


Figure 3.10: Map demonstrating the synthesis of the Interlakes Composite as per Ross (1995: Fig.2) (After Markham, 2013: Figure 3.16). The Flambeau and Minocqua phase is indicated, though not part of the original composite. Major sites throughout the region are indicated; 1) Brohm, 2) Cummins, 3) Sinnock, 4) Round Lake; 5) Pine City, 6) Browns Valley; 7) Silver Mound (source of HSS); 8) Gorto, 9) Renier.

There is a high degree of variability within the four complexes identified as making up the Interlakes Composite. These include the Lake of the Woods/Rainy River, Quetico/Superior, Lakehead, and Reservoir Lakes complexes (Figure 3.10). Ross (1995) proposes that these complexes be grouped into the Interlakes Composite based on the presence of parallel-oblique flaking patterns, lateral and basal grinding and the general morphological shape of the projectile points. The raw material selection is based largely on local bedrock-derived raw materials, but there is a consistent (abeit sparse) representation of Hixton Silicified Sandstone from sites within all four complexes. The presence of this material is largely limited to small numbers of formal tools in the northern and western sites and little to no presence of debitage. This suggests that formal tools were transported north as finished tools (Ross, 1995).

There is a high degree of morphological variability of diagnostic tools within the complexes, with little site context. Most of the examples are found within private collections and are rarely published or discussed. Many of the initial discoveries were surface collections, such as Lake of the Woods/Rainy River and Quetico Superior Complexes, (Reid 1980) or Reservoir Lakes (Steinbring, 1974). The Flambeau and Minocqua Phases were included as part of the Interlakes Composite, based on morphological similarities between projectile points and raw material selection (Ross, 1995). The Lakehead Complex (Fox, 1975) has been subjected to the most extensive analysis and site excavations making it the best understood of the four complexes.

3.5.3 New Discoveries

In recent years, continued work in the region has resulted in more discoveries. Fluted points have been discovered in northern Minnesota and parts of Wisconsin due to the collective efforts of Tony Romano, Sue and Steven Mulholland and Dan Wendt (Markham, 2013). On the north shore of Lake Superior cultural resource management work carried out by Western Heritage as part of highway infrastructure development has resulted in the excavation of a number of sites. These include Mackenzie I and II (DdJf-9 and 10), the Electric Woodpecker sites I, II and III (DdJf-11, 12 and 14), and the RLF site

(DdJf-13). This work also included the re-investigations of the Hodder East (DcJh-44) and Naomi (DcJh-42) Sites. The assemblages collected from these sites have greatly increased the data available concerning the Late Paleoindian occupation of the region. Markham (2013) conducted an extensive analysis of the projectile point assemblage discovered at Mackenzie I, and compared this vast collection (n=380) to the broader Lakehead Complex projectile point assemblage as well as other related late Paleoindian complexes. Markham (2013) also observed the overwhelming presence of parallel oblique flaking (99% of the projectile point assemblage) at the Mackenzie I site. This overwhelming presence can be attributed to the large size of the formal tool assemblage when compared to other Lakehead Complex sites (See Chapter 7). While apparent on some specimens found in other Interlakes Composite assemblages, no other site has demonstrated near-universal expression of the parallel oblique flaking pattern. Given the size and complexity of this site as well as the strong circumstantial evidence of repeated occupation over extended time periods, the near universal expression of this flaking pattern is extraordinary. Fox (1975) identifies the parallel oblique flaking pattern as being a trait used to identify the Lakehead Complex despite the fact that relatively few of the existing formal tools at the time exhibited this pattern. It was hypothesized that this flaking pattern had some significance to the Paleoindian occupation of the region. The analysis of the Mackenzie I assemblage has revealed the possibility that this flaking pattern may have had a technological function for dealing with a difficult raw material.

Markham (2013) noted a surprisingly narrow range of morphological variability within the Mackenzie I projectile point assemblage, that when compared to those recovered from other Lakehead Complex sites, demonstrates some degree of regional morphological consistency. All other Lakehead Complex sites have yielded comparatively small and morphologically varied projectile point assemblages. The meaning of this variability has not been clear because of the low sample size, but the extraordinarily large assemblage from Mackenzie I enables attribute analysis and identification of dominant stylistic trends. When these typological trends are compared to the larger regional assemblage, they are also evident throughout the Lakehead Complex. This indicates greater degree of similarity (and perhaps continuity within and between the complexes making up the Interlakes Composite than is generally thought.

3.6 PALEOINDIAN OCCUPATION OF THE THUNDER BAY REGION

This section reviews some Paleoindian sites and their assemblages in the Thunder Bay area. Site investigation has occurred through academic explorations (MacNeish, 1952; Wright, 1972; Julig, 1990; Dawson, 1963; 1983a; 1983b; 1983c; Stewart, 1984), public archaeology (Halverson, 1992), government mandated exploration (Newton and Engelbert, 1977; Ross, 1979; 1995; 2011; Fox, 1975; 1980; Arthurs, 1986), and Cultural Resource Management (CRM) (Adams, 1993; 1995; Hinshelwood, 1990; 1993; 1994 Hamilton, 1996; McLeod, 1978; 1981; 1982; Racher, 2006). While many sites have been discovered, few have been subjected to comprehensive excavation and analysis. Limited analysis and publication has occurred at the Biloski (Hinshelwood and Webber, 1987), Brohm (Hinshelwood, 1990) and on the Crane Cache sites (Hinshelwood and Ross, 1992; Ross, 2011). To date, Patrick Julig's (1994) work at the Cummin's Site is the most comprehensive analysis of a site in the region.

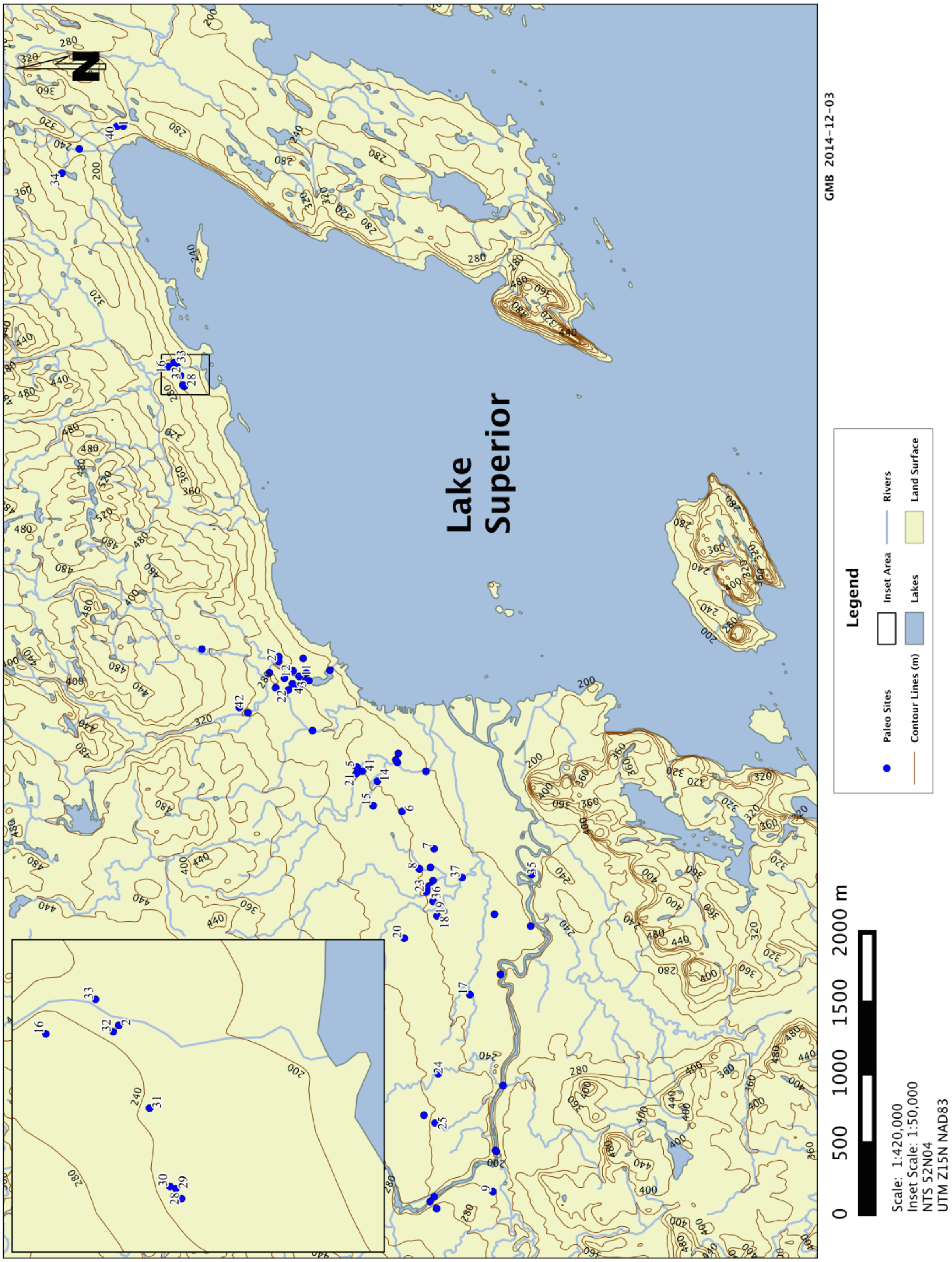


Figure 3.11: Map showing the locations of Paleoindian sites in the study region, inset map indicates the Mackenzie cluster of sites (Modified after Fox, 1975; Julig et al., 1990; 1994; Hinshelwood, 2004).

There have been 39 Paleoindian sites identified in the region as of 1994. Of these, six sites have been subjected to test excavation (Brohm, Cummins, Naomi, Biloski, Simmonds and Crane), while the remainder have been studied through surface collection and/or test pitting (Adams, 1995; Julig, 1994; Ross, 2011). Twenty-four of these sites have yielded diagnostic artifacts (Julig, 1994). With the exception of Julig's investigations at Cummins, little contextual evidence has been collected, making it difficult to interpret post-depositional processes and geomorphology. There have been a number of geomorphic studies carried out in the region a number of which have concentrated on age determinations of the moraines (Zoltai, 1965; Burwasser, 1977; Clayton and Moran, 1982; Lowell et al., 2009) while others have attempted to date the Minong strandlines (Phillips, 1988; 1993; Phillips and Fralick, 1994a; 1994b; McAndrews, 1982; Shultis, 2012).

Table 3.1: Archaeological site names and additional data from the Thunder Bay Region (After Fox, 1975; Julig, 1994; Ross, 1995; Norris, 2011; Markham, 2013)

Map Location[1]	**Site Name**	**Borden Designation**	**Diagnostics**[2]	**Locational Association**[3]				**References**
				PGB	**GF**	**RX**	**W**	
1	Brohm	DdJe-1	P	x			x	McNeish 1952; Fox 1975; Hinshelwood, 1989
2	Newton	DdJf-4	P	x	x		x	Fox, 1975
3	Boulevard Lake	DcJh-2	P	x	x	x	x	Dawson, 1972; Fox, 1975
4	Simmonds	DcJh-4	P	x	x	x	x	Dawson, 1973; Halverson, 1992
5	Biloski	DcJh-9	P	x	x	x	x	Dawson, 1972; Fox, 1975; Hinshelwood and Webber, 1987
6	Catherine	DcJh-11	P	x	x			Dawson, 1972; Fox, 1973
7	Widar	DcJi-6	P	x	x			Fox, 1975
8	Cummins	DcJi-1	P	x	x	x	x	Dawson, 1972; 1973; Fox, 1975; Julig, 1983; 1984; 1985; 1986; Julig et al., 1990
9	Harstone Hill	DcJj-11	A		x		x	Newton et al.,1974; Fox, 1975
	Tower Road	DbJm-11	A		x			Fox, 1975
	South Fowl Lake I	(in Minnesota)	P				x	Platcek, 1965; Fox, 1975

Map Location[1]	**Site Name**	**Borden Designation**	**Diagnostics**[2]	**Locational Association**[3]				**References**
				PGB	**GF**	**RX**	**W**	
	Cressman	DfJn-1	P				x	Fox, 1975
	The Pines	DdJt-1	P	x			x	Fox, 1975
	Rocky Point	DeJj-6	P				x	Dawson, 1972; Fox, 1975; Mcleod, 1981
	High Falls	DaJj-1	A	x			x	Newton and Engelbert, 1976; Fox, 1980
	Narrows	DaJn-7	P				x	Newton and Engelbert, 1976; Fox, 1980
	South Fowl Lake II	(in Minnesota)	P				x	Fox, 1980
10	Crane (Cache)	DcJj-14	A					Ross, 2012
	Vieux Point	DaJt-15	P		x		x	Fox, 1980
11	McDaid	DcJh-16	P	x	x	x	x	Newton and Engelbert, 1976; Stewart et al., 1984
12	Centennial Park	DcJh-17	P	x	x	x	x	Newton and Engelbert, 1977
13	Fourex	DcJh-18	A	x	x	x	x	Newton and Engelbert, 1977
14	Tolvanen	DcJh-23	A	x	x			
15	Irene	DcJh-31	P		x			
16	Stevens	DdJf-5	P	x		x	x	
17	Weight Station	DcJi-12	A	x	x	x	x	
18	Wrestling Ant	DcJi-9	A	x	x	x	x	
19	Shooting Range	DcJi-10	A	x	x			
20	Hills Greenhouse	DcJi-14	A		x			
21	McIntyre	DcJh-12	A	x	x	x	x	Dawson, 1972
22	Richardson	DcJh-22	A		x			
23	Kontio	DcJi-11	A	x	x	x	x	
24	Corbett Creek Quarry	DcJj-12	A		x		x	
25	Vandon Boss	DcJj-13	A		x			
	Wiktowy	DfJg-1	P				x	Arthurs, 1986
	Cryderman	No Bord. #	A				x	Dawson, 1986
	Kor	DbJn-2	P				x	
	Clearwater	DfJo-3	P				x	
	Lumulla	DdJj-7	P					
26	Hodder East	DcJh-44	A	x			x	Gibson, 2014
27	Naomi	DcJh-42	P	x			x	Adams, 1995; Norris, 2010

Map Location[1]	Site Name	Borden Designation	Diagnostics[2]	Locational Association[3]				References
				PGB	GF	RX	W	
28	Electric Woodpecker I	DdJf-11	A	x		x	x	ASI, 2009
29	Electric Woodpecker II	DdJf-12	P	x		x	x	ASI, 2009
30	Electric Woodpecker III	DdJf-14	P	x		x	x	Timmins Martell, 2012
31	RLF	DdJf-13	A	x				Lints, 2013
32	Mackenzie I	DdJf-9	P	x		x	x	ASI, 2009
33	Mackenzie II	DdJf-10	P	x		x	x	ASI, 2009; Norris, 2011
34	Neenookasi	DdJe-7	A	x				Lints, 2013
35	Quackenbush	DcJi-3	A	x			x	Hinshelwood, 2004
36	Neebing Site	DcJi-16	P	x		x	x	Hinshelwood, 2004
37	Stetsko	DcJi-7	A	x		x	x	Hinshelwood, 2004
38	Chairs	DcJh-40	A		x	x	x	Hinshelwood, 2004
39	Happy Days	DcJh-39	A			x	x	Hinshelwood, 2004
40	Anderson	DdJe-2	A	x			x	Hinshelwood, 2004
41	?	DcJh-38	P	x	x	x	x	Hinshelwood, 1987; 2004
42	Cascades II	DcJh-37	A	x		x	x	Hinshelwood, 2004; Arthurs, 1986
Totals for all Sites (N=59)				38	27	25	46	
% of Total				64	46	42	78	
Totals for sites with diagnostic artifacts only (N=31)				20	13	14	27	
%of Total				65	42	45	87	
Totals for sites without diagnostic artifacts only (N=28)				18	14	12	19	
% of Totals				64	50	43	68	

Notes:

[1] Site locations are shown on Figure 3.1

[2] Diagnostic Lakehead Complex artifacts (parallel flaked lanceolate points) Present (P), or Absent (A). Those sites lacking diagnostic artifacts are conditionally placed in a Paleo-Indian context on the basis of large bifaces, prefernțial use of Gunflint Formation lithic raw material, debitage characteristics and site locations.

[3] Site locational associations: PGB on proglacial L. Minong or Agassiz Beach; GF, gunflint formation or quarry source; RX, river or stream crossing beach ridges; W, adjacent to permanent water source (=100 m or less)

3.6.1 Limitations

Paleoindian archaeology within the Great Lakes watershed has been focused on glacial beaches and strandlines. This bias can be traced back to Quimby's (1959; 1960) interpretations of MacNeish's (1952) excavations at the Brohm Site. He asserted that the lanceolate point styles were of Plainview affiliation, while the site association along the relic beaches suggested that Paleoindians settled on active beaches. This led Quimby to coin the "Aqua-Plano" culture to reflect the perspective that they relied on hunting and fishing for subsistence and utilized some form of watercraft to facilitate their shoreline settlement focus (Quimby, 1959; 1960).

3.6.2 Preservation

Boreal forest environments are notorious for limiting site preservation and interpretation. The acidic soils result in poor organic preservation (Phillips, 1993; Wright, 1972), while slow sedimentary accumulation results in shallow site deposition that is subject to ongoing bioturbation and other taphonomic processes. This results in most sites exhibiting poor or no stratigraphic integrity (Dawson, 1983b; Julig, 1994; Phillips, 1993). The minimal organic preservation constrains interpretations to non-organic material culture, and limits interpretive resolution of subsistence, housing and technology (Dawson, 1983b; Julig, 1994; Kingsmill, 2011; Phillips, 1993; Wright, 1995). While taphonomic processes are an issue in any context, those of the boreal/shield environment are particularly severe (Phillips, 1993). These site transformation processes have led many archaeologists to assume that most multi-component and multi-occupation Boreal Forest sites offer minimal interpretive resolution. This is compounded by limited sampling and systematic survey biases (Hamilton, 1996; 2000; Hinshelwood, 2004; Ellis and Deller, 1997; Julig et al., 1990; Phillips, 1988; 1993).

However, recent work using OSL analytical methods have revealed that boreal forest sediments are better preserved than previously assumed. These recent studies (coupled with detailed sedimentological and pedological analyses), demonstrate micro-stratigraphy that is not readily observed without proper equipment and geo-archaeological characterization (Gilliland, 2012; Gilliland and Gibson, 2012; Gilliland et al. 2012, Kinnaird et al., 2012).

Investigations into the Lakehead Complex have been biased with an over-emphasis on searching for sites on the relic shorelines. Conventional survey methods used in heavily forested areas involve labour-intensive shovel testing, but still only generate sparse sampling coverage. Such methods have a very high risk of generating false negative results, particularly when searching for sites characterized by ephemeral deposits found in very small and widely dispersed clusters. Appropriate methods should be developed for boreal forest contexts to reduce the risk of false negatives in shovel testing programs required to comply with regulatory standards, such as the Ontario Archaeological Standards and Guidelines for Consultant Archeologists (Ontario Government 2011). These problems existed before the implementation of the most recent regulatory archaeological requirements and continue to be a problem when conducting archaeological investigations in boreal environments. The largest excavations carried out to date include DcJi-15 and 16 (Hinshelwood, 1993; 1994), Mackenzie I and II (DdJf-9 and 10) and the Electric Woodpecker sites (DdJf-11, 12 and 14), all of which have been conducted as salvage operations. This resulted in the loss of detail due to the methodologies required in salvage operations.

3.6.3 Archaeological Site Bias

The discovery of sites in association with Lake Minong age beach ridges is no coincidence. They are easily observable even today and would have been ideal areas for locating campsites to observe and intercept migrating herds (Hinshelwood, 2004; Kingsmill, 2011; Phillips, 1993). This has held true in Southern Ontario as well, where a number of sites have been located on the relic beach ridges of glacial Lake Algonquin (Ellis and Deller, 1997; Jackson et al., 2000; Roosa and Deller, 1982; Storck and Spiess, 1994). However, there is also evidence for inland sites removed from the main Minong strandlines. This might have included the margins of isolated (and as yet undocumented) early Holocene lakes and river systems. Paleoindian and Archaic materials have been discovered around the shores of Dog Lake (40 km north of Thunder Bay), for example, as well as on sites located on the Kaministquia River delta (Hamilton, 1996; 2000; McLeod, 1978; 1981). These sites are rarely discovered and, in large part, knowledge about these inland areas comes from amateur archaeologists and local collectors. Not only is the terrain an obstacle, but for the most part, CRM investigations have been limited to development along modern and relic shorelines (Anderson et al., 2004; Boyd, 2007, Phillips, 1993).

Boreal forest archaeology is an expensive undertaking, making extensive salvage and academic excavations very rare. Shovel testing and surface collection are the favoured methods which are done prior to any development, sometimes allowing time for the plans to be altered to avoid impacting the site (Hinshelwood, 2004; Julig et al. 1990; Kingsmill, 2011; Phillips, 1993). Many sites have been impacted by both looting and construction due to the fact that Lake Minong beach and deltaic sediments provide aggregate materials (Phillips, 1993). The following site summaries reveal how evident the above limitations are in the Thunder Bay region.

3.6.4 Paleoindian Site Distribution in the Thunder Bay Region

There are a large number of Paleoindian sites located in the Thunder Bay region. The majority of presently known sites are located along the strandlines of Lake Minong with others located further inland (Figure 3.1 Map showing the location of the sites). The known sites are presented in a table Table 3.1. Only a select few sites have been subject to extensive excavation and analysis: the Naomi (Adams, 1995; Norris, 2011), Biloski (Hinshelwood and Webber, 1987), Cummins (Dawson, 1983; Julig, 1994), Simmonds (Dawson, 1973; Halverson, 1992), Brohm (MacNeish, 1952; Hinshelwood, 1990), Crane, (Ross, 2011), and the Neebing River sites (Hinshelwood, 2004). Of the above sites, fewer have had an extensive analysis of the assemblage and attempts at site interpretation. Julig (1994) and Phillips (1993) studied the geomorphology of the Cummins site while McAndrews (1981), took pollen cores from the Cummins and Oliver ponds, both of which are in proximity to the Cummins site and may have been embayments of Lake Minong. Julig conducted a stage analysis of the biface assemblage, attempted residue analysis (Newman and Julig, 1990), and a spatial analysis of the site (Julig, 1994). Some biface assemblages have been analyzed in order to discern the reduction sequence of the Lakehead Complex. These include Biloski (Hinshelwood and Webber, 1987; Hinshelwood and Ross, 1992), Brohm (Hinshelwood, 1990), Simmonds (Halverson, 1992), Crane (Hinshelwood and Ross, 1992) and Naomi (Adams, 1995). The Crane Cache (Ross, 2011), and Naomi (Adams, 1995) have been subjected to spatial analysis studies. A discussion of a select number of the sites follows and is limited to those sites that have had extensive analysis and/or excavations, or those important to defining the Lakehead Complex.

The Brohm Site (DdJe-1) is the most easterly site currently associated with the Lakehead Complex and was one of the earliest discovered. The site is located on the Sibley Peninsula approximately 40 km northeast of Thunder Bay. Brohm was partially excavated in 1950 by Richard MacNeish (1952) as part of a survey of the area. It was again partially excavated in 1987 by the Ministry of Natural Resources as a part of park infrastructure development (Hinshelwood, 1990). The site is located on a terrace formed by dropping lake levels and channel mouth deposits (Hinshelwood, 1990; Phillips, 1988). Pass Lake was once part of Lake Minong, during which time Sibley Peninsula is believed to have been an island separated by a narrow strait, making it an ideal place for caribou to calve (Hinshelwood, 1990; MacNeish, 1952). Dropping lake levels and sediment buildup from wave actions eventually blocked off the narrow strait and Pass Lake became an embayment. Brohm was situated such that would have been an ideal place to procure seasonal game (Hinshelwood, 1990; MacNeish, 1952; Phillips, 1988). The lithic assemblage indicates a Paleoindian occupation as the points were initially identified as Plainview (Figure 3.12) (MacNeish, 1952) and later placed into the late Paleoindian period Lakehead Complex (Fox, 1975; Ross 1982). The 1987 excavations did produce an Archaic side-notched point, indicating that a portion of the site was reoccupied in the Archaic period (Hinshelwood, 1990; 2004). Hinshelwood (1990) re-analyzed the biface assemblage recovered in the 1950 (MacNeish, 1952) excavations along with the assemblage he excavated in 1987, which will be discussed in greater detail in Chapter 4.

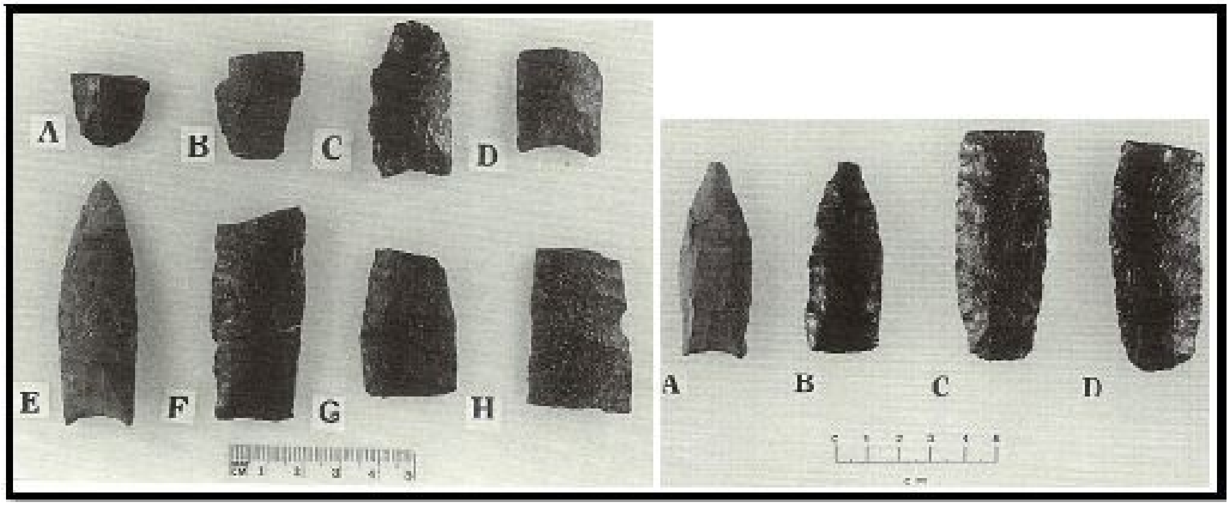


Figure 3.12: Bifaces identified as projectile points from the Brohm Site (after Markham 2013: Figure 3.6).

The Biloski Site (DcJh-9) was subjected to salvage excavations in 1986 due to urban development. The site area was located at roughly 245 m asl, and situated on a Lake Minong strandline near the outlet for the McIntyre River (Hinshelwood and Weber, 1987). As with most sites in the Thunder Bay region, the Biloski site yielded a large lithic assemblage. There were four identifiable projectile points and a small number of other formal tools (Figure 3.13). The assemblage consisted of over 50,000 pieces of debitage and more than 200 bifaces and biface fragments. Hinshelwood and Webber (1987) subjected the biface assemblage to reduction sequence analysis. Using the work of Callahan (1979), 177 of the bifaces were placed into stages of manufacture. This marked the initial attempt to determine the reduction sequence and manufacture methods used by Paleoindian groups in the Thunder Bay Region. This will be discussed in greater detail in Chapter 4 along with the comparison to the Crane Cache (Hinshelwood and Ross, 1992).

Figure 3.13: Bifaces identified as projectile points from the Biloski Site (after Markham 2013: Figure 3.4).

The Simmonds Site (DcJh-4) is located along the Current River in Centennial Park, Thunder Bay. The site is located roughly 236 m asl on the west side of the river, again on a relic beach ridge (Halverson, 1992). As evident with the Biloski Site, the river outlet was near the site but there was no geomorphological analysis undertaken during the excavations. Again the vast majority of the assemblage (99%) consisted of debitage. The assemblage consisted of 22 bifaces, not one of which was complete. They were subjected to a stage analysis following Hinshelwood and Webber (1987) but due to their fragmentary nature the stage analysis was limited to just the non-metric attributes (Halverson, 1992).

The Crane Cache (DcJj-14) is an inland site not associated with a relic strandline of Lake Minong. It consisted of two isolated biface caches yielding 153 bifaces, a number of flakes and shatter, and a small number of scraping tools. Four post moulds were evident. The two caches also appear as if they may have been placed in a basket or bag on the basis of their dense ‘packing’, but no organic trace of such a container was observed during the careful excavation (Ross, 1982; 2011; Ross pers. Comm., 2012; 2014). The bifaces are believed to be unfinished trade blanks, with minimal variability in shape, size, depth of flake scars, and the flaking pattern (Figure 3.14) (Ross, 1982; 2011; Ross pers. comm., 2012;

2014; Hinshelwood and Webber, 1987; Hinshelwood and Ross, 1992). The bifaces were subjected to stage analysis by Ross (1982), and with Hinshelwood, compared to the Biloski and Brohm assemblages (Hinshelwood and Ross, 1992). Ross (2011, Ross pers. comm., 2012; 2014) has hypothesized that this cache was made by a single craftsman and cached in two separate bundles. There are no associated dates but the flaking pattern and methods reflects techniques utilized by Paleoindians (Ross 2011, Ross pers. comm., 2012; 2014).

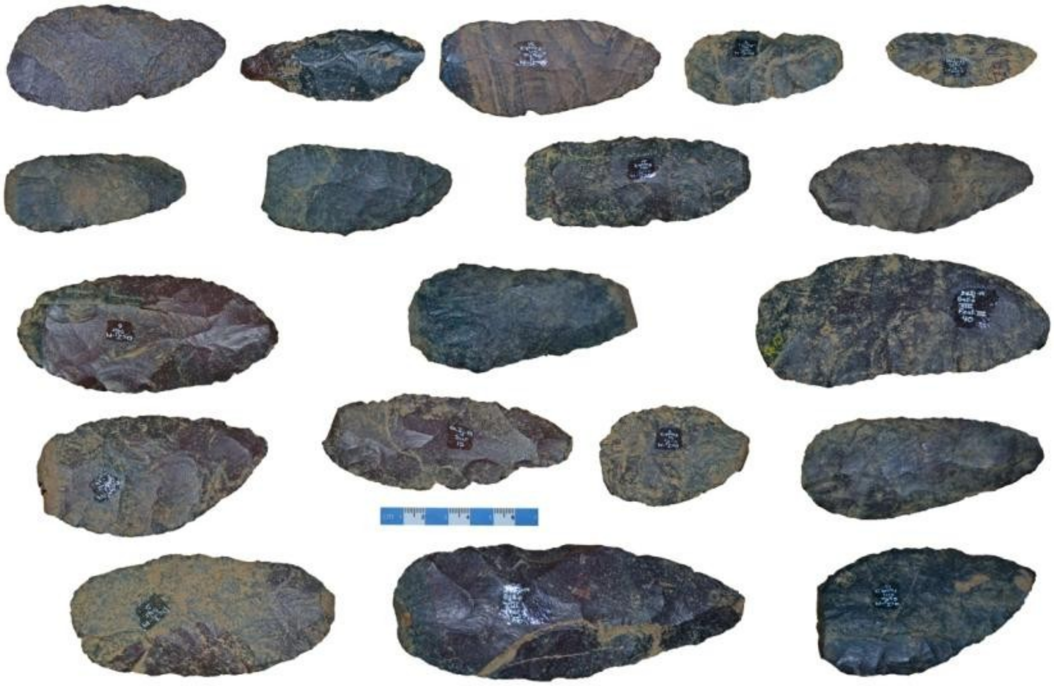


Figure 3.14: Select bifaces from the Crane Cache, note the regular flaking pattern and minimal variability in morphology (Bennett, 2012).

The Cummins Site (DcJi-1) has been extensively studied, and has provided the most comprehensive knowledge concerning the Paleoindian occupation of the Thunder Bay area. Dawson and Wright conducted the initial investigations in 1963 (Wright, 1963; Dawson, 1983a). Julig continued the investigations of the site using a range of techniques as part of his PhD work (Julig, 1990; 1994). Further geomorphological research into the site was completed by Phillips (1982; 1988; 1993). The site itself is located within the city limits of Thunder Bay on a Minong strandline at 230-235 metres asl within the area of a large outcrop of Gunflint Formation material. This has led researchers to hypothesize that Cummins was a habitation site in close proximity to a quarry/workshop site (Dawson, 1983a; Julig, 1994). The Cummins and Oliver ponds to the east and north respectively were former embayments of Lake Minong (Phillips, 1982; Julig 1994). Site extent is uncertain due to the large amount of debitage in the vicinity of the Gunflint Formation outcrop as well as the modern disturbances (Hydro line, railroad, residential lots and access roads) of much of the site area (Julig, 1994).

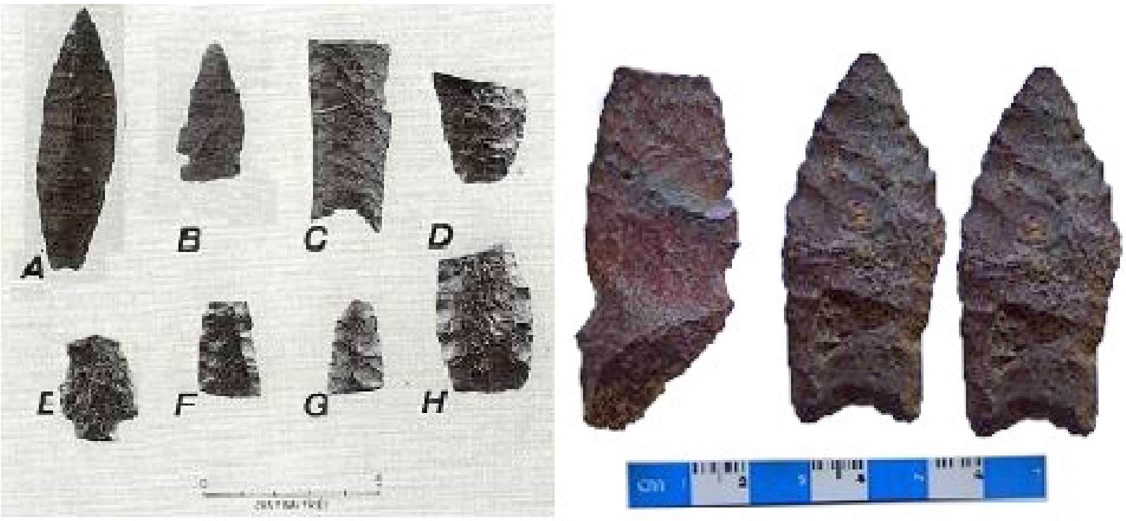


Figure 3.15: Examples of the Cummins site projectile point assemblage, showing the degree of variation (after Markham, 2013: Figure 3.8)

The lithic assemblage from Cummins consisted of formal tools (24 of which were projectile points and fragments Figure 3.15), debitage and bifaces in various stages of manufacture (Julig, 1994). The excavations in the mid-1980s by Julig also yielded a side-notched point indicating an Archaic reoccupation of this site (Julig, 1994). The biface assemblage was subjected to Stage analysis by Julig (1994) following the methods of Hinshelwood and Webber (1987) and Hinshelwood and Ross (1992). This will be discussed in greater detail in Chapter 4.

3.6.5 Archaic Site Distribution in the Thunder Bay Region

The Archaic occupation of the area is even less understood than the Plano one. Evidence from a number of sites suggests the possibility of Archaic reoccupation, likely during the Nipissing transgression

(Hinshelwood 2004). This Archaic association is likely associated with the rise of water levels up to around 210 metres asl dating ca. 5,500 ^{14}C years BP (6,300 cal years BP; Kingsmill, 2011; Phillips, 1993).Initial analysis of the Mackenzie 1 lithic assemblage (Markham, 2013) indicated that there were no definitively diagnostic Archaic tools; however a fire-broken Early Woodland Meadowood projectile point was found during cataloging (Ritchie, 1961; Justice, 1995; Overstreet, 2003). While absolute dates vary across North America, it is generally thought that around 8,000 ^{14}C years BP (8,900 cal years BP) a shift began that is associated with slow transformations in technology, subsistence, settlement pattern and population density. Points are generally notched with the majority of them being triangular (though some remain lanceolate), while specific platform preparation methods (common with Paleoindians) disappear (discussed in greater detail in Chapter 4) (Dawson, 1983b; Wright, 1972; Kooyman, 2000; Bradbury, 2007; Daniel, 2001; Kimball, 1996; Sassaman, 1994; 1996; Bursey, 2012; Ellis et al., 2009; Ellis et al., 1991). Wright (1972) identifies the Shield Archaic as a long-lived tradition present in much of the Canadian Shield from northern Quebec to the southwest Nunavut. Dawson (1983b) refers to the Shield Archaic as a northern expression of the Archaic tradition within the Canadian Shield, defined by diagnostic notched projectile points and the more frequent recovery of woodworking tools such as wedges and adzes and the introduction of copper manufacturing (Dawson, 1983b; Fox, 1977; Hinshelwood, 2004).

The Archaic period is associated with a climatic warming event from around 8,000 ^{14}C years BP (8,900 cal years BP) lasting until 6,200 ^{14}C years BP (7,100 cal years BP; Julig et al., 1990). The warmer climate resulted in a shift to closed boreal forest from more open periglacial environment that may have slightly altered the subsistence base, namely caribou, which would have moved north with their preferred habitat (Dawson, 1983b; Hinshelwood, 2004; Kingsmill, 2011). Improved knowledge of the behaviour of modern Woodland caribou populations suggest that their preferred habitat may not have been so clearly understood. This environmental shift combined with the rising lake levels following the Nipissing transgression, may explain the recovery of Archaic points on Paleoindian sites such as Cummins and

Brohm (McAndrews et al., 2004; Hinshelwood, 2004; Julig, 1994), Dog Lake (Mcleod, 1978; 1981) and the Kaministquia River Delta (Hamilton, 1996; Kingsmill, 2011). The Lake Minong ridges likely remained higher than Nipissing Transgression levels, thereby offering well-drained near-shore ridge lines that would have offered quarry materials and lookout areas. Archaic reoccupation largely occurred on sites that were located where streams and rivers cut through the ancient Minong beach ridges (Neebing, McIntyre, Mackenzie, and Current Rivers). It is also possible that as a result of the Houghton Low and the subsequent lake level rise that sites of Early Archaic age are currently under water. As with the site locations of Paleoindian groups, this proposition is affected by survey biases that again focus on lake strandlines, with minimal survey of outlying areas.

3.7 SIGNIFICANT PALEOINDIAN SITES IN ADJACENT AREAS

Paleoindian occupation of the eastern Great Lakes followed much the same pattern as that of the Thunder Bay region. Sites are generally found on relic strandlines of glacial Lake Algonquin. Again this may be due to sample biases. Sites in the eastern Great Lakes watershed are discussed as they may have had some influence on the study area as well as offering points of comparison to the local situation.

There are a number of Paleoindian complexes identified in the eastern Great Lakes region, including the Gainey, Parkhill, and Crowfield complexes (See Figure 3.5: C). These three complexes are generally associated with strandlines of Lake Algonquin and are believed to be early Paleoindian in age based on the presence of fluted projectile points (Deller, 1976; Deller and Ellis, 1988; Stewart, 1984; Storck, 1983; Ellis and Ferris, 1990). Later Paleoindian occupation of the region includes Holcombe (Fitting, et al., 1966; Ellis and Ferris, 1990) and Hi-Lo (Ellis and Deller, 1982; Ellis and Ferris, 1990) (See Figure 3.5: D, E). Holcombe and Hi-Lo projectile points are generally not found in the Thunder Bay region but some trait similarities in the locally recovered ones may suggest some stylistic influence.

The Caradoc site (AfHj-104) is located to the west of London, Ontario on a relic strandline of pro-glacial Lake Whittlesay 13,000 ^{14}C years BP (15,800 cal years BP). The site itself is believed to date to between 10,500 to 10,000 ^{14}C years BP (12,400 to 11,500 cal years BP), based on the presence of non-fluted lanceolate projectiles bearing resemblance to Holcombe and Hi-Lo point styles (Deller and Ellis, 2001). This site has been added to the discussion because of the presence of a bifaces that appear to have been purposefully broken and then discarded. These bifaces have been struck on the dorsal face possibly on an anvil stone resulting in a non-usage breaking pattern (Deller and Ellis, 2001). It has been hypothesized that this intentional breakage has a ritualistic function in that the biface is sacrificed (See Figure 3.16 Plate 1, image F) (Deller and Ellis, 2001). Similar ritualistic behavior has been observed on other sites as well. The Renier site (Mason and Irwin, 1960), the Pope site in Wisconsin (Ritzenthaler, 1972), and the Gorto site in Michigan (Buckmaster and Paquette, 1988) all exhibit projectiles that have been purposefully burned and are believed to be associated with cremation burials.

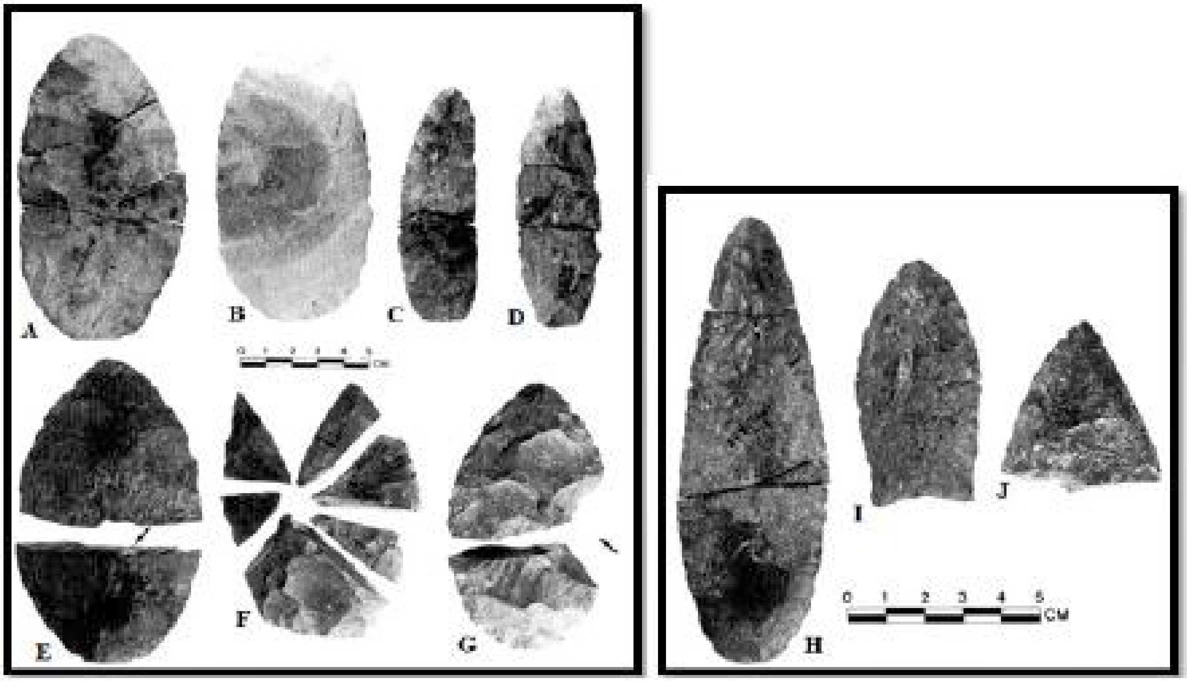


Figure 3.16: Examples of bifaces from the Caradoc Site, F illustrates the radial fracture observed as being intentional fracture of the specimen (Markham 2013: Figure 3.9; modified after Deller and Ellis, 2001).

The Sinnock site (EcKx-4) in Manitoba and the Grant Lake Site (KkLn-4) in Nunavut exhibit projectile points that are stylistically similar to Agate Basin points. The Grant Lake site (Wright, 1976) was relatively dated to the Agate Basin period based solely on the stylistic similarities with the only radiocarbon dated materials providing modern dates (Wright, 1976). It was hypothesized that people travelled north along the western flank of Lake Agassiz and the ice sheets to settle in this area. Wright (1995) proposed that these people travelled far north in pursuit of caribou. Warming conditions after around 7,000 ^{14}C years BP (7,800 cal years BP), resulted in a closed boreal forest environment. It was hypothesized that this resulted in an adaptation to generalized foraging in forested regions, and a technological shift that is described in the literature as the Shield Archaic (Wright, 1995). The Sinnock site yielded projectile points that are stylistically similar to Agate Basin, and associated with a large biface assemblage including adzes identified as trihedral (Buchner, 1981; Steinbring and Buchner, 1980). This site has a single date that places it in the Agate basin time range but it also has two other dates clustering between 4,600 and 4,200 ^{14}C years BP (5,300 and 4,800 cal years BP) (Buchner, 1984). Sinnock has been placed within the Caribou Lakes Complex (Buchner, 1981; Steinbring and Buchner, 1980) established by Wheeler (1978) and Buchner (1979). Like Holcombe and Hi-Lo the Caribou Lakes complex has been hypothesized to have had some influence on the Lakehead Complex (Fox, 1975; Pettipas, 19; Buchner, 1984). It was not included in the Ross's (1995) Interlakes Composite due to observations of the poor quality of flaking, and the presence of trihedral adzes indicating that it is more likely Early Archaic and that it was influenced by the Lakehead Complex (Ross, 1995; pers. comm. 2014)

The Allen Site is a Paleoindian campsite in southwestern Nebraska (Bamforth, 2007). Although it did not have projectile points identifiable as having parallel oblique flaking patterns, they do have morphologically similar characteristics. Flaking patterns in the early stages of manufacture and the overall reduction methods remain consistent with what is understood about Agate Basin and Hell Gap techniques. What is interesting about this site is the range of the toolkit presence. These include expanding base drills manufactured from flakes using co-medial pressure flaking to shape the working end (Figure 7.6: A). Another interesting tool type is what Bamforth (2007) calls 'beveled tools'. These tools range from thick bifaces to lightly modified flake blanks (Figure 7.5). The lightly modified flake blanks could easily be used as scrapers or as expedient cutting tools. The thicker bifaces share morphological characteristics with adzes recovered from the Gault site, Mackenzie I and other Paleoindian assemblages.

Many of the sites from Minnesota and Wisconsin are surface finds and/or identified from private collections (Mulholland et al, 1997). Most significant are those representing the Minocqua and Flambeau Phases from northern Wisconsin which have been placed within the Interlakes Composite. Projectile points identified as Minocqua have been recovered at sites in the Thunder Bay region (Julig, 1994; Fox, 1975; Ross, 1981). Fluted points bearing similarities to Clovis and Holcombe have been found in the Reservoir Lakes region as well as near Pine City, Minnesota (Markham, 2013). A surface collection of points from Shawano County in Northern Wisconsin has been identified as being stylistically similar to Scottsbluff, Agate Basin, Hell Gap and Angostura (Ray Reser, pers. comm., 2012). There is also a series of sites in the Knife Lake region bearing striking similarity to the Mackenzie 1 collection. These include quarry sites (the Wendt site and the JJ site) that exhibit similar reduction methods, and show evidence of the production of non-bifacial cores that would have been carried away from the site to be refined elsewhere. Also present are adzes and prismatic blades. Dates obtained from these sites indicate an Agate Basin/Hell Gap occupation range. While no diagnostic tools have been discovered at the quarry sites, an Agate Basin point and a possible Cody preform were found nearby (Muniz, 2013; Wendt and Mulholland, 2013; Mulholland et al., 1997).

3.8 RAW MATERIALS

Paleoindians appear to have relied upon local bedrock-derived raw materials (Gunflint Formation) for lithic manufacture. Other materials are present, but are largely manifest as formal tools and only rarely present within debitage assemblages. Both Knife Lake Siltstone and Hixton Silicified Sandstone have been identified on sites from the Thunder Bay region. Knife Lake Siltstones are not that far removed and may have been obtained as part of the seasonal rounds, while Hixton sources are far removed and likely obtained through trade. There are siltstones identified as part of the Gunflint

Formation and it may be that the siltstones found on a number of sites in the Thunder Bay region have a local source. Rhyolites and possibly non-local cherts are present as well, again just in the form of formal tools.

3.8.1 The Gunflint Formation

In the past silica-rich Gunflint Formation cherts have been identified by different names. Jasper Taconite (Red to purple, fine to medium grained), Taconite (black to purple, medium to coarse grained), Kakabeka Chert (banded black/brown, fine to medium grained), and Gunflint Silica (grey to brown, semi-translucent with ‘pepper flake’ inclusions, fine grained) have all been identified as part of the formation. The Gunflint formation is a part of the Animike banded iron formation that is exposed on the western end of Lake Superior and can be found in glacial till and as cobbles in river beds. The various terms have been used to describe subtle variations but due to the banded nature of the formation it is possible to have a single piece that exhibits internal banding of varying character (Lindenberg and Rapp, 2000). The chert bands are separated from each other by alternating bands of shale. Lithic quality varies both between bands and within individual chert bands (Figure 3.17). Nearly all the bands contain iron-rich compounds. Fracture planes are present in all bands to varying degrees. These are welded back together by iron and silica precipitates. The fracture planes cause the material to be prone to failures and fractures. As a result of the alternating bands, combined with the fracture planes and iron-oxide flaws, it is relatively simple to pry loose large blocks of the material from the bedrock source (Pye, 1968; 1969). Bands vary in quality and ranging from fine to coarse grained material (Figure 3.18). The visual expression of the outcrops of taconite and the quality of the raw material are important to the understanding of Paleoindian tool raw material acquisition and manufacture (discussed further in Chapter 6).

Figure 3.17: Examples of Gunflint Formation chert raw material; Plate A): Banded Gunflint Formation Chert, note the separation of bands by the shale/mudstone layers; Plate B): Individual block of Gunflint Formation Chert, note the lustrous inclusion indicating varying degree of quality within bands.

The Cummins, Irene, Simmonds and McDaid sites are possible quarry sites located on or near prominent outcrops of the Gunflint Formation. Exposed bands near these sites range in quality and thickness, but are generally of higher quality fine- to medium-grained material. Exposures east of Thunder Bay on the way to the Mackenzie site generally exhibit medium- to coarse-grained bands with some admixture of fine-grained material within bands (Vickruck and Surette, pers. comm., 2014). The tabular blocks used as the source material for cores are easily removed by prying them free from the outcrops (Julig et al., 1990). There is debate whether heat treating improves the quality of the material, but it is agreed that extensive edge and platform preparation is required (Hinshelwood and Webber, 1987, Dan Wendt pers. comm., 2011; Gary Wowchuck, pers. comm., 2012).

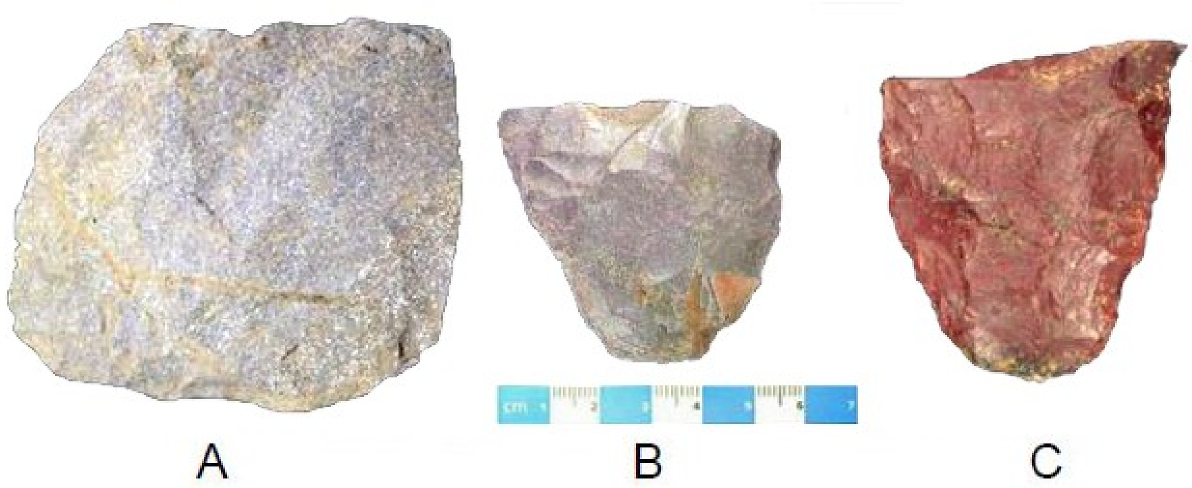


Figure 3.18: Variation is quality of the Gunflint Formation cherts, A) Coarse-grained with inclusions B) Medium-grained with iron oxide inclusion on dorsal face C) Fine-grained high quality.

3.8.2 Knife Lake Siltstone/Lake of the Woods Chert

Knife Lake Siltstone is available in a series of outcrops on Knife Lake along the Ontario/Minnesota border to the south of Thunder Bay. Initially there was a distinction made on the basis of raw material quality. Reid (1980) identified high quality dark grey to black material as Lake of the Woods Chert, but Nelson (1992) and Wendt (2013) identified this material as being Knife Lake Siltstone. Nelson (1992) performed a chemical analysis on the source material and found that although some of it was rougher and duller in texture, it was chemically identical to the finer-grained material. Wendt (2013) identified bands at the Wendt and JJ site quarries that ranged in quality from dull grey medium-grained material, to dark grey/black lustrous fine-grained material (Figure 3.19). This material patinates when exposed to sunlight/moisture. Initial patination results in a blue/green sheen to the material, while full patination results in the exposed face becoming light grey to white (Figure 3.19). Siltstone debitage has been found on sites in the Thunder Bay region, but is predominantly represented in the form of bifaces and formal tools. As mentioned previously some of the siltstone may be local as part of the Gunflint Formation or may possibly come from Dog Lake to the north (Surette, pers. Comm., 2014).

Figure 3.19: Knife Lake Siltstone examples. Right: example of a block with patinated cortex observable on ends (From Minnesota Fieldnotes newsletter, 4 Nov. 2011): Top left: examples of non-patinated flakes (Bennett, 2014); Bottom left: example of patinated tool (From Minnesota Fieldnotes newsletter, 4 Nov. 2011).

3.8.3 Hixton Silicified Sandstone (HSS)

Hixton Silicified Sandstone (HSS) is found in only one primary deposit, in west-central Wisconsin near the town of Hixton, at a site called Silver Mound. Silver Mound is elevated 65 m above the surrounding landscape, and is flanked by multiple rivers and creeks. The surface of the mound is pock-marked by quarry pits, while the surrounding area has several workshop areas and rock-shelters (Carr and Boszhardt, 2010). HSS ranges in colour from white to orange with mixing of colours; high quality veins are semi-translucent and all demonstrate a grainy texture identified as ‘sugary quartz’ in appearance (Figure 3.20) (Carr, 2005).

HSS is often present on sites far removed from the main quarry area, and is usually represented in the form of projectile points (Adams, 1995; Buckmaster and Paquette, 1988; Carr, 2005; Mason and Irwin, 1960; Ross, 1995; Julig, 1994; Norris, 2012). Formal tools are rarely found at the quarry workshops, indicating that final finishing occurred elsewhere (Carr and Boszhardt, 2010). Many of the sites far removed from the quarry site that have projectiles made from HSS also exhibit little to no debitage, indicating the possibility of widespread interaction networks (Carr, 2005).

Figure 3.20: Hixton Silicified Sandstone (HSS) examples. Bottom left: examples of flakes; Top left: example of a block with cortex; Right: example of a block with no cortex, (Bennett, 2014).

3.9 SUMMARY

Between 10,700 and 10,400 ^{14}C years BP (12,700 and 12,300 cal years BP) the ice sheets retreated northwards exposing outlets between Lake Agassiz and the Superior. During the Marquette Re-advance at approximately 10,000 ^{14}C years BP (11,500 cal years BP), these outlets were closed and the Lake Superior Basin was again covered in ice. By around 9,500 ^{14}C years BP (10,700 cal years BP) the ice again retreated northwards reopening the drainage connection that resulted in a catastrophic draining event into the Superior Basin (Clayton, 1983; Farrand and Drexler, 1985; Phillips, 1993; Teller, 1985).

These events had a profound impact on what cultural traditions were present in the region and impacted what areas were available for settlement.

The Paleo-Indian sequence of North America is a long and complex series of cultural traditions. In some areas there is clearly a defined sequence of occupation by different traditions as can be seen at large stratified sites such as Hell Gap and Agate Basin. In the boreal forest of Northern Ontario the succession of different traditions is not clear at all. The Lakehead Complex sites may indicate occupation by a single tradition or they may be mixed occupation sites. Various factors preclude the identification of Mackenzie 1 and other Lakehead Complex sites with established traditions. By analyzing the assemblages it may be possible to better define what the Lakehead Complex consists of, making it possible to compare it more readily with other traditions.

CHAPTER 4

LITHIC THEORETICAL FOUNDATION

4.1 INTRODUCTION

Throughout most of human history, stone was the most important raw material for making tools. Such stone tools were used as hunting weapons, to process plants and animals, to build boats and shelters, to process hide for clothing, and other activities essential to human survival. For this reason lithic assemblages are frequently used to study human behaviour and cognitive processes (Andrefsky, 2009). A strong relationship also exists between stone tools and human organizational strategies. The procurement, reduction and use of stone tools are informed by the ecological conditions, the economic needs and cognitive strategies of the tool producers. Stone tools are morphologically dynamic and this ongoing transformation is intimately associated with the tool use. Different needs during the use life of the tools determine their morphology and this can be observed in assemblages left behind by ancient people (Andrefksy, 2009).

This chapter focuses on the theory underlying lithic analysis studies, and how it aids in understanding past human behaviour. This chapter begins with a review of the history of lithic analysis and the theoretical foundations as it relates to human land-use practices. Binford (1973; 1977) was particularly influential in developing these perspectives, and was the basis for much of the theory that follows. This includes methods and theories mentioned earlier, with more emphasis on conceptual models for tool manufacture. This includes a more focused discussion and comparison of Lithic Reduction and *Chaîne Opératoire* with rationale for selecting one over the other.

4.2 LITHIC ANALYSIS FOUNDATION

Lithics do not degrade easily; therefore they are often the only material remains left to document past human behaviour. Since the first discovery and analytic consideration of stone tools a wealth of theory and methods have been developed to help understand how they were made, how they were used, and why some tool forms change and others remain constant. More recently there has also been a shift in analytic strategy designed to aid in understanding the behaviour and cognitive processes behind the manufacture of tools. There has also been increased use of statistics and mathematical models to extract more information from lithic assemblages. Some examples of methods for studying lithic assemblages include mass analysis of the lithic debitage (Ahler, 1989; Shott, 1994; Andrefsky, 2001; 2007), minimum analytical nodule (Hall and Larson, 2004), typological studies of formal tools (Andrefsky, 1997; Callahan, 1979; Crabtree, 1966; Frison and Stanford, 1982; Morrow, 1995; Smallwood, 2010; Bamforth, 2007; Kornfeld et al. 2010), use wear analysis and residue analysis of formal and informal tools (Andrefsky, 1998; Odell, 2003; Kooyman, 2005), conceptual models of the trajectory of formal tool manufacture (Holmes, 1890; Shott, 2003; Bleed, 2001; 2011; Skinner and Ainswirth, 1991; Soreesi and Dibble, 2003; Waldorf, 1984; Callahan, 1979; Crabtree, 1966; Flenniken, 1978; Bradley, 2010; 2009; 2011;Bamforth, 2007; Whittaker, 1994; Andrefksy, 1998; Frison and Stanford, 1982; Johnson, 1993; Rozen and Sullivan, 1989; Odell, 2003), cognitive process studies (Bonnichesen and Young, 1984; Pollock 1984; Bleed 2001, 2011; Odell, 1980), and behavioral ecology studies (Surovell, 2009). All represent methods of studying lithic assemblages.

When considering the analysis of lithic assemblages, Binford (1973; 1977) offered the concepts of lithic technological organization and curation. These concepts are closely linked to his model of hunter-gatherer land use. Lithic Technological Organization (Binford, 1973) informs researchers about how toolmakers and users organized their lives and activities using lithic technology. The ways in which tools and debitage are designed, produced, recycled and discarded are intimately linked with land-use practices as well as environmental and resource exploitation strategies (Andrefksy, 2009).

The idea of curation is linked to the discussion of lithic technological organization and studies dealing with the production of stone tools (Binford, 1973; 1979). Curation was considered in two contexts: considerations affecting the transportation of tools from one place to another with the intent of being used in that second location; and the effectiveness or utility of tools (Binford, 1973; 1979). The concept of curation also came to be linked with the effectiveness of the tool throughout its use-life (Bamforth, 1986; Andrefsky, 1991; 1994; 2009; Hayden et al, 1993; Parry and Kelly, 1987; Bamforth, 1991; Bradbury and Franklin, 2000; Kuhn, 1994; MacDonald, 2008; Wallace and Shea, 2006).

Curation as a concept is more accurately described as a continuous variable in understanding the utility of a tool rather than as a categorical state (Shott, 1996). Shott (1996) defines curation as the relationship between the realized (or expended) and maximum utility of tools. This is an approximation of how used up the tool is at discard. It is a variable linked in models of activity and assemblage formation to characteristics of ancient cultures (Binford, 1973; Schiffer, 1976; Shott, 1996). Curation is linked to reduction and furtehr engages the concept of utility (Shott, 1996; 2005). In this definition it is practically linked to the amount of use a tool can conceivably supply. The maximum utility is approximated as the greatest amount or degree of reduction a tool can undergo, while realized or expended utility is the reduction that the tool actually experiences before discard (Shott, 1996). Both are approximated using the object mass, dimensions or volume. Curation is not the same as use-life though both are co-variant and increase through time and use (Shott, 1996). These two concepts are measured using different scales (Shott and Sillitoe, 2005). The use-life of a tool is an indication of the longevity of the tool through time, the number of uses or other units (Shott, 1996). Specimens of a tool-type can be highly curated even if the use-life is relatively short. Curation is a measurement of the amount or degree of reduction on a tool, this is measured by a comparison of the approximation of the original tool form with the reduced size of the tools (Shott, 1996). This concept of curation has been applied to a number of assemblages (Shott and Sillitoe, 2005; Shott and Ballenger, 2007; Shott and Weedman, 2007).

Understanding curation of tools can help us understand the behaviour of a people. Improved definitions of curation inform researchers of the cognitive processes of past peoples as well as the amount of quality material (Andrefksy, 2009). Curation studies inform morphological and functional changes which in turn can inform the cognitive processes and lithic technological organization.

4.3 TOOL MANUFACTURE ANALYSIS

The manufacture of stone tools is informed by the cultural norms and cognitive processes of tool makers and tool users. Curation and Lithic Technological Organization have been used to study the manufacture process and the cognitive processes informing tool manufacture. Researchers utilize two main theoretical constructs to study these processes, though in reality the difference is just in the name. Lithic Reduction Studies and *Chaîne Opératoire* both look at the sequence of tool manufacture in terms of the cognitive processes informing the sequence.

The manufacture of stone tools is a reductive process that follows a sequence throughout the use-life of a stone tool. Initial concepts of reduction of stone tools by Holmes (1890) laid the foundation for this method of staged lithic reduction. This sequence is not fixed into preconceived or definitive steps, but is informed by the needs and skill of the tool maker/user, the mechanics of manufacture, and the nature of the raw material itself. Conceptual models are used to describe the ideal process of tool manufacture (Crabtree, 1966; Collins, 1975; Callahan, 1979). Lithic Reduction studies describe this process using a series of discrete stages, while *Chaîne Opératoire* describes the process as being more fluid. This distinction reflects some researchers' perspective that the process is too fluid to permit a comparatively rigid 'stage' classification system. Despite this debate, it is generally agreed that the process is informed by the cognitive processes of the tool users. Stage sequence lithic reduction studies were developed in North America to describe the manufacture of fluted toolkits. This method of analysis has continued to be used to describe the manufacture of late Paleoindian non-fluted toolkits. For reasons of consistency the stage sequence reduction methodology will be followed.

Procurement takes place at quarries where the quality and durability of the material is initially tested. Quarry blanks are roughly flaked in order to reduce the mass, and ensure that only the best quality material is carried away. Further reduction can occur in diverse locations. This can include a nearby manufacturing camp, a main campsite some distance away from the source, and at small hunting/processing camps away from the main camp. An understanding of what activities were being undertaken at a site can help the researcher to determine site function(s). This interpretive process is at the foundation of many archaeological analyses. Insight can be gained as to the technological processes of past people that can include the skill and knowledge of ancient artisans who used and produced such tools, and the adaptability of the human mind in how problems were identified and resolved. Through activity analysis, paleo-anthropological researchers can gain insight into the level of cognitive advancement evident among hominids and researchers might also discriminate between cultural groups separated temporally or geographically (Kooyman 2000, Odell 2003, Andrefsky 2009; Whittaker, 1996; Bradley, 2009; 2010; Bamforth, 2008).

4.3.1 History of Lithic Reduction Studies

The beginnings of Lithic Reduction studies in North America can be traced back to the late 1800s. In 1890 William Holmes investigated a site in Washington, DC, that was deeply stratified, and contained stone tools at various stages of completion. Holmes identified three stages of manufacture (Figure 4.1) based on the degree of work observed on a given piece. Stage 1 pieces were identified as cobbles crudely shaped into a more refined form; generally bifacial but unifacially flaked pieces were included in this stage as well. Stage 2 pieces were more finely flaked with an emphasis on thinning and shaping. These pieces were thinned considerably from the previous stage and roughly shaped into a large oval. The Stage 3 pieces were identified as being thinner, leaf-shaped in form, with a more refined flaking pattern evident. Holmes determined that the site represented a quarry workshop since no other finer flaked pieces were in evidence. He believed that the desired stage for the workshop was the Stage 3 piece and these were taken elsewhere to be further refined into completed tools (Holmes, 1890; 1894 a; 1984 b; 1919). This was the earliest documented attempt by an American archaeologist to think of the process by which raw stone is worked into usable tools.

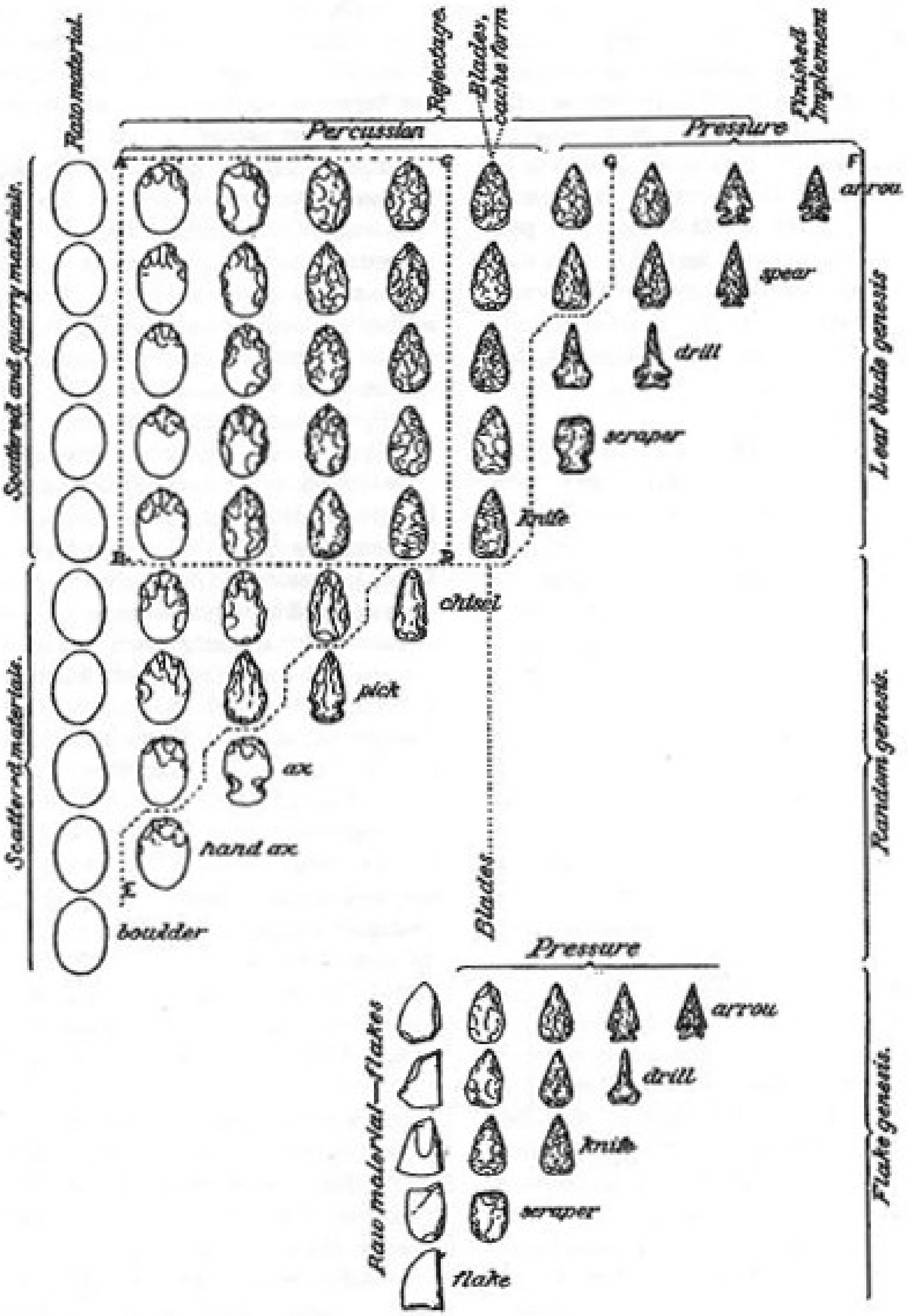


Figure 4.1: Initial lithic reduction sequence as identified by Holmes, modified after Holmes, 1894: Diagram 1; 129.

It was not until the 1960s that archaeologists again addressed how stone tools were manufactured. In the intervening time, archaeological enquiry was largely focused on reconstruction of culture history through research that identified and documented tools useful for defining archaeological cultures that could be ordered temporally or geographically. Beginning in the 1960s processual archaeologists sought to enhance the scientific rigour of the discipline. These archaeological theorists began to focus on how things were made and the reasons behind them (Trigger, 2006; Hodder, 2001). This was highlighted by the well-publicized debates that raged between François Bordes and Lewis Binford concerning how Mousterian toolkits were manufactured (Binford and Binford, 1966; Bordes, 1961; Bordes and de Sonnenville-Bordes, 1970).

In North America the early 20th century discovery of Clovis and Folsom projectiles led archaeologists to seek insight into where and how these distinct tools originated, with influential analyses that contributed to more widespread consideration of the tool manufacture process. The initial studies were site-specific analyses of how these iconic projectiles were manufactured (Wilmsen, 1970; Painter, 1965; Newcomer, 1971; Muto, 1971; Crabtree, 1966; Flenniken, 1978; Frison and Bradley, 1980; Bradley and Frison, 1987; Sharrock, 1966; Callahan (1979) and provided the overarching theoretical foundation for Lithic Reduction analysis. Newcomer (1971) recognized that some Stage 2 or 3 bifaces were meant to be used as bifacial cores from which usable flakes were detached. Muto (1971) observed changes in the percussor at different steps in his reduction scheme and measures undertaken to correct and salvage knapping errors (1971). Sharrock (1966) examined bifaces from Pine Springs in Wyoming, and to Callahan's (1979) knowledge was the first researcher to identify the difference between Primary and Secondary thinning stages. Callahan (1979) was largely focused on replicating the Clovis reduction sequence of Flint Run and Williamson in Virginia, but his work became the subsequent basis for more generalized reduction sequence studies. During the late 1990s and into the 21st century a generalized conceptual model was created (Odell 2003; Kooyman 2000; Andrefsky 1998; Whittaker 1994) using Callahan (1979) as a major source.

Callahan (1979) will be discussed in greater detail later in this chapter since this was the direct source for initial manufacture sequence studies addressing the Lakehead Complex that occurred during the late 1980s and into the mid 1990s (Hinshelwood and Webber 1987; Hinshelwood, 1990; Hinshelwood and Ross, 1992; Adams, 1995; Julig, 1994; Halverson, 1992).

4.3.2 *Chaîne Opératoire*

Leroi-Gourhan (1964) introduced the term "*Chaîne Opératoire"* to describe an approach to lithic analysis that has been subsequently adopted by many European scholars (Bourguignon et al, 2004; Boeda, 1995; Martinon-Torres, 2002; Carr and Bradbury, 2011; Bleed, 2001; 2011; Bar-Yosef and Van Peer, 2009). This biface analysis conceptual model has seen limited use in North America (Burke, 2007; 2006; Eid, 2012, Pepin 2012; Kolhatkar, 2012; Shott 2003). Advocates of this method of analysis observe that the manufacture process was rather fluid, and therefore it better describes the cognitive processes behind the manufacture sequence.

The fundamental idea is that the process of manufacturing stone tools is best described as a *chaîne* to reflect the fluid continuum beginning with the procurement of the raw material, and ending with the completion of the desired finished form. A different *chaîne* is envisioned to exist for different cultures and thorough understanding of the *chaîne* reveals the mechanical process of tool production. This fluid process also reveals the culture system that informs the process. There is no series of stages identified, but it is clear that some sort of culturally defined sequence existed at least within the knapper's mind. The cognitive process is identified through the culturally mediated stopping points used by the knapper to reset and switch to a different flaking method and pattern (Andrefsky, 2009).

Regardless of the method used, both approaches fully describe how blocks of raw material are reduced into formal tools. These methods are a means to understanding the Lithic Technological Organization of a culture. Even though the reduction sequence model appears to be rather rigid (with analytically defined stages), it is fluid enough to describe the cognitive processes and the cultural intent. Lithic reduction and *chaîne opératoire* are essentially the same concept, both are used to describe the reductive process of lithic tool manufacture (Shott, 2003).

4.3.3 Cognitive Approach to Tool Manufacture

The idea of a cognitive approach to the analysis of reduction sequences was initiated by Young and Bonnichsen (1984), Pollock (1984) and most recently by Bleed (2001; 2011). A cognitive approach involves attempting to discern the thought process of ancient people by applying modern psychological theories. Cognitive psychologists have developed ways of describing the organization of tasks in ways similar to how archaeologists have described reduction sequences. These are described in terms of how the sub-actions of a system relate to the one another: narrow systems are ones where each potential action directly informs the following action in a direct linear series, while in a wide system each potential action provides the operator with a number of options (Bleed, 2011).

Reduction sequence studies are often thought of as a narrow system regardless of whether one defines it as a reduction sequence or *Chaîne Opératoire*. Each action is generally thought of as directly informing what the following action will be. All cultural groups have the ideal, conceptual model in the back of their minds informing them of the process required to successfully produce a formal tool. Errors are largely irrevocable within these sequences as they are reductive. However archaeologists still need to think of these sequences as both wide and narrow (Bleed, 2011). The operators combine their knowledge of the conceptual model, their experience with the material being processed, and their honed motor skills to make decisions based on their previous action. The models themselves can be thought of as narrow systems but the execution of the model results in the creation of a more open system. The manufacture of stone tools reveals a number of decisions to be made at any point of the process. Flaws revealed in the material, reduction causing portions to narrow, or if the blank has a form allowing for easy reduction into formal tools provides the knapper with a number of options (Bleed, 2011).

4.4 THE LITHIC REDUCTION CONCEPTUAL MODEL IN NORTH AMERICA

The Lithic Reduction Sequence conceptual model in North America was developed and refined to inform the analysis of Clovis and Folsom bifaces and distinct projectile forms. It has since been used to describe subsequent late Paleo-Indian flaking sequences. Previous analyses on Lakehead Complex biface assemblages have employed a modified version of Callahan's (1979) reduction sequence model. The analysis of the Mackenzie 1 biface assemblage also follows this model, with modification deriving from the more recent works of Whittaker (1994; see Figure 4.2), Andrefsky (1998; see Figure 4.3), and Odell (2003; see Figure 4.4). Due to the use of the Callahan (1979) model to analyze the Brohm (Hinshelwood, 1990) and Biloski (Hinshelwood and Webber, 1987) assemblages it has been determined that this model should be applied to Mackenzie I to engage in cross-site comparisons throughout the Lakehead Complex. This analysis focuses upon the reduction sequence observable within the large collection from Mackenzie 1, furthering the understanding of the Lakehead Complex.

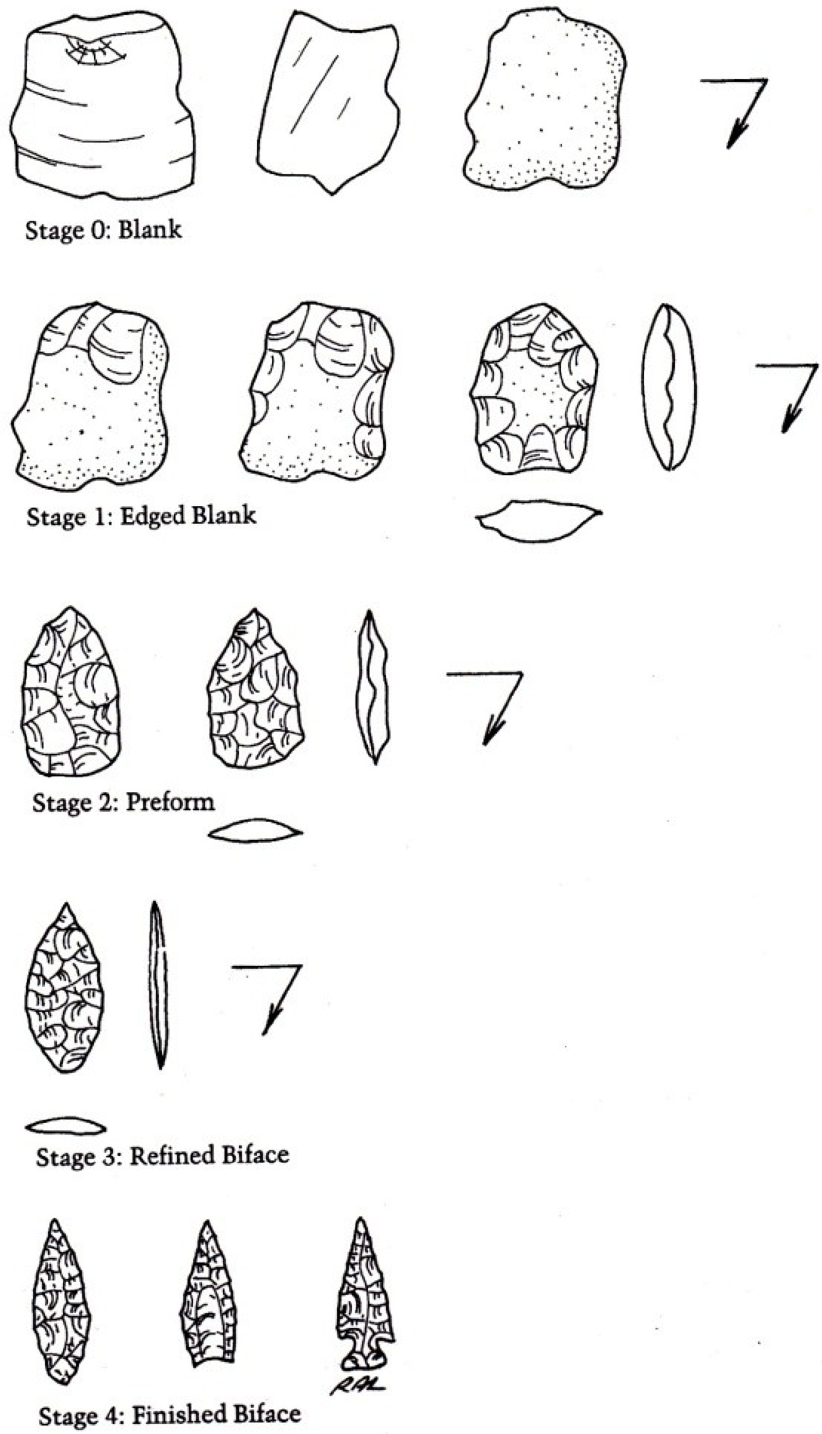


Figure 4.2: Idealized lithic reduction conceptual model modified after Whittaker, 1996: Figure 8.21; 200.

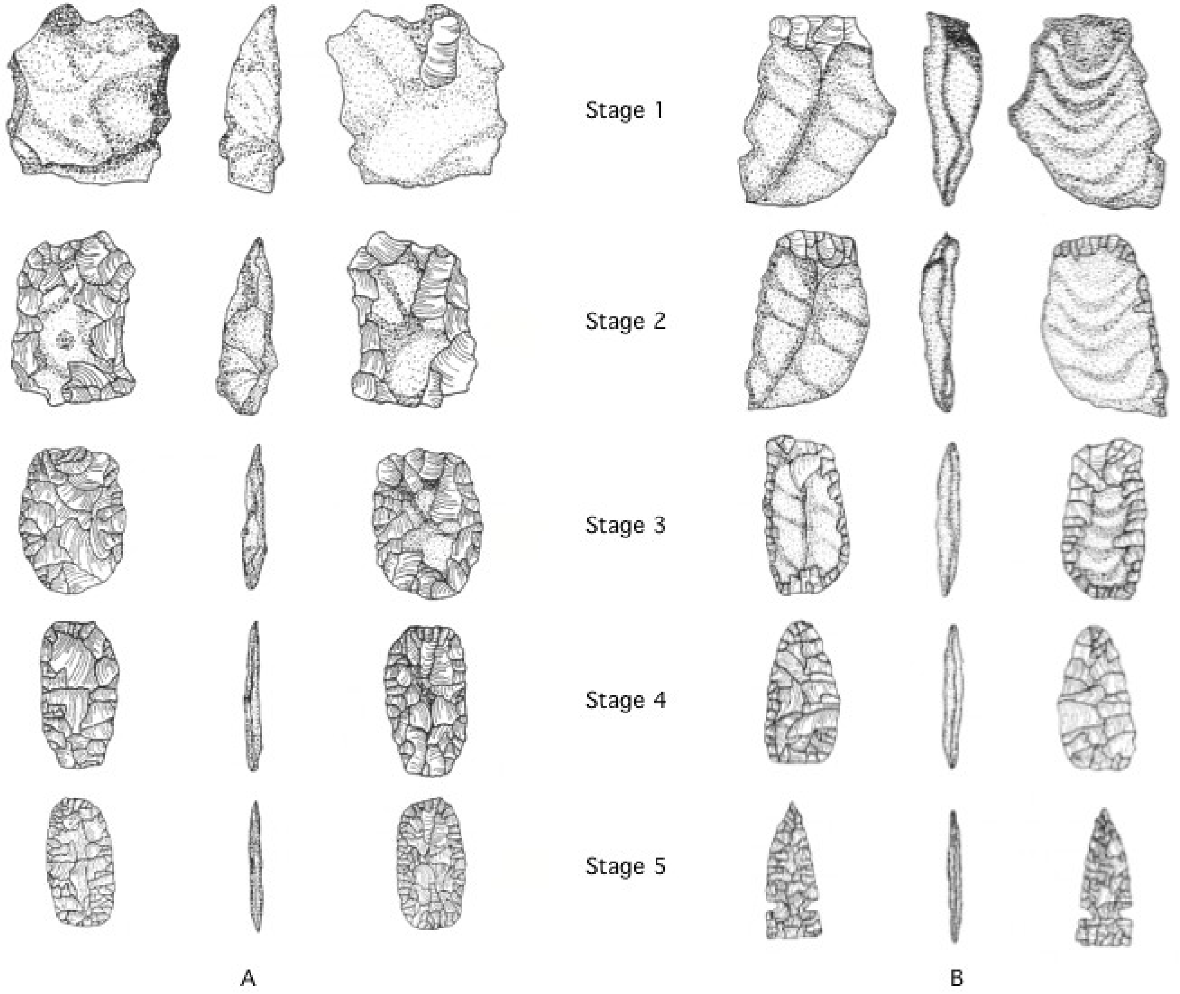


Figure 4.3: Idealized lithic reduction conceptual models, Biface Trajectory (Plate A), Flake Trajectory (Plate B). Modified after Andrefsky, 1998: A) Figure 7.31; 182, B) Figure 7.32; 183.

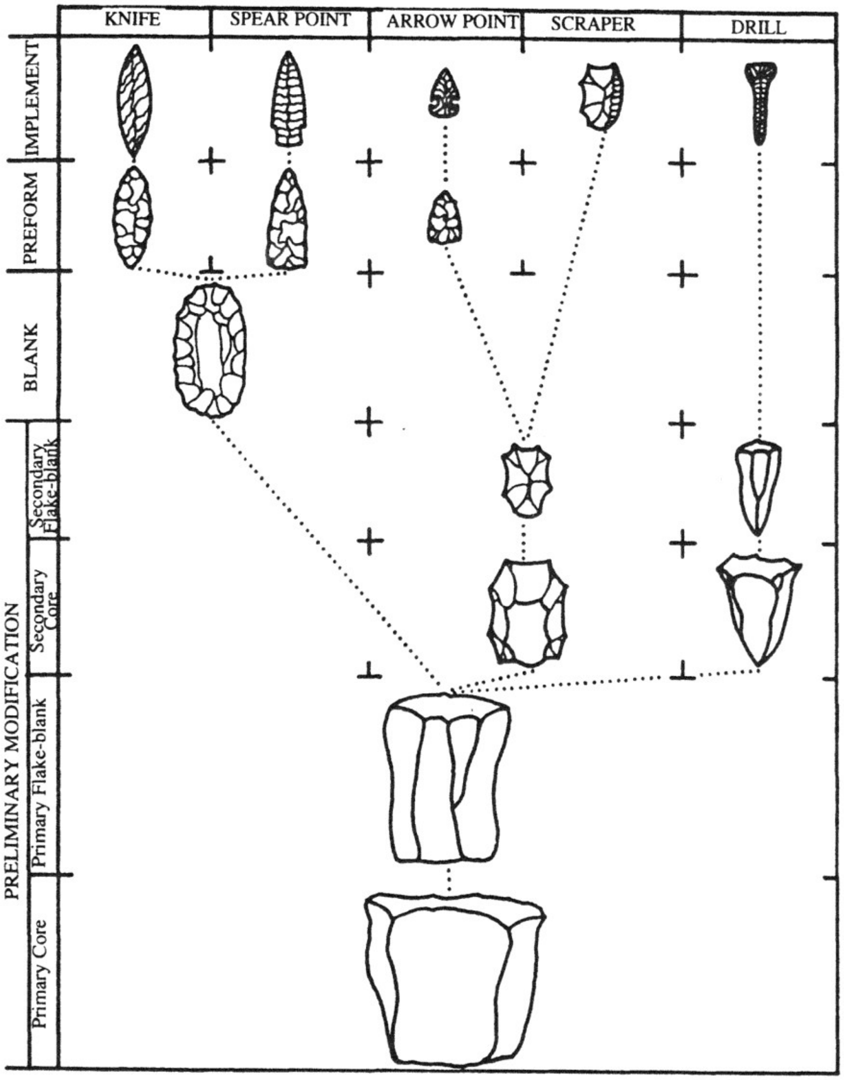


Figure 4.4: Idealized lithic reduction conceptual model modified after Bradley (1975: Figure 1; 9).

The manufacture of a biface is part of the ongoing use-life of the object. It does not end when the biface reaches an imagined final stage of production such as a hafted projectile point. Retouching and reuse regularly occurred, which extended the use-life of many stone tools. Callahan (1979) discusses use-life and manufacture largely in terms of Clovis-like bifaces but much of what he has observed can be more broadly applied to all bifacial tool industries. The manufacture is a continuum with analyst-defined stages, observable when a shift in the flaking approach takes place. Failure to execute the stages with the proper tools and without properly preparing the piece for the next stage increases the chance that it will fail during manufacture (Callahan, 1979).

The morphology of bifaces, reflecting patterns of learned behaviour, vary between cultures and can sometimes be used as diagnostic markers. This is true for the hafted bifaces that have been most transformed towards a culturally-mediated end objective. Flintknappers used culturally-learned flaking sequences to produce these tool forms. Early stage bifaces were often used as tools, and in some cases this continued to be used as the specimen was reduced. Most biface analyses focus on the projectile points and other diagnostic tools (knives). These studies often ignore the more generic bifaces and preforms. Hafted bifaces are distinguishable by the extra work done on the basal portion to prepare it for insertion into a shaft, or hilt. Hafting preparation can range from simple end thinning and grinding, fluting as in Clovis and Folsom, or notching observed in Archaic manufacture techniques (Andrefsky, 1998). This has enabled the development of projectile point typologies to document culturally diagnostic finishing strategies.

4.4.1 Clovis Lithic Reduction

Many biface assemblages are characterized by distinctive attributes. Many of these attributes first appear with the Clovis fluted tradition, and can be observed in subsequent traditions. Thus, an understanding of the early stages of Clovis manufacture is useful in understanding of how bifaces continued to be manufactured in North America. An in-depth review of Callahan's (1979) analysis of the Clovis manufacture sequence is offered here since many of his observations are relevant for defining many subsequent bifacial toolkits (both fluted and the later non-fluted traditions). Clovis points have been widely studied because they were once believed to be the oldest cultural group in North America, and are widely distributed throughout the continental United States and parts of southern Canada.

On the basis of examination of two Clovis assemblages, Callahan (1979) determined that Clovis-like bifacial tools go through nine stages of manufacture to achieve the iconic fluted Clovis projectile form. Of the nine stages specific to Clovis technologies, the first five can be readily applied to any bifacial tool technology (Figures 4.5 through 4.9). The last four stages (Figure 4.13) are specific to the hafting elements associated with Clovis. This seems to be common with bifaces produced by all cultural entities, whereby the last production stages are generally unique, and need to be described on a group-by-group basis (Crabtree, 1966; Flenniken, 1978; Bradley and Frison, 1987; Frison and Bradley, 1980; Bamforth, 2009; Bradley, 2009; 2010; Frison and Stanford, 1982; Bradley, 2009; 2010; Pitblado, 2003).

Stage 1 - The Blank: Obtaining the blank involves any action whereby the flintknapper removes a suitable piece of material from a larger block or core or through the collection of suitable cobbles, frost spalls, or other expedient pieces (Callahan 1979). This can also involve collecting frost spalls from quarries or other such nodules that can be found at an outcrop.

Callahan identifies three basic forms of blanks. The first forms are those that were used without prior modification, and include cobbles, frost spalls, or heat spalls. The second form includes specimens identified as double blanks. These are large chunks, nodules or river cobbles which are split into two usable pieces. The third form is called multiple blanks. These are large cores from which flakes of sufficient size to be used as blanks are removed. The cores vary in shape and are divided into block cores and spheroid cores (Callahan, 1979).

When making Clovis points, Callahan (1979) found that the best flakes are fairly regular, nearly parallel sided and twice as long as they are wide. Such flakes often have longitudinal ridge scars from previous flake removal. Callahan calls such pieces “blade-flakes” due to his observation that morphologically they fall between the definition of flakes and blades. A regular flake of sufficient size can be used as well and are usually wider than they are long (Callahan, 1979).

Stage 2 - Initial Edging: Flake removal at this stage involves the creation of a centered edge to permit further flaking or remove a sharp, acute angle edge that frequently occur on flake blanks. Core blanks, spalls, and tabular blanks usually exhibit a squared or flat edge on one or both edges. The initial edge work was required in order to create a roughly centered edge with a slight wave pattern (Figure 4.5). Roughly centered edges are the easiest to work from and are therefore desired. Sharp protrusions remained as isolated platforms created by hard hammer percussion. This initial work created an edge angle of between 55 and 75 degrees. The flake scars usually covered less than half the dorsal or ventral face of the piece. Cortex can be present on one or both faces, or on an edge or edges depending on the nature of the blank. This produced a piece with a hexagonal, irregular to thick lenticular cross-section (Figure 4.5). Reduction from a tabular core blank produces a width/thickness ratio of between 2.00 to 3.00. Working from a flake blank is the other option and depending on the original thickness of the piece the Width/Thickness ratio may exceed 6.00. The progression of Stage 2 manufacture is presented in Figure 4.6 along with the typical angle of striking and the typical edge angle and cross-section. When working from relatively thin flake blanks edging is often minimal and confined to preparation for the upcoming thinning stages, often skipping directly to secondary thinning or Stage 4 (Callahan, 1979).

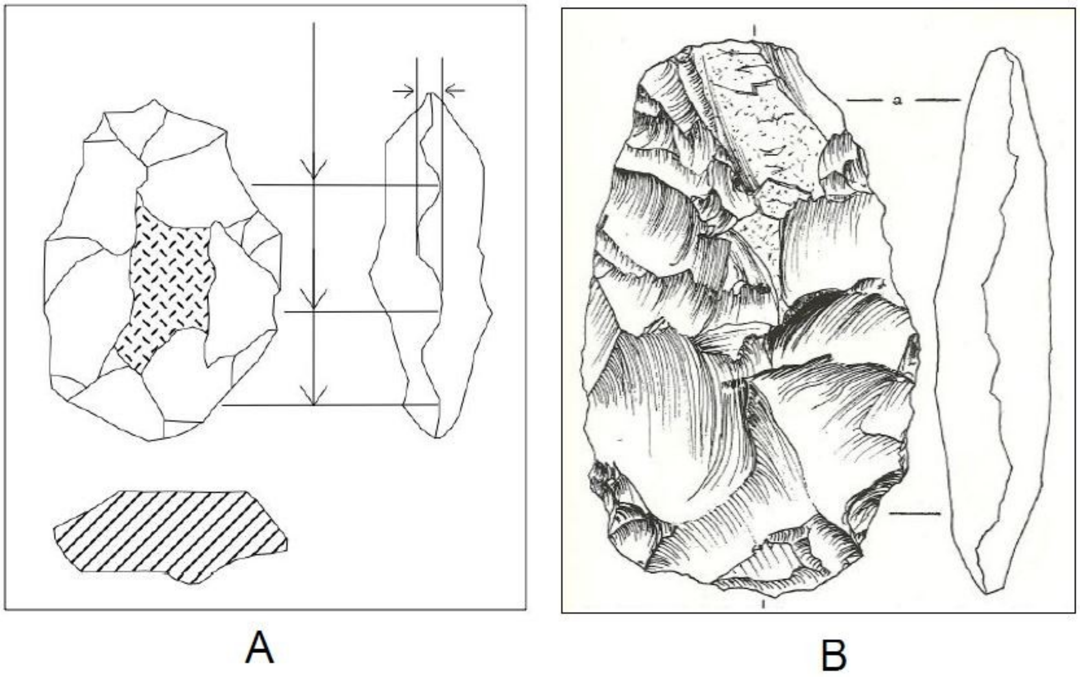


Figure 4.5: Plate A) ideal Stage 2 flake removal modified after Callahan (1979: Table 2b; 11) Plate B) experimental example of Stage 2 flake removal modified after Callahan (1979: Figure 21a; 71).

End thinning flakes are present on pieces in this stage in response to the removal of stepping fractures that resulted in large humps. During Stage 2 work this is not as great of a problem as it is in later stages. Step fractures or hinge fractures of 3mm depth are tolerable at this stage and can, with care, be removed in later stages. Specimens in this stage are thick, crude looking pieces which can often be mistaken for cores (Callahan, 1979)

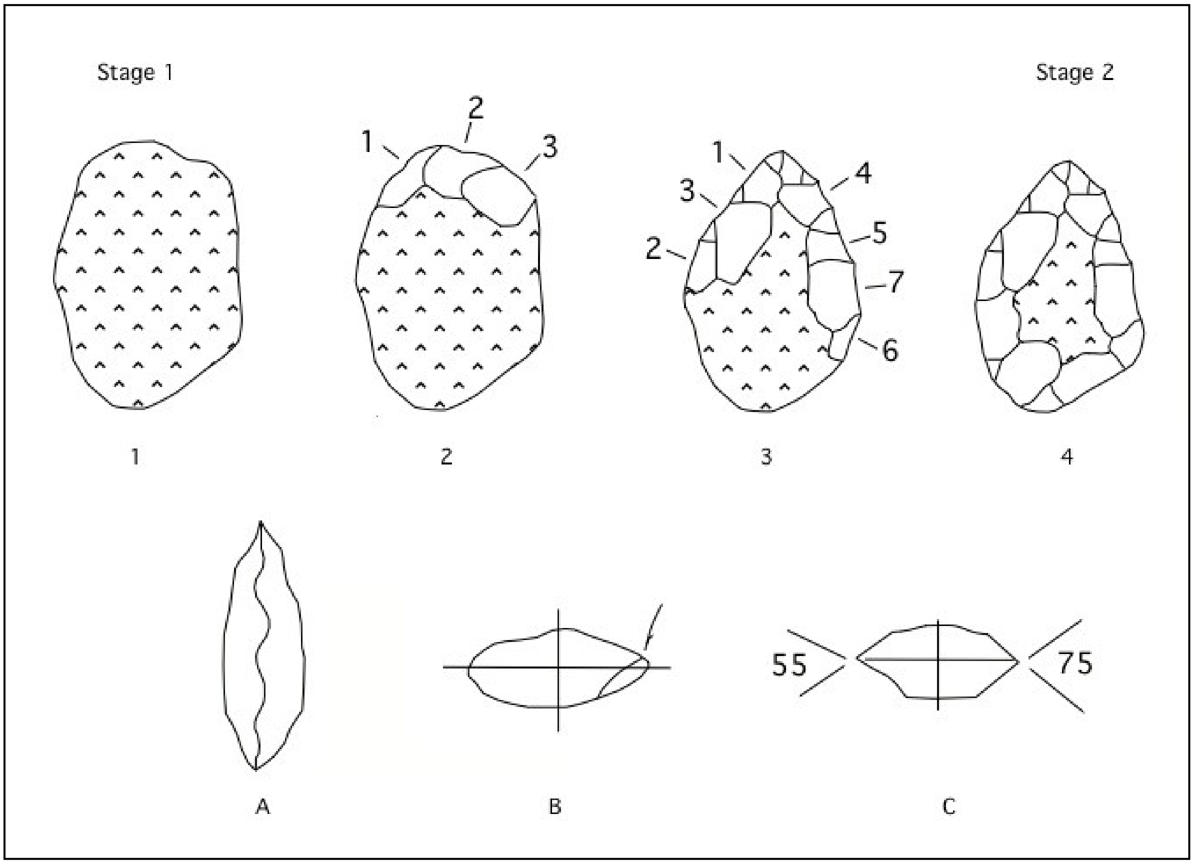


Figure 4.6 Stage 2 progression, from blank to Stage 2 (Left to Right), numbers indicate the sequence of flake removal, A) longitudinal profile, B) Ideal angle of flake removal, C) Cross-section with edge angles indicated, modified after Callahan (1979: Table 1; 10).

Stage 3 - *Primary Thinning*: At this stage the first series of flakes are removed to reduce the thickness and minimize the reduction of the width. The ideal end-product is a specimen with a lenticular cross-section, with flakes scars travelling to center or just across center. Overshot flaking (Figure 4.16) which is prevalent in Clovis biface manufacture, may be present in this stage if surface irregularities are severe enough to warrant this style of flake removal. If done correctly the piece can be thinned with a minimum of flake scars. However, this flaking pattern can result in more frequent failure (Callahan, 1979; Bradley, 1982; 2009; Bradley et al., 2010; Waters et al., 2011). Width/thickness ratio should fall between 3.00 and 4.00. The edge should be aligned centrally to the midline of the stone, and edge angles should measure between 40 and 60 degrees (Figure 4.7). The width/thickness ratio is stabilized, meaning that if a similar sequence of flakes were removed the biface would become narrow at the same rate it becomes thinner (Callahan, 1979).

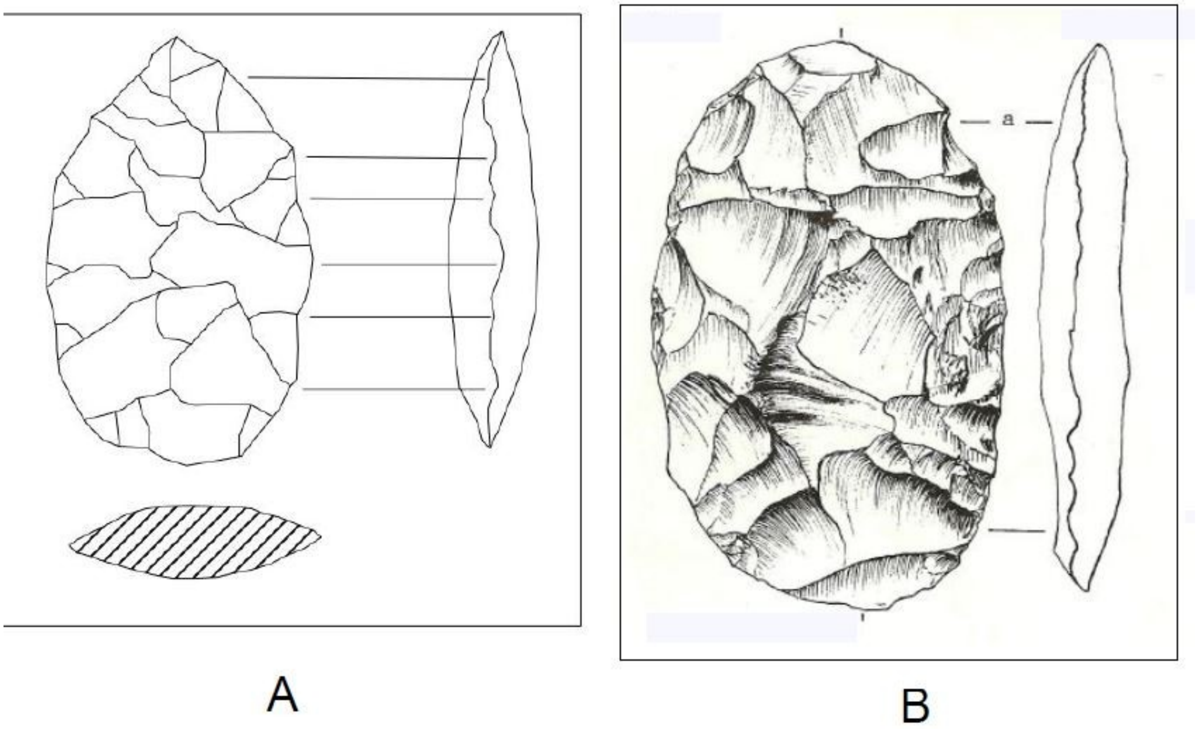


Figure 4.7: Plate A) ideal Stage 3 flake removal modified after Callahan (1979: Table 2b; 11) Plate B) experimental example of Stage 3 flake removal modified after Callahan (1979: Figure 36a; 96).

Flake removal is designed to set up the edge required to properly work the surface and set up platforms. These platforms are prepared at or near the center line and are struck at a shallow angle so that the flake travels across the face. The flakes removed in this stage are intended to remove some of the larger humps and irregularities on the surface. It also stabilizes the width/thickness ratio (Callahan, 1979). The progression of Stage 3 reduction can be observed in Figure 4.8.

Stabilization of the width/thickness ratio removes any pronounced humps or concavities and creates a lenticular cross-section. This reduces the chance that the piece will fail upon further flaking. Generally bifaces which have made it to this stage are relatively free of flaws that can result in fracture. These bifaces have the most strength and the most resistance to breakage. As a result these specimens could be used as chopping and cutting tools. Callahan notes that cache and trade blanks often show distinct Stage 3 characteristics. Bifaces in this stage may also display culturally defined flaking sequences (Callahan, 1979).

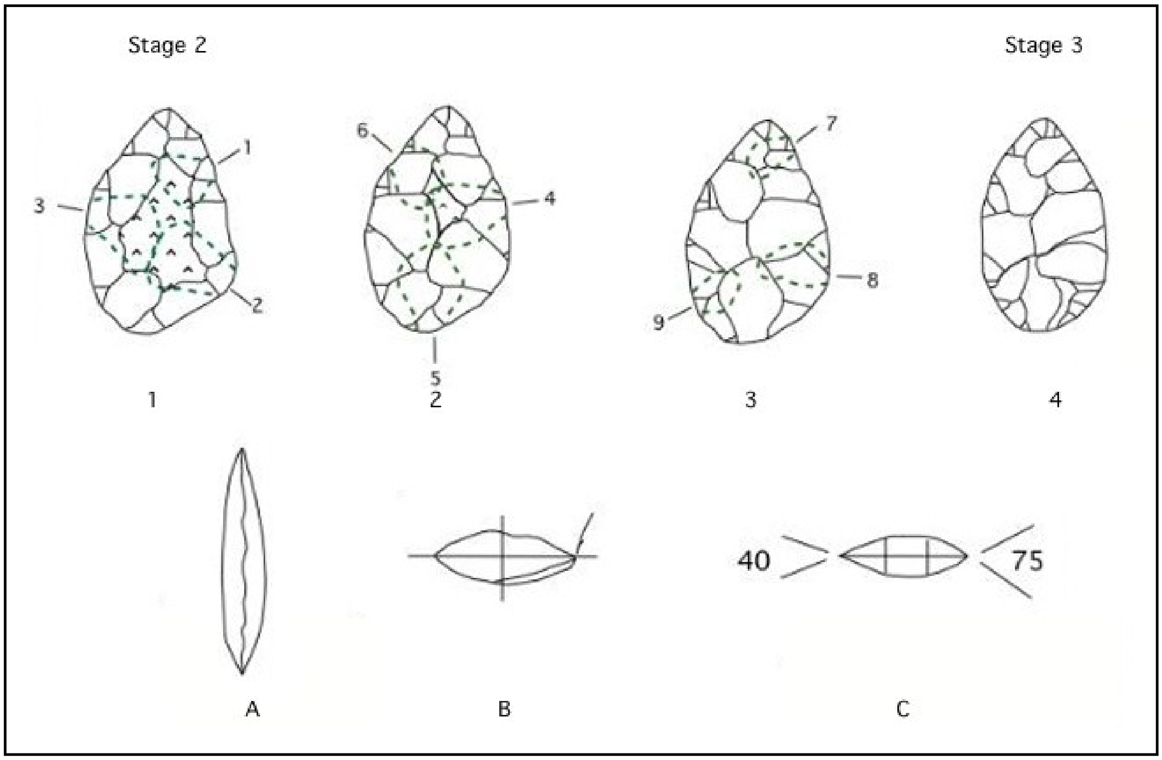


Figure 4.8 Stage 3: Progression from Stage 2 to Stage 3 (Left to Right), numbers indicate the sequence of flake removal, A) Longitudinal Profile, B) Ideal angle of flake removal, C) Cross-section with edge angles indicated, modified after Callahan (1979: Table 1; 10).

Stage 4 - Secondary Thinning: It is during this stage that the cross-section of the biface becomes more flattened, thinning faster than narrowing (Figure 4.9). Serial patterned flake removal, often working from tip to base is the most common method. Flake scars cross the midline, slightly undercutting the corresponding flake scars originating on the opposite edge. Overshot flaking is often present in this stage, though they are executed with greater care and greater degree of platform preparation. The flake scars are very regular and executed with similar force and striking angle (Callahan, 1979).This creates the desired flattened cross-section with a Width/Thickness ratio of 4.00 and 5.00 or more. The edge angles should continue to be centrally aligned with angles of between 25 and 45 degrees. At this stage most if not all surface humps, hinges, step-fractures, or median convexity should be removed (Callahan, 1979).

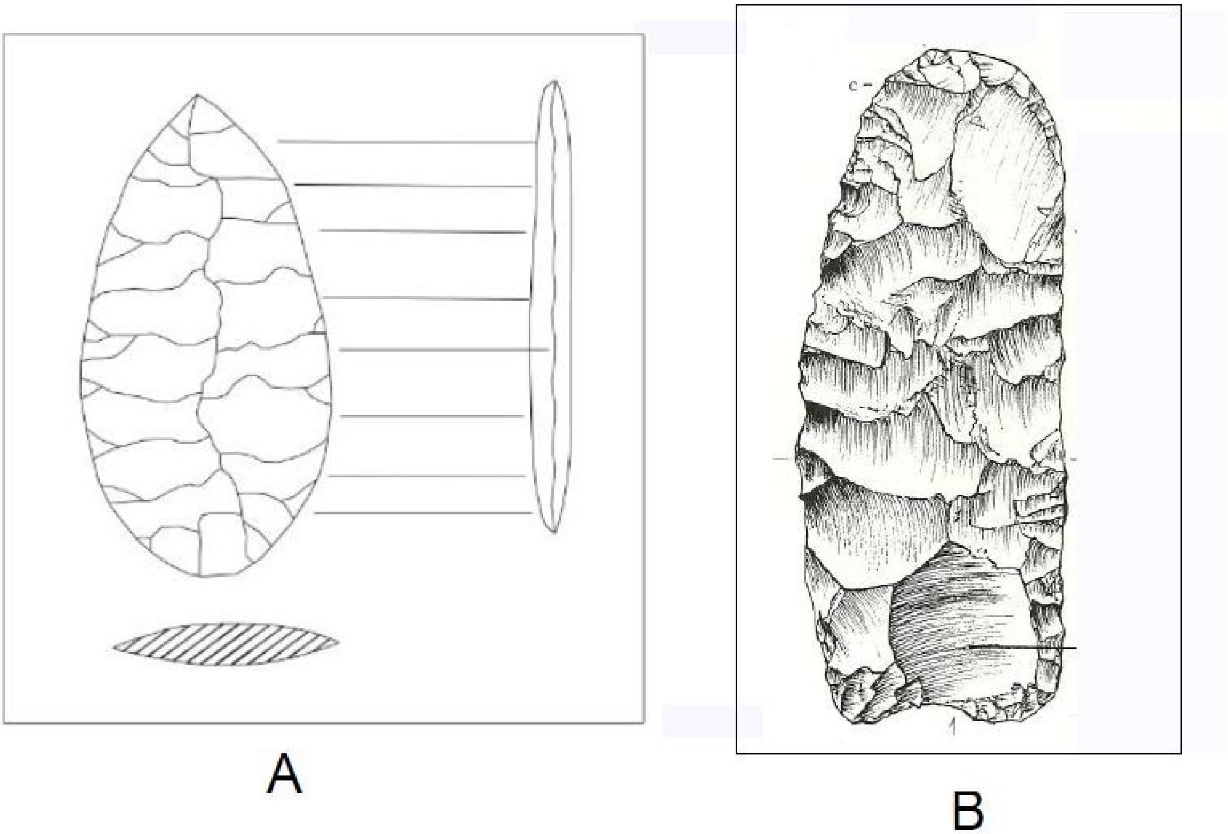


Figure 4.9: Plate A) ideal Stage 4 flake removal modified after Callahan (1979: Table 2b; 11) Plate B) experimental example of Stage 4 flake removal modified after Callahan (1979: Figure 47c; 120).

In some lithic reduction sequences these specimens can be considered to be the final preform. Callahan (1979) states that Stage 5 bifaces are the preform in fluting traditions. Cache and trade blanks are also noted as being Stage 4 bifaces. Callahan states that they may have been "dressed out later for trade in thinned flawless preforms 'cache blanks' or 'trade blanks'" (Callahan, 1979; 116).

The regular flaking pattern on bifaces of this stage means that platforms are carefully prepared rather than expediently selected. At this stage it is more likely to observe edge preparation, grinding, retouching or a combination to create platforms (Callahan, 1979). The ideal biface in this stage has measurements of 7.5-10cm long, 4-5cm wide and .8-1.3cm thick. It is also more likely that a culturally determined flaking pattern can be observed on bifaces in this stage (Callahan, 1979).

Callahan also carried out techno-functional tests on Stage 4 bifaces. Working with field school students he determined that, depending on the thinness of bifaces in this stage, they were best used for sawing, incising, scraping, cutting and rasping. These experiments also determined that the edge angle was not good for chopping or digging as they blunted far too quickly to be useful (Callahan, 1979). The progression of Stage 4 reduction can be observed in Figure 4.10.

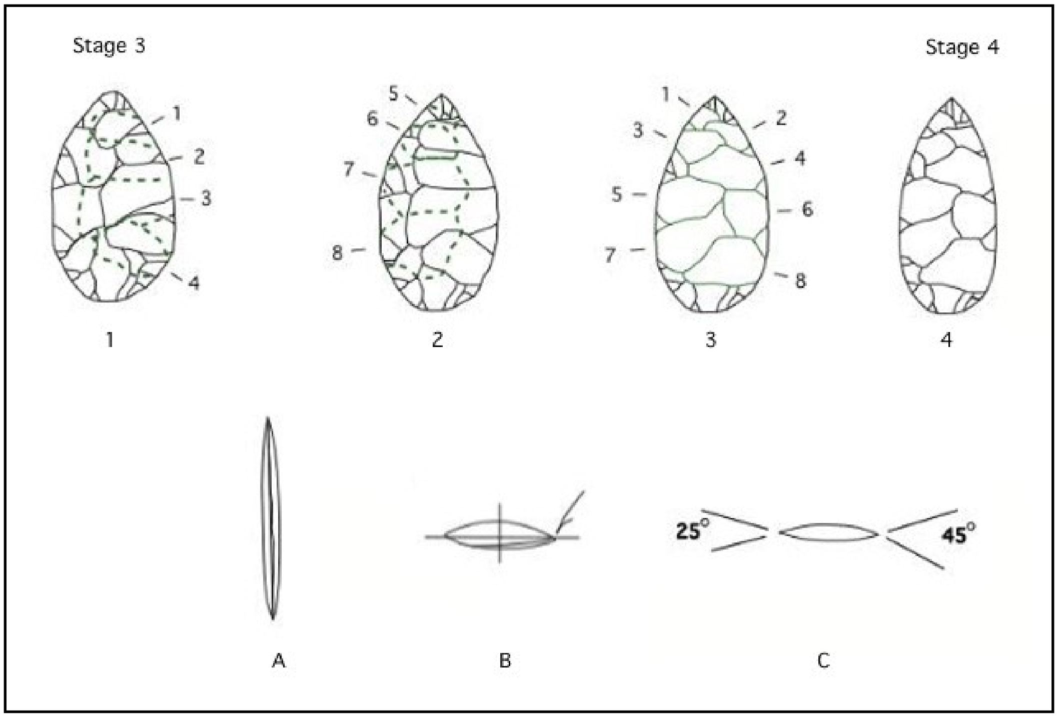


Figure 4.10: Stage 4 progression from Stage 3 to Stage 4 (Left to Right), numbers indicate the sequence of flake removal, A) Longitudinal Profile, B) Ideal angle of flake removal, C) Cross-section with edge angles indicated, (modified after Callahan 1979: Table 1; 10).

Stage 5 - The Preform: Preform manufacture and refinement occurs at this stage. Bifaces are shaped and refined so that the end product is clearly visible. A preform generally has the rough shape of a finished tool, and only the final retouch is required to complete it. Width/Thickness ratio and edge angles are the same as a Stage 4. It is at this point that fine edge work occurred, ensuring the edge is centrally aligned and any remnants of platforms are removed to create a fine sharp edge. If the piece is being hafted it is at this stage that any preparation work is undertaken (Callahan, 1979).

The end of Stage 5 involves platform preparation for the removal of the first flute. Stage 6 is the removal of the first flute followed by Stage 7 platform preparation for the removal of the second flute. Stage 8 involves removal of the second flute and basal and lateral grinding. In terms of what the stage can be defined as for other groups, this depends entirely on the end product. For the manufacture of hafted bifaces this would be the stage where the haft element was prepared for subsequent completion. Many researchers just lump this into a single stage termed Finishing. The distinctions made between Stages 4 through 6 can sometimes be vague and misleading, even more so than those between Stages 1 to 3. In order to determine the different stages non-metric attributes are used leaving it up to the discretion of the researcher.

Depending on the organization of a cultural groups' lithic technology, bifaces in this stage may be considered complete. Stage 5 is often described as concluding with edge preparation for the finishing of the hafting portion. The subsequent Stages 6 through 8 in the Callahan sequence describe the methods used to flute the projectiles and finish the edges. Even though Callahan was specifically looking at Clovis reduction at two sites in Virginia the basic concepts from the early stages can be seen in subsequent Paleoindian biface toolkits. Callahan (1979) discusses the use of both blade/flakes and flakes as blanks. The reduction scheme follows that of the biface trajectory and is illustrated in Figure 4.11 and Figure 4.12. The final stages of Clovis manufacture involve the finishing of the edges and manufacturing the distinctive flute. Callahan (1979) broke this portion of the manufacture into five stages (Figure 4.13). The process remains very similar until the finishing stages where culture-specific methods are used to finish the piece. Callahan has created one of the seminal treatises on the biface manufacture sequence. By studying the archaeological specimens with the goal of replicating them he was able to understand the cognitive process more completely. This analysis of the reduction stage of Clovis has been the source of nearly all subsequent studies of bifacial manufacture sequences. Later analyses of the Clovis manufacture sequence have resulted in more defined stages of manufacture (Figure 4.14; Bradley, 2009; 2010). Clovis lithic technology also consisted of the use of blades (Bradley, 2009; 2010; Waters et al, 2008). Blade technology in Clovis consisted of the use of highly prepared conical cores with a flat top and carefully prepared striking platforms (Figure 4.15). This facilitated the removal of long narrow blades which were ideally used as expedient tools, or blanks for smaller tools such as thumbnail scrapers and drills.

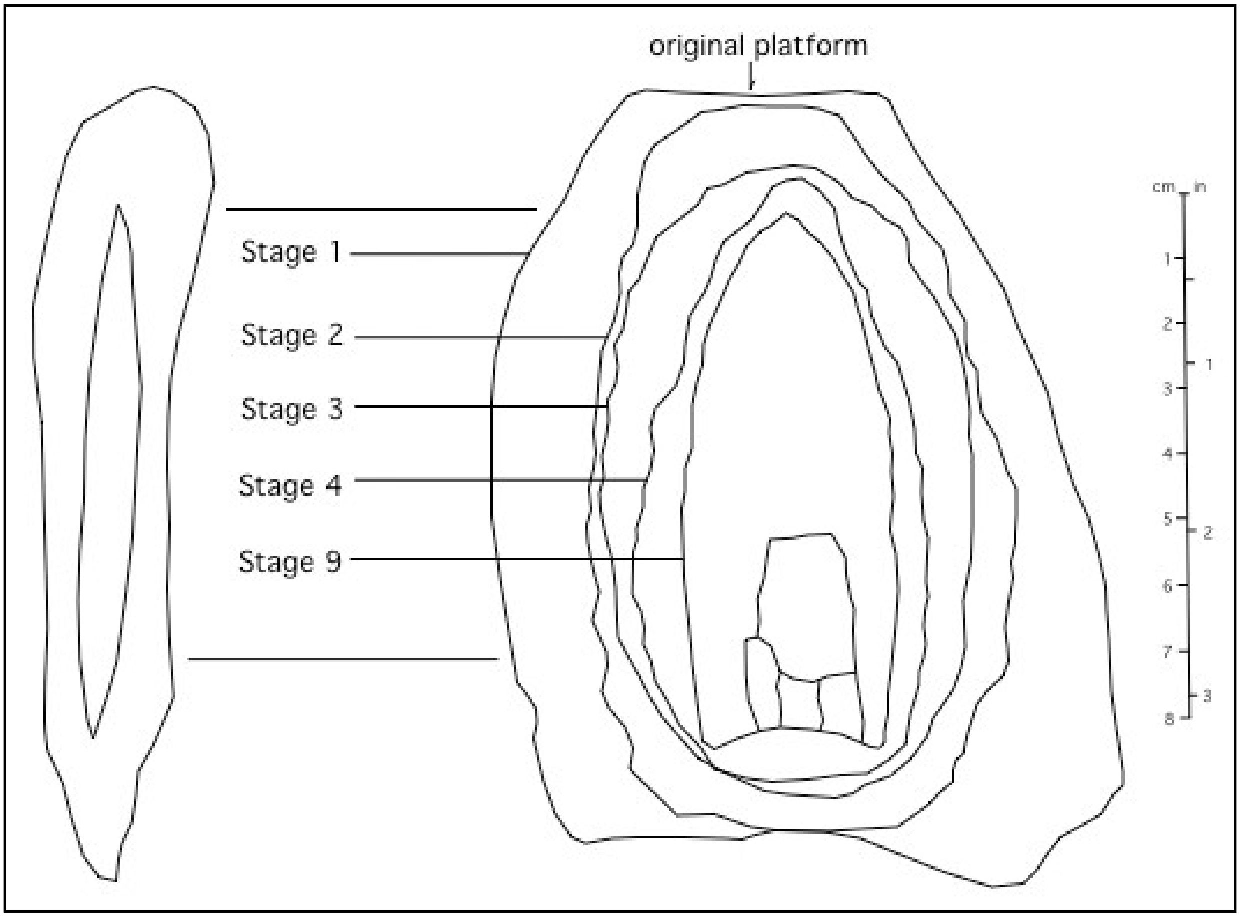


Figure 4.11: Clovis flake Reduction Model illustrating the ideal reduction model using a blade/flake as a blank (modified after Callahan 1979: Figure 66; 154).

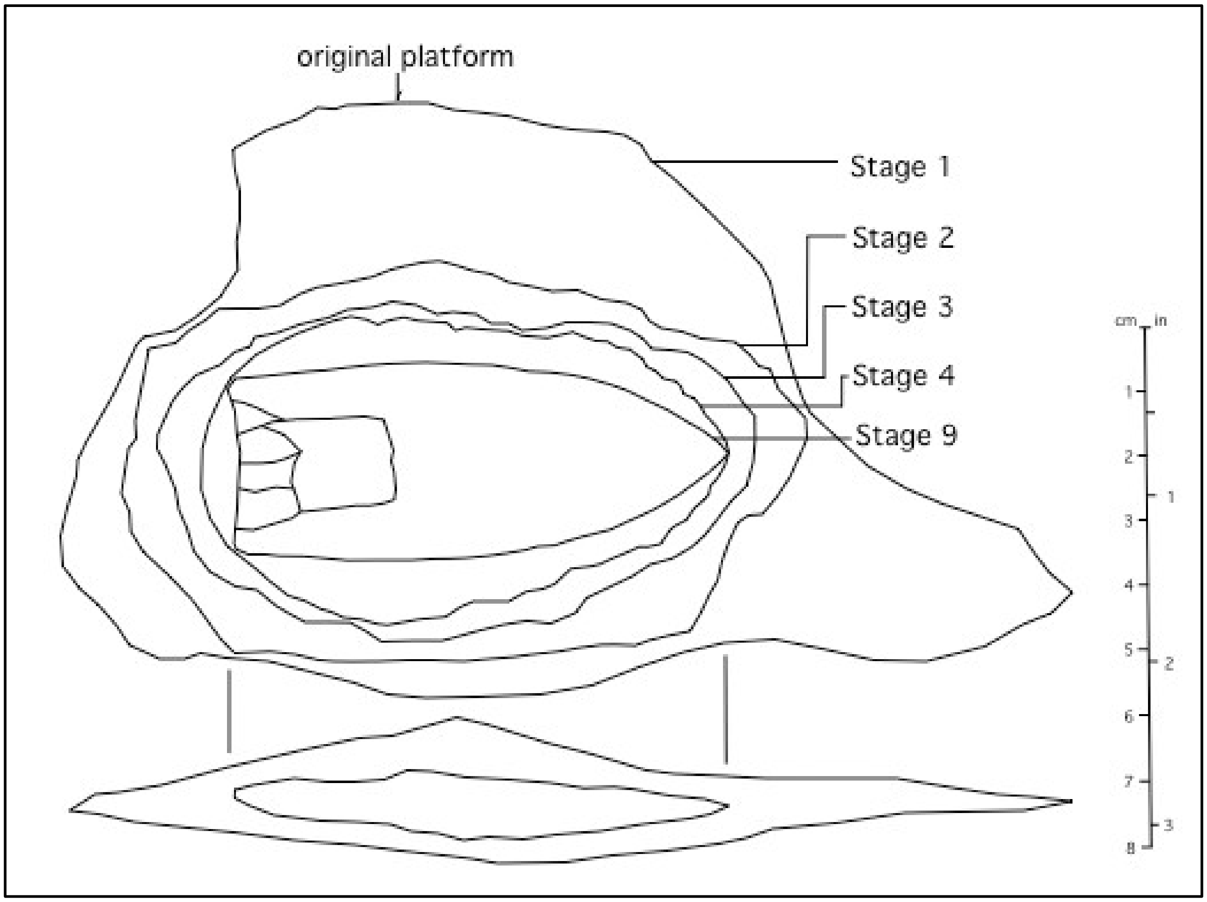


Figure 4.12: Clovis flake reduction model, (modified after Callahan, 1979: Figure 66; 154), illustrating the ideal reduction using a broad flake blank.

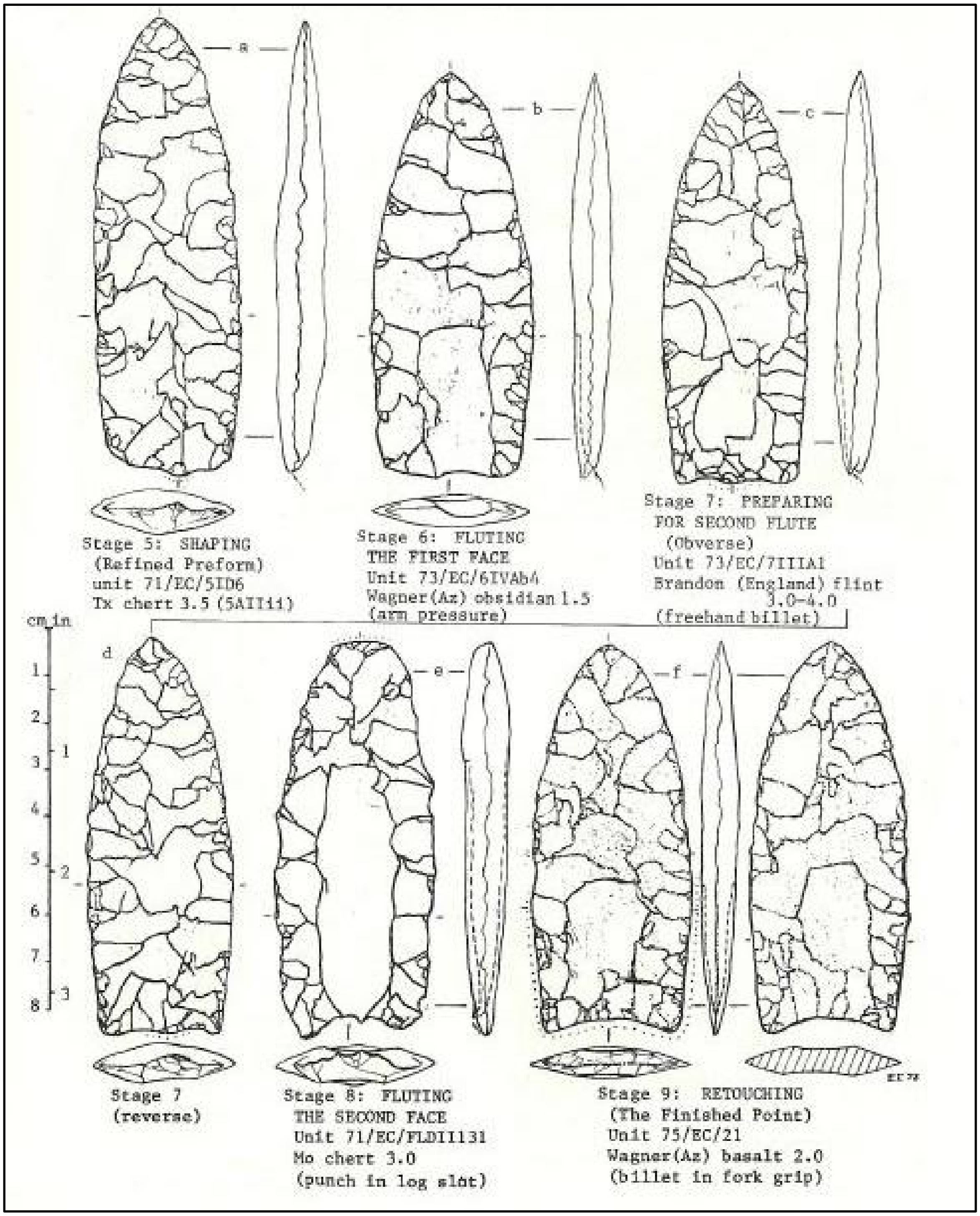


Figure 4.13: Final stages of Clovis reduction utilizing preforms made following both trajectories of manufacture, (modified from Callahan 1979: Figure 67; 155).

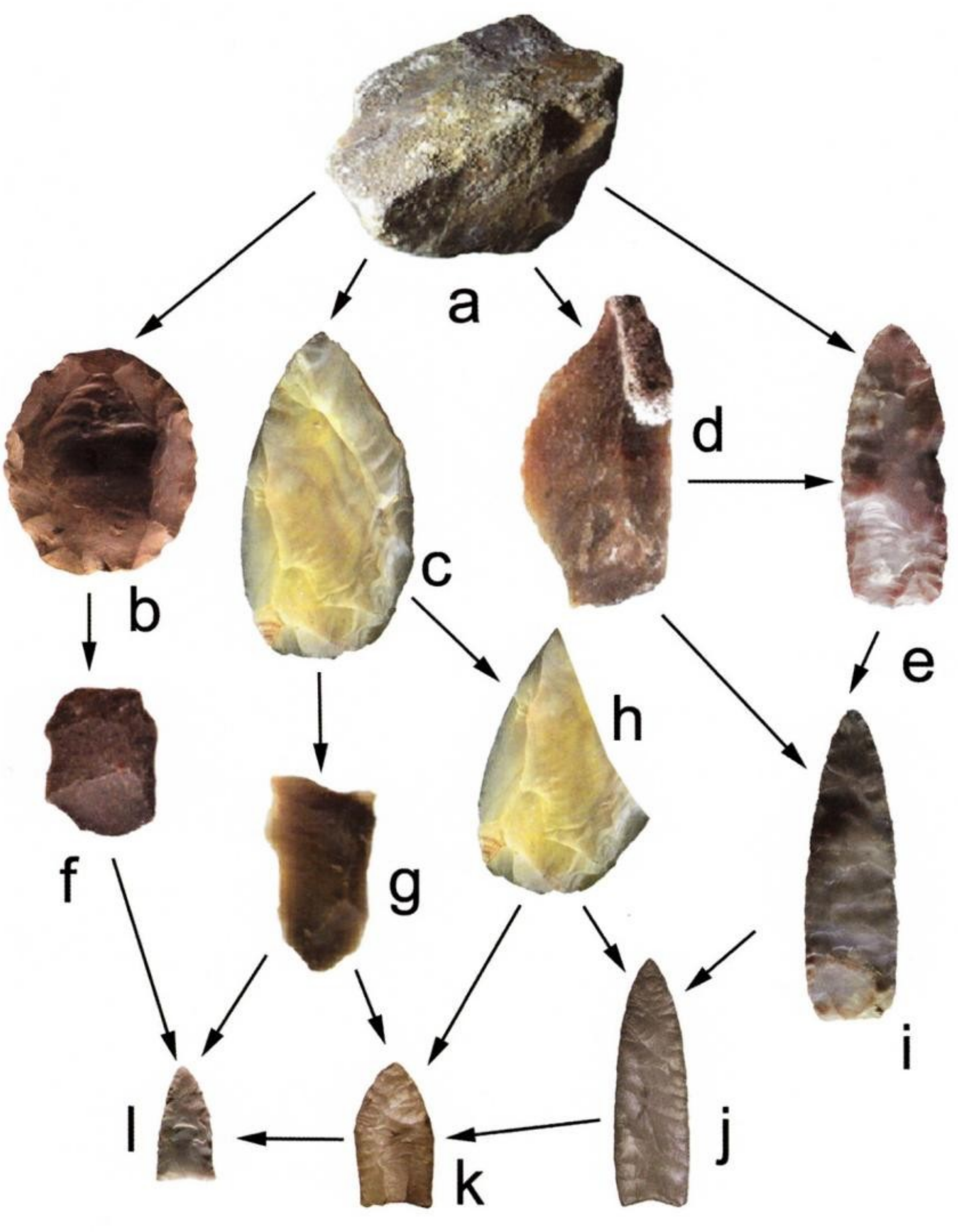


Figure 4.14: Subsequent Clovis Reduction Model, showing the various blanks which can be used in Clovis projectile manufacture, (modified after Bradley et al., 2010: Plate 4; 182).

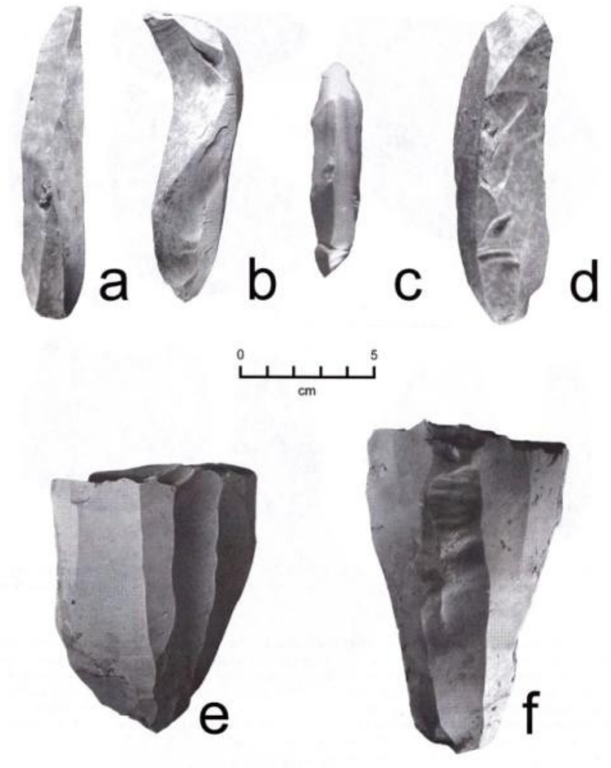


Figure 4.15: Clovis Blade Technology a through d represent blades, e and f represent specialized blade cores, (modified after Bradley et al., 2010: Figure 2.25: 39).

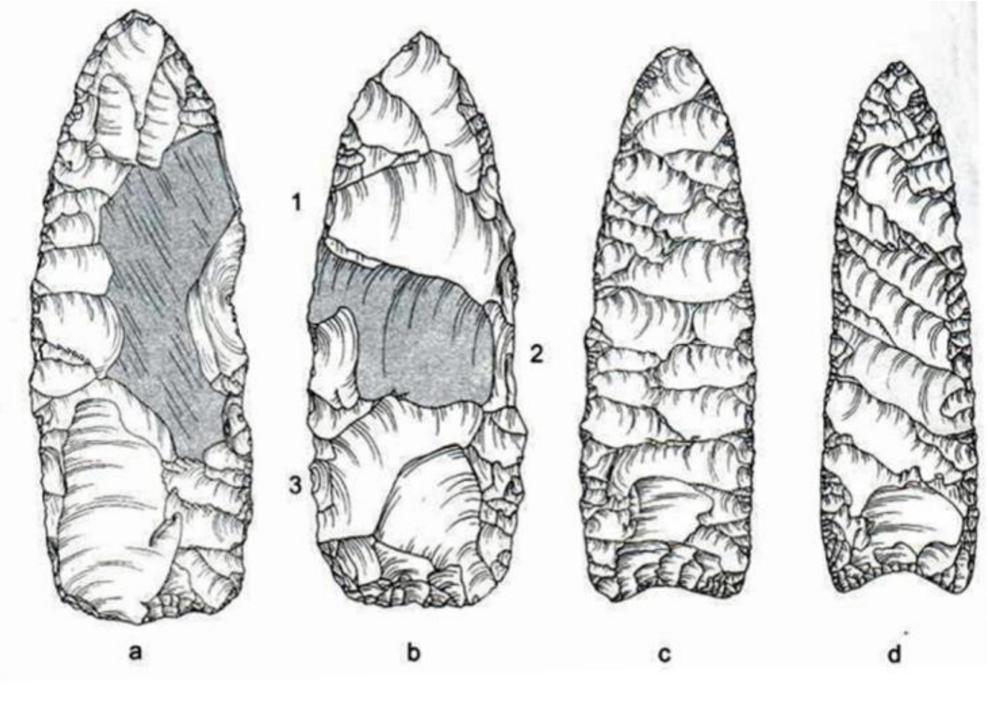


Figure 4.16: Clovis use of Overshot Flaking, highlighted in grey (modified after Bradley, 2010: Figure 9.5: pp. 468, in Kornfeld, Frison and Larson, 2010).

4.4.2 Folsom Lithic Reduction

The Folsom tradition has been subjected to nearly the same level of study as Clovis, in large measure because of its distinctive lithic flaking technology featuring fine pressure flaking of projectile point edges and the fluting that extends nearly to the point tip (Crabtree, 1966; Flenniken, 1978; Frison and Bradley, 1980; Bradley and Frison, 1982).

The Folsom tradition was extensively studied by Crabtree (1966), Flenniken (1978) and Frison and Bradley (1980; 1982); all focusing on how the projectiles were manufactured. These studies, like most Clovis studies, are concerned largely with how the fluting was accomplished. Careful preparation is required to successfully detach the flutes, and often a nipple (remnant platform) remains in the basal concavity. Crabtree (1966) focused on the Lindenmeier site assemblage. He determined that the concave base was formed as a result of the fluting and that the convexity (or nipple) present in the basal concavity was a remnant platform from removal of the second fluted face. Two diagonal pressure flake scars present on the base on both sides of the bulbar scar are recognized as distinctly Folsom. The explanation given for these scars is to reduce the ridges left by the flute flake in order to thin the base further. Crabtree determined that the pressure flaking of the edges occurred prior to the fluting. These pressure flakes are parallel sided and more than 4 times longer than their width. Due to being terminated by the fluting, true length cannot be determined. The fine pressure flaking along the lateral edges was done base to tip on one edge, and then base to tip on the opposite edge (Figure 4.17). Careful preparation was done on the base to remove the first flute. The characteristic diagonal pressure flakes on the first flute scar were done for the preparation of the platform for the second flute removal (Crabtree, 1966).

After examining the preforms, Crabtree (1966) determined that the tip was left thicker than the rest of the piece and was ground in order to accomplish the fluting. Crabtree (1966) believed that to successfully execute a Folsom style flute, the knapper placed the point tip down on an anvil, secured using a vice, and then used direct or indirect percussion to remove the flute. None of this would be possible without meticulous platform preparation prior to the first flute removal (Crabtree, 1966).

Flenniken (1978) revisited the Folsom manufacture sequence and added to the understanding of the earlier stages of manufacture. He identified a 7 stage process, with fluting occurring at Stages 5 and 6. These are based on experimental reproductions as well as more extensive assemblages that included more than just completed points. His analysis focused on the use of flakes as blanks and the specialized reduction methods required to reduce a flake blank. This analysis determined that the pressure flaking occurred as the final stage of manufacture and that the preforms were too thin to facilitate the use of a vice (Flenniken, 1978).

Bradley and Frison (1980) further defined the Folsom biface production sequence (Figure 4.18) with materials from the Hanson site. This analysis also involved documentation of the Agate Basin manufacture sequence, and comparison to Folsom reduction strategies. During this comparison they noted that there is bevelling retouch on the edges. As this flaking is only noted on a distal/lateral margin they believe this is indicative of edge preparation for use and/or platform preparation (Bradley, 1982).

Bradley (2009) analyzed the biface assemblage from the Hell Gap site, specifically addressing occupations assigned to Late Fluted (Folsom/Midland/Goshen), Agate Basin, Hell Gap and Alberta/Cody complexes. This analysis was of particular importance because it revealed new aspects of the manufacture process and the cognitive decision-making associated with it. Bradley (2009) treated the Folsom/Midland/Goshen layer together in his discussion as there is and remains temporal and typological confusion among these three complexes (Figure 4.19). These assemblages were relatively small so statistical relevance validity is questionable. Overshot flaking techniques were observed in Folsom occupation levels at the Hell Gap and Agate Basin sites, but there is some uncertainty as to whether or not these were intentionally done (Bradley, 2009).

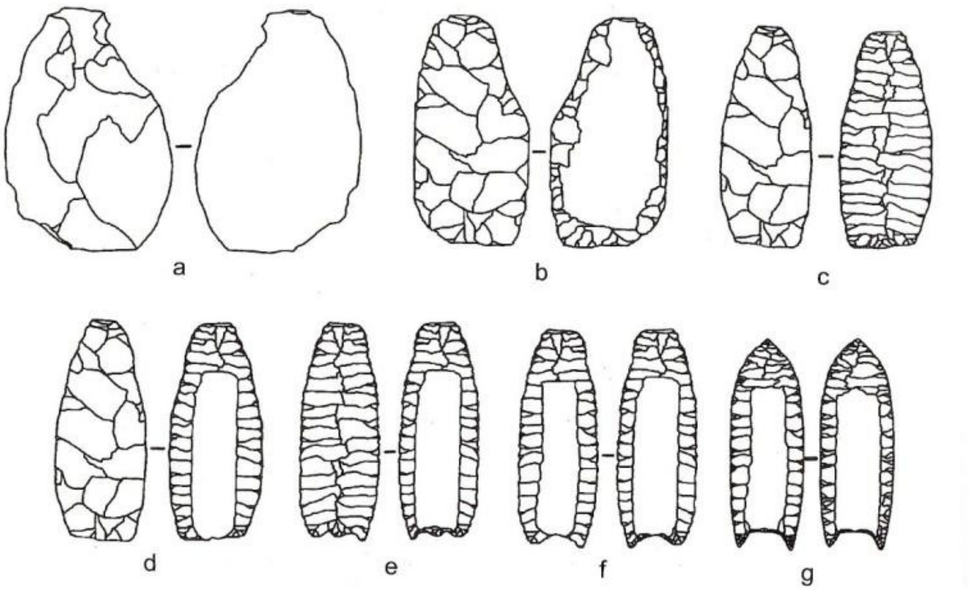


Figure 4.17: Folsom Reduction Model, (modified after Bradley, 2010: Figure 9.12: pp. 476 in Kornfeld, Frison and Larson, 2010).

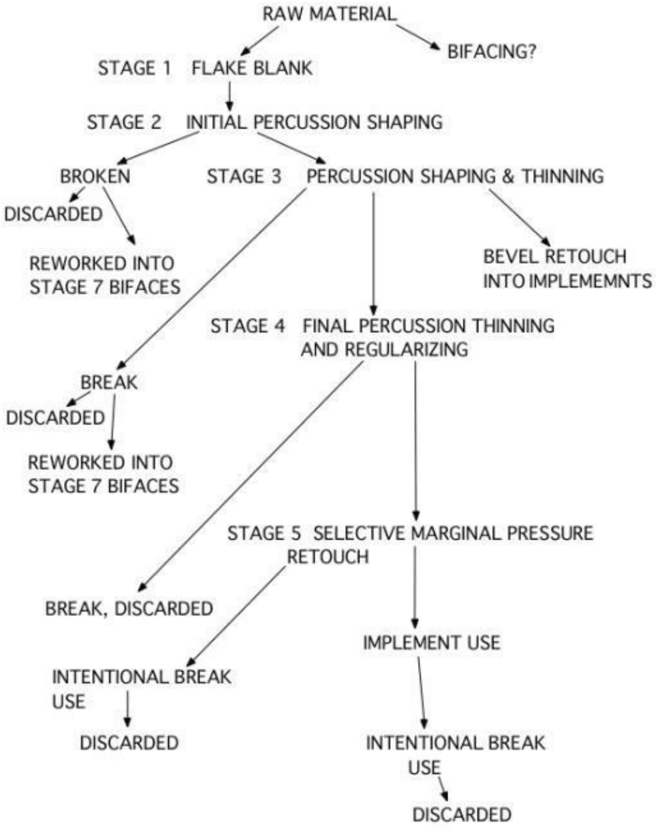


Figure 4.18: Folsom reduction sequence flowchart, (modified after Frison and Bradley, 1980: Figure 26; 43).

Figure 4.19: Folsom bifaces from the Hell Gap site (modified from Bradley, 2010: Figure 17.5; pp. 264 in Larson, Kornfeld and Frison, 2010).

4.4.3 Agate Basin Lithic Reduction

The reduction sequence for Agate Basin was first proposed by Frison and Bradley (1980) at the Hanson Site. This was subsequently applied to the assemblages from the Agate Basin type site (Bradley, 1982) and the Hell Gap Site (Bradley, 2009; 2010; see Figure 4.23). Initial stages of manufacture utilized percussion techniques, with biface finishing involving pressure flaking. The latter is rarely trans-medial in its extent across the dorsal and ventral faces, and has a more random appearance. Finishing of the points involves lateral and basal edge grinding, much like that observed in the fluted traditions. In this sequence Bradley proposed that during the middle stages a regular longitudinal section was finished using a combination of widely spaced full face flaking, combined with carefully executed overshot flaking (See Figure 4.23 and 4.24). This method of bifacial thinning in the middle stages is also evident with Hell Gap assemblages (Bradley, 2009; 2010). Very few Agate Basin sites or levels have revealed early stage manufacture techniques so it is uncertain what type of blanks were utilized (Bradley, 2010).

There is some evidence from the type site indicating the possible use of blade technology, with blade production from a nodule of local chert with clear blade removal (Figure 4.22). Refitting analysis was done on this core and it appears that some of the flakes were removed from the site. However, it is unclear whether this indicates a standardized blade-making technology (Frison and Stanford, 1982). Asymmetrical bifaces are interpreted to be knives, produced using the same technology as that used to manufacture the projectile points (Figure 4.20). The analysis of the available Agate Basin assemblages indicates that it typifies methods common to Paleoindian reduction sequences, but with sufficient differences to indicate it may not have been derived directly from Folsom (Bradley, 2010). Production may reflect the use of thin blanks (Blade/Flakes) that retain the D-shaped cross-section of the flake. Bradley (2010) notes that specific methods of platform preparation observed in Folsom biface reduction are present in Hell Gap and may also be present in Agate Basin assemblages. Recent analysis of a series of 11 sites (AJM, Arabasque, Erin, JJ, Lillian Joyce, Maggie's site, Stella Blue, Wendt, ZeaM4, and two topographic saddles) in northwest Minnesota has added to the understanding of the Agate Basin production sequence with increased understanding of the early stages of manufacture; see Figure 4.21 (Muniz, 2012).

Figure 4.20: Agate Basin knife from the Hell Gap Site, (modified after Bradley, 2010 Figure 9.22; pp. 484 in Kornfeld, Frison and Larson, 2010).

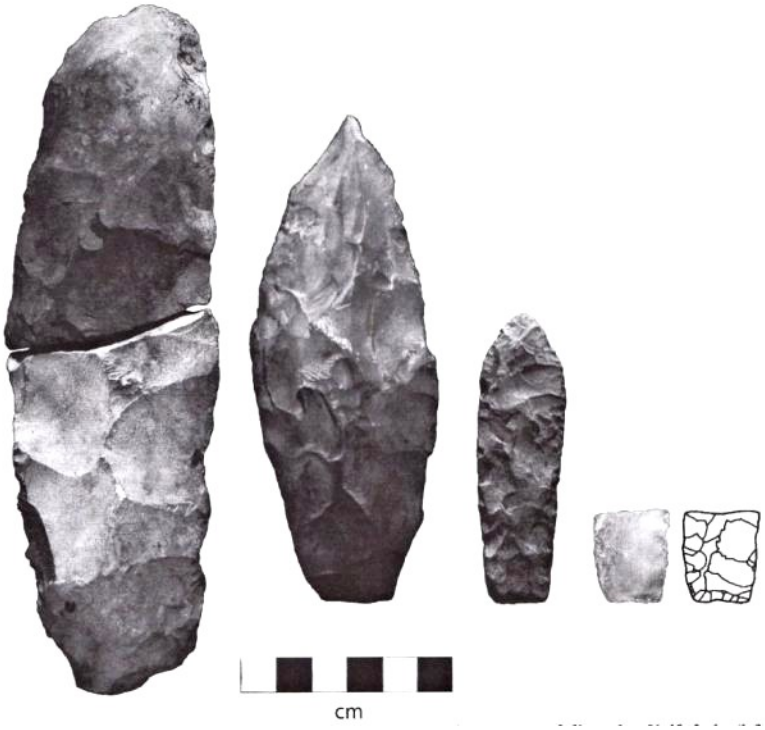


Figure 4.21: Agate Basin Reduction Model from the Wendt site, (modified after Muniz, 2012: Figure 4; pp. 119).

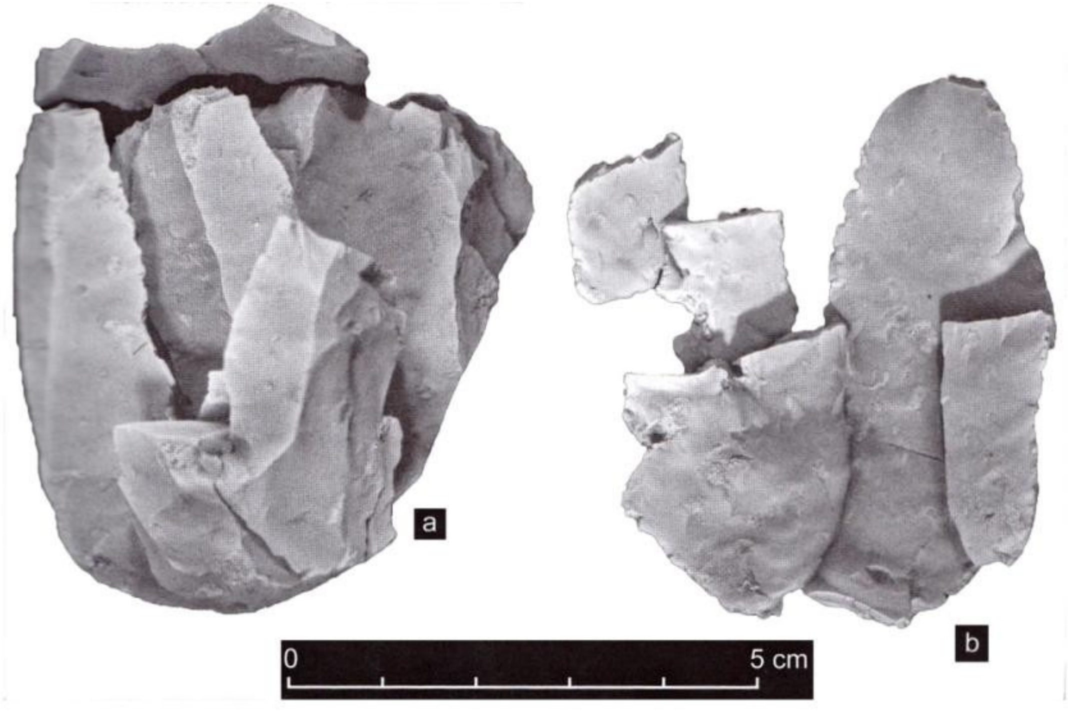


Figure 4.22: Agate Basin refitted blade core from the Hell Gap site, (modified after Bradley, 2010 Figure 9.23; pp. 485 in Kornfeld, Frison and Larson, 2010).

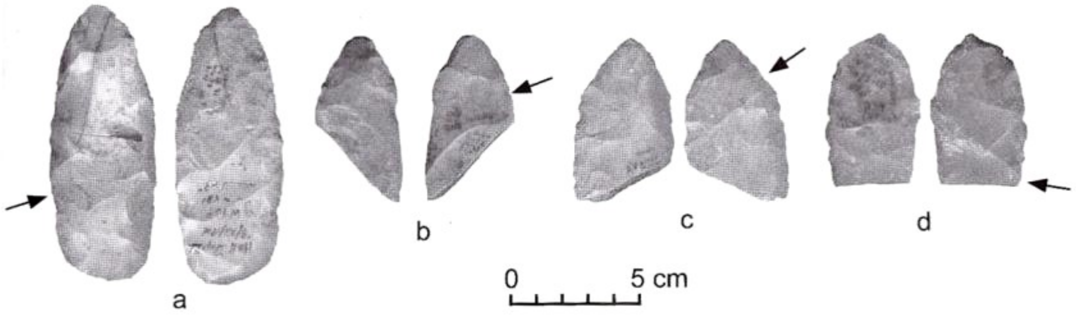


Figure 4.23: Stage 4 Agate Basin bifaces from the Hell Gap site, arrows indicate overshot flake removals (modified after Bradley, 2010 Figure 9.20; pp. 483 in Kornfeld, Frison and Larson, 2010).

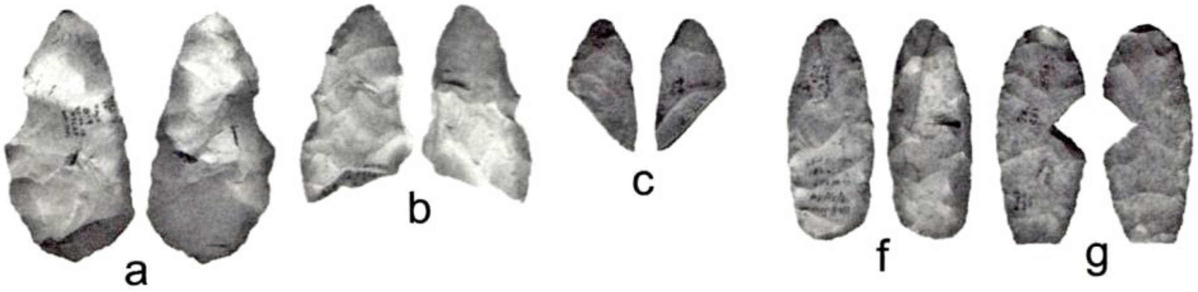


Figure 4.24: Stage 3 and 4 Agate Basin bifaces from the Hell Gap site, highlighted flake scars indicate presence of overshot flaking (modified from Bradley, 2010: Figure 17.6; pp. 265 in Larson, Kornfeld and Frison, 2010).

4.4.4 Hell Gap Lithic Reduction

Biface reduction in Hell Gap assemblages follows much the same sequence as observed in Agate Basin assemblages (Bradley, 2009; 2010). The main difference appears to be that the reduction sequence was terminated earlier in Hell Gap (Figure 4.25 and 4.26). The sequence began with percussion thinning that gave way to refined pressure flaking. Two methods of finishing have been observed on Hell Gap assemblages that seem to exhibit geographic patterning. Bradley (1974) notes that throughout the northwestern plains, marginal pressure flaking extending onto the face occurs only at the tip and the stem. In contrast Stanford (1974) observed that throughout the Rocky Mountains this manner of flaking covers the entirety of both faces. As with previous traditions, grinding of the basal and marginal portions of the stem occurred.

A biface reduction activity area was identified at the Seminoe Beach Site, located north of the Casper Site (Bradley, 1996). One of the early stage bifaces from this site appears to have been manufactured using a blade-flake as the blank (Bradley, 2010). At the Casper Site Frison and Bradley (1980) observed a specialized reduction technique whereby the one margin was flaked nearly to the opposite margin and then was flipped over and the opposite margin was worked the same way (Figure 4.27). This resulted in an offset lenticular cross-section. Platform preparation was observed in the form of grinding to isolate the platform. This was first observed in Folsom reduction and Bradley (2010) notes that it is possible that this manner of platform preparation and isolation may be present in Agate Basin as well (Frison and Bradley, 1980). Other aspects of the Hell Gap toolkit include the possible presence of asymmetrical bifacial knives similar to those found in Agate Basin assemblages. There is also a continued use of flakes as informal tools produced from either bifacial or non-bifacial cores. There is no direct evidence for blade technology in Hell Gap assemblages (Bradley, 2010).

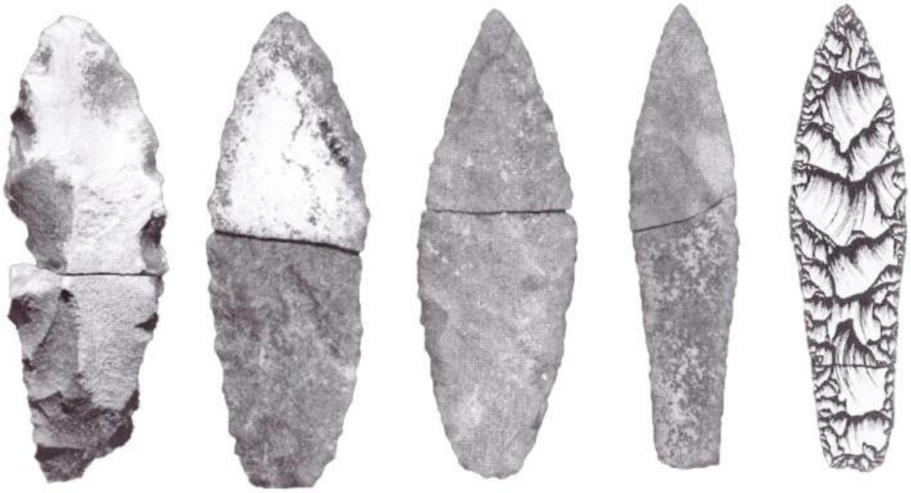


Figure 4.25: Hell Gap Reduction Model (modified after Figure 9.25 Bradley, 2010 in Kornfeld et al., 2010).

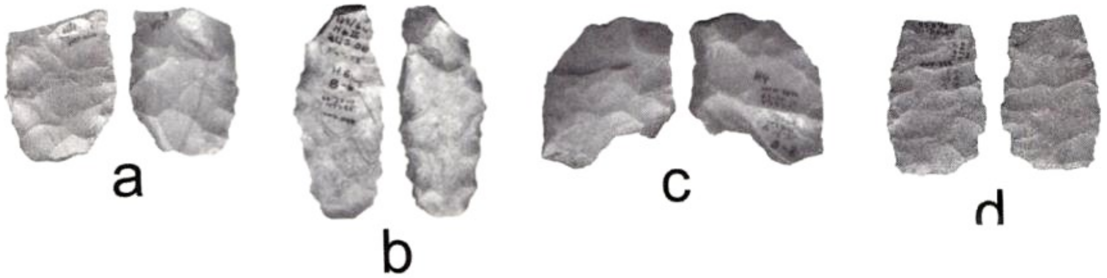


Figure 4.26: Hell Gap bifaces from the Hell Gap site, (modified from Bradley, 2010: Figure 17.8; pp. 267 in Larson, Kornfeld and Frison, 2010).

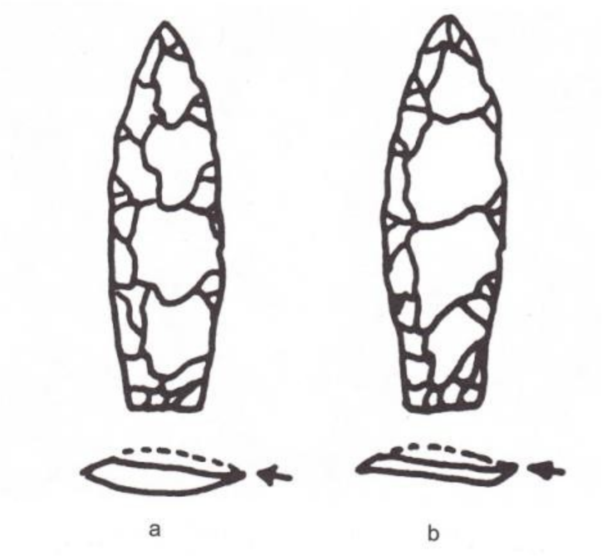


Figure 4.27: Hell Gap use of offset bevelling and alternate edge flaking, example of Hell Gap use of overshot flaking, (modified after Bradley, 2010 Figure 9.26; pp. 488 in Kornfeld, Frison and Larson, 2010).

4.4.5 Alberta/Cody Complex Lithic Reduction

The Alberta/Cody Complex assemblages from Hell Gap and from other assemblages examined by Bradley indicate a shift away from the use of overshot/full-face percussion techniques. In this manufacture process flake removal tended towards co-medial percussion shaping and serial retouching. This aided in the creation of the distinct diamond cross-section of the diagnostic projectile points. It reveals an interesting shift away from what appeared to be the established manufacture process for bifacial toolkits in North America (Bradley 2009). This reduction sequence is not well defined and there seems to be significant variation between sites. At the Hudson-Meng site serial co-medial flaking was used to thin the biface and was followed by pressure retouch along the blade edges, pressure thinning of the stem, and grinding of the stem and base (Huckell, 1978). Bradley (2009) notes that this was not observed at Hell Gap or other numerous finds across the Great Plains. Huckell (1978) makes no mention of specialized platform preparation and isolation to carry out this manner of flaking but Bradley (2010) states that it would have to be done in order to properly execute the flaking.

Most of the Alberta/Cody bifaces are fairly well-made, although they are somewhat asymmetrical with a wavy margin. There is selective co-medial flaking on the projectiles but it is not well-developed (Figure 4.28). The early stages are not well-defined and it is not certain whether there was any use of overshot flaking but it would seem that platform preparation and isolation was a requirement (see Figure 4.29; Bradley, 2010). Later projectiles include the Eden and Scottsbluff styles that both exhibit serial co-medial flaking that is much more refined when compared to Alberta and Cody projectiles (Figure 4.30). The Cody knife also appears to conform to the same flaking methods but with increased flaking on one margin creating the distinct margins. The Alberta/Cody Complex appears to follow directly from Agate Basin, exhibiting a refinement in the process with the serial/co-medial flaking. The use of large thinning flakes as expedient tools with minimal edge retouch continues to be present (Bradley 2010).

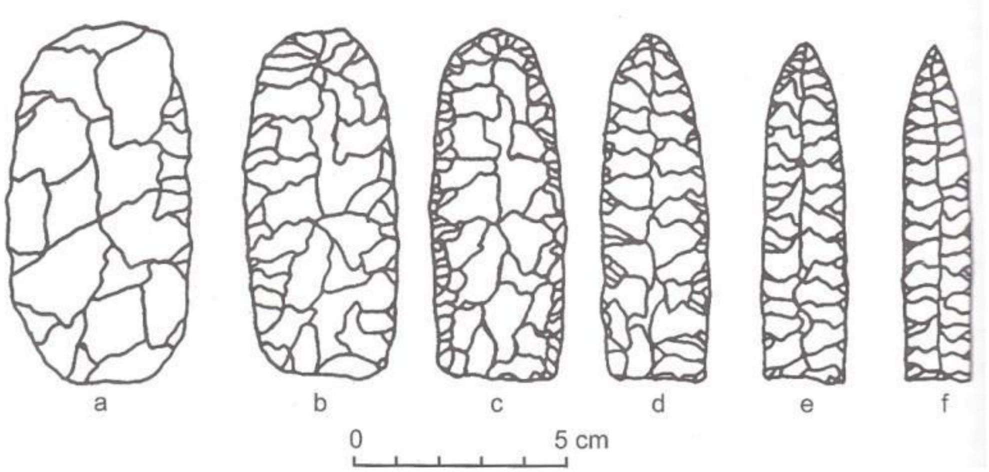


Figure 4.28: Alberta/Cody Reduction Model (modified after Bradley, 2010 Figure 9.31; pp. 492 in Kornfeld, Frison and Larson, 2010).

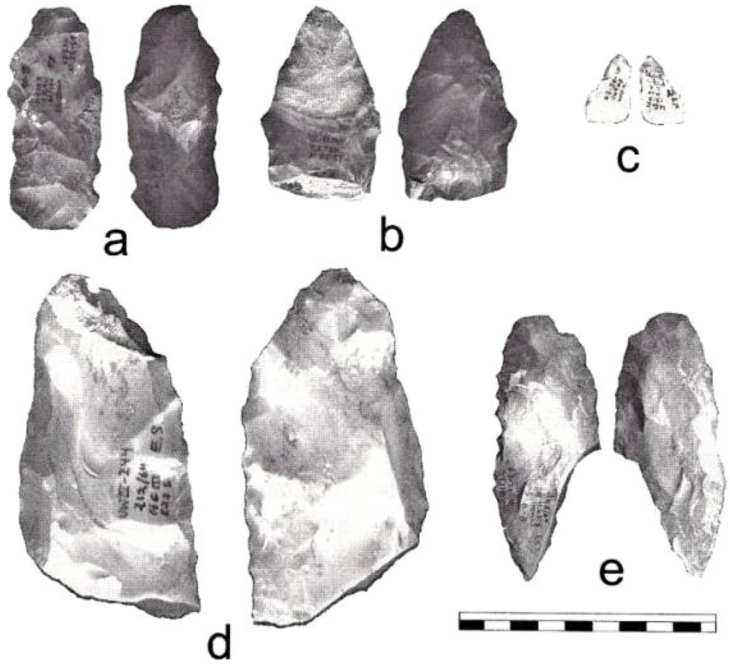


Figure 4.29: Alberta/Cody middle and late stage bifaces from the Hell Gap site, what appears to be overshot flaking can be observed on (d), (modified from Bradley, 2010: Figure 17.11; pp. 269 in Larson, Kornfeld and Frison, 2010).

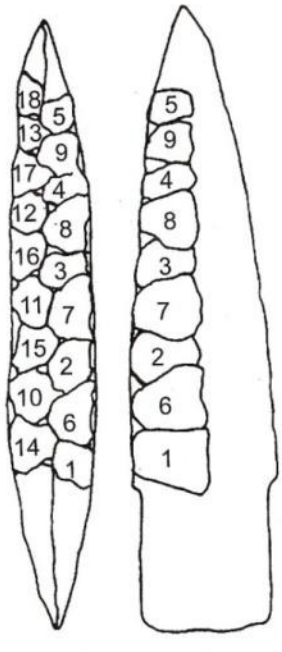


Figure 4.30: Alberta/Cody point flaking sequence, numbers indicate the sequence of flake removal, (modified after Bradley, 2010 Figure 9.29; pp. 491 in Kornfeld, Frison and Larson, 2010).

4.4.6 Late Paleoindian/Plano Complexes Lithic Reduction

The most recent complex within the Late Paleoindian period is a largely undefined group of generally lanceolate projectile points (Kornfeld et al, 2010; Pitblado, 2003). The one thing they have in common is that they exhibit characteristic parallel-oblique flaking patterns. A number of types belong to this complex, ranging from Pryor Stemmed to Lovell Constricted (Frison, 1978; Frison and Walker, 1984; Husted, 1969; Lahren, 1976; Wedel et al., 1968), as well as those placed into the Frontier Complex (Kornfeld et al., 2010; Frison, 1978; Frison and Walker, 1984). The Frontier Complex includes point types identified as Frederick, Lusk, Allen, Angostura and Browns Valley (Bradley 2009; 2010; Kornfeld et al., 2010; Frison, 1978; Holder and Wilkes, 1949). The initial thinning involves bifacial percussion, switching to a serial patterned percussion/pressure thinning that tends to produce parallel oblique patterns (Figure 4.31). Not much is known about the early stages of the production sequence and there is no discussion about the presence of full-face/overshot flaking or the use of carefully prepared isolated platforms (see Figure 4.32; Bradley, 2009; 2010). The Frederick assemblage from Hell Gap (Bradley, 2009) appears to have a large portion of the sequence represented, though the methods of manufacture are not discussed in great detail.

There is no mention of the presence of a blade technology in this complex, nor is the preferred blank type discussed (Bradley, 2010). Quartzites are the preferred material even though there is a significant amount of finer cherts available in the area. There does not appear to be a strong connection between these points and contemporary Alberta/Cody Complex points. The preference of quartzites may indicate that the origin may be in the Great Basin where obsidian and basalts are the main raw material. The brittle volcanic and quartzite materials may be the best material for this style of flaking. Diagonal flaking patterns tend to travel across the face whereas other methods tend to result in step terminations (Bradley, 2010).

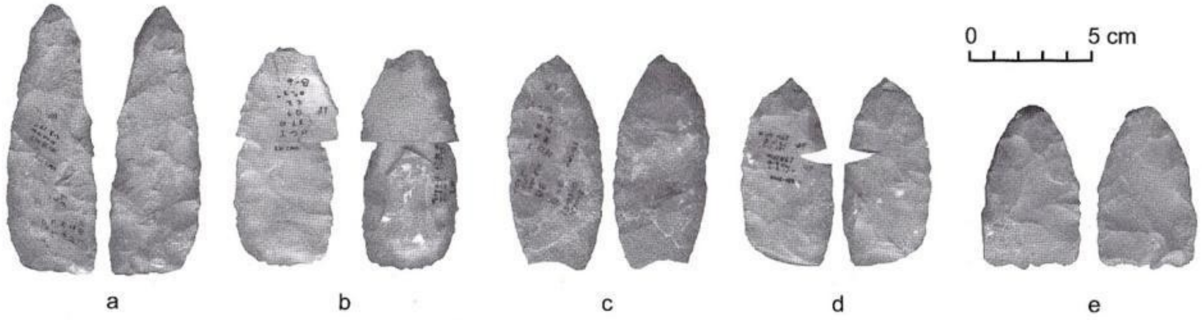


Figure 4.31: Frederick assemblage from Hell Gap, fine oblique flaking present, as well as what appears to be overshot flaking (modified from Bradley, 2010: Figure 17.12; pp. 270 in Larson, Kornfeld and Frison, 2010).

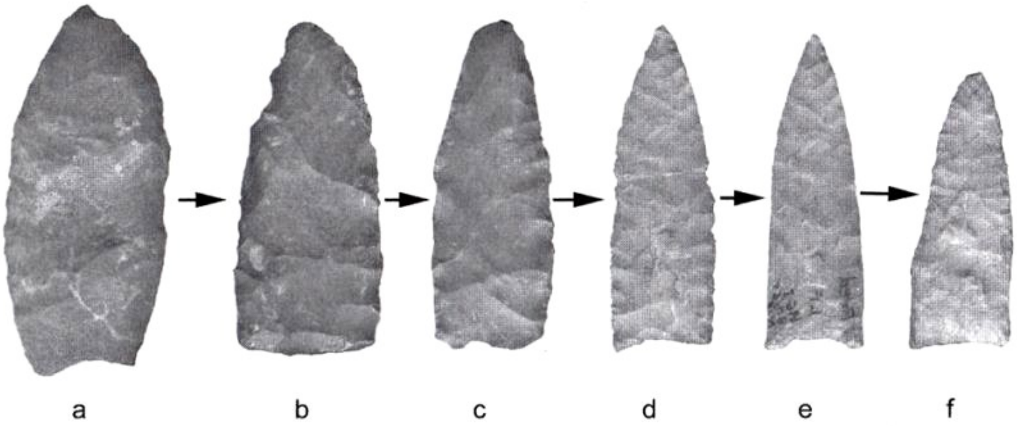


Figure 4.32: Frederick Projectile Manufacture Sequence, overshot flaking can be observed on a and b (modified from Bradley, 2010: Figure 17.13; pp. 271 in Larson, Kornfeld and Frison, 2010).

The analyses of the lithic reduction sequences employed by groups subsequent to the Fluted Traditions (Crabtree, 1966; Flenniken, 1978; Bradley and Frison, 1980; Frison and Bradley, 1982; Bradley, 2009; 2010) have revealed that there is a certain degree of cultural/technological continuity. Crabtree's (1966) analysis revealed the use of meticulous platform preparation for subsequent serial patterned pressure flaking. The use of blade-flakes was noted by Callahan (1979) as being present in Clovis assemblages, but Flenniken (1978) showed that in the manufacture of Folsom projectiles this was the preferred blank. Further work by Bradley and Frison (1980) revealed the presence of alternate edge bevelling as a method of edge preparation. Together they defined a manufacture sequence for Folsom assemblages and applied this to the Agate Basin levels at the type site. Bradley (2009; 2010) showed that overshot/full-face flaking techniques first noted as being used by Clovis people continued in use into the

Late Paleoindian period. The flaking methods used initially by Clovis people have continued to be used into the Late Paleoindian period with additions as new methods were developed and different raw material was encountered.

4.4.7 Archaic Lithic Reduction Sequence

The Early Archaic period 7,000 ^{14}C years BP (7,800 cal years BP) is little understood in much of North America as is the transition from Late Paleoindian to Archaic. It is clear that there is a general shift away from the lanceolate style projectiles present in the Late Paleoindian period, to a triangular point style with notches, in southeastern North America. These notches occurred on the sides or as angled basal notches (Kornfeld et al., 2010; Justice, 1987; Julig, 1994). There have been a few studies undertaken on specific early archaic complexes from the United States (Bradbury, 2007; Daniel, 2001; Kimball, 1996; Sassaman, 1994; 1996) and some in Canada (Wright, 1972; Bursey, 2012; Ellis et al., 2009; Ellis et al., 1991), many of which are limited to site descriptions and only cursory analysis of the tool assemblage.

Justice (1987) places the Kirk Corner Notched (KCN) assemblages within the Early Archaic circa 8,500 to 6,100 ^{14}C years BP (9,500 to 6,900 cal years BP) in the southern United States. Dates of arrival in northern regions are uncertain but there is evidence for this complex in southern Ontario (Bursey, 2012). A study of a KCN assemblage, with the site designation of 15LO207, from Kentucky revealed that both hard and soft hammer percussion was used in the manufacture of the bifaces, and that a standardized reduction sequence was followed (Bradbury, 2007). There is no mention of specially prepared platforms or overshot flaking observed on the bifaces from the site (Bradbury, 2007). In a series of replication experiments Bradbury (2007), made use of grinding in preparing specialized platforms but it was not made clear if this was observed on archaic bifaces.

At a series of KCN sites in Southern Ontario the various biface assemblages were subjected to a production sequence analysis (Figure 4.33). This revealed that the main goal was to produce blanks that were easily worked into projectiles. This involved the production of flakes to be used as informal tools and narrow blade/flake blanks (Bursey, 2012). The reduction sequence from these sites was observed to exhibit both overshot flaking and grinding/polishing of platforms in preparation for striking off thinning flakes (Figure 4.34). The corner flakes struck from the blocks were used as narrow preforms for bifacial butchering tools, most likely knives. It is noted that in Paleoindian times the manufacture of these blades was for the purpose of making unifacial scrapers rather than narrow knives. Based on this evidence it is possible that a blade technology remained into early Archaic times. There is also a continuation of the specific manufacture of flakes to be used as informal tools (Bursey, 2012).

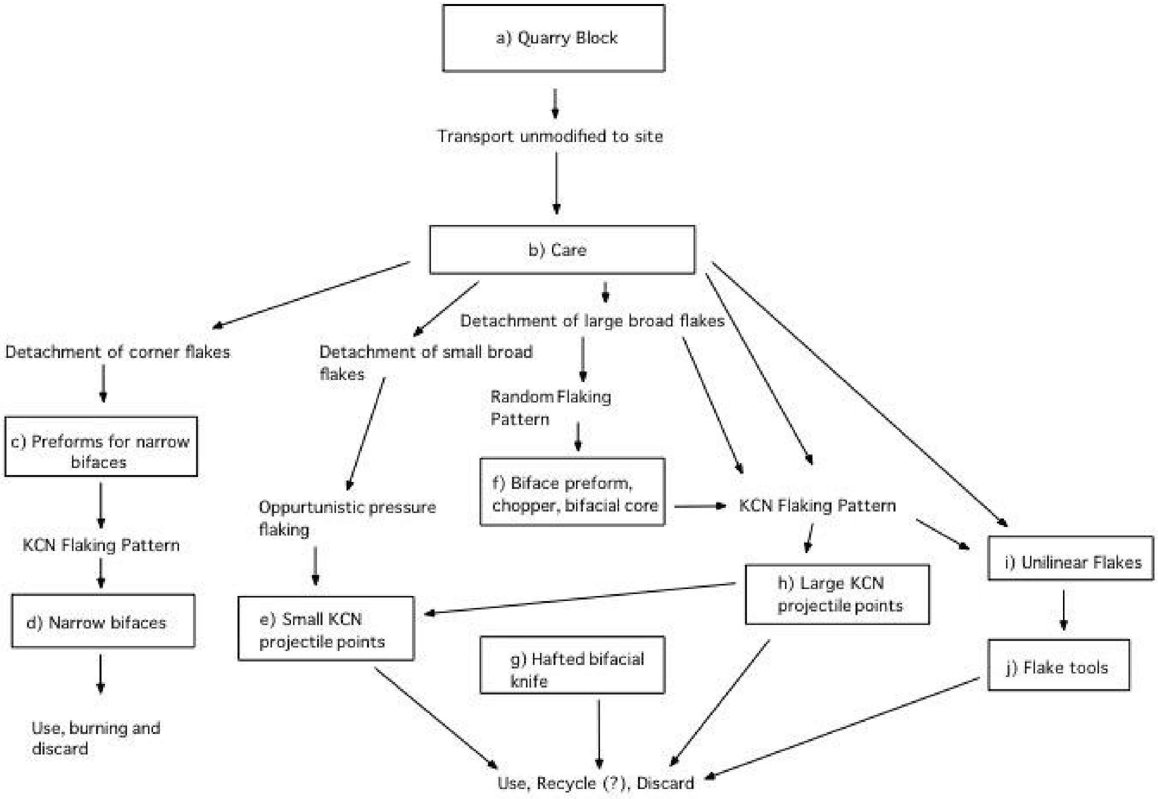


Figure 4.33: KCN conceptual model flowchart of biface reduction, (modified after Bursey, 2012: Figure 2; 111).

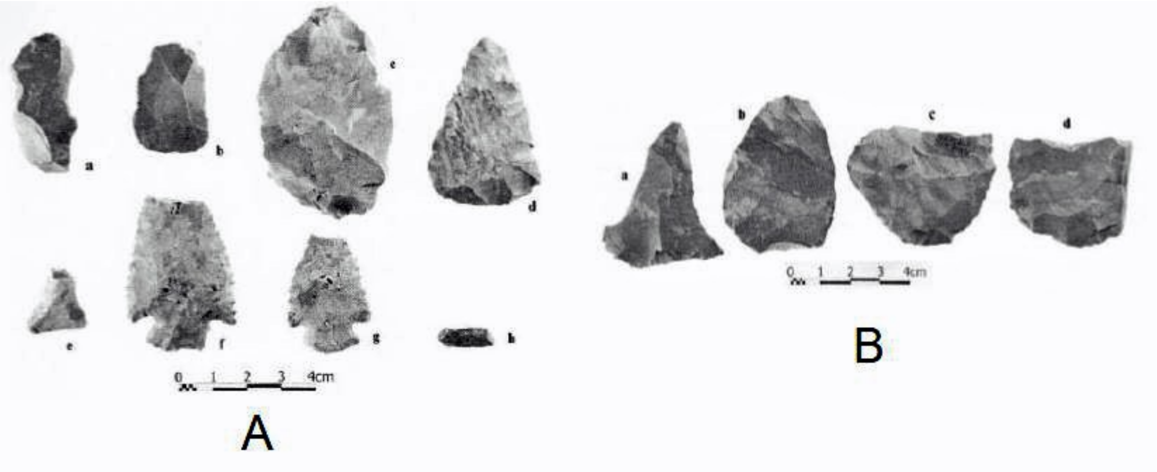


Figure 4.34: KCN bifacial tool examples, (modified after Bursey 2012: A) Figure 7; 114, B) Figure 8; 114).

The Shield Archaic is believed to have derived from the northern Plano groups of southwestern Nunavut, said to be Agate Basin-like (Wright, 1972). There are a number of projectile point types considered within the Shield Archaic, some of which are lanceolate. Bifacial reduction is the main technology used to produce the toolkit (Figure 4.35). Part of the assemblage includes the production of flakes to be used as informal tools. There is limited evidence for the use of blade technology in certain Shield Archaic sites (Wright, 1972). Analysis of the bifaces from the Shield Archaic sites indicates that there was no platform preparation in evidence on the earlier stage bifaces. The flaking patterns are not as refined when compared to Paleoindian artifacts (Wright, 1972).

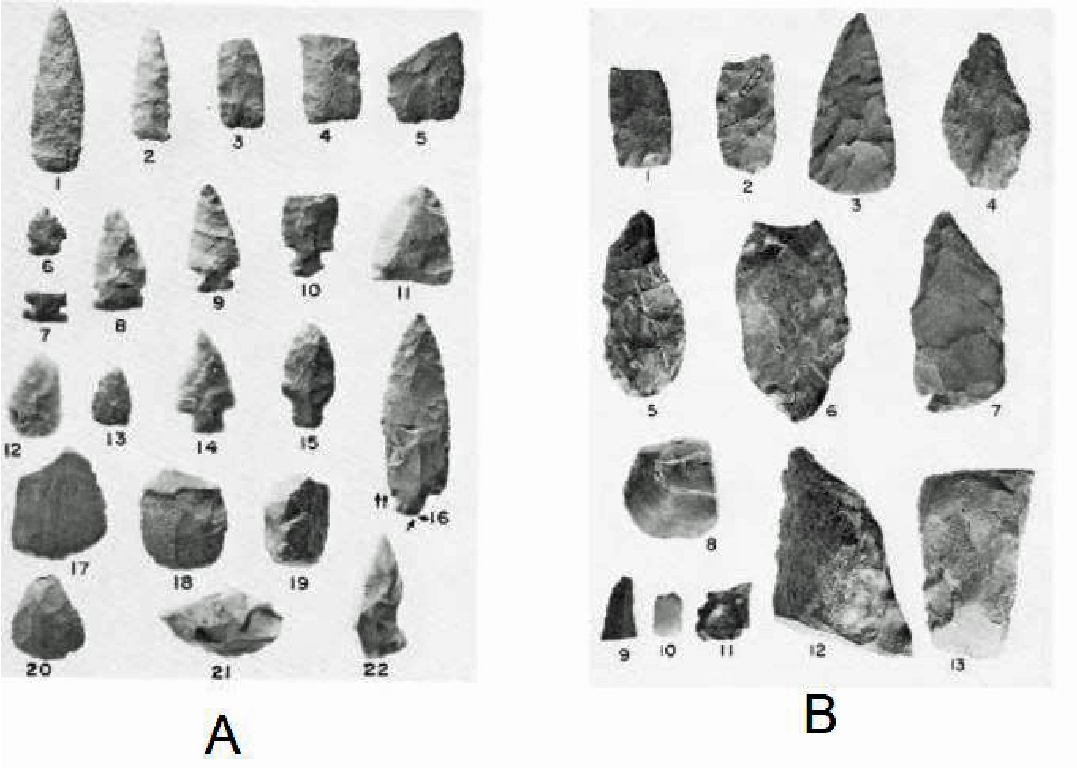


Figure 4.35: Shield Archaic bifacial tool examples, (modified after Wright, 1972: A) Plate II, pp. 95 and B) Plate IV, pp. 99).

At sites associated with Archaic occupation in Ontario, it does appear that there are certain aspects of Paleoindian tool technology that persist. This includes the continued use of some form of modified blade technology, the specific manufacture of flakes to be used as informal tools, and bifacial reduction methods. Based on the evidence from the KCN occupation of southern Ontario platform preparation in the form of grinding was in evidence as was the use of overshot flaking. There is a shift from bifacially worked knife forms as observed in Agate Basin and Cody complexes, to a unifacially worked knife (Bradley, 2010). Observations made on the Gerlach Cache from northern Ontario show a distinct lack of edge preparation though they do exhibit full-face to overshot flaking (Figure 4.36). These bifaces were all made from Hudson’s Bay Lowland Chert and were generally all classifiable as Stage 3 to 4 cache blanks (Ross, 2011).

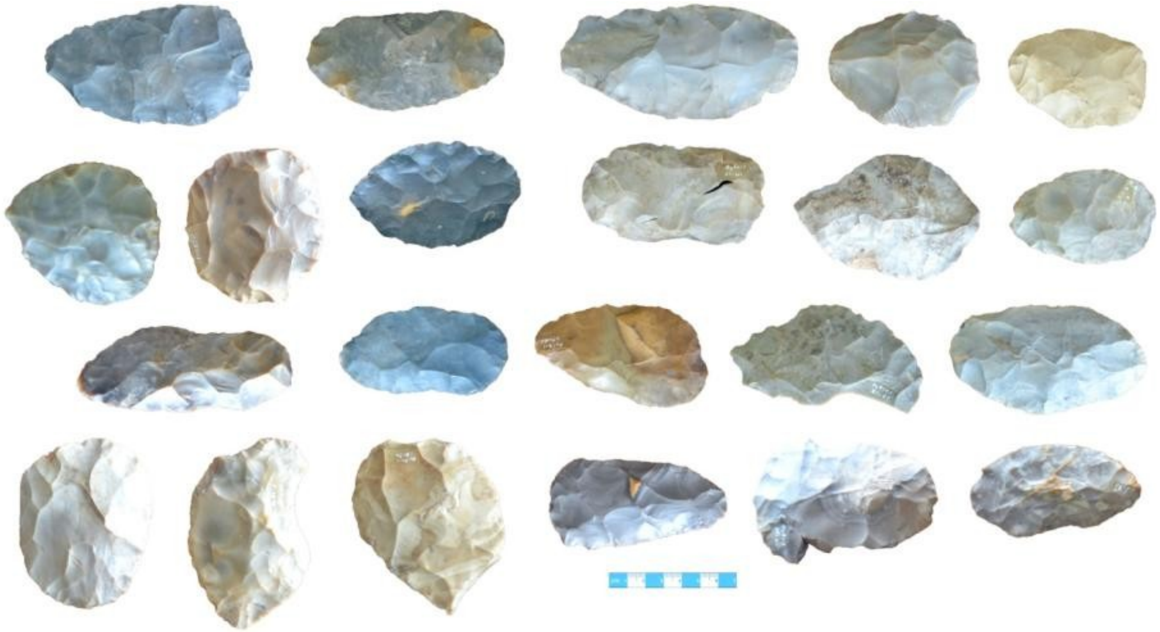


Figure 4.36: Select bifaces from the Gerlach Cache (Bennett, 2013).

4.5 LAKEHEAD COMPLEX LITHIC REDUCTION

Biface analyses have been previously undertaken on Lakehead Complex assemblages, including those from the Biloski (Hinshelwood and Webber, 1987), Brohm (Hinshelwood, 1990), Naomi (Adams, 1995), Crane (Hinshelwood and Ross, 1992), Simmonds (Halverson, 1992) and Cummins (Julig, 1994) sites. Hinshelwood and Webber (1987) used Callahan's (1979) Clovis Reduction Sequence as the foundation of the first in-depth biface analysis on a Lakehead Complex assemblage. Hinshelwood (1990) re-examined the Brohm site assemblage after conducting further excavations, using the same stage sequence analytic approach developed for Biloski. The current analysis of the Mackenzie 1 biface assemblage builds upon these initial studies, first using the reduction stage model adapted from Callahan (1979), and then testing the problems identified by Hinshelwood and Ross (1992) on a larger assemblage. More recent research (Whittaker, 1994; Odell, 2003; Kooyman, 2000; Andrefsky, 1998) was also used to determine if the more generalized conceptual models might better describe biface manufacture processes.

Hinshelwood and Webber's (1987) analysis of the Biloski biface assemblage sought to consider it within a defined reduction sequence. Since there is no clear consensus about how many stages represent the ideal or the norm, direct comparisons between cultures or within them are difficult. To overcome this issue, Hinshelwood and Webber (1987) modified Callahan's (1979) Clovis reduction sequence, enabling comparison between early and late-Paleoindian groups. Production of Lakehead Complex bifaces began with the procurement of the raw material from bedrock exposures, river beds and boulder fields. These bedrock deposits would be subject to weathering fractures, allowing frost spalls and runoff spalls (of sufficeint size) to be collected, as well as cobbles from within boulder fields and riverbeds (Hinshelwood and Webber, 1987). Since the Gunflint Cherts are found locally in banded outcrops (See Chapter 3), in the past they could be directly quarried by extracting usable blocks from the surrounding material.

The Reduction Sequence proposed by Hinshelwood and Webber makes use of additional stages or sub-stages, introduced to account for problems specific to Lakehead Complex materials. One of their research goals was to determine why there were so many fragmentary biface pieces. Many of the pieces exhibit irregularities (either morphological or natural), or appear to have been discarded. Three categories were defined to address the presence of these bifaces in the assemblage. These are Failed, Broken, and Rejected (Hinshelwood and Webber, 1987).

The Biloski site (DcJh-9) biface analysis used the information available from the broken, discarded and rejected bifaces, to formulate a possible scenario for the manufacturing process at the site. These bifaces should not be considered examples of fine prehistoric implements but rather good examples of what can go wrong since the balance represent residual materials abandoned in production (Hinshelwood and Webber, 1987). Manufacturing was done by visually sorting the bifaces into stages, based on the non-metric attributes discussed in the methods section. Next, the metric attributes of the edge-angle, width/thickness ratio and cross-section were collected, as discussed by Callahan (1979). These observations were used to formulate a reduction sequence for Lakehead Complex materials.

Of the more than 200 bifaces and biface fragments collected from the Biloski site, 177 were given a stage designation (Hinshelwood and Webber 1987). Given the influence of Callahan (1979) in framing the Biloski biface analysis, most of the definitions used remained the same. Some modifications were required to address the nature of the local raw material, or the lithic technological organization specific to the Lakehead Complex (Hinshelwood and Webber, 1987).

Stage 1 - The Blank: Blanks observed at the Biloski site were generally blocky tabular specimens, reflecting how taconite was removed from the outcrops. There are few if any flake scars, although there may be some resulting either from testing at the quarry, or deriving from bedrock removal. Cortex and/or joint plane material are present and often remain until Stage 3. Bifaces rejected at this stage usually reflect the nature of the material. Hard inclusions and/or joint planes might cause the piece to narrow faster than it thins. In such cases the subject piece would be considered too narrow and/or too thick to warrant continued working (Hinshelwood and Webber, 1987).

Stage 2 - The Edged Blank: Flaking pattern and extent rarely reach or cross the midline. Considerable morphological variability exists between individual pieces in this stage. This stage likely reflects efforts to test the material by stressing it in order to preselect those objects most likely to produce the preferred final product. Part of the analysis involved dividing the Stage 2 bifaces into three subcategories based on distance from Stage 1. These were early, middle and late and were based on how much of the edge exhibited edge work. Stage 2 anomalies were also identified. These were pieces that were reduced in width far faster than the thickness, and were likely discarded because there was no chance for successful completion of the preferred tool form. Specimens with an adze-like morphology and a fractured broad end are considered as rejected Stage 2 anomalies in the Biloski analysis (Hinshelwood and Webber, 1987).

Stage 3 - Primary Thinning: Flakes are removed to or just across the midline, with the removal of any ridges, humps, or other irregularities. The outline also begins to become far more regularized. At the Biloski site observations were made of thinned bifaces that do not show flaking over the entire surface. Flaking on these pieces reveals a certain degree of familiarity with the material, whereby the knapper retains a joint plane on one edge in order to utilize it as a natural platform. The removal of this natural platform usually occurs in Stage 4. Broken bifaces in this stage often reveal transverse fractures, with both pieces being found in the knapping area. This likely demonstrates that the break occurred during manufacture. Variation in shape is also observed at Biloski, with some bifaces being discoidal and others lanceolate. There is also some evidence for the use of blade-flakes, though they are not termed as such by Hinshelwood and Webber (1987). At Biloski these blanks are said to enter the reduction sequence at this stage. These pieces exhibit extensive flaking on the dorsal surface to remove excess material and to thin the cross-section. There may also be thinning flake sets on the proximal portion of the ventral surface removing the bulb of percussion. Distally on the ventral surface there may only be edge work for platform preparation. This quickly takes the piece from Stage 3 to Stage 4 (Hinshelwood and Webber, 1987).

Stage 4 – Preform: Bifaces in this stage bear great similarity to the final form and are more obviously distinguishable between ovoid and lanceolate forms. It is in this stage when bifaces are generally cached (Crabtree, 1973). Hinshelwood and Ross (1992) cite the Crane Site (DdJj-14) as an example of a Lakehead Complex cache. As in Stage 3, flake scars extend to or just beyond the center of both faces, but unlike Stage 3, the pattern is more regularized. It is at this stage that nearly all surface irregularities and joint plane material are removed. During this stage there is more potential for use-wear to exist resulting in some researchers assigning such bifaces a tool-type, based on functional interpretation, much like Stage 2 pieces which look like adzes (Hinshelwood and Webber, 1987).

Stage 5 - Refined Biface: Final shaping is undertaken in this stage, clearly distinguishing between ovoid and lanceolate forms. In the case of non-hafted bifaces, the edges are retouched to create a more regular and sharper working edge, and/or dulled along the back edge in the case of a hand-held cutting/sawing tool. Non-hafted bifaces can be considered to be finished in Stage 5. The shape of diagnostic tools is confirmed at this stage though the hafting element is not completed. For hafted tools the edges and the basal platforms are prepared in anticipation of the final forming of the hafting portion (Hinshelwood and Webber, 1987).

Stage 6 Finished Biface –Hafted bifaces are finished in this stage with the final shaping of the hafting portion and grinding of the edges and the base in preparation for hafting. The use of pressure retouch in this stage is prominent in getting the edges and the base ready for hafting. Once the desired basal shape is flaked the edges are ground in order to dull them for hafting. At the Biloski site only two of the bifaces identified as Stage 5 or 6 were complete while the rest were fragmentary with no refits. It is assumed that the fragmentary projectile point remains were broken elsewhere and discarded at the site during replacement of the broken point (Hinshelwood and Webber, 1987).

With the discovery of the Crane Cache, Hinshelwood and Ross (1992) compared the Biloski assemblage to the uniform cache-blanks recovered from the Crane site. Callahan's (1979) metrics of width/thickness ratio and edge angle measurements along with the cross-section morphology were used to determine the production stage of the Crane Cache bifaces. The Biloski site material was then compared to the smaller of the two caches from the Crane site. This comparison revealed that cached bifaces are more easily defined by stages using the metrics than the manufacture rejects recovered from sites such as Biloski. In this comparison it was clear that use of edge angle to determine stage in rejects was unreliable while the width/thickness ratio, while still not completely reliable, was more accurate (Hinshelwood and Ross, 1992).

Specific aspects of the manufacturing process were observed on certain specimens from the Biloski site. It is possible that such aspects are observable throughout the Lakehead Complex. Edge preparation and heat alteration were noted in the Biloski assemblage. There is no clear indication when edge preparation first entered the sequence, or became more prominent. However it appears to have become more widely utilized during the later stages in order to better direct the flakes. For the Biloski bifaces there is increasing frequency of edge preparation in the later stages, representing above 50% in the Stage 3 bifaces and higher all the way through to Stage 6. It was also noted that seven of the undesignated fragments show signs of edge preparation. The percentages were very close and it was difficult to draw conclusions but it seems that it was likely widely used because of how failure prone Gunflint cherts are.

One biface has what has been identified as a vitrified flake but it was noted that due to the variability of the Gunflint material visual determination of heat treating is almost impossible (Hinshelwood and Ross, 1992).

It was concluded that the system developed for the Biloski biface assemblage is very useful in dealing with a large collection of manufacturing failures when there is very little in the way of finished tools. The observation of specimens at different manufacturing stages reflects the amount of reduction undertaken, and enables the functional characterization of sites. Due to the presence of a large number of early stage bifaces at the Biloski site, Hinshelwood and Ross (1992) argue that it represents a quarry/workshop site with early stages of processing and transport of the best material elsewhere to be finished. With the presence of fragments of finished artifacts and low numbers of Stage 4 bifaces it is assumed that either production failure was less of a problem at this stage or that the finished tools were brought in after being finished elsewhere (Hinshelwood and Ross, 1992).

4.6 SUMMARY

The system developed for Biloski will benefit from attempts at replication using other Lakehead Complex materials. An inventory of finished tools attached to specific forms of Stage 4 and/or Stage 3 preforms will also be beneficial (Hinshelwood and Webber 1987). The first benefit has been achieved with the utilization of this system on other Lakehead Complex sites; Hinshelwood (1990) at the Brohm site, Hinshelwood and Ross (1992) comparing the Biloski and Crane assemblages, Julig (1994) at the Cummins site, Adams (1995) at the Naomi site, and Halverson (1991) at the Simmonds site. This analysis of the Mackenzie 1 assemblage uses the modified reduction sequence model of Hinshelwood and Webber (1987) and critiqued by Hinshelwood and Ross (1992) to create a greater sense of consistency within the Lakehead Complex. This large assemblage consisting of not only large amounts of manufacturing failures but also of large numbers of completed formal tools will add to the knowledge base of the Lakehead Complex and the early peopling of Northwestern Ontario.

CHAPTER 5

METHODOLOGY

5.1 INTRODUCTION

This chapter introduces the Mackenzie I site with a review of the excavation methodology and a summary of the cataloguing methods. A summary of the Lakehead Complex reduction sequence (Chapter 4) follows. Utilizing the methods of Hinshelwood and Webber (1987) and Hinshelwood and Ross (1992) metric and non-metric attributes were collected and compared to other Lakehead Complex sites and to other comparable Paleoindian assemblages.

5.1.1 Biface Analysis: Summary

Biface analysis is an integral part of the analysis of lithic assemblages as a whole. It can occur independently of debitage analysis or in conjunction with various methodologies to determine site functionality, relative age of occupation, and behavioral or cognitive processes of past lithic artisans. As discussed in Chapter 3 typologies have been used to name traditions and/or complexes based on distinct differences in diagnostic tool types, mainly projectiles. Chapter 4 included a summary of the understood Paleoindian reduction sequences, which included a breakdown of specific methods of reduction and the associated diagnostic tool types.

In all the reduction sequence analyses there is an observable degree of variation that can be explained by the quality of the raw material, knapper skill and desired morphological final product. The idealized final product of each stage is observable in the biface assemblage. Although there is variation in the methods used for flake removal certain attributes remain diagnostic of the stages of manufacture.

5.1.2 Methods Discussion: Context of Mackenzie I Analysis

This biface analysis employed methods originally developed to address early Paleoindian biface reduction strategies (Callahan 1979; Crabtree 1966; Flenniken 1978) that were adapted by Hinshelwood and Webber (1987) to apply to Lakehead Complex materials and then tested by Hinshelwood and Ross (1992). The present analysis revealed that all stages of manufacture are represented in the Mackenzie I assemblage. The collection also includes a large number of formal tools. Besides the manufacture and maintenance of these formal tools, a variety of activities likely occurred at the site that further modified them. This includes hide processing, woodworking, butchering and hunting.

The biface analysis revealed that there were two primary behavioral trajectories employed in the manufacture of the formal tools. The first is the Biface Trajectory that is largely consistent with the reduction stages articulated by Callahan (1979) and modified by Hinshelwood and Webber (1987), and appear to reflect the reduction sequence leading to increasingly refined biface preforms. The second is a Flake/Blade Trajectory, observed in Clovis (Callahan, 1979; Bradley, 2009; 2010) and Folsom (Flenniken, 1978; Crabtree, 1966; Bradley, 2009; 2010) and refined by Odell (2003) and Andrefksy (1998).

There are limiting factors that constrain the completeness and comprehensiveness of this analysis. One, a limitation, derives from the fact that a comparatively small portion of the collection remains un-catalogued, while the balance was catalogued by thirteen individuals based in four separate laboratories in four provinces. This resulted in the inevitable differential identification of lithic attributes for similar kinds of artifacts. The result was that, though standardized criteria were used in catalogue construction, some variation occurred in tool and core identification that reflected individual discretion and the level of expertise. Due in part to time constraints and the massive size of the assemblage the cataloguing process was streamlined to aid in expediting the process. This streamlining resulted in further reducing the ability of cataloguers to engage in specialized analysis, and resulted in subsuming critical artifacts into general categories. The nature of the raw material and the relative uniqueness of this raw material to some cataloguers resulted in misidentifications of familiar artifact types. During the process of collecting the sample for analysis the author assumed that it was possible that Stage 1 Blanks may be present in the core/core fragment portion of the assemblage. Around 100 cores were separated from the main debitage assemblage before this process was halted and only bifaces, formal and informal tools were separated. These 100 cores were examined and nine Stage 1 blanks were discovered. Interestingly a number of fragments were actually identifiable as Stage 2 and 3 biface fragments. These were pulled and the author tested whether this may be the case with a portion of the catalogued collection available at the time of analysis. A further 100 cores were identified being spread between 10 and 20 units in the debitage collection. These were analyzed and it was determined that around 75% were actually misidentified bifaces and biface fragments.

This was supported by continued research into the Mackenzie I site by Stefan Bouchard, who is currently studying the lithic assemblage including analysis of its quartz and amethyst tools and debitage. As part of his work he examined the portion of the Mackenzie I debitage assemblage currently in storage at Lakehead University and discovered that a significant portion of the biface assemblage was catalogued as part of the debitage assemblage. It was previously noted that misidentifications occurred but it was not until recently that it became clear that formal tools were either misidentified due to their fragmentary nature or by simply not being segregated by the cataloger. This included a small parallel sided basal portion manufactured out of taconite (Figure 6.41), and a small biface manufactured out of Onondaga chert (Figure 6.18 A).

5.2 EXCAVATION OF THE MACKENZIE I SITE

The Mackenzie I site (DdJf-9) is located on an ancient Lake Minong strandline on the western edge of the Mackenzie river gorge, around 40 km east of Thunder Bay. The site was within the right of way for the Highway 11/17 twinning. During 2010 and 2011 the site was excavated as part of salvage operations carried out by Western Heritage. Over 2500 m^2 were excavated (Figure 5.1) that yielded a variety of tools and extensive amounts of debitage. Field excavation methods conformed to the provincially mandated archaeological standards (Archaeological Standards and Guidelines for Consultant Archaeologists, MCL 2011), and consisted of 1) the establishment of a Cartesian grid, with topographic mapping of the site locality; 2) excavation of 1 m^2 units, with the matrix removed in 5 cm thick levels, with each level divided into 4 quadrants (Northeast, Northwest, Southeast and Southwest); 3) removal of sediment using a combination of shovel and/or trowel excavation; and 4) screening the matrix through rocker screens equipped with both 3 mm and 6 mm mesh. Artifacts that were discovered *in situ* were measured and reported using three-point provenience. All data were collected and recorded on prepared individual serialized level forms including, depth, estimate of recoveries, maps of any provenienced artifacts and soil discolourations and notes on sediment texture and disturbance factors. All artifacts were catalogued by Western Heritage employees across four offices. All artifacts, records and digital information will eventually be curated and stored at Lakehead University to facilitate further research.

The site is situated at around 246 m asl positioned on the top edge of the west bank of the Mackenzie River gorge that may have represented a glacial outwash channel (Shultis, 2012). The artifacts were recovered from within bioturbated sand and pebbles above intact river mouth deposits (Shultis, 2012). The northern portion of the site south of the bedrock controlled uplands consisted primarily of beach deposits. In this area, the artifacts were recovered from bioturbated sands with no visible stratigraphy (Shultis, 2012). The southern portion consisted of well-sorted small to medium gravel and silty sand characteristic of river mouth deposits. This could indicate the presence of a former shallow stream crossing outwash channel (Shultis, 2012).This portion of the site was also characterized by bedrock controlled edges to the east and south. Two large glacial erratics were also present in the southern end of the site (Figure 5.1).

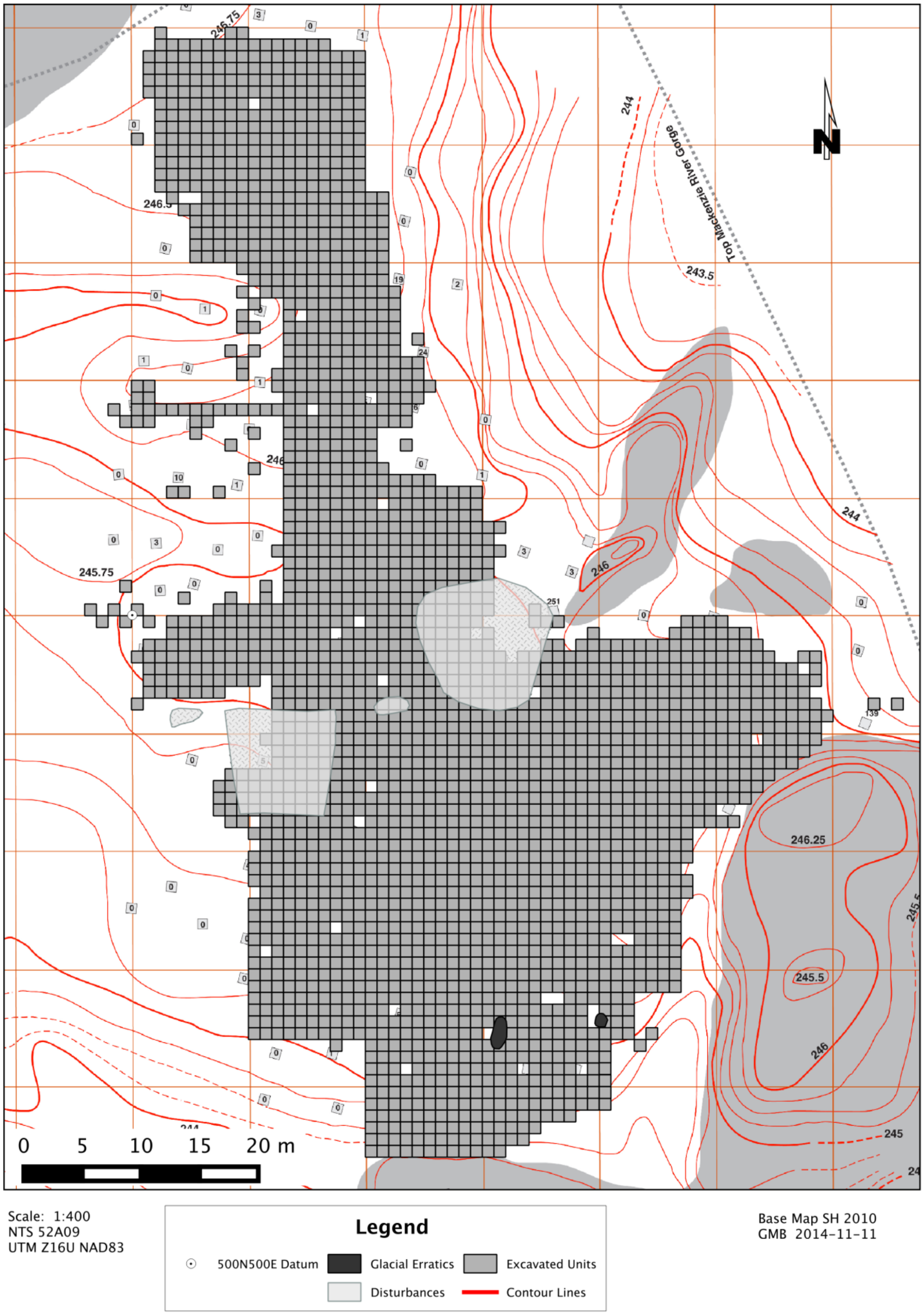


Figure 5.1: Map of the Mackenzie I site (DdJf-9) excavations, showing the topography, units excavated and the location of Canadian Shield bedrock outcrops.

Shultis (2012) suggests that there is no evidence for artifact sorting as a result of fluvial reworking of the site, suggesting that, other than normal amounts of bioturbation, the artifacts were largely recovered *in situ*. On any site of this age there is a degree of taphonomic processes that would cause some small amounts of artifact migration. These can include cryoturbation, and bioturbation, as well as aeolian movement of the sediments. There is also no evidence for occupation of the site during active beach formation (Shultis, 2012). Artifacts were recovered up to 1 m below the surface but generally they were located between 0 and 30 cm below the surface. Sediment size within the occupation and below is similar indicating that there was a degree of bioturbation that brought artifacts closer to the surface (Shultis, 2012). In summary there was a degree of bioturbation resulting in some artifact movement but there is no indication that fluvial actions moved any artifacts before or after occupation.

The Mackenzie I site may represent a habitation area where multiple activities were carried out. These would have included everything from domestic habitation, meat and hide processing, and the manufacture of stone tools. The presence and nature of the formal tool assemblage indicates that meat and hide were processed in the site vicinity. The vast debitage collection, combined with bifaces in all stages of manufacture, indicate that artifacts were manufactured and utilized on site. The location of the site may have been initially located to act as an ambush site at a stream outlet crossing. There may have been a caribou crossing at the Mackenzie River that would have been located much higher (Shultis, 2012). Caribou crossings have been hypothetically found in close proximity to a number of sites in southern Ontario, indicating a heavy preference for base camps located along waterways (Deller, 1976). The presence of a high number of projectile point fragments (tips, bases, and midsections with no apparent refits) seem to indicate that a kill/processing site was nearby. Broken tips would be found in the carcass and discarded, while other portions would be removed from the shaft and replaced at the base camp (Frison, 1989).

The context of the recoveries may be questioned as the absolute dates obtained from the site are inconsistent with the morphology of the lithic assemblage. Samples were dated using both AMS and OSL methods and produced inconsistent results. As mentioned above the top 30 to 40 cm (where most of the artifacts were recovered) was heavily bioturbated (Shultis, 2013). The size of the site and the density of recoveries indicate that the Mackenzie I may have been a multi-occupation site of Paleoindian origin (Odell, 2001; Kooyman, 2000; Andrefksy Jr., 1999; Kornfeld et al, 2010; Bradley and Stanford, 2012, Binford, 1980; Pitblado, 2003). The presence of adzes (though found on Paleoindian sites) may indicate an Archaic reoccupation; the single Meadowood projectile (Early Woodland) point adds to the possibility of later reoccupation of the site (Figure 5.2 and 5.3) (Ellis and Fisher, 1990; Fox, 1976; Cook, 2014; Bamforth, 2007; Waters et al, 2011; Kenyon, 1980; Ritchie, 1961; Justice, 1995; Waldorf, 1987; Overstreet, 2003).

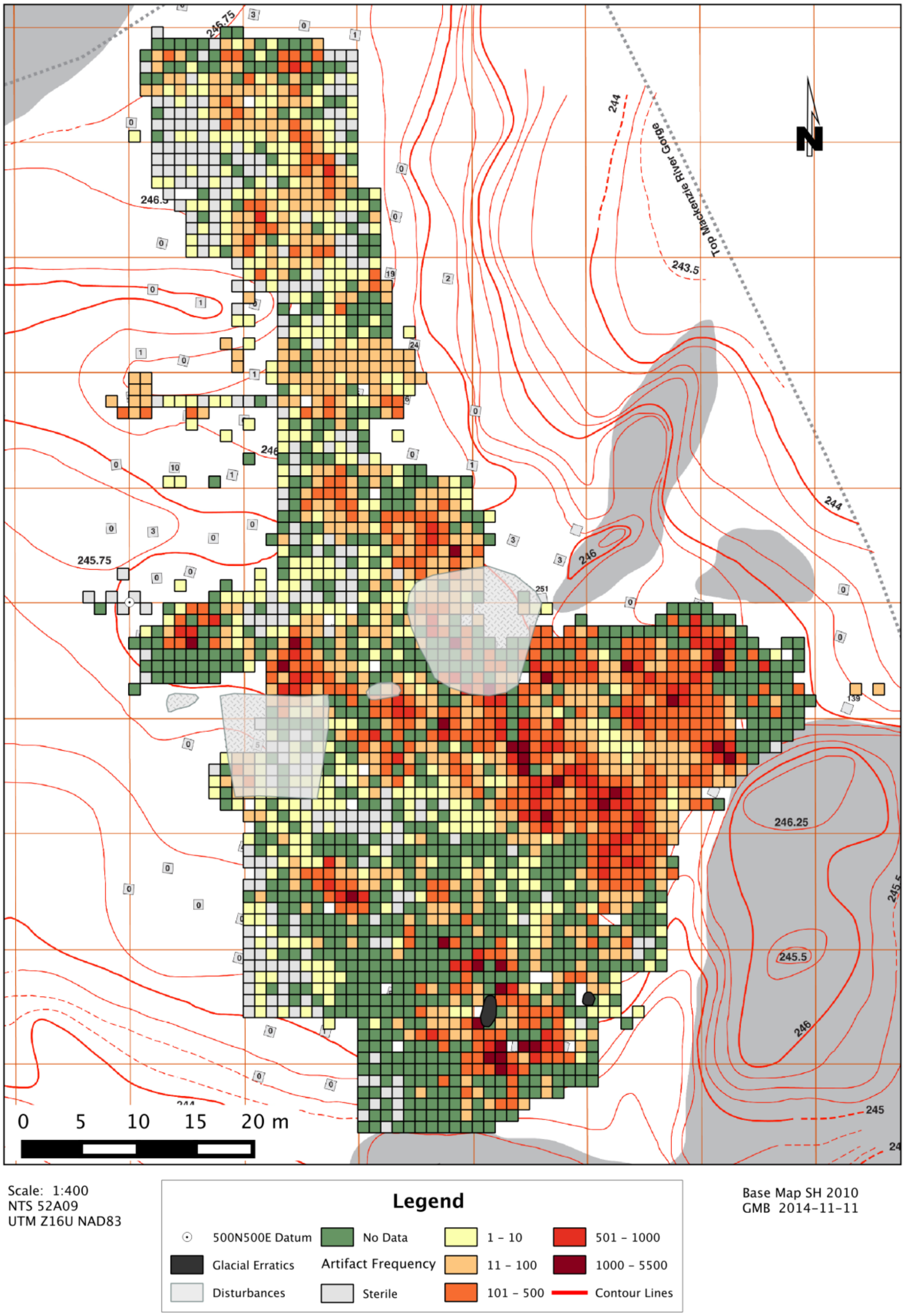


Figure 5.2: Map of the Mackenzie I site (DdJf-9) excavations, showing the total artifact frequency by unit.

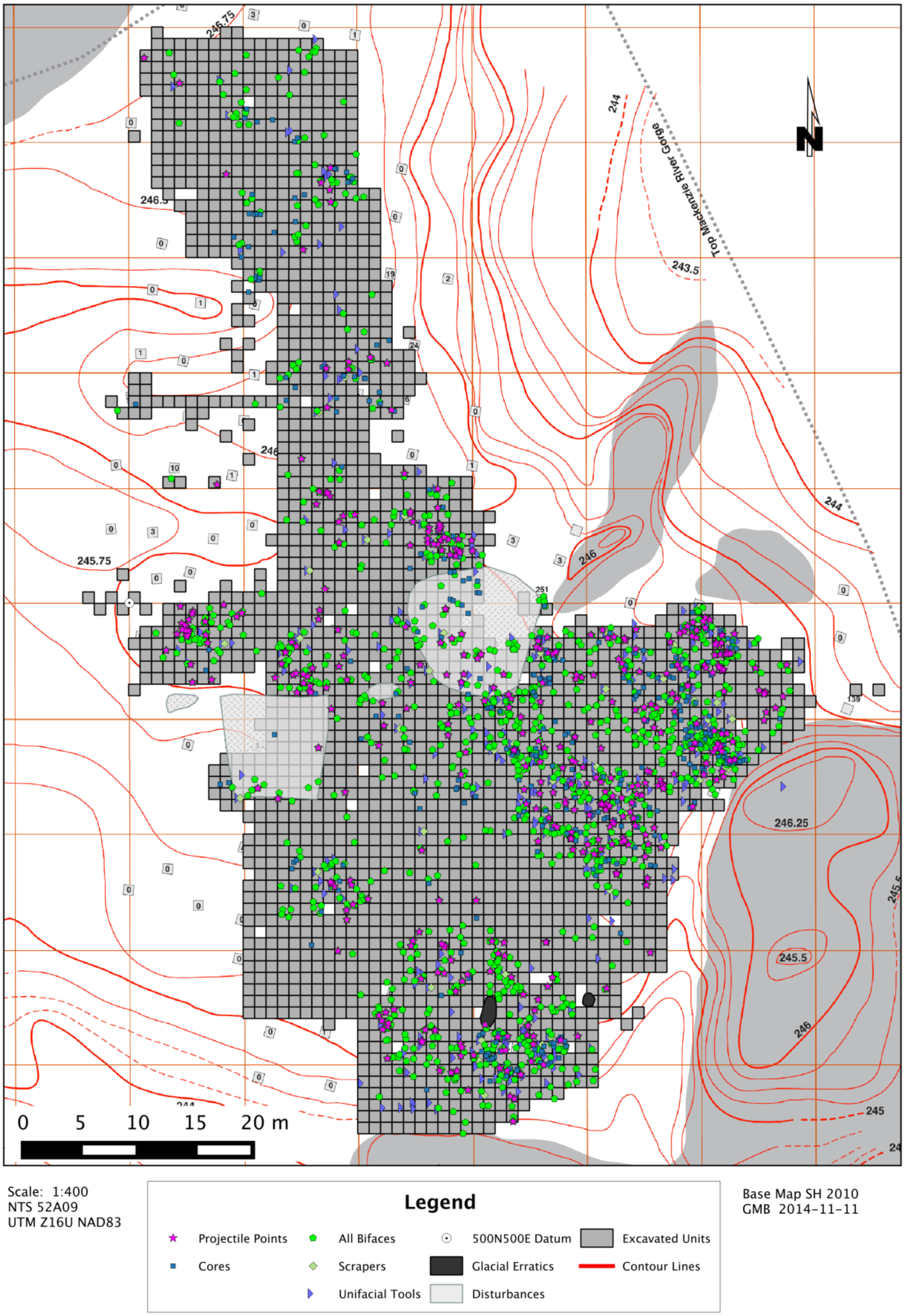


Figure 5.3: Map of the Mackenzie I site (DdJf-9) excavations, showing core, biface, formal and informal tool locations.

5.2.1 Optical Stimulated Luminescence (OSL) and Radiocarbon (AMS) Dates

Samples were collected for OSL dating from both Mackenzie I and the neighboring site of Electric Woodpecker I (DdJf-11) to the west. OSL dating measures the radiation accumulated in quartz and feldspar crystals subsequent to burial in order to assess the last time these crystals were exposed to light (Gilliland et al., 2012). Charcoal was collected from a supposed pit feature at Mackenzie 1 and from within a flake cluster at Electric Woodpecker II (DdJf-12).

The problems with the dating of the Mackenzie I site deposits are more fully addressed by Shultis (2012) and Markham (2013). The OSL dating from both sites give a stratigraphical/chronological sequence with the oldest dates coming from the base of the site sediments and becoming progressively younger with less stratigraphic depth, indicating the site experienced time progressive sedimentation with no disturbance. However, the oldest OSL dates from Electric Woodpecker I of 7980-7040 years BP (Gilliland, 2012; Kinnaird et al., 2012) and from Mackenzie I of 6500-5680 years BP (Gilliland, 2012; Gilliland and Gibson, 2012; Kinnaird et al., 2012), may not date the cultural occupation of the site or when the beach was active. Established lake level chronologies indicate that during this time period lake levels were between Minong and Houghton levels at around 230-183 m asl (Boyd et al., 2012; Kingsmill, 2010; Shultis, 2012; Yu et al., 2010). The beach sediments of Minong age strandlines would have been deposited after the Marquette ice retreated between 10000 and 9300 BP (Yu et al., 2010). An AMS date from Electric Woodpecker II of 8680 ± 50 BP (Beta 323410) and calibrated to 9760-9540 cal years BP (Markham, 2013; Shultis, 2012). A single AMS date of 3540 ± 30 BP (Beta 301998) from Mackenzie 1 was obtained which is inconsistent with current understanding of the Paleoindian period, the deglaciation sequence and the OSL dates.

5.2.2 Cataloguing of the Mackenzie I Assemblage

During the field seasons of 2010 and 2011 it was necessary to obtain approximate counts of the tools present at the sites. To do this a field lab was initiated whereby the unit bags were fact-checked and any identified formal and informal tools were separated. This collection of separated tools from both years was largely catalogued by the researcher while the rest of the assemblage was split between four laboratories across four provinces (Ontario, Manitoba, Saskatchewan, and Alberta). In total around 15 employees were involved in cataloguing the assemblage. Not all tools were caught in the initial pass through the unit bags in the field lab. Tools that were missed were separated during the cataloguing process. Cores were initially separated but, it was later decided to leave the cores and core fragments with the debitage.

A streamlined version of the cataloguing software was used for the cataloguing of the Mackenzie I material. This catalogue methodology was heavily streamlined to allow for maximum speed of artifact categorization, curation and analysis. As the assemblage consisted primarily of lithics the catalog was formatted such that all other initial artifact categories (faunal, metal, ceramic etc.) were removed. The lithic assemblage was divided into categories that included cores, debitage, and tools. Tools were further subdivided into bifacial, and unifacial chipped specimens and were then further subdivided to reflect likely function (knife, projectile, scraper, etc.). If possible tools could be subcategorized as preforms as well. All identified bifaces, preforms and a selection of the cores were subjected to specialized analysis by the researcher.

5.3 SUMMARY OF METRIC AND NON-METRIC DATA ATTRIBUTES

Lithic terminology has been standardized in a number of sources (Odell, 2003; Kooyman, 2000; Andrefsky, 1998; Whittaker, 1994; Waldorf, 1989; Bradley, 2009; 2010). Those terms with a direct relevance to this thesis are presented below. The analysis of biface assemblages uses metric and non-metric attributes to determine the stage of manufacture. They can be used independently or together, generally resulting in the same stage of manufacture.

5.3.1 Metric Attributes

The metric attributes used in this analysis include length, width, thickness, width/thickness ratios and edge angle measurements. These attributes were utilized by Callahan (1979) and later by Hinshelwood and Webber (1987) and Hinshelwood (1990). For this study length, width and thickness measurements were all obtained using digital calipers or an appropriate ruler for larger specimens. Length was measured on only those bifaces that were complete or refitted into a complete biface (Figure 5.4).

Width was measured at the widest point of the biface on all specimens where the maximum width was observable (lateral edges that did not refit were not considered) (Figure 5.4). Thickness was measured at the thickest point on pieces which were deemed to be successfully thinned (Figure 5.4), specimens with a thick flaw (knapper's error or natural flaw, see Figure 5.12) were measured at this point at on a section where thinning was successful. With such specimens the successfully thinned portion was used in the calculation of the width/thickness ratio. The width/thickness ratio was calculated by dividing the width by the thickness as per Callahan (1979).

Edge angles were obtained by using a contact goniometer (Figure 5.5). Two measurements per edge were taken and averaged (Dibble and Bernard, 1980). There were cases where one edge or a section of an edge was abnormally steep for the degree of work completed on the piece. In these cases it was noted whether this was the result of a natural fracture plane or as a result of retouch to form a bevelled striking platform in preparation for the next stage of work.

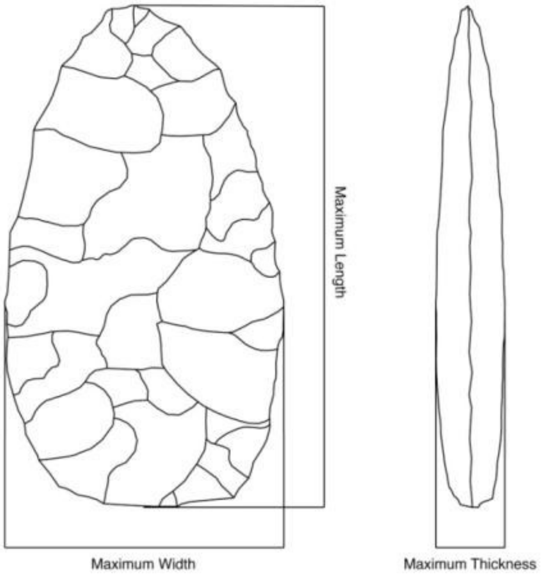


Figure 5.4: Schematic drawing of the measurements taken.

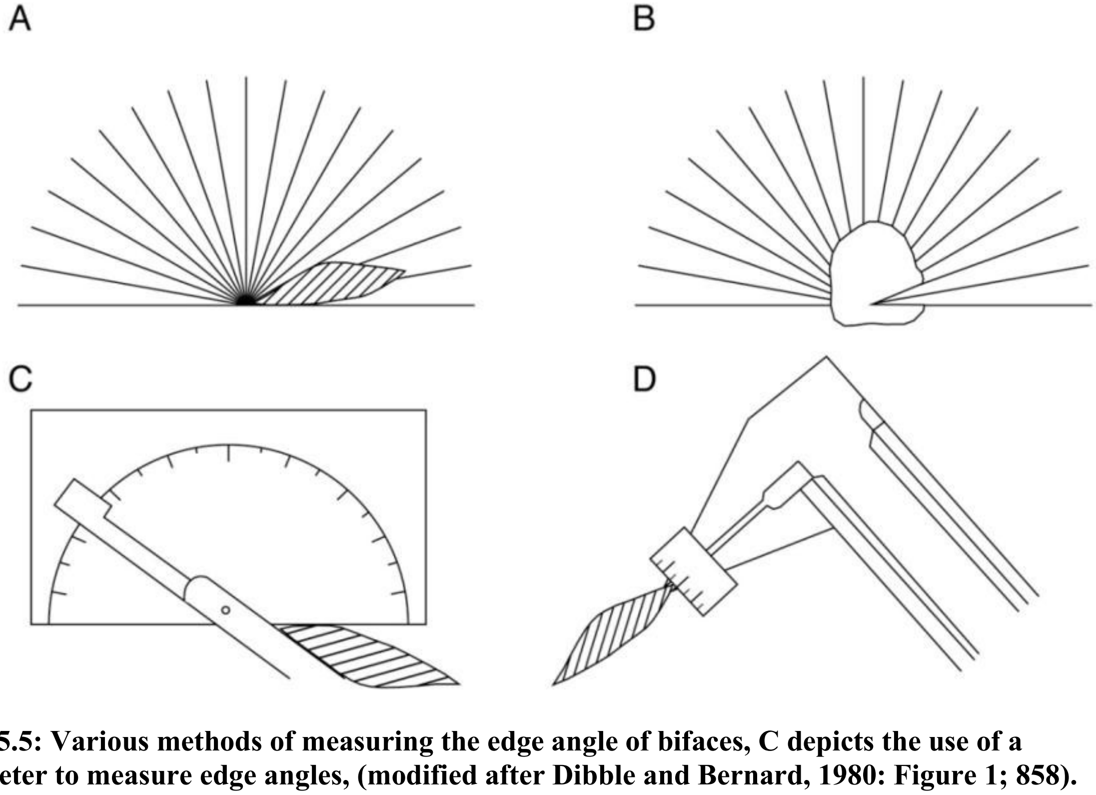


Figure 5.5: Various methods of measuring the edge angle of bifaces, C depicts the use of a goniometer to measure edge angles, (modified after Dibble and Bernard, 1980: Figure 1; 858).

All bifaces that were determined to be measurable were subjected to the above measurements. All data was collected into a spreadsheet (Appendix 2) and stage determinations were made according to Andrefsky, Jr., (1999; Table 5.1).

Table 5.1: Technical description of biface stages modified after Andrefsky, Jr., 1999: Table 7.7; 181.

Biface Stage	Name	W/T Ratio	Edge Angle (degrees)	Description
Stage 1	Blank	N/A	N/A	Cobble or spall with probability of cortex
Stage 2	Edged biface	2.0 to 4.0	50 to 80	Small chips removed from around edges with a few flake scars across face(s)
Stage 3	Thinned Biface	3.0 to 4.0	40 to 50	Flakes removed to center of biface, with most cortex removed
Stage 4	Preform	4.1 to 6.0	25 to 45	Large flat flake scars, flat cross section
Stage 5	Finished biface	4.1 to 6.0	25 to 45	Refined trimming of edges, possibly hafted

5.3.2 Non-Metric Attributes

Non-metric attributes are observable attributes that indicate the degree of work on an artifact. These attributes aid in placing the biface into stages as described in Chapter 4. In some situations, non-metric attributes were used solely in stage determination, with reference to joint planes, edge bevels, or the nature of Gunflint Formation material, when these factors combined to skew the metric staging. This problem was first observed by Hinshelwood and Webber (1987) and again by Hinshelwood and Ross (1992). Due to the nature of the material measurements often indicated an earlier stage of manufacture while the non-metric attributes indicated that the piece is in a later stage. As these attributes are observable they are more prone to error and interpretation. The non-metric attributes were determined based on those of Callahan (1979), Hinshelwood and Webber (1987) and Julig (1994).

1. *Cross-Section* – This was defined as Lenticular (Bi-Convex), Elliptical, Plano-Convex (D-Shaped), Diamond, or Hexagonal. In some cases more than one attribute was observed on a single specimen and this was noted as well. The Lenticular cross-sections were often offset due in part to the alternate edge bevelling observed on certain pieces and/or the nature of the flake blank (Figure 5.6).

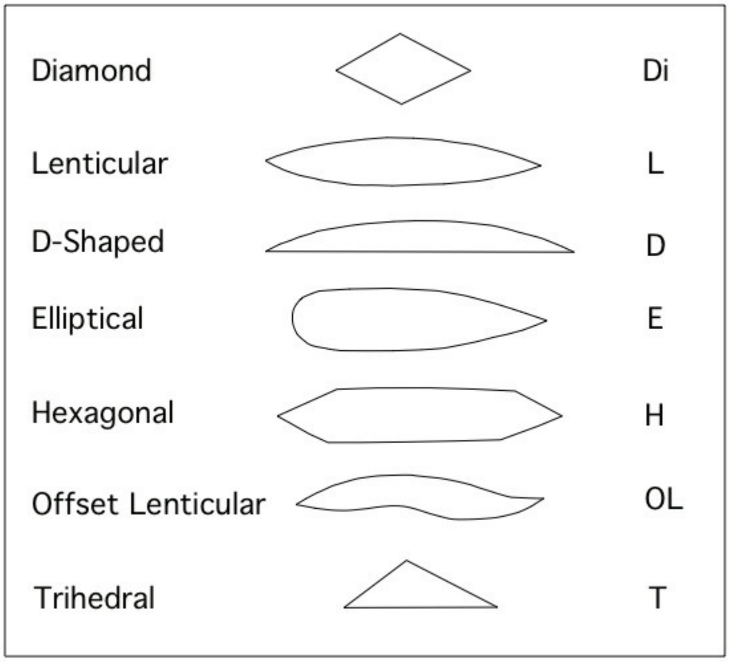


Figure 5.6: Illustration of cross-sections observed at Mackenzie I.

2. *Longitudinal Profile* – This was observed by looking at the piece edge on and was determined to be Straight, Twisted, Curved, or a mix (Figure 5.7).

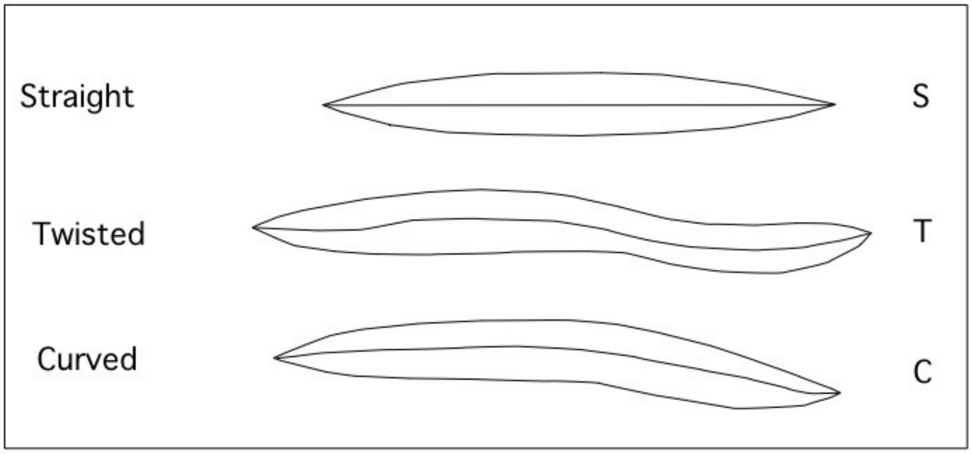


Figure 5.7: Illustration depicting the longitudinal profiles observed at Mackenzie I.

3. *Cortex/Joint Plane* – The presence or absence of both cortex and joint planes were noted. Taconite is prone to failure along joint planes which were often exploited in order to obtain blanks. Such blanks had readily bevelled edges which made excellent striking platforms from

which to begin work. Cortex is important to note because it seems that cortex was also used as striking platforms and often kept well into the later stages of the process (Figure 5.8).

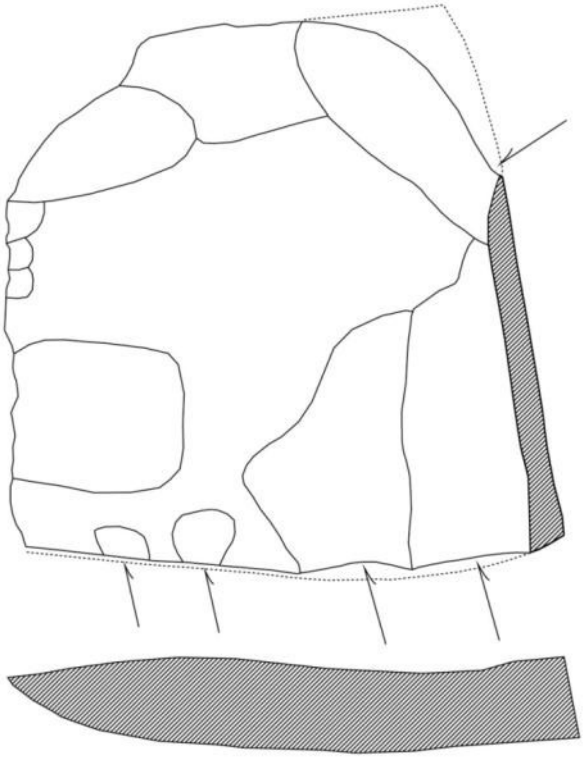


Figure 5.8: Illustration of an early stage biface from Mackenzie I depicting the cortex and joint plane present in gunflint formation material.

4. *Flaking Pattern* – These included parallel oblique, co-medial and/or random patterned (Figure 5.9). The nature of the flake termination was also observed as being feathered, hinged, stepped, overshot, or axial (Figure 5.10).

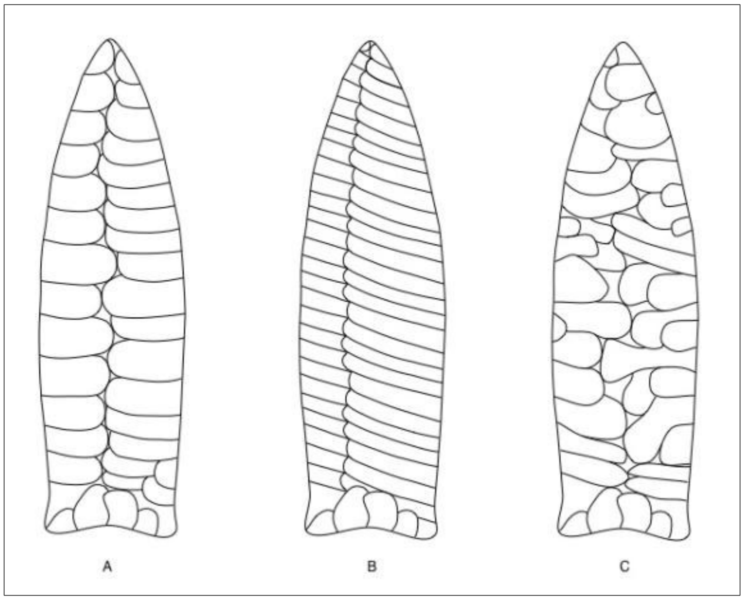


Figure 5.9: Illustration depicting the primary flaking patterns observed at Mackenzie I A) co-medial, B) parallel oblique and C) random patterned.

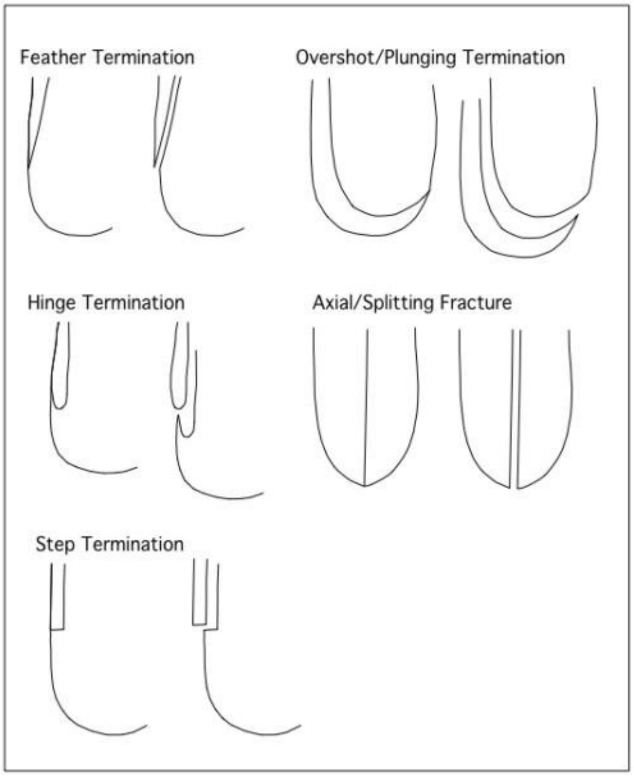


Figure 5.10: Illustration depicting the nature of flake terminations, (modified after Odell, 2003: Figure 3.10; 57).

5. *Platform Preparation* – This was noted as consisting of either grinding, to varying degrees, or retouch flaking to create a bevelled edge. When a bevelled edge was present it was most often as

an alternate edge bevel (Figure 5.11). These were often both present on a single piece and in such cases it was noted and to what degree it was present.

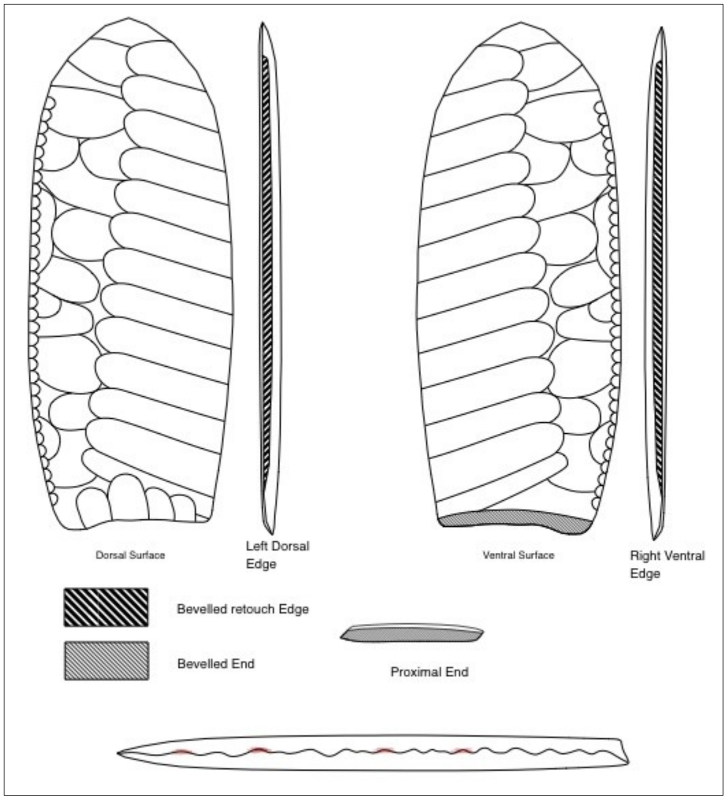


Figure 5.11: Illustration demonstrating the use of platform preparation methods observed at Mackenzie I Bottom: example of grinding used in platform preparation, Top: use of bevelled retouch in platform preparation.

6. *Material* – The raw material used to make the piece. This was largely Gunflint Formation material (See Figure 3.17 and 3.18), but did include a sample of Hixton Silicified Sandstone (See Figure 3.20) and Knife Lake Siltstone (See Figure 3.19).
7. *Type of Failure* – Noted as Rejected, Broken, Failed or Discarded after Hinshelwood and Webber (1987). Broken bifaces were defined as those where the knapper's error is obvious and could be identified as the reason for failure (Figure 6.4, 6.6, 6.10) Rejected bifaces were those where the knapper observed that further reduction was no longer possible and the piece was discarded (Figure 6.4, 6.6, 6.10). Failed bifaces were those fractured specimens where the fracture was the result of an internal or otherwise unobservable (Figure 6.4, 6.6, 6.10). Discarded bifaces were

generally defined as formal tools which have reached the end of their use-life (Figure 6.39, 6.40). These pieces ended up in the archaeological record when the tool user/manufacturer deemed them not worth the effort to resharpen or repurpose. In some situations a combination of breakage was possible and such specimens were noted as such combining the relevant categories.

8. *Nature of Fracture* - The nature of the fracture was observed as being longitudinal or transverse. Following this the fracture was then identified as oblique, straight or multi-directional. A description of the fracture followed, smooth joint plane, jagged or perverse, snapped, and hinged (Figure 5.12).

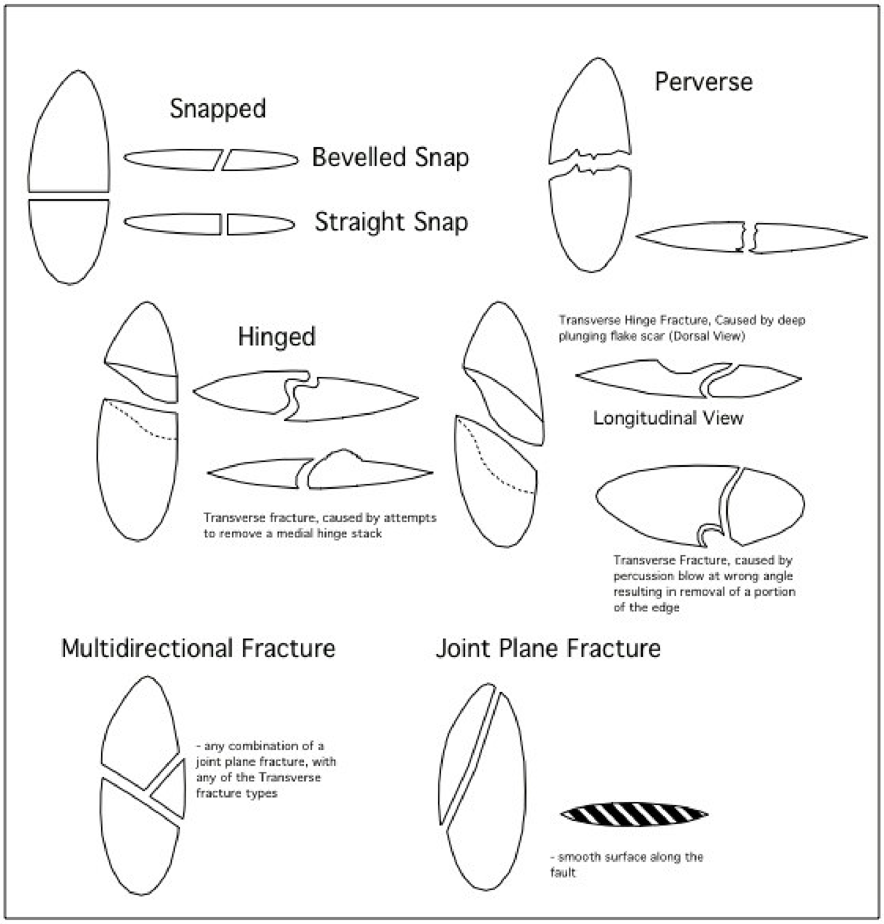


Figure 5.12: Illustration of the breaking patterns observed in lithic assemblages and associated terminology for lithic artifacts (modified after Odell, 2003).

9. *Medial Ridge* – Presence or absence was noted. When present the location was described as well as the directionality of the attempts at removal. Not all were present along the midline in some cases they were part of an edge (Figure 5.13).

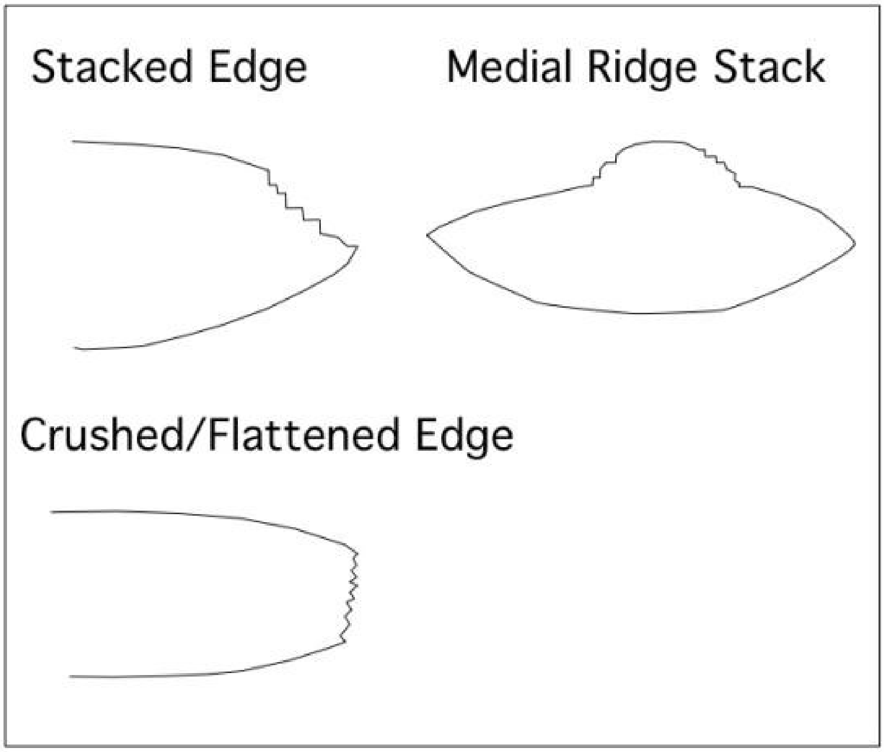


Figure 5.13: Illustration demonstrating problems as a result of flintknapper error and/or natural flaws in the material.

10. *Recycling of Fragments* – Retouching or reuse of broken fragments was noted as being present or absent. Where present the location and degree of retouch was noted. If possible to determine, the morphology of the new tool was noted (Figure 5.14).

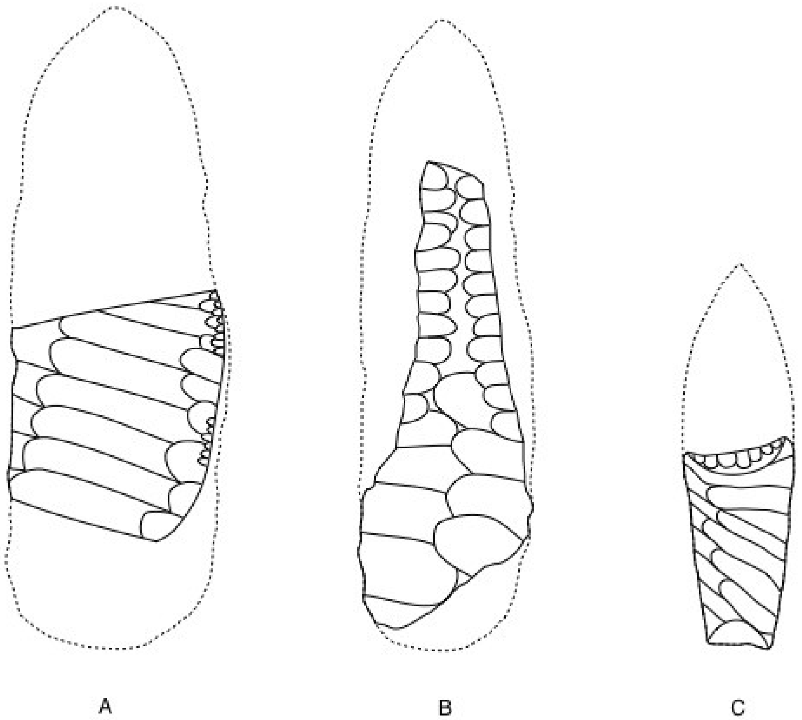


Figure 5.14: Illustration of bifaces which show evidence of recycling, A) reuse of an edge as an expedient cutting tool, B) reworking of a fractured piece into a drill (preform), C) reworking of a fractured projectile point into a scraper.

11. *Basal Thinning* – This was noted as being present or absent only on pieces where a basal portion was present. Where present a description followed as either being short retouch flakes, or long percussion scars (Figure 5.15: B). Presence or absence of a bevelled base was noted as well and where the basal thinning occurred in relation to this bevel (Figure 5.11 and 5.15: A).

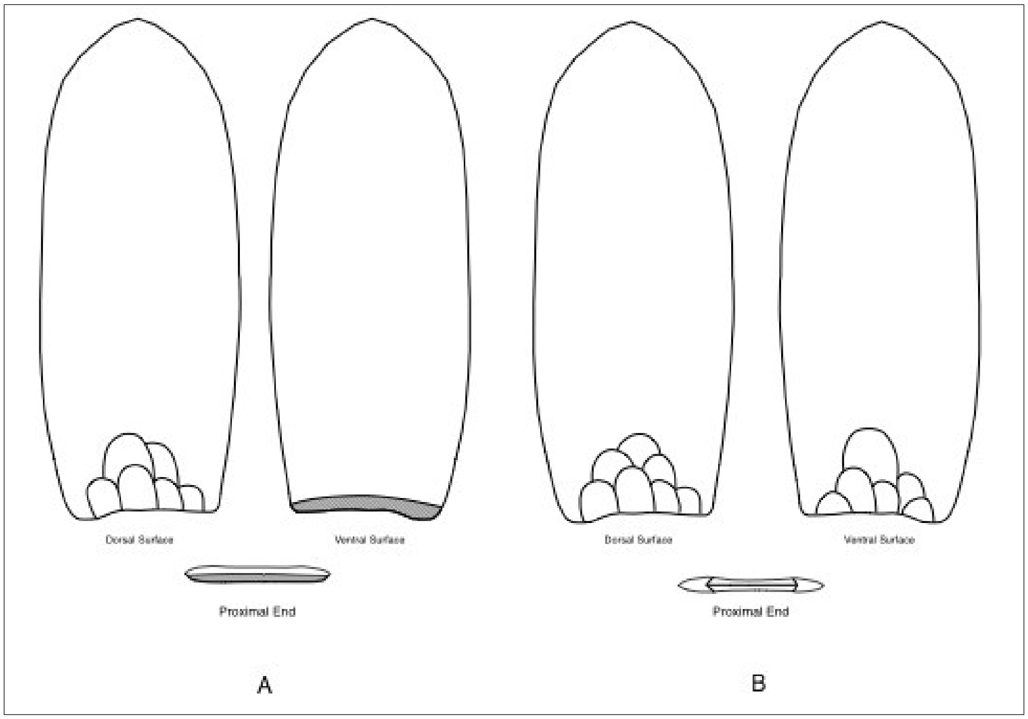


Figure 5.15: Illustration of observed basal thinning methods from the Mackenzie I site. Plate A: depicts the use of a bevelled end as a striking platform; Plate B: depicts the use of bifacial thinning and the use of a prepared platform (grinding and retouch).

12. *Blank Type* – These were noted as being tabular pieces, which had remnants of joint planes or cortex (Figure 5.16: A). Large flakes were used as well either large tabular flakes with joint plane presence and a visible bulb of percussion (Figure 5.16: B), or as a broad thick flake with a striking platform and pronounced bulb of percussion (Figure 5.16: C). Blade-flakes were distinguishable from other flake blanks due to their being long and narrow with more pronounced flake features, such as striking platform and bulb of percussion (Figure 5.16: D). Blades were also present in the assemblage and were distinguished by being long and narrow with a pronounced bulb of percussion and a dorsal ridge caused by previous flake removal from the core (Figure 5.16: E). Blanks that had no indicators above were considered as indeterminate.

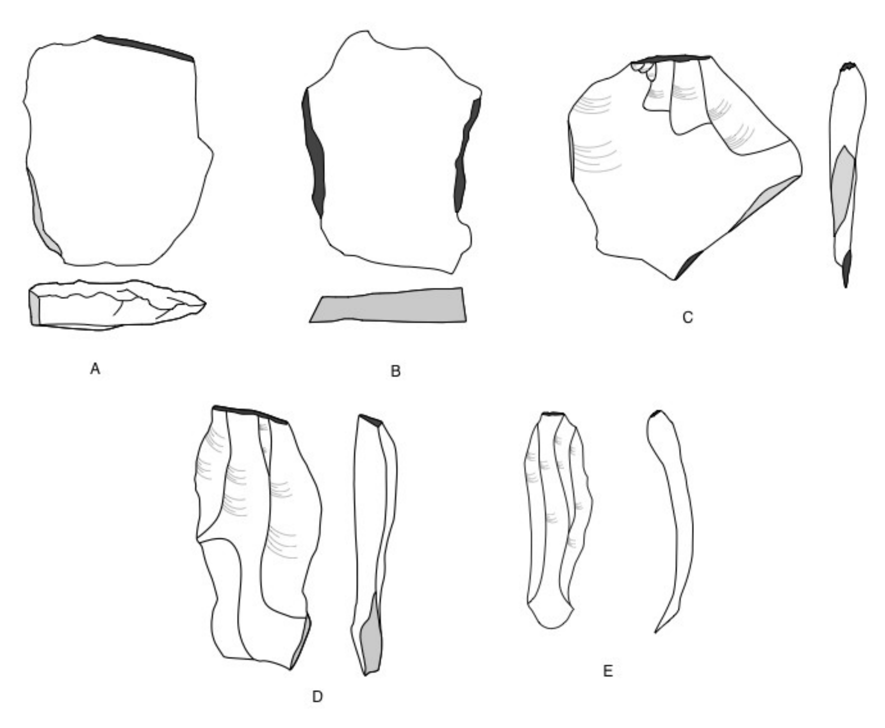


Figure 5.16: Examples of blank types, A) tabular block, modified from Callahan, 1979: Figure 7b, 49 B) tabular flake, modified from Whittaker, 1994: Figure 8.23, 208 C) flake blank, modified from Callahan, 1979: Figure 14c, 58 D) blade/flake blank, modified from Callahan, 1979: Figure 11c, 55 E) Blade.

13. *Edge Configuration* – Noted as being regular, slightly irregular or irregular, representing an indication of degree of completion. Regular or smooth edges parallel, convex or asymmetric were indicators of later stages (Figure 5.17: A). Slightly irregular pieces with isolated platforms were indicative of mid-stage bifaces (Figure 5.17: B). Irregular pieces either wavy/scalloped or denticulate were usually indicators of early stage pieces where percussion flaking creates deep scars. Pronounced irregularities were caused by either the nature of the material or the striking platforms of the deep percussion flake scars (Figure 5.17: C).

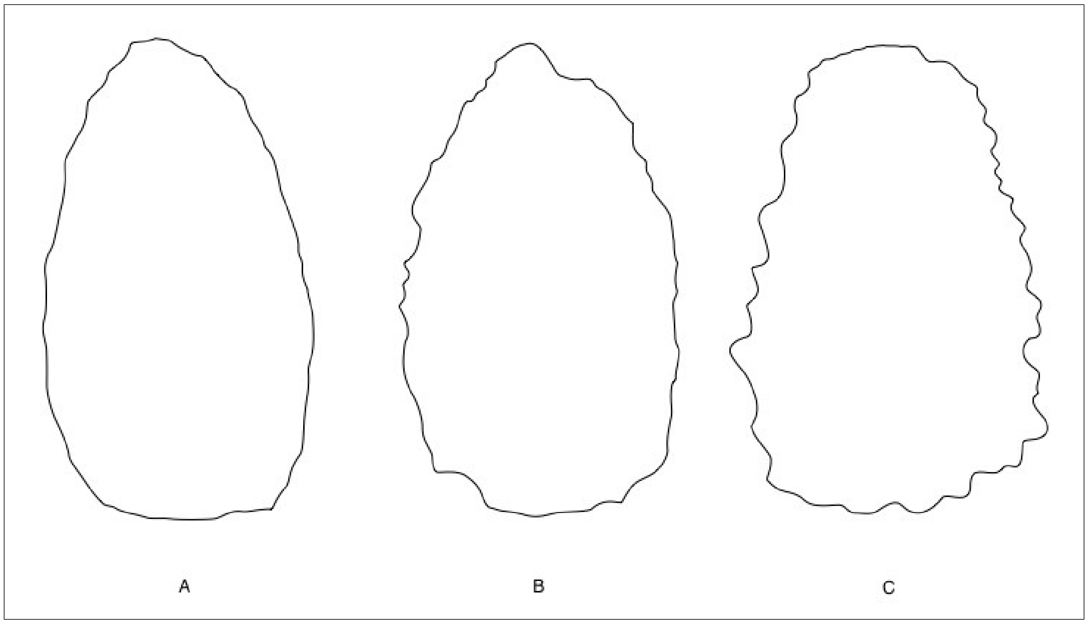


Figure 5.17: Examples of edge configuration, A) regular, modified from Callahan, 1979: Figure 35d, 95 B) slightly irregular, modified from Callahan, 1979: Figure 35c, 95 C) irregular (modified after Callahan, 1979: Figure 34a, 94).

All the bifaces including those that were measurable were described using the non-metric attributes as well. The data from the bifaces subjected to just a non-metric analysis were collected and placed in an excel spreadsheet (Appendix 3). Those bifaces that were determined to be too fragmentary to warrant even a non-metric attribute analysis were entered into an excel spreadsheet (Appendix 4) as well with a brief description of the portion present (lateral edge, tip, base, midsection), the nature of the fracture (if possible), and if there was any observable reworking.

As this analysis was focused solely on the bifaces preceding the finished points some attributes useful in describing the finished projectile points were omitted from this analysis. These measurements were collected by Markham (2013) and will be presented along with the data collected from the early stage pieces, and other non-projectile bifacial implements.

5.4 SUMMARY

The methods followed those established by Callahan (1979) and later applied to Lakehead Complex materials by Hinshelwood and Webber (1987). The more recent works by Whittaker (1994) and

Andrefsky (1998) were used as they were directed more at creating a generalized reduction sequence analysis that could be applied to any bifacial reduction technological organization. The smaller assemblages analysed previously tested the viability of using generalized reduction sequence attributes to describe what stages were present at Lakehead Complex sites and what could be determined from the collections. The larger assemblage from Mackenzie I will aid in the testing of the limitations identified in the previous studies.

CHAPTER 6

RESULTS AND DISCUSSION OF ATTRIBUTES

6.1 INTRODUCTION

This chapter presents the results of the metric and non-metric analysis of the Mackenzie I bifaces. This contributed to the placement of the bifaces into the reduction stage sequence, and aided in the identification and definition of two manufacture trajectories. Only bifaces of sufficient size/completeness for the observation of both the metric and non-metric attributes were staged using the methods outlined in Chapter 5. The edge angle and width/thickness measurements were used to place the bifaces into the designated stages following Callahan (1979), Andrefsky (1998), Whittaker (1994) and Hinshelwood and Webber (1987). Following metric analysis, the non-metric attributes were used to refine the stage identification of bifaces which were slightly anomalous. The extent and nature of flaking, morphological shape of the biface, edge regularity, cross-section, and the nature of platform preparation were the main non-metric attributes utilized. A number of non-metric attributes were analytically significant and include grinding and edge bevelling, flake pattern, basal thinning/bevelling, fracture category and presence of reworking.

The bifaces were identified using the Western Heritage catalog number (e.g., #0000), but a number of bifaces were not yet catalogued and were identified using the serial number (e.g., WHS-00000). As with Markham's (2013) analysis of the projectiles, the biface assemblage from the 2009 preliminary survey conducted by Archaeological Services Inc. (ASI) was included in this analysis. These specimens were identified using that company's catalog numbers (e.g., L0000). Refit specimens are discussed using either catalog numbers or serial numbers depending on the circumstances (e.g., #00000/0000 or WHS-0000/00000).

6.2 BRIEF SUMMARY OF THE METRIC AND NON-METRIC ANALYSIS

The metric and non-metric data were collected and compiled in a series of tables presented in the appendices. The metric measurements include length (complete pieces or complete refits only), width, thickness, the width/thickness ratio and the lateral edge angles. During the cataloguing process all bifaces were weighed as part of the procedures used by Western Heritage and this data is presented as well. These measurements were initially used to determine the biface production stage following the methods of Callahan (1979). The non-metric attributes include the flaking pattern, presence or absence of edge preparation (grinding and/or bevelled retouch), presence/absence of basal thinning, extent of flaking, lateral edge configuration, cross-section, and edge profile. A number of non-metric attributes specific to the Lakehead Complex include the presence/absence of joint planes and cortex, use of joint planes as a striking platform, and presence of a medial ridge. These are presented in greater detail in Chapter 5.

As with the previous Lakehead Complex reduction sequence studies the metric analysis was important but is constrained by several limitations. Callahan's (1979) metric attributes were useful in the stage determination of the bifaces, however they do not allow for variation caused by the raw material used. To overcome this, both non-metric and metric attributes were conjunctively considered, and proved far more effective in the staging of the bifaces. Non-metric attributes used to determine biface stage, include the flaking extent, lateral edge profile, nature of the platforms and edge preparation, degree of cortex and/or joint plane presence or absence.

6.3 OBSERVATIONS MADE ON THE MACKENZIE I BIFACE ASSEMBLAGE

The Mackenzie I bifaces were divided into those that were measurable using the metric attributes (Completes/Complete-refits and large fragments) and those that were too fragmentary but were staged using the non-metric attributes. The metric staging resulted in a number of bifaces which were deemed to be anomalies as there was a discrepancy between the width/thickness ratio and the edge angle measurements (Table 6.3). The results of the metric staging can be observed in Table 6.4. This table illustrates the presence of W/T ratios below 2 and above 6 illustrating the presence of metrics unique to the Mackenzie I reduction sequence. Using the combined metric and non-metric data the bifaces were placed in stages. This analysis divided the bifaces into the observed stages of manufacture, and the methods used to stage them (Metric, Non-Metric, or a combination). The major limitation of exclusive use of metric attributes to stage the bifaces relates to the challenges introduced by the raw materials. This resulted in some specimens being inappropriately classed at early production stages. By combining the non-metric attributes to infer an actual state of completion it is hoped that this limitation will be resolved.

The assemblage considered here consists of 1424 bifacial tools, the analysis of which revealed that there were 544 formal tools and 880 Stage 1 to 5 bifaces. This reflects the total of all fragmentary and complete tools that have been recognized to date. During this analysis, and also with the projectile analysis completed by Markham (2013), some broken objects were identified that could be refitted, and consequently counted together. In her projectile point analysis, Samantha Markham (2013) conducted a morphological analysis of the 380 complete, refitted and fragmentary Stage 6 projectiles. This thesis addresses bifaces representing the stages leading up to the finished formal tools, and therefore, only addressed the Stage 1 to 5 bifaces. The formal tools will be discussed only in terms of what can be determined about the trajectory used to manufacture them.

Table 6.1: Total biface assemblage from Mackenzie I broken down by staged and un-staged bifaces on the left and showing the result of refitting analysis on the right.

Total Biface Assemblage	
Staged	667
Un-Staged	223
Anomalies	21
Subtotal	911
Formal Tools	532
Total	1443

Refitted Biface Assemblage			
Staged	573	Stage 1	15
Un-staged	215	Stage 2	103
Anomalies	16	Stage 3	225
Formal Tools	472	Stage 4	128
Total	1276	Stage 5	102
		Stage 6	472
		Total	1045

Table 6.2: Chart illustrating the methods of analysis used to Stage the bifaces from Mackenzie I

Staged Bifaces			
Metric/Non-Metric		*Non-Metric*	
Stage 1	0	Stage 1	15
Stage 2	50	Stage 2	53
Stage 3	107	Stage 3	118
Stage 4	88	Stage 4	40
Stage 5	66	Stage 5	36
Stage 6	452	Stage 6	20
Total	763	Total	282

Table 6.3: Chart illustrating the results of the metric attributes used to Stage the bifaces compared with the combined metric and non-metric attributes from Mackenzie I

	Metric Stage ID	Combined Stage ID
Stage 1	0	0
Stage 2	168	50
Stage 3	57	107
Stage 4	67	88
Stage 5	26	66
Stage 6	381	454
Anomalies	68	2
TOTAL	767	767

Table 6.4: Chart illustrating the frequency of the metric attributes used to Stage the bifaces from Mackenzie I.

W/T Ratio	Frequency	Edge Angles	Left	Right
1.0 - 1.9	26	50-80	189	177
2.0 - 3.0	97	46-50	57	71
3.1 - 4.0	129	25 - 45	142	149
4.1 - 5.0	116			
5.1 - 6.0	20			
6.1 - 7.0	9			

The 880 bifaces were refitted and analyzed following the methods outlined below. This resulted in a final assemblage of 780 bifaces and biface fragments, of which 299 (37%) could be classified into a production stage using both the metric and non-metric attributes, while 255 (33%) bifaces could only be classified to a production stage using the non-metric attributes. There were 216 (28%) fragments which could not be staged accurately and 14 that, following analysis were deemed to be anomalies. A portion (n=85) of the cores and core fragments (n=444) recovered from the site were examined in search of miss-identified bifaces and Stage 1 blanks. Of the total of 85 specimens examined, 9 were identified as actually being Stage 1 blanks. This indicates that about 10% of the objects identified as cores or core fragments in the catalogue are incorrectly identified.

Two manufacture trajectories were observed as being present in the Mackenzie I assemblage. The Biface manufacture trajectory makes use of large blanks and follows a standard reduction sequence thinning both faces evenly. The Flake trajectory makes use of thinner flakes as blanks requiring a shift in thinning methodology, whereby the ventral surface remains largely un-worked late into the reduction sequence. The breakdown of the biface stages into the observed trajectories can be observed in Table 6.3. Following this the Stage 6 tool assemblage was further divided into the identified functional tool types and is presented in Table 6.4.

Table 6.5: Breakdown of the Mackenzie I biface assemblage into the observed trajectories.

	Reduction Method		
	Biface	Flake/Blade	IND
Stage 1	9	6	0
Stage 2	79	24	0
Stage 3	186	39	0
Stage 4	74	54	0
Stage 5	33	68	1
Stage 6	86	188	11
ANM	12	1	3

Table 6.6: Stage 6 Mackenzie I tool assemblage broken down into the observed trajectories

	Reduction Method			
	Biface	Flake/Blade	N/A	Total
Point	56	106	225	387
Knife	0	5	5	10
Drill	2	46	11	59
Adze	13	0	0	13
Gouge	3	2	0	5
Scraper	5	4	100	109
Expedient Tool	0	0	288	288

Table 6.7: Breakage categories observed by Stage in the Mackenzie I Assemblage B) Broken F) Failed R) Reject D) Discard

	Breakage Categories								
	B	F	R	D	B/D	B/F	B/R	D/R	F/R
Stage 1	5	3	7	0	0	0	0	0	0
Stage 2	64	18	19	0	0	0	2	0	0
Stage 3	168	30	10	1	0	14	2	0	0
Stage 4	101	14	8	0	0	2	0	0	3
Stage 5	78	10	6	4	2	0	2	0	0
Stage 6	401	1	0	61	9	0	0	0	0
ANM	13	0	3	0	0	0	0	0	0
Unstaged	92	91	2	1	0	24	2	1	3

6.3.1 Stage 1 - Blanks

Stage 1 blanks are represented by 8 artifacts; 3 were found by ASI and 5 by Western Heritage. All were initially identified as cores, core fragments or primary reduction flakes. This indicates that further analysis of the broader lithic assemblage will reveal that the biface assemblage is larger. During this analysis, 4 were identified as broken, 2 as rejects and 2 as failures. The broken pieces fractured in such a way that the knapper may have deemed them as unfit for further reduction. These include a large flake blank with a deeply plunging flake scar, and a cobble which was discarded after the quality testing flakes plunged too deeply. The failed pieces were those that fractured along a joint plane, causing a shearing fracture that resulted in the piece being discarded. Rejected blanks were tabular in nature with a joint plane on one or more edges, these pieces were most often triangular spalls broke off the edge of a large block of taconite. Once these pieces were tested, they were discarded due to the inability of the knapper to reduce the thickness of the specimen. This does not hold true in all cases as there are a small number of later stage bifaces that clearly have a trihedral to D-shaped cross-section and had been extensively knapped. Nonetheless, these pieces appear to have been eventually rejected. In some cases it appears as though certain specimens were flaked into adzes and were used until fractured.

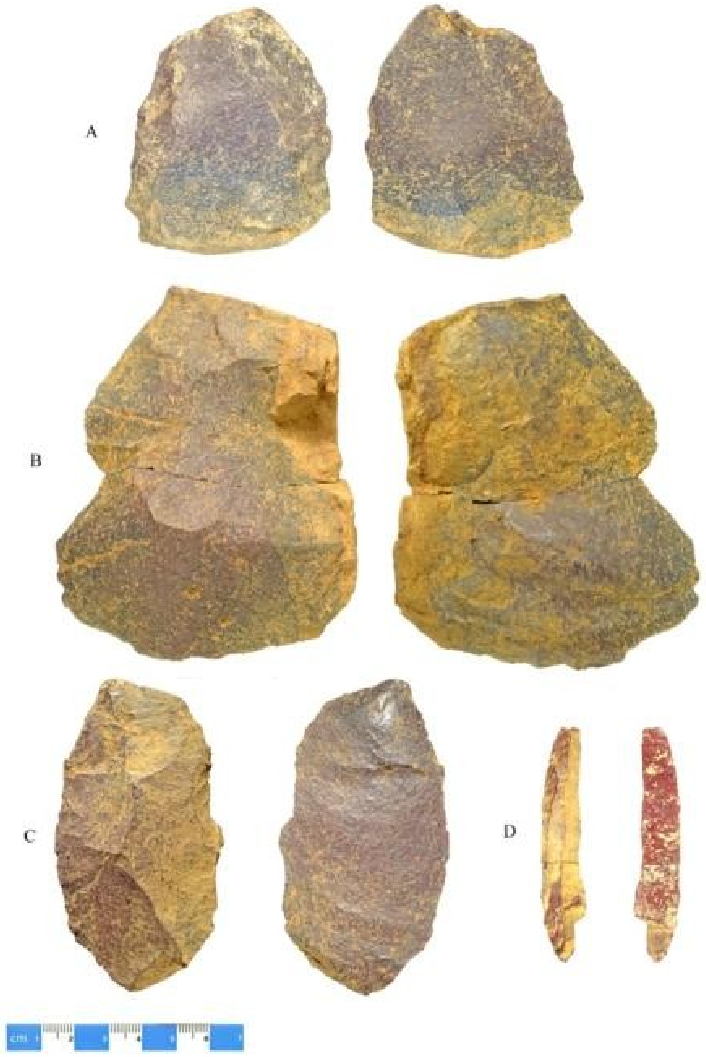


Figure 6.1: Dorsal (left) and ventral (right) views of Stage 1 Blanks from Mackenzie I A) tabular blank (Artifact #52113), B) large flake spall blank (Artifact #52236), C) Blade/Flake blank (Artifact #51536), D) Blade blank (Artifact #51601/51602).

All of the identified Stage 1 blanks were of Gunflint Formation cherts. Of the core assemblage (n=444), from which it is possible misidentified blanks and biface fragments are present, 382 (86%) are of Gunflint Formation cherts. The pieces identified as belonging to this production stage have few if any flake scars, and therefore hindered identification during the initial cataloguing. Flake scars that are present are characterized by broad deep channels associated with hard hammer percussion. Those on the dorsal surface may be a remnant of removal from the block, or as a method of testing for quality prior to reduction.

6.3.2 Stage 2 – Edged Blanks

Stage 2 edged blanks are represented by 102 artifacts, 45 (n=5 refits) of which were staged using both the metric and non-metric attributes, while 57 (n=1 refit) fragments were staged using only the non-metric attributes (Figure 6.2). When considering the Biloski site assemblage (Hinshelwood and Webber, 1987) identified adze-like bifaces with a transverse fracture on the broad end as being Stage 2 bifaces. Such bifaces are present at Mackenzie 1, a number of which have a working bit present or have a refitted working bit. For this reason they were catalogued as adzes and/or chopping tools. These 17 specimens reveal metric attributes that are consistent with the Stage 2 category, but are treated here as Stage 6 tools. There was no attempt made to salvage the large fragments (Figure 6.3). It could be argued, therefore, that a certain number of the adze-like bifaces from Biloski could be considered as fractured and discarded formal tools rather than Stage 2 edged blanks. This is just one example of *ad hoc* production strategies that can be observed within the reduction sequence, whereby an early stage biface might offer an ideal form, size and/or quality to be shaped into a specific tool form. The branches of the reduction sequence will be discussed in further detail following the presentation of the results.

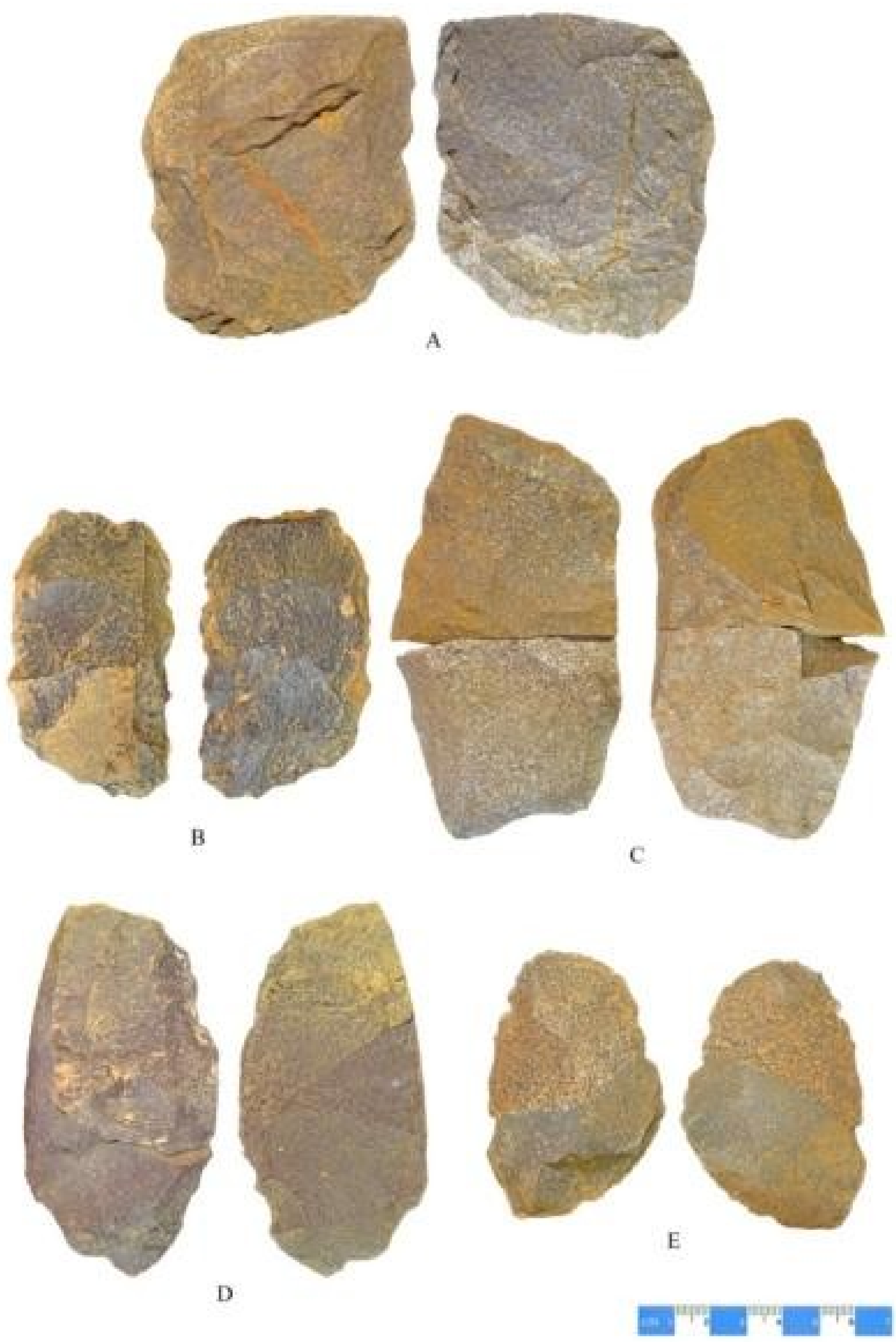


Figure 6.2: Dorsal (left) and ventral (right) views of typical Stage 2 Bifaces from Mackenzie I (DdJf-9) Biface Trajectory A – D (Artifact # 7526/8678, 14622, 21407, 27571/48528) Flake/Blade Trajectory E (Artifact # 51947).

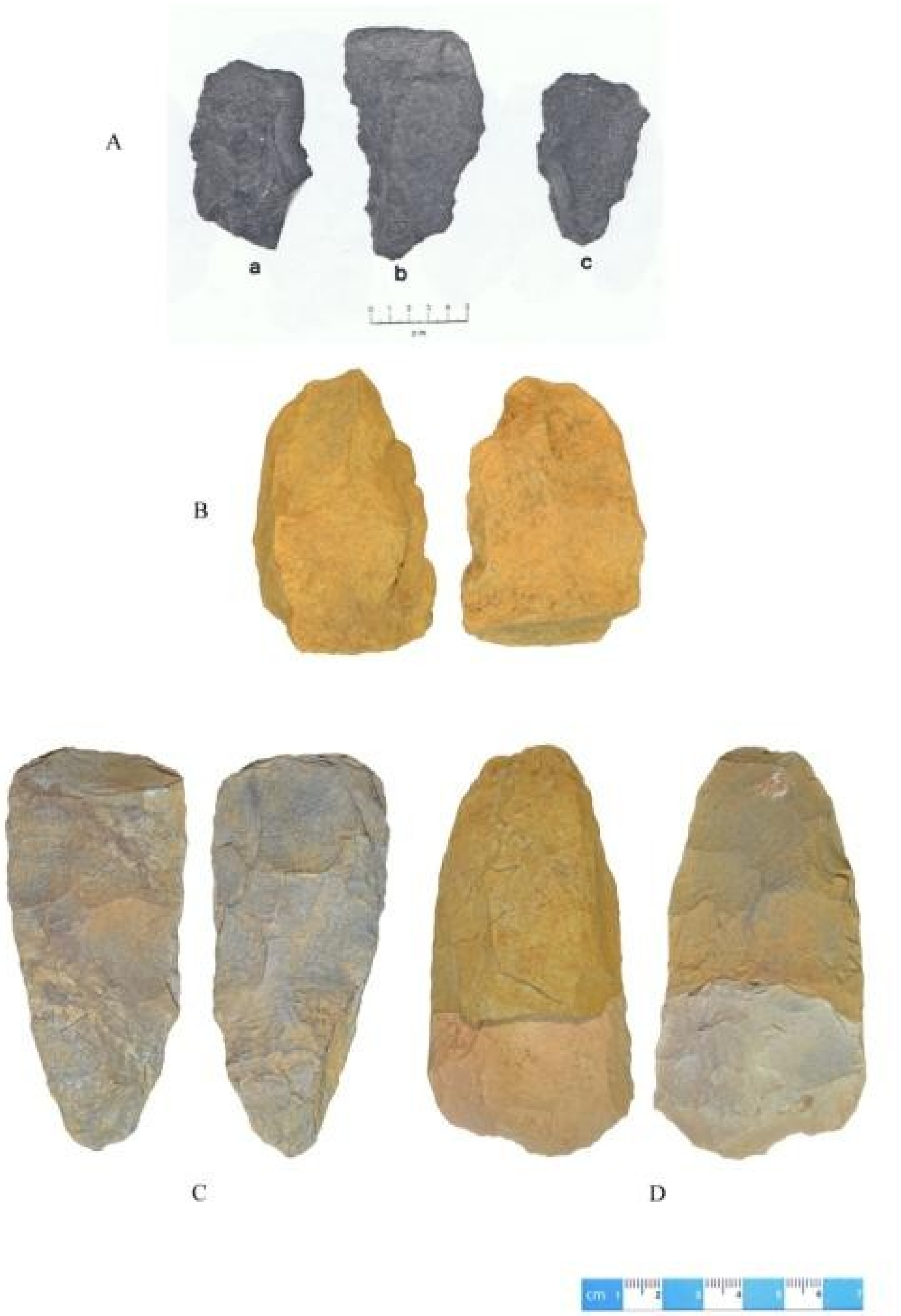


Figure 6.3: (A) Adze-like bifaces from Biloski modified from Hinshelwood and Webber, 1987 Plate 9, (B), Stage 2 biface from Mackenzie I that exhibits the proximal morphology of an adze with a hinge/bevel fracture on the distal end (Artifact #51549), C) complete adze with working bit from Mackenzie I (Artifact #51585), D) refitted adze from Mackenzie I, proximal portion would fit in with the adze-like bifaces from Biloski, constricting base with a hinge/bevel fracture at the refit, (Artifact # 40936/43458). Mackenzie 1 adzes are depicted as dorsal (left) and ventral (right).

The edged blanks were further subdivided into the breakage categories, Broken (Figure 6.4: A) (n=65), Failures (Figure 6.4: B) (n=18), Rejects (Figure 6.4: C) (n=18) and Broken/Rejects (n=1). The broken bifaces were the direct result of knapper's error most often characterized by plunging flake scars left from attempts to regularize the edge and remove a joint plane that was present on one or both edges. A plunging flake scar on one side can weaken the piece so that removal of a flake from the opposite side often causes it to fracture. These are characterized by transverse to slightly oblique hinging fractures following the direction of flake removal. Failures generally reflect breaks along a joint plane, often with a broad plunging flake scar terminating at the fracture. Rejected bifaces often exhibit repeated attempts to remove a joint plane on a tabular piece resulting in a step/hinge stack on the edge. These stacks are often irreversible as this creates a hardened edge with a thick medial ridge on one or both faces. A small number of these bifaces exhibited transverse hinge fractures resulting from attempts to remove the medial ridge. The knapper might attempt removal by striking longitudinal flakes originating from striking platforms at the ends of the piece. Failed attempts resulted in a deeply plunging flake scar obliterating much of the center mass of the piece and causing the piece to fracture. The lone biface categorized as a Broken/Reject is roughly trihedral in cross-section, with joint planes making up the 3 sides. It is unclear whether the piece broke or was rejected due to the knapper's inability to regularize the edge.

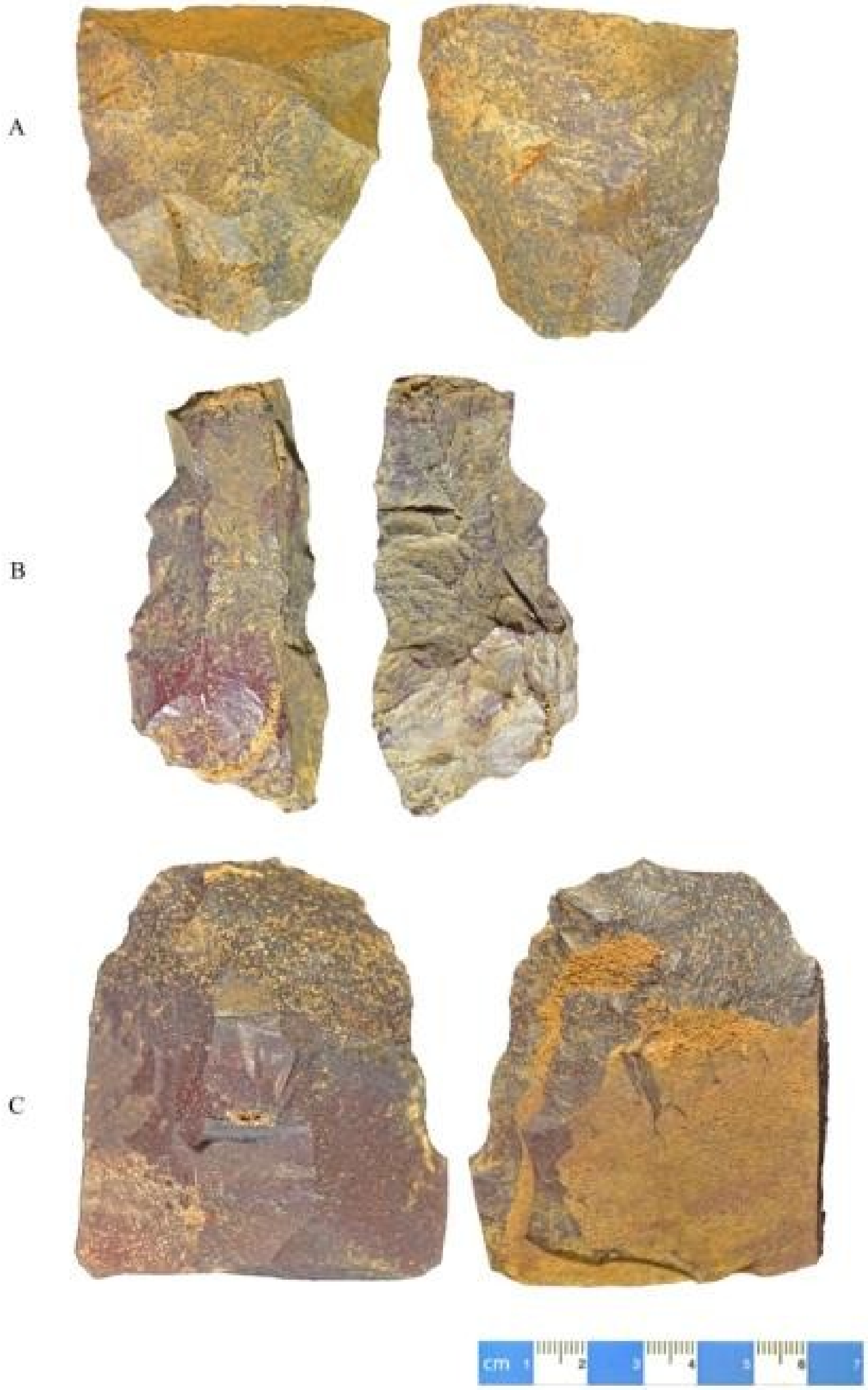


Figure 6.4: Dorsal (left) and Ventral (right) views of Stage 2 bifaces from Mackenzie I exhibiting typical patterns of fracture, A) broken biface, highlighted plunging flake scar, (Artifact #52260) B) Rejected biface highlighted flaw (Artifact #48486) C) Failed biface, highlighted fault as cause of fracture (Artifact #7171).

There were 78 Stage 2 bifaces that reflect reduction strategies following the Biface Trajectory, 24 following the Flake/Blade Trajectory. Those placed in the Biface Trajectory consisted of large tabular blanks, or large thick flake spalls (often with a joint plane present on an edge or on a portion of the ventral surface). Large, broad, deep flakes were removed from the edges only, creating a regularized edge with steep angles (Figure 6.2: A - D). This was done using hard hammer percussion with either a heavy antler billet or a hammer-stone. Pieces identified as belonging to the Flake/Blade Trajectory consist of thinner flake spalls that are considerably narrower. These pieces have a distal end much thinner than the rest of the piece, often because the proximal end coincides with the remnants of the striking platform and the bulb of percussion deriving from the initial removal of the flake-blank (Figure 6.2: E). In such cases the edge would have been regularized by the removal of small flakes using a light antler billet and pressure flaking on the distal end. Indirect percussion may have been employed during flake removal as well.

6.3.3 Stage 3 – Primary Thinning

Stage 3 bifaces are represented by 226 pieces (Figure 6.5), 108 (n=24 refits) of these were staged using both metric and non-metric attributes while 118 (n=6 refits) fragments were staged using only the non-metric attributes. Hinshelwood and Ross (1992) noted that bifaces exhibiting Stage 3 non-metric attributes (working extent) often had metric attributes indicating that they were Stage 2. This was also observed in the Mackenzie I assemblage. Of the 108 bifaces placed in Stage 3, 60 of them have metric attributes consistent with Stage 2. Using both analytic approaches these pieces were more appropriately placed in Stage 3 groupings based largely on the flaking pattern and extent.

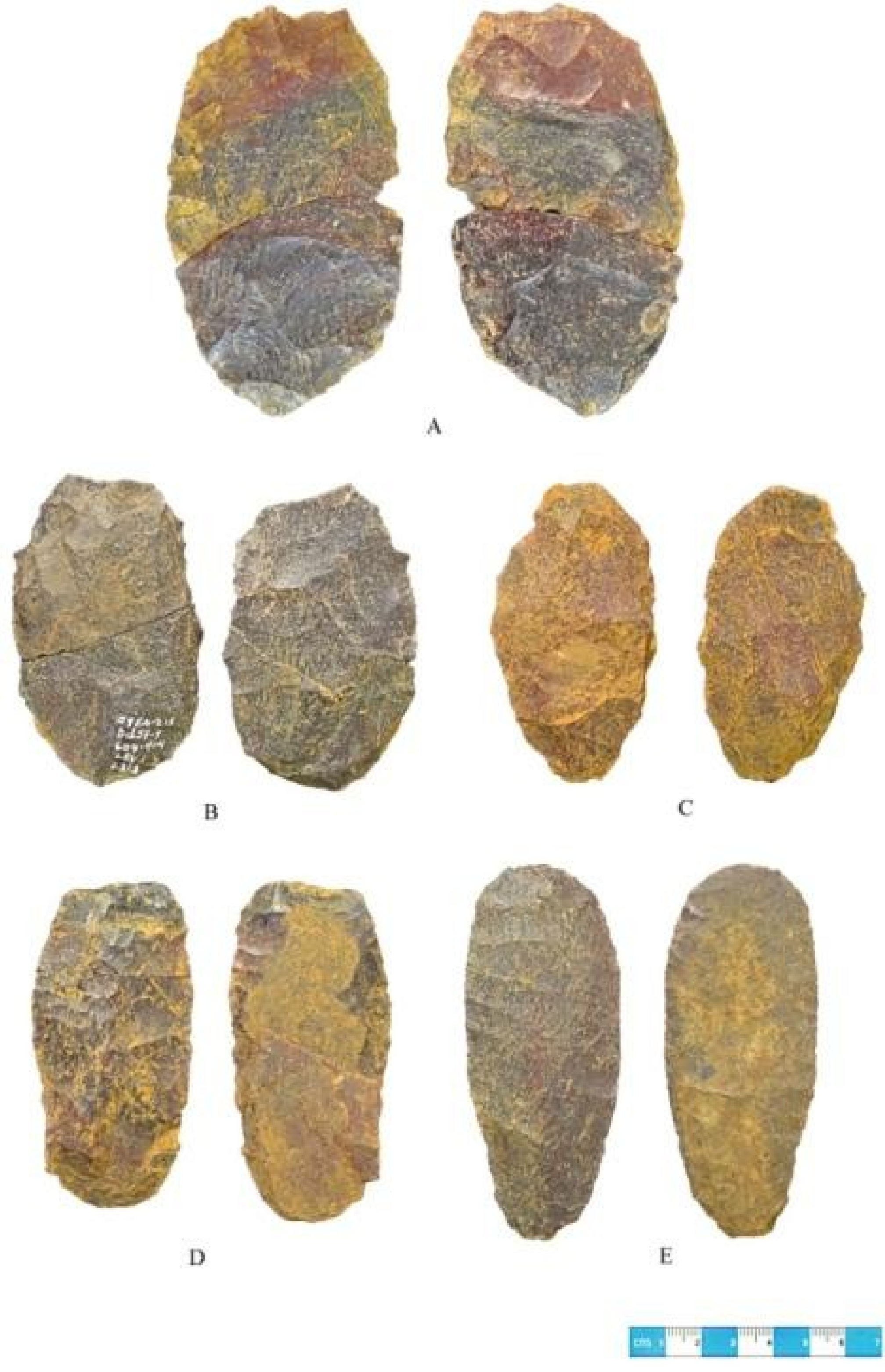


Figure 6.5: Dorsal (left) and ventral (right) views of a typical Stage 3 Bifaces from Mackenzie I (DdJf-9) Biface Trajectory A-C (Artifact #7234/52291, 8709/L313, 41078 D-E (Artifact #52268, 51550).

These bifaces were further categorized as Broken (Figure 6.6: A) (n=169), Rejects (Figure 6.6: B) (n=10), Failures (Figure 6.6: C) (n=30), Broken/Failure (Figure 6.6: D) (n=14), Broken/Reject (n=2) and Discards (n=1). Bifaces in this stage generally fractured much the same way as the previous stage. Transverse hinge fractures as a result of plunging flake scars were the main cause. Medial ridges occur in this stage of manufacture as well, largely due to inherent flaws in the raw material. These were removed much the same way as in the previous stage, but also through overshot flaking or longitudinal flaking. The use of overshot flaking was also a cause for breakage when plunging flakes at the edge caused a portion of the opposite edge to snap or hinge off the piece (Figure 6.7, See also Figure 6.5: C). If it was clear that the flake scar plunged into a joint plane, but was the result of striking the biface at the wrong angle it was considered to be the knapper's error (Broken) rather than a failure of the material. In cases where it was not clear whether it was a broken or failed they were placed into the broken/failure category. Rejects in this stage were discarded after it became apparent that the piece had too many flaws. Flake removal in this stage proceeded as the stone dictated. The knapper likely made observations about the nature of the platforms, the corresponding flake scars and ridges, and then began the next set of flake removal. Even with this apparent planning and strategizing, problems arose due to the fracture mechanics of the raw material. Specimens categorized as Rejects have a stacking ridge on either an edge or on the dorsal surface, and often exhibit (usually unsuccessful) attempts to remove the ridge.

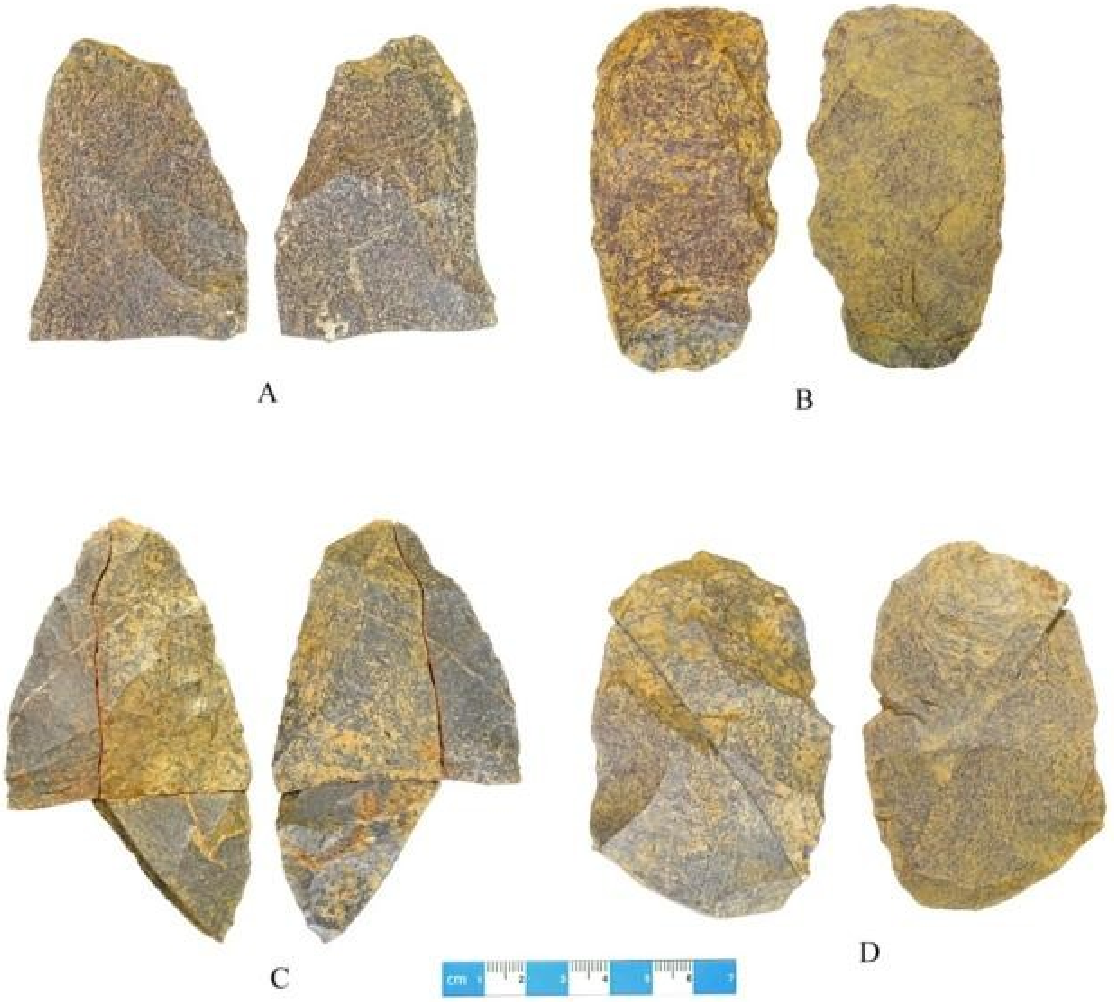


Figure 6.6: Dorsal (left) and ventral (right) views of Stage 3 bifaces exhibiting typical patterns of fracture, A) broken biface, highlighted plunging flake scar (Artifact #51538), B) Rejected biface highlighted flaw (Artifact #52246), C) Failed biface highlighted fault as cause of fracture (Artifact #33482/34954/38869) D) Biface exhibiting a fracture which may have been caused by either knapper's error or natural fault (Artifact #48523/48524).

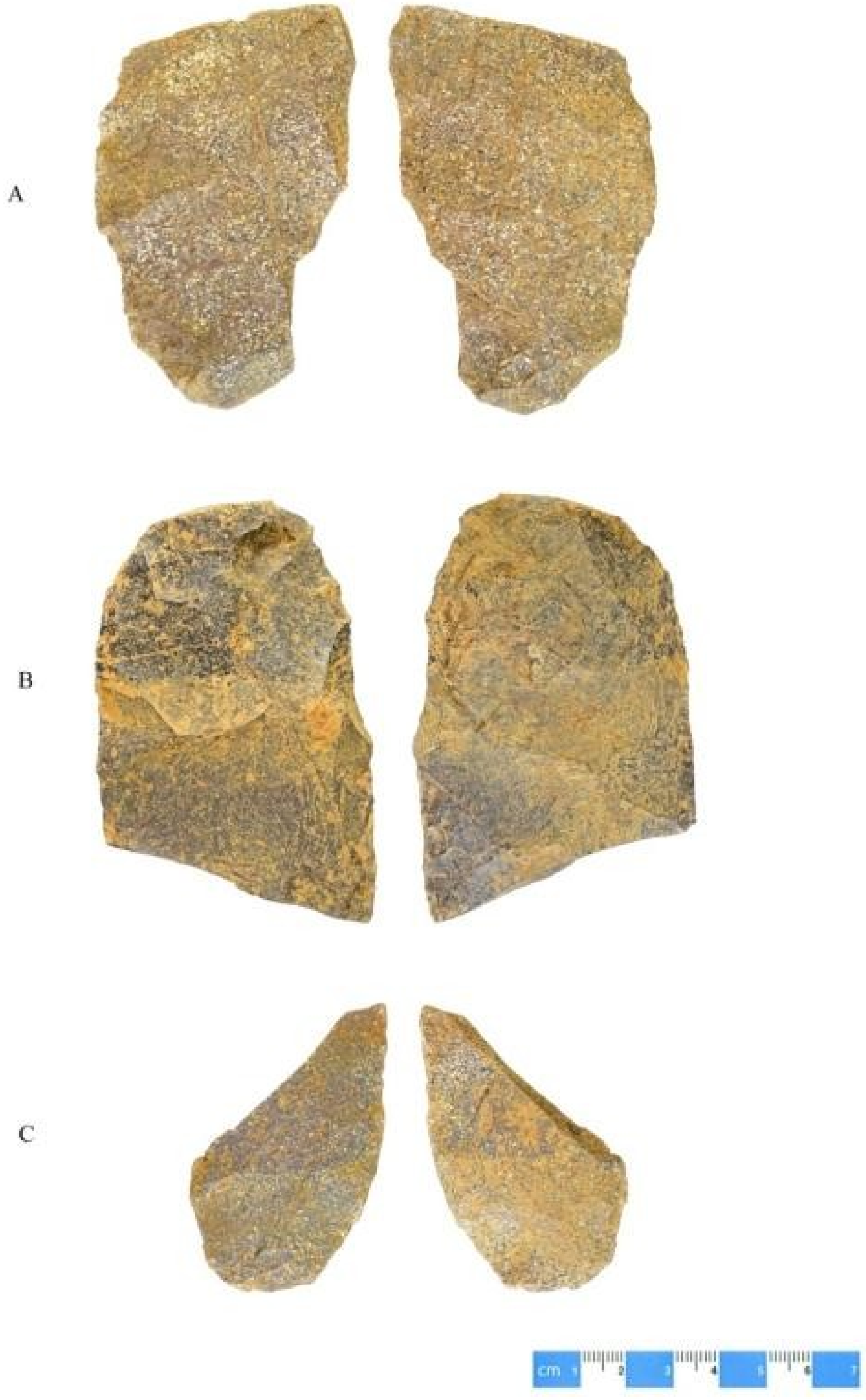


Figure 6.7: Dorsal (left) and ventral (right) views of Stage 3 bifaces with overshot flaking present (Artifact #4817, 28665, 34058).

There were 187 bifaces placed into the Biface Trajectory while 39 were placed into the Flake/Blade trajectory. Specimens in the biface trajectory are defined non-metrically by a more regularized outline, flaking which covered the entire surface, a more lenticular profile and little to no cortex, joint planes or medial ridges remaining. These pieces exhibit broad flaking performed by direct percussion, using either a light hammer-stone or a medium antler billet (Figure 6.5: A). Specimens in the flake/blade trajectory consisted of thin flake blanks that exhibit minimal flaking on the ventral surface, a plano-convex (D-Shaped) cross-section and flaking across the dorsal surface. Flaking extends to the midline on the dorsal surface (direct percussion with a light antler billet or pressure flaking), while ventral flaking consists largely of edge retouch (pressure flaking) used to regularize the edge. Dorsal surfaces can be humped and also retain longitudinal flake scars reflecting the initial removal of a sequence of blanks from the primary core (Figure 6.5: B). The purpose of the Stage 3 flaking is to remove any dorsal irregularities and create an edge which can readily be flaked. If the flake/blade blank did not have such a humped dorsal surface, primary thinning was skipped and the piece went directly to Stage 4.

During the Stage 3 flaking there is a mix of both soft and hard hammer percussion in the initial sets of flake removal. There is evidence of overshot flaking that removes much of the thickness without greatly reducing the width. The goal of Stage 3 flake removal was to obtain a specimen with a thin lenticular cross-section, edges prepared for more serial patterned flake removal, and few to no flaws remaining. The flake scars evident on the biface surfaces are comparatively random in their removal (Figure 6.8: A), but both co-medial (Figure 6.8: B) and parallel oblique flaking (Figure 6.5: E) are periodically observed. A combination of techniques was used to successfully work this difficult material.

Figure 6.8: Stage 3 specimens with more patterned serial flaking (Artifact #14541, 5806, 63272/63273).

6.3.4 Stage 4 – Secondary Thinning

Stage 4 bifaces were represented by 128 artifacts, 86 (n=20 refits) bifaces were staged using both metric and non-metric attributes and 42 (n=3 refits) were staged using just non-metric attributes (Figure 6.9). The bifaces in this stage exhibit both co-medial and parallel oblique flaking patterns. Platforms were very carefully prepared, and not selected based upon isolated platforms. This was achieved through extensive edge grinding, combined with pressure retouch to create a bevelled edge. Careful selection of platforms allowed for more directed flaking that resulted in shallow flake scars extending across the midline. Flakes removed in this stage were relatively narrow, shallow and long. This is consistent with the observations by Hinshelwood and Ross (1992). Bifaces at this stage exhibit clear non-metric markers indicating that they had passed through the initial thinning stage but still maintained metric attributes consistent with Stage 3.

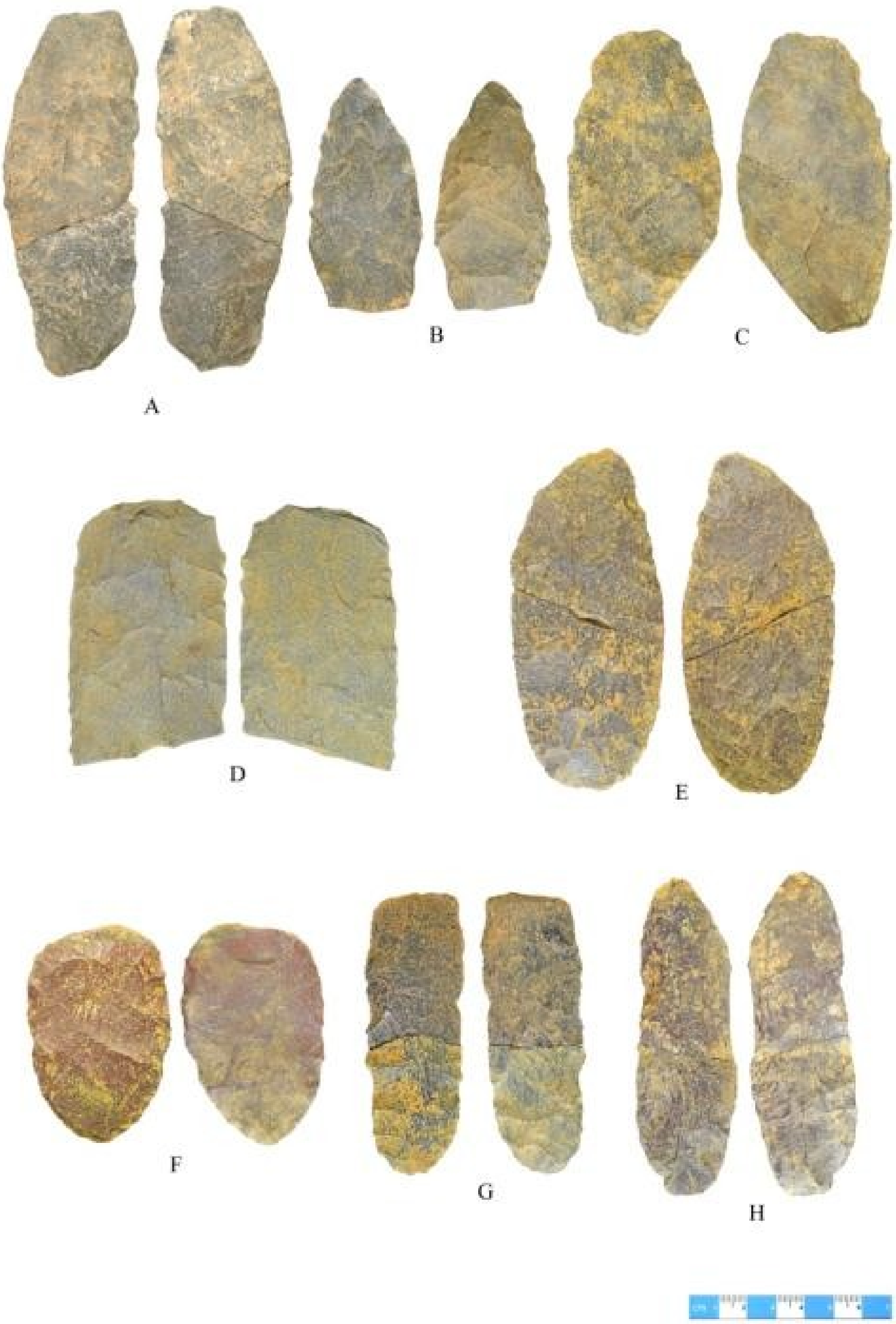


Figure 6.9: Examples of a Stage 4 Bifaces from Mackenzie I (DdJf-9) Biface Trajectory A-E (Artifact #30613/48511, 42843, 48499, 48506, 52178/52273) Flake/Blade Trajectory F-H (Artifact #52082, 28058/52286, 8501/8506).

The biface categories in this stage are Broken (Figure 6.10: A)(n=100), Reject (Figure 6.10: B) (n=9), and Failure (Figure 6.10: C) (n=14). Upon examination of some artifacts it was unclear whether reduction was terminated because of insurmountable problems caused by natural flaws, these include a

Failure/Reject category (n=3) and a Broken/Failure category (n=2) (Figure 6.10: D). Breakage at this stage was largely the result of the knapper error and includes striking the platform at the wrong angle with too much force, resulting in a transverse hinge fracture with either a crushed edge or a plunging flake scar. It is possible that fractures in any stage may be the result of torsion fracture as a result of use. Stage 4 specimens can easily be used as knives or other cutting tools and can result in 'usage fracture'. Generally there is no evidence of impact fractures as these pieces were too thin to be used as chopping tools and were too unrefined for use as projectiles.

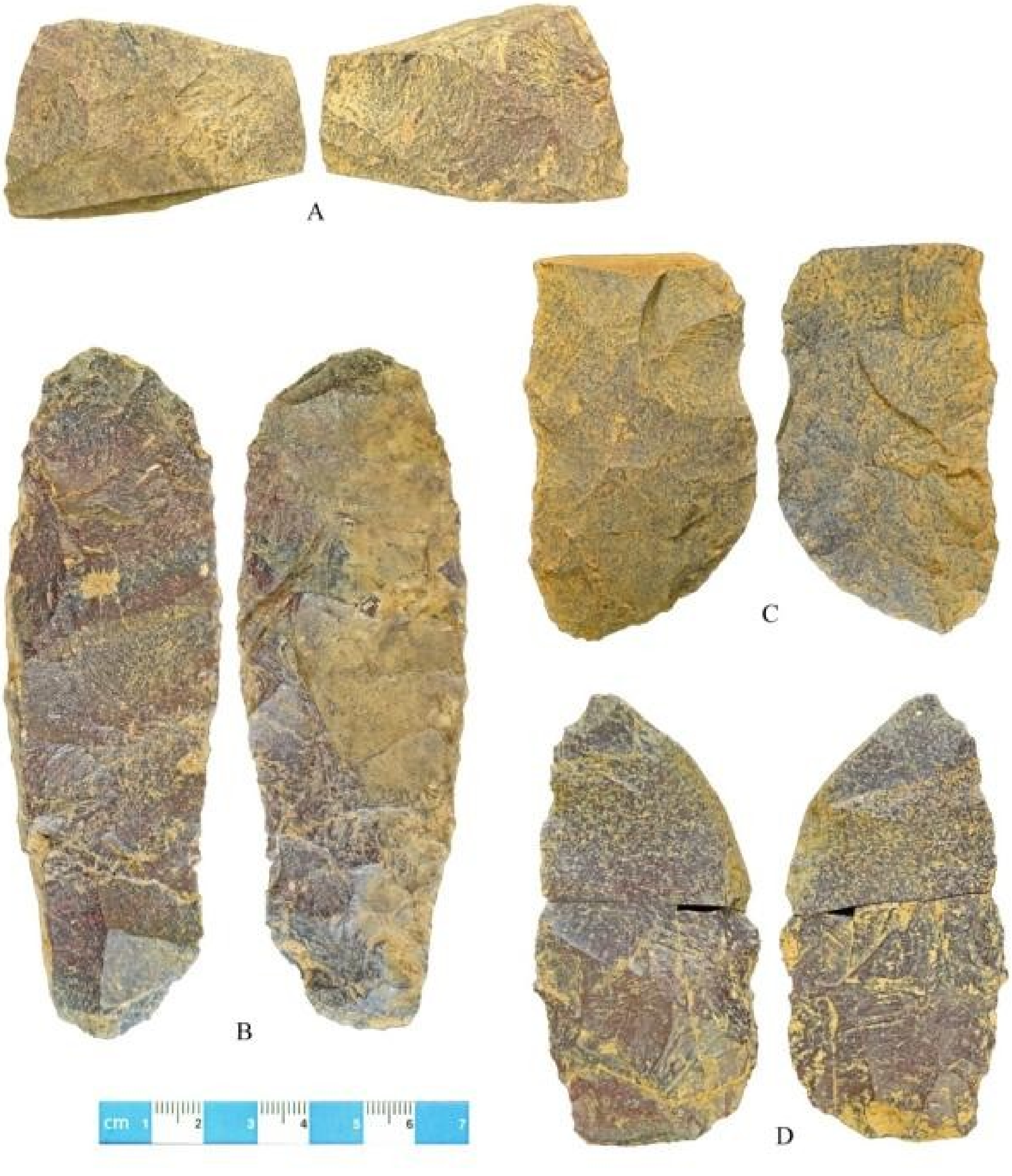


Figure 6.10: Stage 4 bifaces exhibiting typical patterns of fracture, A) broken biface, highlighted plunging flake scar (Artifact #4971), B) Rejected biface highlighted flaw (Artifact #44519) C) Failed biface, highlighted fault as cause of fracture (Artifact #48509) D) Biface exhibiting a fracture which may have been caused by either knapper's error or natural fault (Artifact #23303/52166).

Pieces identified as following the Biface Trajectory (n=74) exhibited broader flaking, and clear indications that both faces were extensively worked. In some rare cases joint planes remain on an edge, or the ends of the artifact. Morphologically these bifaces are often bi-pointed lanceolates (Figure 6.9: A-D).

It is at this stage of manufacture that bifaces were most often cached as trade blanks, or carried around to be reduced into more refined tools as required. Bifaces which followed the Flake/Blade trajectory (n=53) were extensively worked on the dorsal surface with more extensive patterned flaking on the ventral surface than was evident in earlier stages. In these pieces the flaking on the ventral surface followed the same pattern as on the dorsal surface, with flakes crossing the midline and feathering into or intercepting the flake scars originating from the opposing edge (Figure 6.9:E-F). Overshot flaking remained present on certain specimens placed within this stage category (Figure 6.9 and Figure 6.11). It was limited to only those bifaces which were reduced following the biface trajectory. Though present as a method of reduction on specific bifaces (Figure 6.9: 52082 and Figure 6.11 52251) on others (Figure 6.11: 51965, 52102) it would appear that these are remnant flake scars from Stage 3 reduction as evidenced by the presence of further flake removal within the area of the overshot flake scar.

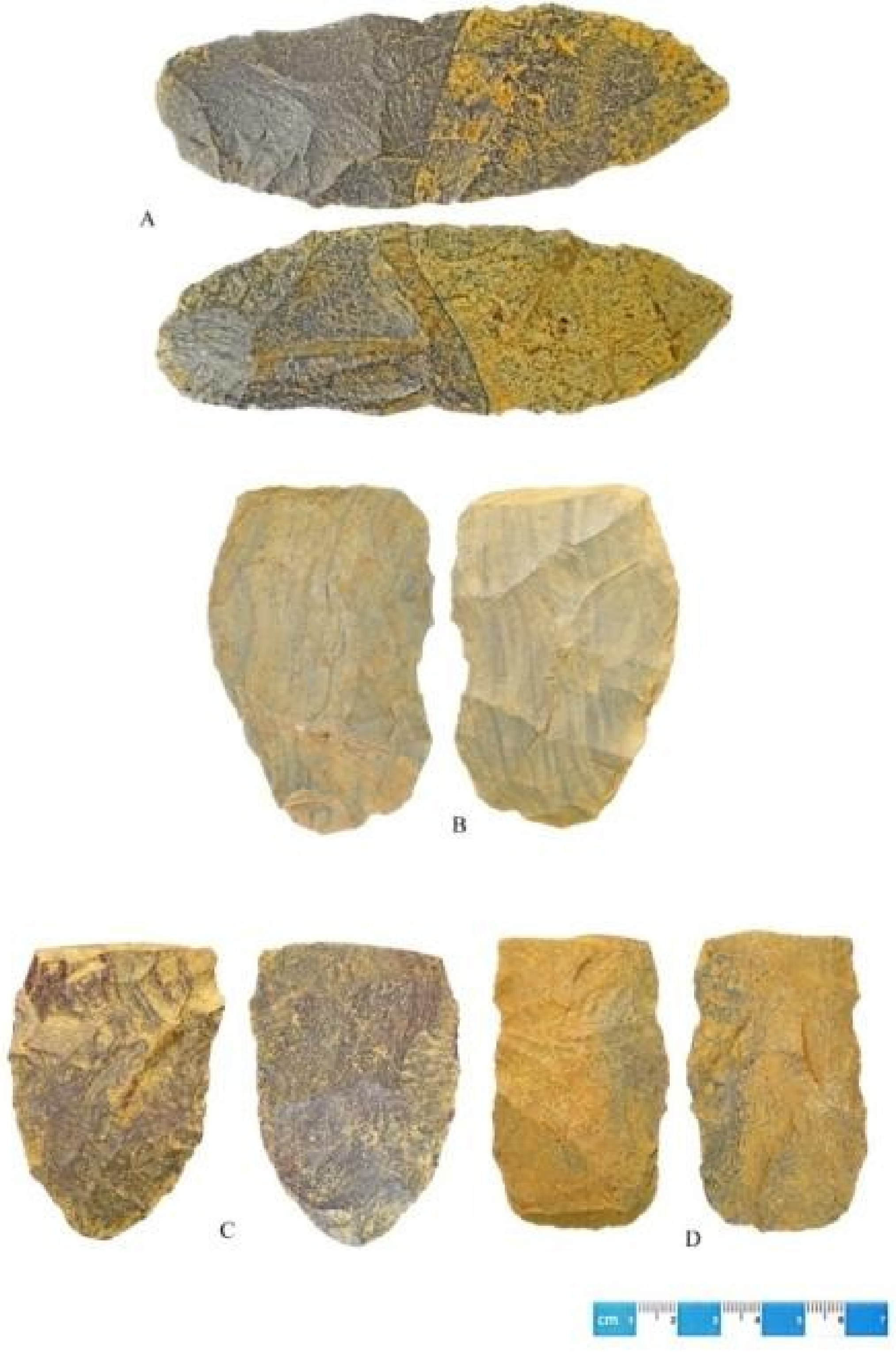


Figure 6.11: Stage 4 bifaces from Mackenzie I (DdJf-9) which exhibit the use of overshot flaking (Artifact #51965, 52102, 52251, 38794/38836).

In her analysis of the projectiles Markham (2013) reported a number of specimens exhibited a twisted cross-section, alternate edge bevelling and a cross-section that was either D-shaped or offset-lenticular (caused by the alternate bevelling). Bifaces in the Flake/Blade trajectory, exhibit these traits in a coarser form. The use of alternate edge bevelling as a method of platform preparation combined with the natural curvature of the flake blank accounts for both the twist as well as the offset lenticular cross-sections (Figure 6.12). The D-shaped cross-sections are the result of Flake/Blade blanks which would have been extremely thin and would have had little to no flaking until late in this stage or in the subsequent stages, these specimens would result in a projectile with a curved longitudinal profile.

Figure 6.12: Example of alternate edge bevelling observed on Stage 4 bifaces from Mackenzie I (DdJf-9) (Artifact # WHS-10079, 36077/48508, 52306/51560)

6.3.5 Stage 5 – Preforms

Stage 5 Preforms are represented by 94 bifaces, with 57 (n=16 refits) staged metrically and 35 fragments staged non-metrically (Figure 6.13). The bifaces assigned to this stage reveal both parallel oblique and co-medial flaking patterns that are no more than 5 mm wide. While these patterns were present on the Stage 4 bifaces, they are not as refined as that observed on the Stage 5 and 6 bifaces. The bifaces in this stage do not exhibit basal forms which indicate they were a completed formal tool. Bifacial knives found as complete discarded tools appear to be un-hafted, but with one lateral edge ground (Backed Knives) to reduce the chances of cutting into the palm of the user. Finished specimens exhibiting the general knife shape, but those with both edges remaining sharp are treated as preforms. The fine flaking patterns present on these bifaces were likely the result of pressure flaking or indirect percussion. There is some disagreement among knappers who have attempted to replicate these patterns on taconite as to how these patterns were executed. All agree that both methods can easily reproduce these patterns on finer cherts and obsidian, but that it is very difficult to feather across the midline when using pressure flaking on taconite (pers Comm. Bill Ross, Gary Wowchuck, Ernie Reichert, and Dan Wendt).

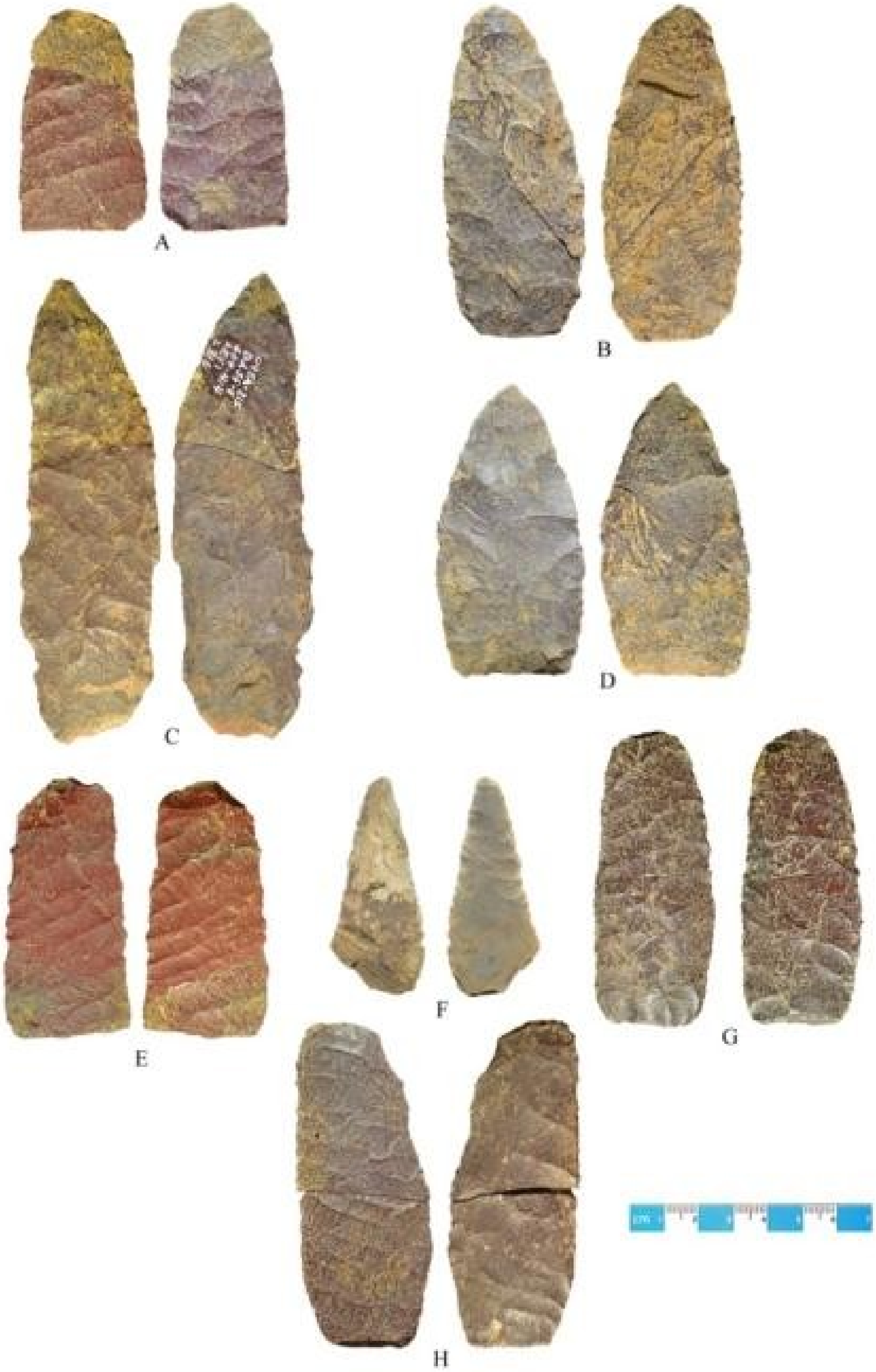


Figure 6.13: Examples of typical Stage 5 bifaces from Mackenzie I (DdJf-9) Biface Trajectory A-D (Artifact #17612, 52136/52297, 32925/L316, 48502/51611) Flake/Blade Trajectory E-H (Artifact #19134, 29447, 49109, 24202/39313).

The biface categories in this stage are Broken (Figure 6.14: A, See also Figure 6.13 17612) (n=71), Reject (Figure 6.14: B) (n=6), Failure (Figure 6.14: C) (n=10), Discard (n=3) Broken/Discard (n=1), and Broken/Reject (n=3). The broken bifaces largely exhibited transverse hinge fractures where the knapper's error was clearly evident. These errors included an impact stack at the fracture point, plunging flake scars, and ridging. The ridges remained present on some late stage bifaces in the flake/blade trajectory. Breaks could easily occur when the attempt was made to remove the ridge as they switched to soft hammer percussion in an attempt to undercut the ridge from either the opposite edge or from the proximal end. Rejects demonstrate that the knapper could not properly thin the specimen. In the case of drills these were trihedral blades with a joint plane as one or more edges. When it became clear that the piece could not be properly shaped it was discarded (Figure 6.14: B Catalog 17683). Blade/Flake trajectory preforms often exhibit a dorsal ridge at the midline, as a result of the morphology of the blank. Due to extreme thinness on some specimens the knapper may have anticipated that attempts to remove the ridge would result in a fracture and thus rejected the piece. The failures in this stage mimic those of previous stages. Discarded pieces exhibit formal tool morphology but are not as refined as most of the formal tools found at the site, or they have a clear fracture point which has been reworked into a different formal tool type from the intended (projectile preform with a bevelled scraper edge).

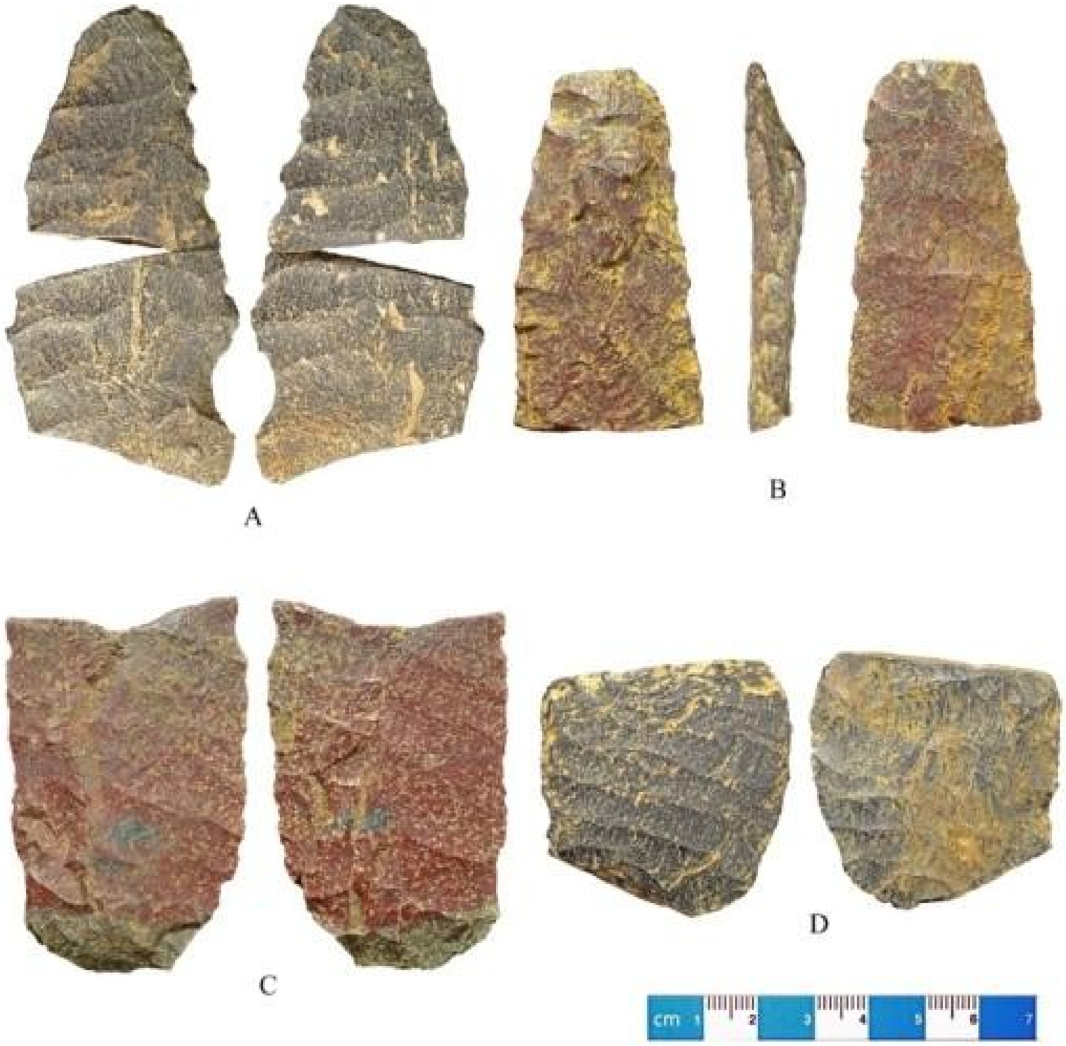


Figure 6.14: Stage 5 bifaces exhibiting typical patterns of fracture, A) broken biface exhibiting a plunging flake scar (Artifact #52233/58518), B) Rejected biface with an extreme hinge stack on the proximal end (Artifact #52321) C) Rejected biface exhibiting an internal flaw (Artifact #52240) D) Failed biface, exhibiting a fault as cause of fracture (Artifact #2643).

The bifaces in this stage were divided into the Biface Trajectory (n=34) and the Flake/Blade Trajectory (n=58). By this stage it is more difficult to discern whether the piece followed the Biface or Flake/Blade Trajectory. Those placed in the biface trajectory exhibited fine parallel oblique flaking patterns on both faces, creating a straight longitudinal profile and a lenticular cross-section (Figure 6.13: A-D). On some of the preforms that follow the biface trajectory the flaking pattern is far more random (not clearly as patterned as those which are parallel obliquely flaked). Those placed in the Flake/Blade trajectory (Figure 6.13: E-H) exhibited a longitudinal curve and/or twist combined with a D-shaped cross-section. Most of these pieces had a parallel oblique flaking pattern on both surfaces, though a small number retained the co-medial flaking on the dorsal surface. Stage 5 specimens from Mackenzie I also exhibit the presence of alternate edge bevelling as a method of platform preparation and flake removal (Figure 6.15 See also Figure 6.13: 32925/L316).

Figure 6.15: Stage 5 bifaces from Mackenzie I exhibiting alternate edge bevelling (Artifact #14139, 25210, 10508/WHS-13668).

Preforms produced following the biface trajectory, were generally bi-pointed upon completion of Stage 4 thinning (the cache blank). This resulted in an intermediate step whereby one end was determined to be the base. Once this was determined the basal end was snapped off creating a bevelled platform that was used to set up the basal thinning (Figure 6.16: A). This bevel was generally angled to the ventral surface and was used as a platform for the initial dorsal thinning flakes (Figure 6.16: B). This method of determining and forming the base may also have been presented in a limited fashion as part of the Flake/Blade trajectory.

Figure 6.16: Stage 5 bifaces exhibiting a ventral bevel on the base and dorsal end thinning using the bevel as a striking platform (Artifact #WHS-02042, 52134, 15020).

Within the Stage 5 artifacts there are interesting pieces that exhibit unique morphological characteristics and should be discussed further. These pieces are not considered anomalies but should be noted for their uniqueness and similarities with other Paleoindian groups. The first of these artifacts is a semi-lunate specimen that, by all appearances, could be classified as a Stage 6 knife, but for the fact that all edges remain sharp (Figure 6.17: A). Generally the back edge is dulled as these were held in the palm of the user and a sharp edge would result in a cut hand. The second biface composed of rhyolite is a unique refit of 3 pieces (Figure 6.17: C). This biface was originally wide and long and relatively thin, at some point the specimen fractured in a transverse slightly oblique fracture. The distal portion was then reworked on the left edge only reducing the width to half that of the original biface. It is unclear what the exact function of this piece would have been as there is no evidence of shaping of the hafting portion of the distal end. The final biface that merits further discussion is a refit of three pieces of taconite which exhibit an extreme length to width ratio. This specimen has been finely flaked using the parallel oblique pattern on the entire length. The distal end is pointed and appears to be a finished projectile point. This portion of the piece does not quite refit completely but the nature of the banding within the material indicates that all 3 pieces are from the same original biface (Figure 6.17: B). It may be that there is a finished base that refits to the tip of this piece and would indicate that this piece was flaked into an extremely long narrow preform, purposefully snapped and then the distal portion was made into a projectile point.

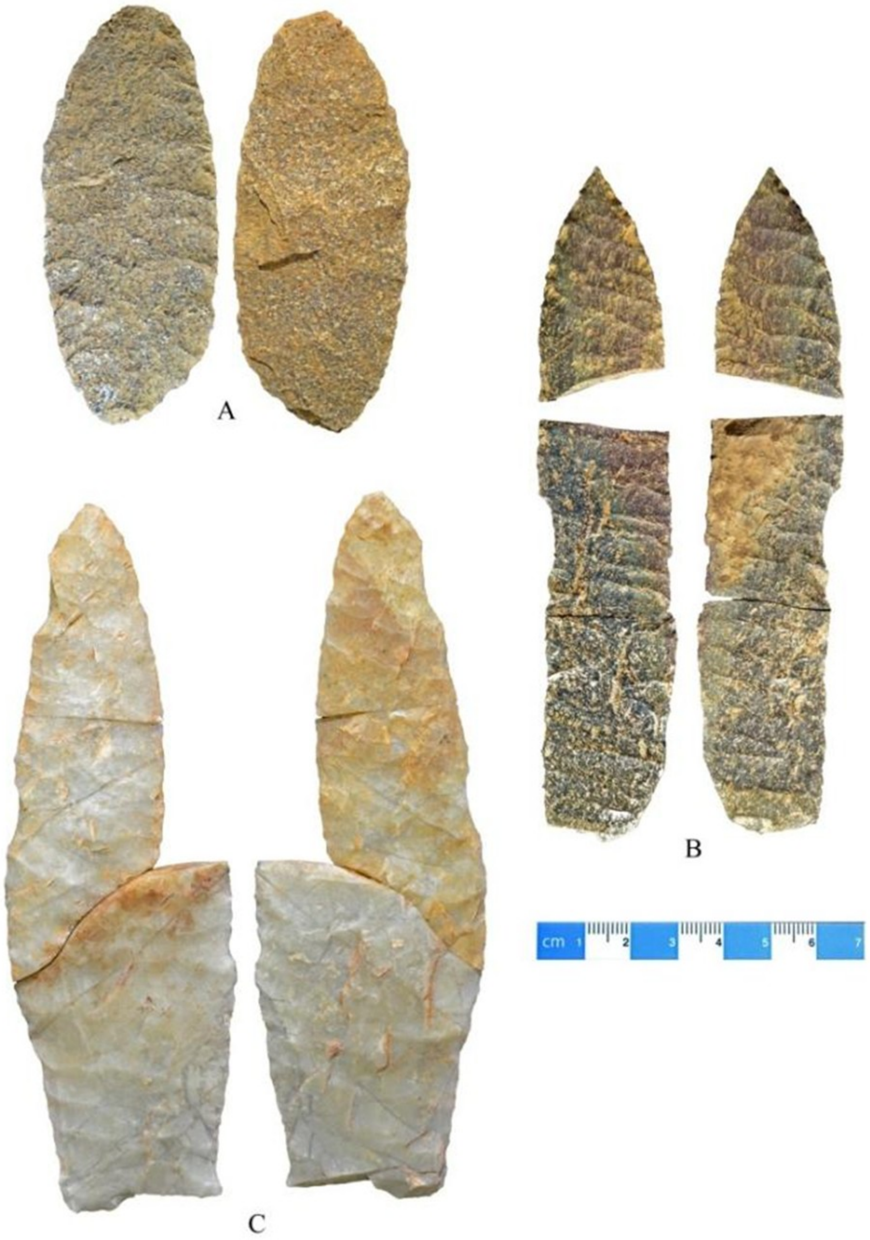


Figure 6.17: Stage 5 bifaces that exhibit unique morphological characteristics A) Semi-lunate piece which appears to be a knife preform (Artifact 33118) B) refit of rhyolite biface exhibiting extensive edge reworking on the distal portion only (Artifact #51671/WHS-10056) C) Refit of 3 pieces exhibiting an extreme length to width ratio (Artifact #WHS-09729/01948/01963)

6.3.6 Stage 6 – Formal Tools

The majority of the formal tools (n=380) were analyzed by Markham (2013). Her data was added to that collected from projectiles points not available during her analysis and from the other formal tools (knives, drills, adzes, gouges). In total there were 482 formal tools available for analysis. The Stage 6 formal tools were largely analyzed to determine if the manufacture trajectory was observable (Table 6.4). Of the 380 projectile points previously analyzed the complete points, refitted complete points, and the nearly complete refitted points (n=162) were examined to determine manufacture trajectory. The formal tools not part of Markham's analysis included the drills (n=57), knives (n=10), adzes (n=19), and any projectile points (n=8) unavailable at the time of her analysis. Gouges (n=5) were discussed ancillary to the projectiles by Markham (2013), but not with the same detail as the projectiles.

Table 6.8: Bifacial tools present at Mackenzie I

	Tool Assemblage		
	Broken	Discard	Reworked
Point	339	39	9
Knife	5	5	0
Drill	51	5	3
Adze	6	7	0
Gouge	5	0	0
Scraper	38	60	11
Retouched Flakes	194	94	0

The biface categories in this stage are Broken (n=408), Reject (n=2), Failure (n=1), Discard (n=62), and Broken/Discard (n=9). There is significant less rejection and failure in this stage of manufacture. The broken bifaces clearly make up the vast majority of tools in this stage of manufacture. Breakage in this stage is likely considered use damage rather than manufacture breakage. The fragments of the projectiles that were not considered in the cursory analysis to determine manufacture trajectory are all considered to be broken during use-life.

The bifaces in this stage were divided into the Biface Trajectory (n=88) and the Flake/Blade Trajectory (n=129), with 49 bifaces that could not be placed into either production trajectory. There were also a number of projectile fragments which were not analyzed, due to size and fragmentary nature (n=216). Following this the Stage 6 bifaces were broken down by tool type (Table 6.6). Blades found at

Mackenzie I and RLF could easily be flaked into the drill forms observed at Mackenzie I and there are a number of drill preforms that were made using blades. There are 2 drills that were manufactured using the lateral edges broken off a biface and are therefore be classified a recycled artifact.

6.3.7 Anomalies

Anomalies are bifaces that did not conform to the analytic attributes measured using the Stage system. These bifaces exhibited metric attributes which would place them at a stage 2, for example, but they had non-metric attributes which would place them at a stage 4 or 5. In some cases the metrics for a piece would indicate that it was a Stage 3 but based on the flaking pattern and extent it should be classified as a Stage 4. These are considered to reflect variation caused by the knapper's skill or the material quality. Bifaces which are considered anomalous include that are manufactured using a material not normally observed as being used as a tool-stone (sandstone and mudstones) as they are comparatively soft and very difficult to flake. Tools made from such material would dull quickly, be prone to use fractures, and could not be used on harder materials (bone, wood or antler). It is also difficult to make any positive conclusions on the morphology of such specimens as well as the flaking pattern and extent. The anomalous bifaces could not be easily explained using natural variation. Within the collection there were 14 bifaces placed in this category. Anomalous bifaces also include those made from a mudstone and heavily weathered (n=3), a single heavily degraded sandstone biface, and a thick wedge/chopper bisected by a vein of quartz.

Two singular bifaces of note are included in the section of anomalies due to their rare presence on site. These specimens are manufactured from what appears to be Onondaga chert, generally only found in Southern Ontario. There is very little presence of this material type in Northwestern Ontario with the only other piece being an Archaic Meadowood cache blade preform (Bill Ross, pers comm 2013). There is limited evidence for an Archaic reoccupation of certain Lakehead Complex sites (see Hinshelwood 2004 for a comprehensive overview), and it is even rarer for there to be a material type such as Onondaga chert to be found. At Mackenzie I there is a single Meadowood projectile point manufactured form Onondaga chert (Figure 6.14: A) and a small biface (Figure 6.14: B) that may be Onondaga chert but could also be Hudson's Bay Lowland chert. The projectile point consists of 4 fragments that refit. Both the ventral and dorsal surfaces are potlidded with a single potlid flake being found that refits to the dorsal face. The projectile was discovered from a buried context on the leeside of the large exposed bedrock in the southeast portion of the site. All the debitage consisted of Gunflint Formation materials and it is uncertain how this single projectile fits into the occupation history of the site. The small biface was initially missed in the analysis due to the specimen being miscataloged as a secondary reduction flake. The flaking pattern is random and very rough, it has a lenticular cross-section and a straight, slightly irregular profile. The metrics indicate that it is a Stage 2 specimen, while the flake scars travelled full face. The right lateral edge is an overshot flake scar on the dorsal face with subsequent flake removals on the ventral face utilizing the overshot edge as a platform. It is clear that it is not a piece which would be further reduced into a projectile point due to the small size but it may have been used as a knife or a bifacial scraping tool.

Figure 6.18: Bifaces found at Mackenzie I manufactured from cherts not normally observed in Northwestern Ontario A) The Meadowood projectile point (Artifact #48895/84218/84220/84233/WHS-24326) B) the small biface (Artifact #58065).

There are a number of anomalous bifaces manufactured from Gunflint Formation cherts. These bifaces exhibit metric attributes that would indicate a stage of manufacture which the non-metric attributes do not support. The first biface anomaly from Mackenzie 1 is a refit of 5 fragments that resulted in a long, wide, and relatively thin biface which according to the metric attributes would indicate that the piece was a Stage 6 (Figure 6.19). There is a presence of parallel oblique flaking on a portion of this biface while the remainder of the piece exhibits random patterned to co-medial flaking. The biface is 78 cm wide and nearly 200 cm long indicating that it is too large to be a finished formal tool. The edge angle of this biface is between 25 and 45 degrees (L:38 R:39) which indicates that it could be a stage 4 to 6 biface. Combined with the width/thickness ratio of 5.8 would also indicate that the piece would be a Stage 4 to 6. The flattened lenticular cross-section and the combination of parallel oblique and co-medial flaking also would indicate that it was a late stage biface. The thin edges combined with the length indicate that it was not a large chopping tool, as it would likely have broken during such use. It may be that it was a large knife but the morphology of the piece does not fit with what is understood as being a part of the toolkit. There are morphological similarities with a number of large, flat, bifaces from the Caradoc site. These pieces from the Caradoc site have a breakage pattern that indicates these were intentionally broken (Figure 3.16). The breakage pattern and the presence of an impact scar at the midpoint on both the dorsal and ventral surfaces of the Mackenzie 1 specimen indicate the piece may have been purposefully fractured.

Figure 6.19: The large thin biface from Mackenzie I, 5 piece refit with possible evidence of intentional fracture (Artifact #28549/51544/51588/51589/52282).

Two of the biface anomalies manufactured from Gunflint formation chert have indications that they may have been reworked into drills and either broke during use or as a result of reduction. The first specimen, Artifact #52241, (Figure 6.20 A) is a narrow curved biface fragment with offset notching, a pointed proximal end and a thick constricting distal end which is hinge fractured. The hinge fracture on the distal end has the appearance of a possible torsion fracture and the degree to which it has been narrowed indicate the possibility it was a drill, though no refit was found among the recovered drill fragments. Similarly Artifact #17759 (Figure 6.20 B) may also be the proximal end of a biface which was reworked into a drill. Unlike Artifact #52241 though, this biface has a thick lenticular cross-section with an ovate profile and slightly irregular edges. The distal end has been narrowed significantly through a series of plunging flake scars directed at opposing angles creating a slightly triangular cross-section of the transverse snapping fracture. It is possible that the snapping fracture occurred through the use of this piece as a drill, though due to the sharp edges of the base it is more likely that the fracture occurred during the process of narrowing the working bit.

Figure 6.20: Gunflint Formation chert bifaces which were possibly reworked into drills, A) Artifact #52241 note the offset notching, the curved profile and the hinged, transverse distal fracture B) Artifact #17759 note the ovate profile, sharp irregular edges of isolated platforms and the transverse snapping fracture with angled flake scars proximal to the fracture.

The remaining anomalies from Mackenzie I manufactured from Gunflint formation cherts are slightly more difficult to explain. The first is a very thick relatively narrow biface with an exaggerated diamond cross-section. This piece has the appearance of being a chopping tool with metrics which place it in Stage 2. The flaking extent meets at the midline on both faces and managed to pass through a large quartz vein running the length of the specimen (Figure 6.21 A). This biface is largely complete except for a portion of the distal end where there is a step stack to the left of the fracture on both surfaces (Figure 6.21 A). The presence of these stacks in close proximity to the fracture indicates that the attempts to remove them caused the fracture. It is unclear whether this piece was utilized as a chopping tool of some kind, it is also unclear the reason behind spending so much effort to reduce a piece with such a thick quartz vein (Figure 6.21 A).

The refitted biface of Artifact #51920/51923 has a D-shaped cross-section, co-medial flaking on the dorsal surface and shallow co-medial to random flaking on the ventral surface. The fracture plane the piece refit along is a transverse hinge fracture with a plunging flake scar at the point of fracture (Figure 6.21 B). The distal fracture is bevelled and morphologically similar to the fracture pattern observed on the adzes, with the bevel angled ventrally (Figure 6.21 B). This piece has morphological similarities with the adzes found at Mackenzie 1. This piece is considered as an anomaly because it has these adze characteristics but it is less than half the size of the smallest adze.

The final biface has a lenticular cross-section with a straight profile and two major fracture planes. There is a transverse, slightly perverse fracture on the distal end. There is also a lateral perverse fracture which may have been the cause of the transverse fracture (Figure 6.21 C). The piece is of extremely poor quality Gunflint Formation material which has degraded. There appears to be flake scars on the proximal end of both surfaces, while the edges are extremely rounded. The rounded edges and the extreme degradation of the fracture planes may indicate that this piece was poorly consolidated and very prone to chemical weathering, which was exacerbated by water battering of the specimen (Figure 6.21 C).

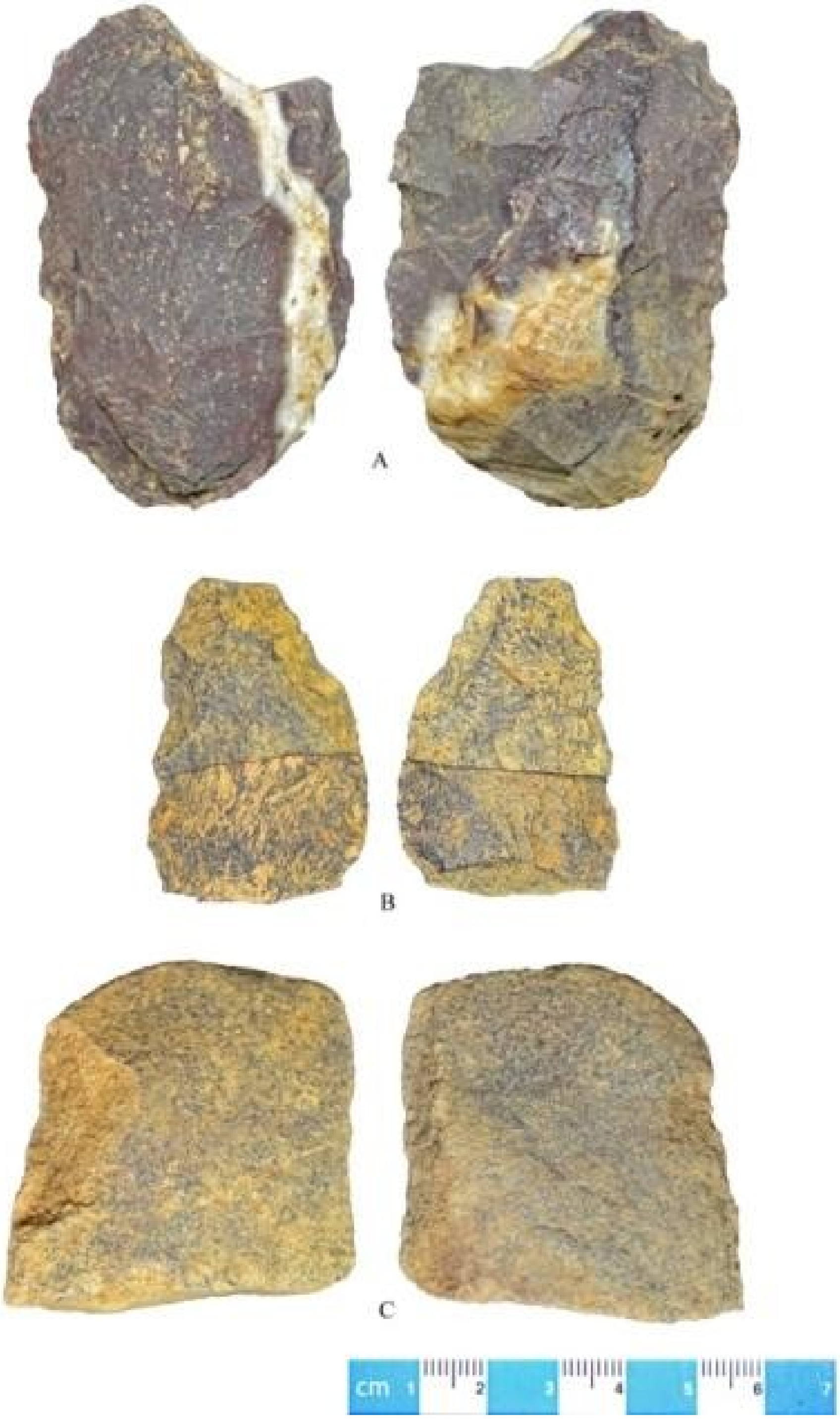


Figure 6.21: The remaining Gunflint Formation chert bifaces which exhibit various anomalous morphologies A) Artifact #42657 note the thick cross-section, the flake scars running through the quartz vein and the distal fracture B) Artifact #51920/51923 note the bevelled fracture on the distal end, the transverse refit fracture with the plunging flake scar and the adze-like shape C) Artifact #52104 note the chemical weathering of the edges, the dulled edges and possible flake scars.

A number of the biface anomalies are manufactured from a mudstone, possibly sourced to the Dog Lake area north of Thunder Bay (Markham, 2012). These bifaces are considered anomalous due to the fact that they are manufactured on such a soft stone and would appear to have no functional purpose due to the inability of the material to hold an edge. Mudstone artifacts could be used as a scraper for finer hides, morphologically though the majority of the mudstone bifaces exhibit knife and/or projectile point characteristics (Figure 6.22 A-D). There is also a base from a projectile which appears to have been manufactured from mudstone (Figure 6.22 F) and a heavily degraded narrow base/midsection of a possible projectile point (Figure 6.22 E).

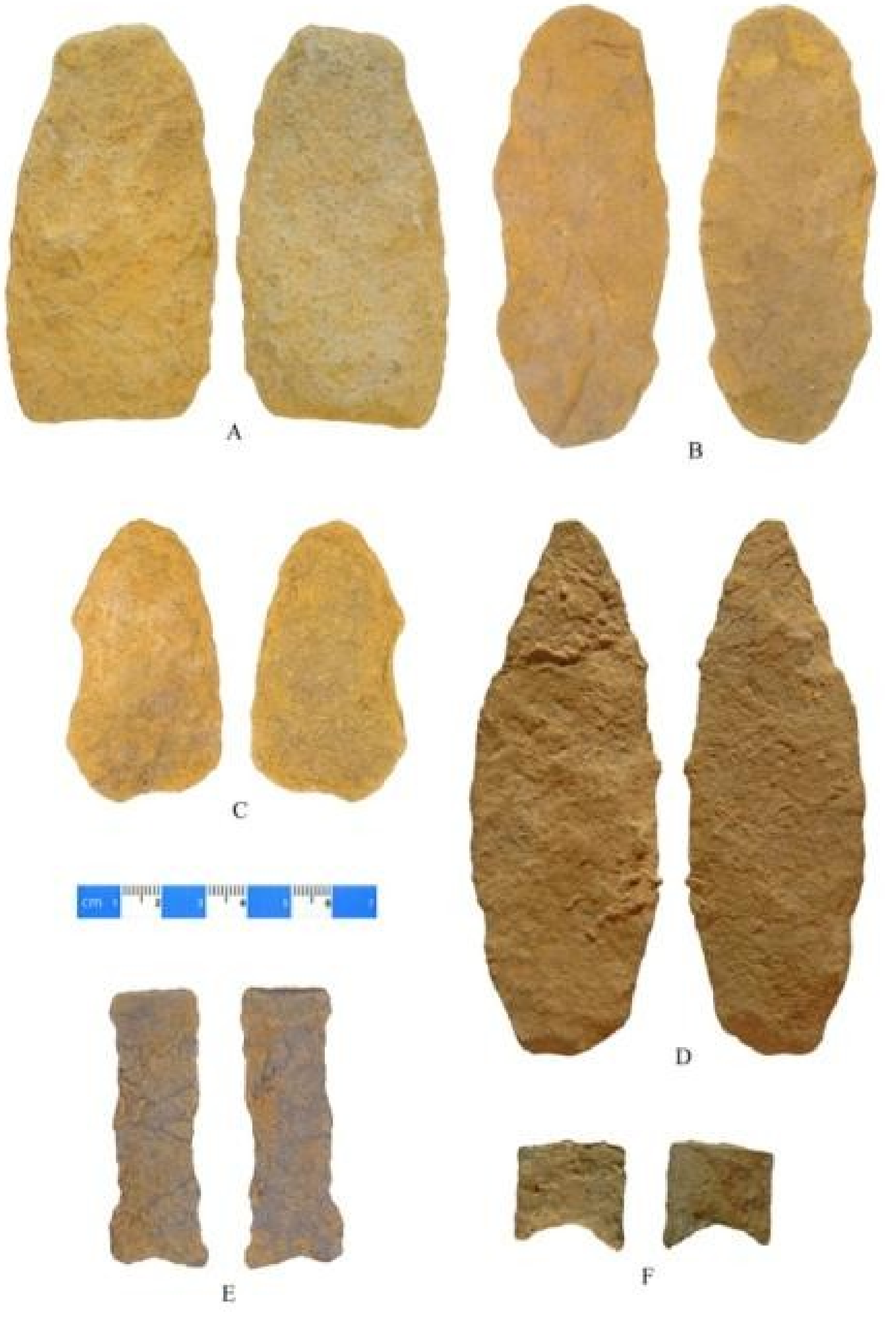


Figure 6.22: The mudstone anomalous bifaces with a knife/point morphology from Mackenzie I (DdJf-9) A) Artifact # 52078 note the flat base, lanceolate morphology of a Biface Trajectory preform B) Artifact #52323 note the lanceolate morphology with rounded ends and the curved profile C) Artifact #51925 note the proximal and lateral fracture planes and the rounded tip D) Artifact #WHS-07135 note the lanceolate profile with a defined tip and rounded base E) Artifact #39496 note the hourglass profile with a concave base F) Artifact #WHS-19875 note the deep concave base and the transverse hinge fracture.

The remainder of the mudstone bifaces from Mackenzie I consist of two thick lenticular pieces which exhibit edge work only. This combined with the metric analysis indicate that these two pieces can be classed as Stage 2 bifaces. They were again separated due largely to the oddity of the raw material used. Artifact #27708 (Figure 6.23 A) is a large relatively thick edge blank manufactured from a tabular piece of mudstone. There is considerable step stacking on the dorsal face and a transverse snapping fracture with a step stack on the dorsal surface at the fracture point. It is likely that attempts to mitigate this stack with longitudinal flake removal caused the fracture. The final specimen exhibits adze-like features of the distal end (Figure 6.23 B). The possible working bit is angled ventrally and shaped by longitudinal flake scars on both surfaces, with those on the ventral surface plunging deeper and ending in step stack. The proximal end consists of a snapping stack fracture that exposed a red interior material (Figure 6.23 B).

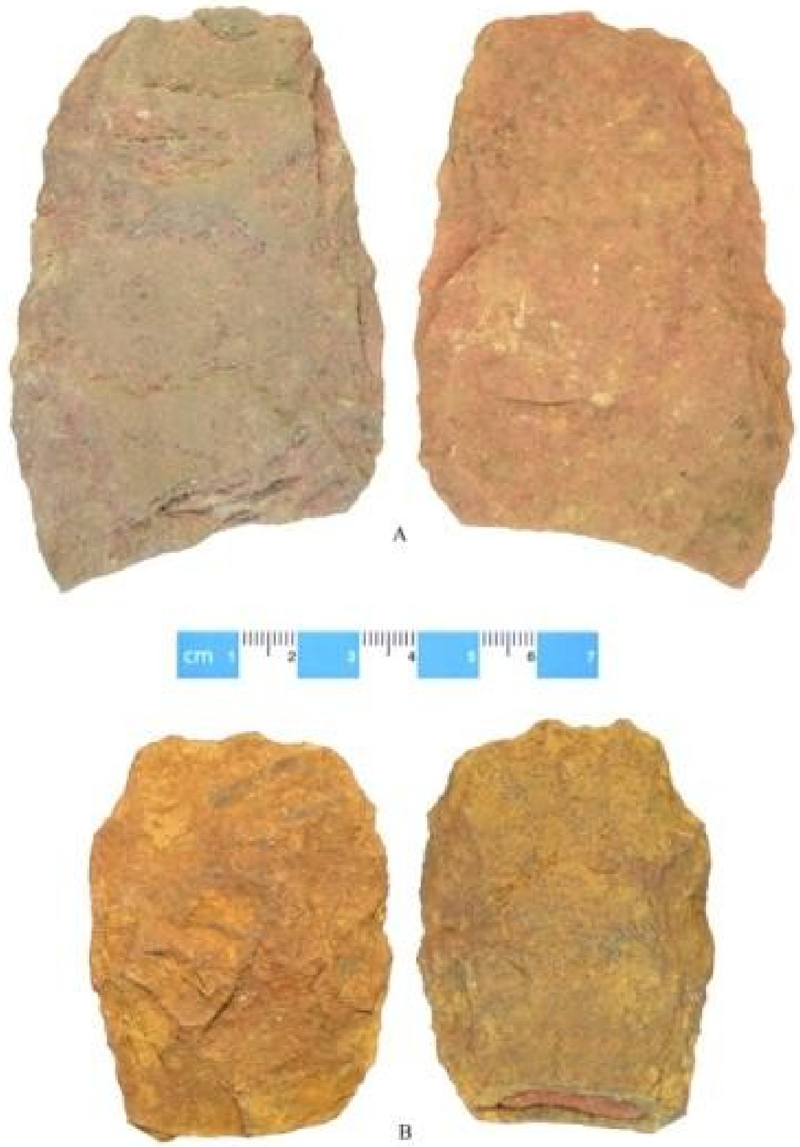


Figure 6.23: The thick mudstone anomalies which can be classified as Stage 2 bifaces A) Artifact #27708 with clearly defined edge work only B) Artifact #52267 with clearly defined edge work and distal fracture exposing a red interior material.

The remaining anomalous bifaces are manufactured using a variety of materials including a very coarse greenstone (Figure 6.24 A-B), what appears to be heavily degraded sandstone (Figure 6.24 E) and an extremely thin portion of a biface made from a coarse siltstone (Figure 6.24 C-D). The two specimens manufactured from a coarse greenstone material exhibit edge work, a thick morphology and are classified as Stage 2 bifaces. Artifact #51976 exhibits adze-like features including a broad distal end with a flaked ventral bevel, a narrowing proximal end and steep flake scars on the left lateral edge to give it a rough trihedral cross-section (Figure 6.24 B). The other greenstone biface made use of a tabular blank, exhibits edge work only and has a hinged transverse fracture (Figure 6.24 A). This specimen exhibits clear Stage 2 flaking and breakage patterns present on a material not observed as being present in any of the latter stages of manufacture.

The first of the siltstone bifaces is an extremely thin biface fragment which may be the result of a longitudinal fracture which bisected the piece. There is evidence of flaking on the dorsal surface while the ventral surface is a flat tabular plane (Figure 6.24 C). The second specimen has edge work on both faces with a severe step stack on the dorsal surface at the distal end. This may have been the result of this being the working end and this specimen could be considered as a form of adze or chopping tool. The proximal end has a slight concavity with an apparent flake scar on both surfaces. These flake scars are the result of a hinging fracture that caused the flake on the ventral surface to be removed (Figure 6.24 D).

The last of the anomalous bifaces is the heavily degraded sandstone biface (Figure 6.24 E). This biface exhibits edge flaking on the both surfaces, much of which has been obscured by the chemical weathering which resulted in much of the surface removal from the piece (Figure 6.24 E). It has a lenticular cross-section, no basal thinning and an irregular cross-section. The material type has resulted in a dulled edge and it is impossible to say whether there is a degree of platform preparation let alone what methods were used. Based on the edge work it would seem that this piece could be classified as Stage 2 but it was not able to be measured due to the loss of much of the edges due to weathering.

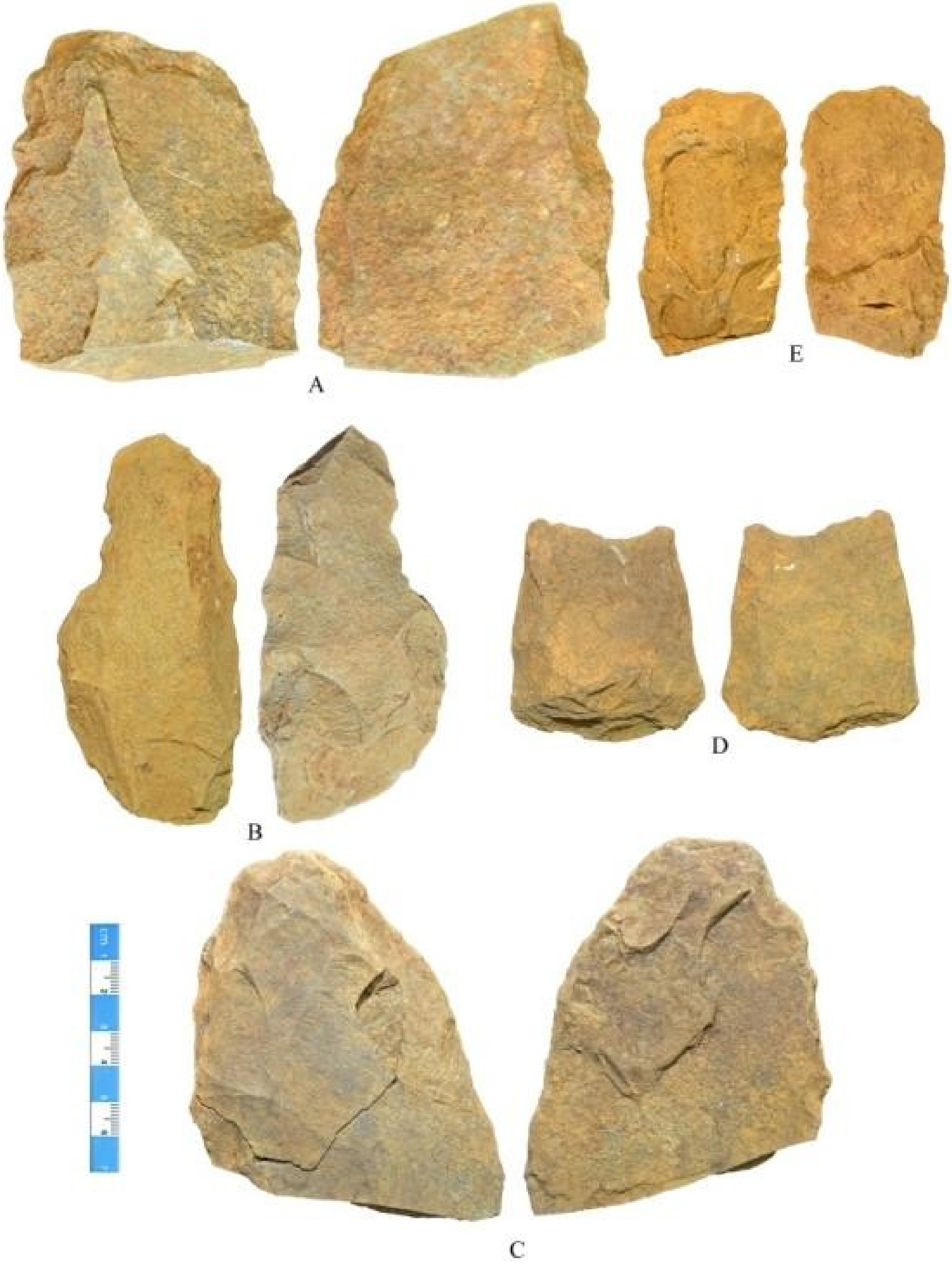


Figure 6.24: The remaining anomalous bifaces from Mackenzie I (DdJf-9) A) Artifact #52326 made from a coarse greenstone material note the tabular nature of the ventral surface and dorsal edge work B) Artifact #51976 made from a coarse greenstone material note the adze-like features C) Artifact #12728 made from an unknown siltstone note the very thin cross-section and dorsal flaking D) Artifact #48505 made from an unknown siltstone note the fracture pattern and the distal thickness E) Artifact # 52192 made from a really soft sandstone note the apparent flaking on the edges of this piece.

6.4 THE REDUCTION SEQUENCE OBSERVED AT MACKENZIE I

The application of the Lakehead Complex reduction sequence (Hinshelwood and Webber, 1987) to the Mackenzie I assemblage revealed that there were two trajectories of biface manufacture which occurred parallel to each other. Methods of reduction crossed trajectories at certain points of the overall reduction process, while certain methods were reserved for only one trajectory. The reduction sequence initially described by Hinshelwood and Webber (1987) was essentially a biface trajectory with blades or blade-like flakes entering the sequence at Stage 3. Observations made on the Mackenzie 1 assemblage indicate that while this may have held true with some Blade/Flakes it would seem that a parallel method of reduction making exclusive use of Blade/Flakes was part of the overall process.

The Mackenzie I assemblage afforded the opportunity to determine a likely conceptual model for ideal biface manufacture for the Lakehead Complex and the likely methods for the manufacture of the projectile points. The two production trajectories observed using the Mackenzie 1 assemblage are the Biface Trajectory and the Flake/Blade Trajectory. The methods observed at Mackenzie 1 can be applied to other sites within the Lakehead Complex (Gibson, 2014; Langford, ND). Select bifaces from other sites (Catherine, Widar, Biloski, Brohm, Cummins, and the Neebing Sites) were also analyzed using these methods as part of the analysis of the Mackenzie I assemblage.

6.4.1 The Biface Trajectory

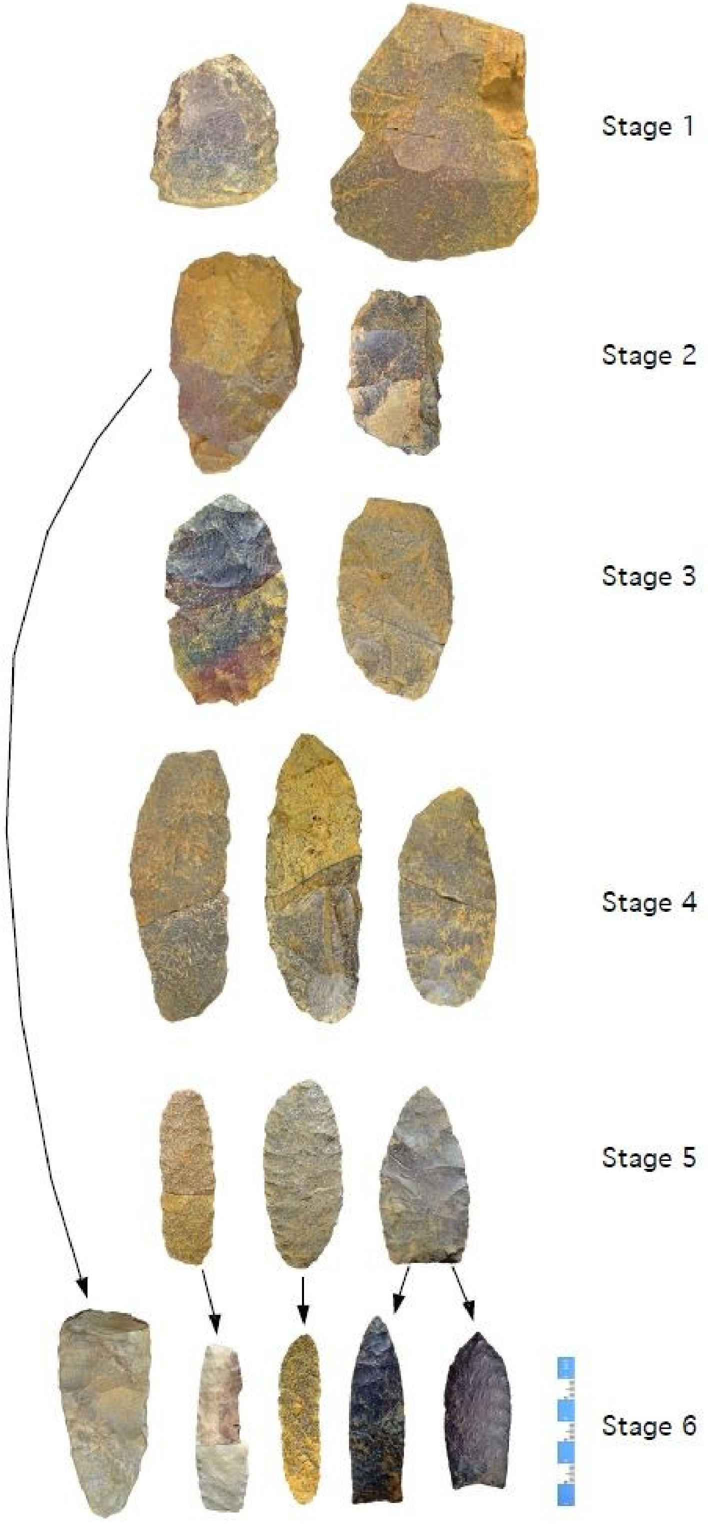


Figure 6.25: Biface Trajectory conceptual model

The Biface Trajectory (Table 6.7) follows the staged conceptual models first observed by Callahan (1979) as part of the Clovis manufacture sequence. Others have observed similar methods of manufacture on Folsom (Crabtree 1966; Flenniken 1973, Bradley 2004; Bamforth, 2009). The Lakehead Complex reduction sequence utilized large blanks, reducing them in a systematic pattern utilizing specific flaking methods and careful platform preparation. This reveals an extensive knowledge of the raw material which enabled the knapper to overcome the periodic low quality of the raw material.

Table 6.9: Breakdown of the Biface Trajectory Attributes

Biface Stage	**Name**	**W/T Ratio**	**Edge Angle (Degrees)**	**Edge Preparation**	**Flaking Pattern**	**Cross-Section**	**Profile**	**Platforms, Flake Scar depth**
Stage 1	Blank	N/A	N/A	N/A	N/A	Thick, irregular	Thick, straight	N/A
Stage 2	Edge Blank	2.0 to 4.0	50 to 80	Not Present	Random, Overshot (rare)	Hexagonal, thick lenticular	straight profile, irregular edge	Isolated Platforms, plunging flake scars
Stage 3	Primary Thinned Biface	3.0 to 4.0	40 to 50	Present (largely just grinding, offset retouch rare)	Random, Overshot, patterned rare (Parallel oblique used very rarely)	lenticular, diamond, thinning	straight profile, more regular edge	Isolated Platforms, plunges decrease in severity
Stage 4	Secondary Thinned Biface	4.1 to 6.0	25 to 45	Increasing use, medium to heavy grinding, offset beveled retouch	Parallel oblique flaking, random, and overshot still used	lenticular, diamond, thinning	straight profile, increasingly regular edge	Less isolated platforms, shallow flake scars
Stage 5	Preform	4.1 to 6.0	25 to 45	Heaviest use, medium to heavy grinding, offset beveled retouch	Increasing use of parallel oblique flaking, random is rare, overshot not purposeful	lenticular, diamond, thinning	straight profile (can have a slight twist) regular edge	Few isolated platforms, narrow, shallow flake scars
Stage 6	Formal Tool	4.1 to 6.0	25 to 45	Grinding on hafting portion, retouch to sharpen and regularize the blade portion	Near exclusive parallel oblique flaking, co-medial is common, random rare, overshot absent	lenticular, diamond, thinning	straight profile (can have a slight twist) regular edge	Absent, narrow, shallow flake scars

Stage 1 - The blanks used can range from tabular blocks, to large, thick, tabular flakes. Initial flaking made use of hard hammer direct percussion to remove the blanks from the block, or split cobbles. There may be flake scars on these pieces but are limited to remnant scars from platform preparation of the core or direct percussion used to test the quality of the raw material. Joint planes can be present on the edges and/or cortex on the ends. Ventral surfaces on some of the tabular pieces are solely a joint plane. Joint planes and other flaws including iron-oxide and quartz veins are prevalent in these blanks as is banding of the material. Banding within some Gunflint Formation materials result in differential quality of material with a portion being coarse grained and the rest fine-grained. It would appear that biface reduction methods were particularly employed when manufacturing tools from the lower quality raw material. The testing of the raw material determined the fracture mechanics of the blank, this could also be determined by the removal from the core. Flaws would be exposed and during this removal process other flakes may be removed. This exposed internal flaws and revealed the fracture mechanics of the piece. From this the knapper could then determine the trajectory to follow.

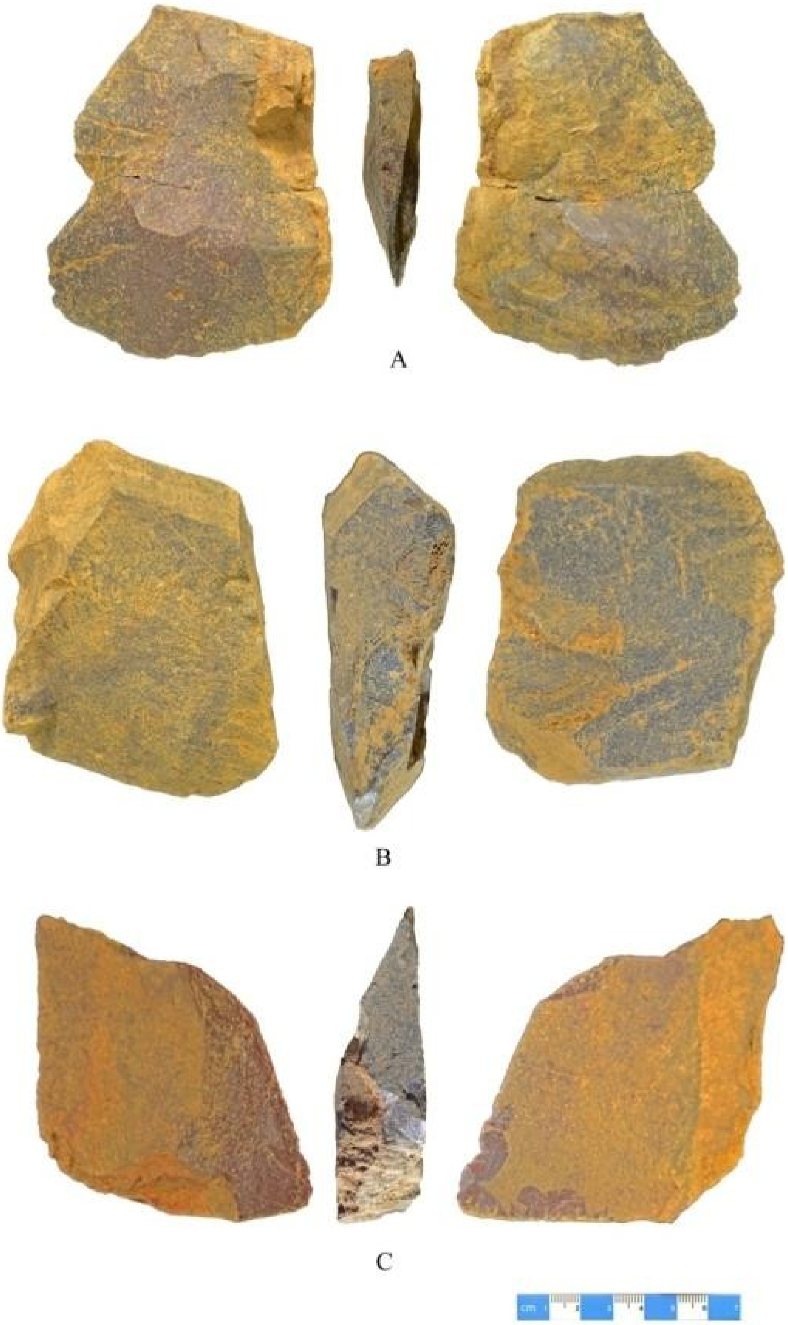


Figure 6.26: Stage 1 Biface Trajectory blanks (Artifact #52018, 4779, 52236).

Stage 2 – The edged blanks are created through direct percussion flaking using a hammer-stone or heavy antler billet. The edge is randomly flaked by selecting propitious isolated platforms and the use of joint planes and/or cortex as platforms. The hard hammer direct percussion technique was used to test the material and expose internal flaws and other faults. Discovery of flaws in this stage was a pre-emptive method used to identify flaws early and discard unusable material, thereby lessening the chance of failure in the subsequent stages of manufacture. This was not an infallible strategy, as hidden flaws can be weakened by such forceful percussion flaking, resulting in failure occurring later on in the sequence. The edges are regularized and brought to the midline, this results in an edge which can be prepared for the more patterned flake removal sets. There is little to no edge preparation in this stage of manufacture and the flake scars rarely extend to the midline. Overshot flake removal is present though it is often limited. Longitudinal flake scars are also observed during this stage but again it is rare.

The Gunflint formation materials range in quality, with a high probability of failure, breakage and rejection. Flaws within the material include quartz veins, iron-oxide inclusions, iron rich deposits, and joint planes. These flaws can lead to step termination and stacking, joint plane exposure, plunging flake scars, hinge terminations, crushed edges and perverse fractures. Once a stack or crushed edge occurs it is often impossible to continue flaking following the conventional method. Overshot and longitudinal flaking were employed in an effort to fix knapper's errors or overcome the flaws in the material. These methods are used to carefully direct the flakes and remove the flaw, or regularize the edge through removal of a portion of the flaw. Use of these methods increases the chances of breakage and/or failure. These flakes can plunge deeply, hinge off or halt at the point of the inclusion in either a step or hinge termination. This could lead to the transverse fracture of the piece, medial or transverse fracture along a joint plane or rejection of the piece after it hinged on the stack, thereby frustrating efforts to thin the biface midline height. In some cases the biface is large enough that it can be used as a flake core for obtaining either flake blanks for formal tool manufacture or expedient flake tools. The use of longitudinal and full face/overshot flaking can be observed on such large bifaces as they have the greatest chance of producing useful flakes.

Figure 6.27: Stage 2 Biface Trajectory bifaces (Artifact #21407, 51958, 7526/8678).

Stage 3 – Primary thinning occurs in this stage of biface manufacture, is observed in the Mackenzie I assemblage as more patterned flaking with careful selection and preparation of platforms (Figure 6.22: A). While appearing random, flake removal was carefully executed so that the piece thins without removing much width, and to avoid the flaws in the raw material. These flaws result in most of the breakage observed in this material, either due to failure when they were unexpectedly intercepted or as a result of unsuccessful attempts to work around or through a flaw. This process began at this stage of reduction with the careful selection of platforms, combined with edge preparation by means of edge grinding. Flake removal at this stage used direct percussion, using a medium antler billet or a light hammer-stone.

Ground/prepared platforms are essential for directed flake removal as they produce a solid platform that reduces the risk of crushing and stacking. This stage of reduction takes more time to complete due to the careful observation and planning followed by more intensive preparation of platforms. The initial flake removal is chosen based on the nature of the material, the careful observation is used to aid in determinations of the fracture mechanics and likely location of hidden flaws. Joint planes, when present, were used as naturally bevelled platforms to initiate the first set of thinning flakes. Once the flake set had been started, subsequent removal is determined based on the material and the fracture mechanics of the individual specimen. Flake removal in this stage of manufacture is conditional on the quality of the material and the skill of the knapper to observe the structural flaws of the specimen.

Once these determinations are made, the platform is isolated and prepared by grinding (Figure 6.22: B). Retouch bevelling is observed but is not common. Medial flaws present, whether an iron-oxide inclusion or joint plane, were removed through carefully directed flake removal. Successful flake removal results in a ridge scar which can be used to direct the flakes through the flaw. Unsuccessful flake removal results in either failure, or a stack/ridge to form on the flaw. Further flaking will increase the height of the stack, cause a fracture, or result in rejection. It is possible to remove the flaw by altering the direction of flake or shifting entirely to longitudinal flake removal. Overshot flake removal was also used in an attempt to mitigate flaws (Figure 6.22: C). These methods for ‘fixing’ flaws were not always successful, and could result in a deep plunging flake scar which hinges or steps that can worsen the flaw, or cause a fracture. The final product of this stage of manufacture is a lenticular cross-sectioned specimen, with a coarse pattern of flake removal on both faces. Those specimens which had a joint plane or cortex are now largely free of such surfaces, though they may remain in a reduced capacity.

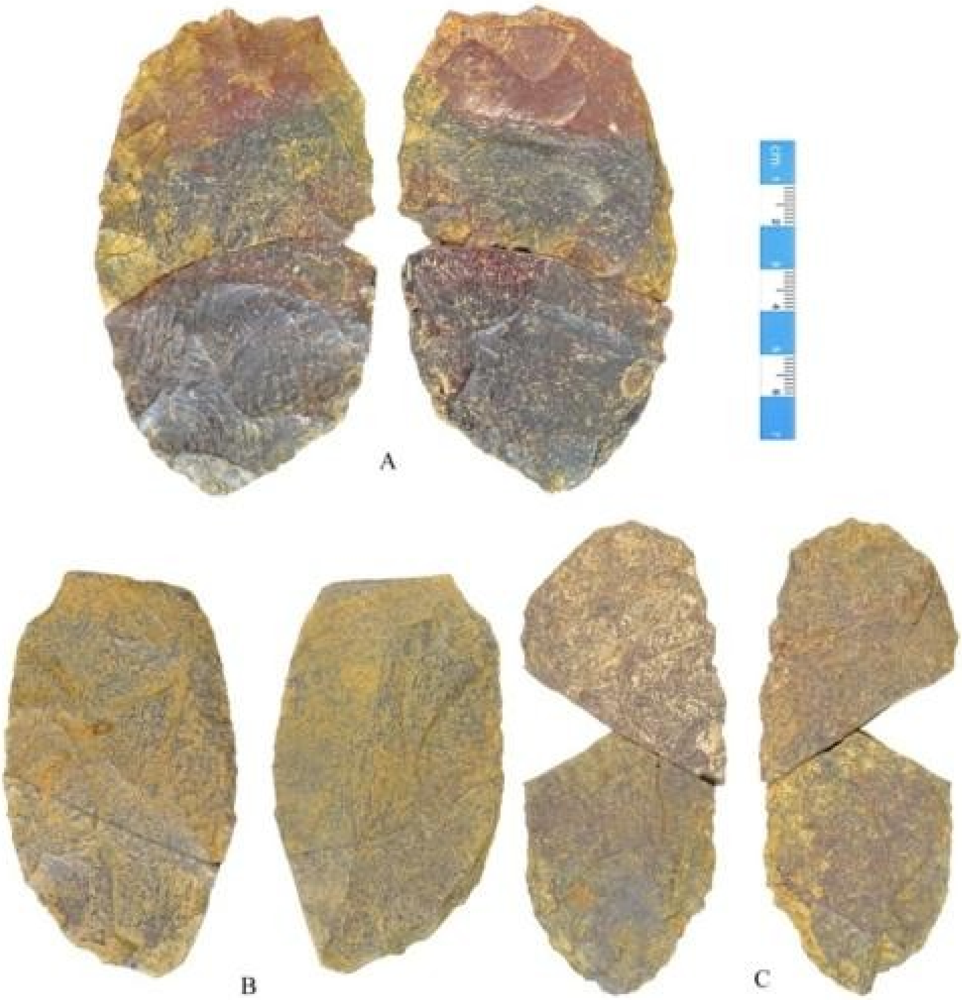


Figure 6.28: Stage 3 Biface Trajectory bifaces (Artifact #7234/52291, 52288/52320, 3086/32443).

Stage 4 – Secondary thinning consists of an increasing presence of serial patterned flake removal, platform preparation, and the start of basal thinning. Precisely executed directional flaking requires heavily prepared platforms. The edges are retouched using pressure flaking to create a bevelled edge followed by grinding and isolation of platforms. Flake removal makes use of the flake scar ridges from the previous stage to aid in directing the flakes. Using the flake ridge scar involves preparing the platform so that the ridge is centered on the platform. Flake removals occurred on one edge of one face followed by the opposite edge of the other face. The pattern was then filled in by feathering flakes into the flake scars from the opposite edge. In some cases this was the end of the Stage 4 thinning, in others it was necessary for another round of flake removals if the piece was not of desired thinness. The subsequent set of flake removal was a cognitive decision on whether the piece was thin enough to move on to the next stage.

The second set of flake removal followed the same method as the initial set. Once the piece was deemed to be of the proper thinness there were two main options open to the knapper; refinement into a preform, followed by the production of a formal tool, or setting the specimen aside for later needs in a cache. Parallel oblique flaking increased in frequency of expression in this stage of manufacture. There were isolated portions on some Stage 3 specimens that exhibit some parallel oblique flaking. Stage 4 specimens exhibited parallel oblique flake scars on an entire face, and often on both faces. However they were often broader than that observed on Stage 5 and 6 specimens, suggesting that the ridges between these broad flake scars were used to direct the refined parallel oblique flake scars observed on the projectile points. Bi-pointed specimens selected for the manufacture of hafted bifaces followed a specialized process for haft manufacture. The end deemed to be the base was snapped off to create a bevelled ventral platform which was used to remove longitudinal thinning flakes on the dorsal surface. Not all bifaces were intended to form hafted tools; non-hafted lunate and semi-lunate knives are present in the formal tool assemblage at Mackenzie 1 and involve leaving the piece as a bi-pointed biface into Stage 5. Retouching of the edges likely involved the use of an antler punch to pressure the flakes off the edge. The removal of the thinning flakes, following the edge retouch, was likely direct percussion using a light to medium antler billet but may have also involved pressure flaking again using an antler punch. It is also possible that indirect percussion methods were used as well.

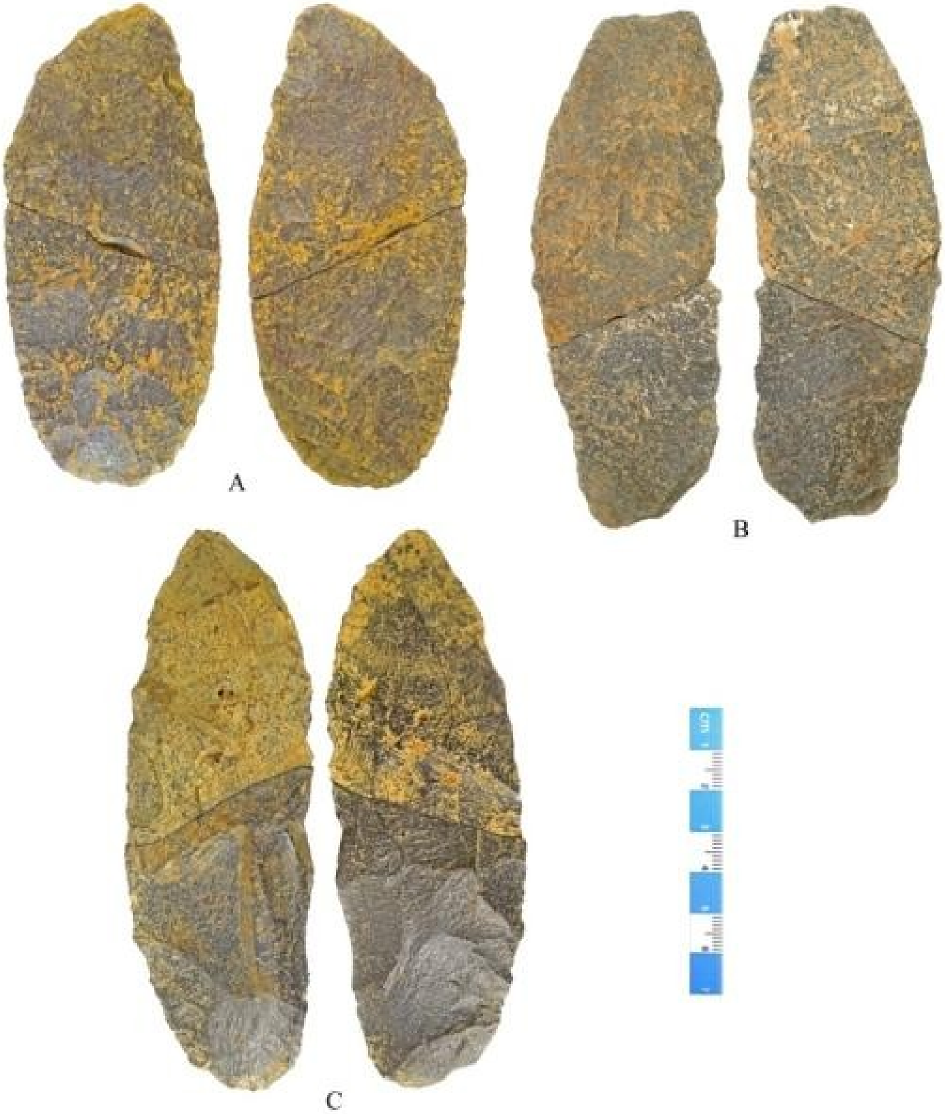


Figure 6.29: Stage 4 Biface Trajectory bifaces (Artifact #52178/52273, 30613/48511, 38794/38836).

Stage 5 – Finishing the preform into the desired tool form occurred in this stage, and involved a significant work on the points, but minimal flaking and retouch on knives and gouges. Initial flaking in Stage 5 refined the edges, followed by basal thinning and shaping. Non-hafted tools were sharpened and regularized, by removing isolated platforms on the cutting edge, and grinding the back edge. Gouges were likely hafted and thinned basally using longitudinal thinning followed by grinding, the working bit would have been hollowed through the use of a longitudinal plunging flake.

Flaking patterns in this stage were largely parallel oblique, with co-medial flaking being the second most widely utilized. This was also reflected in the formal tools. It is possible that soft hammer percussion using a light antler billet or a soft wood billet was used, but pressure flaking or indirect percussion may have been used as well. The edge would have been bevelled using pressure retouch, then ground to prepare the platforms. The initial pass of parallel oblique flaking occurred, following the alternate edge bevelling, and then a second pass from the opposite edge followed. Co-medial flakes are broader than the parallel flakes and meet at the midline. This manner of flaking can easily be accomplished using prepared platforms, and direct percussion or pressure flaking. Retouching was used to sharpen the edge and remove any isolated platform to create a smooth, sharp cutting edge.

These preforms can morphologically be called a finished tool but are missing a number of key attributes. Hafted bifaces require the presence of a definitive hafting portion. Determination of tool completion is based on the presence of ground and retouched hafting portions (Markham 2013). Non-hafted bifaces are determined to be complete based on the sharpness of the convex edge. Knives from Mackenzie 1 that had two sharp edges were considered to be preforms rather than a completed tool.

Figure 6.30: Stage 5 Biface Trajectory preforms A) Knife Preform (Artifact #33118) B) Point Preforms (Artifact #48502/51611, 52136/52297) C) Possible gouge preform (Artifact #52202/52203).

6.4.2 The Flake/Blade Trajectory

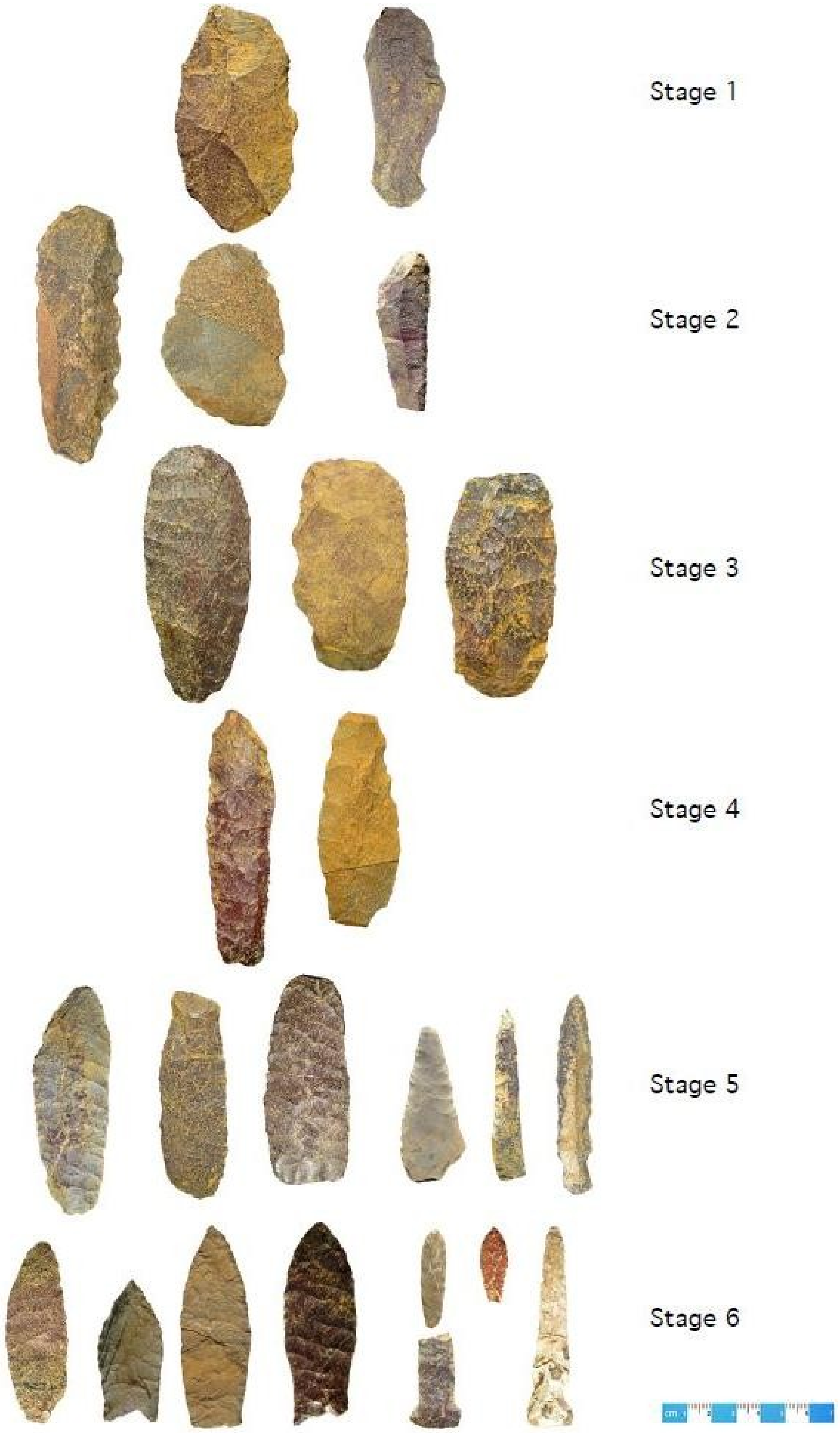


Figure 6.31: Flake/Blade Trajectory Conceptual Model

The Flake/Blade Trajectory (Table 6.8) follows the staged conceptual models first observed by Callahan (1979) as part of the Clovis manufacture sequence. Callahan noted the use of large blade/flakes within the Clovis manufacture sequence (See Figure 4.11), but it was not formalized as a distinct conceptual model until Whittaker (1994). Hinshelwood and Webber (1987) noted the use of large blade-like flakes in the analysis of the Biloski assemblage. It was hypothesized that such blanks entered the reduction sequence in Stage 3, and could be reduced into a formal tool in much the same way as a biface would (Hinshelwood and Webber, 1987). The Mackenzie I assemblage allowed for greater insight into how the blades and blade/flakes fit into the reduction sequence. This method of tool manufacture utilizes blanks which can be classified as blades and blade/flakes. An initial blade was removed using a joint plane corner as both the striking platform and central ridge. Once the blanks were so obtained, flaking followed a similar conceptual model as that of the Biface Trajectory but with some minor distinctions. While the material used in the biface trajectory can range in quality from coarse to fine grained materials, the Flake/Blade trajectory makes near exclusive use of the fine-grained Gunflint Formation material. This differential selection of material quality is due to the fracture mechanics of the material, the finer grained silica rich material does not cause flakes to step terminate as frequently, there are not as many joint planes, iron-oxide inclusions, or quartz veins. The better quality material reduces the need for heavy hammer percussion to search for hidden joint planes and remove structural flaws in the material. In effect this simplifies the reduction process, and significantly improves the chances that the initially extracted blade/flake could be reduced into the desired formal tool form.

Table 6.10: Breakdown of Flake/Blade Trajectory attributes

Biface Stage	Name	W/T Ratio	Edge Angle (Degrees)	Edge Preparation	Flaking Pattern	Cross-Section	Profile	Platforms, Flake Scar depth
Stage 1	Blank	N/A	N/A	N/A	N/A	Thin, D-Shaped	Twisted to Curved	N/A
Stage 2	Edge Blank	3.0 to 4.0	40 to 50	Retouch	Random	Thin, D-Shaped	Twisted to Curved, irregular edge	Isolated platforms, shallow proximal scars
Stage 3	Primary Thinned Biface	3.0 to 4.0	40 to 50	Grinding and Beveled Retouch	Parallel Oblique or Co-Medial, overshot absent	Lenticular to D-Shaped, dorsal surface thinning	Twisted to Curved, edge is less irregular	Isolated platforms, shallow dorsal scars
Stage 4	Secondary Thinned Biface	4.1 to 6.0	25 to 45	Ground and beveled retouch, all edges	Parallel Oblique or Co-Medial, overshot absent (mostly dorsal surface)	Lenticular to D-Shaped, dorsal hump decreases significantly	Twisted to Curved, edge regularizing	Less isolated platforms, narrow shallow flake scars
Stage 5	Preform	4.1 to 6.0	25 to 45	Heaviest use, medium to heavy grinding, offset beveled retouch	Parallel Oblique or Co-Medial, increasing use of PO flaking ventrally	Lenticular to D-Shaped	Twisted profile, regular edge (can be curved)	Few isolated platforms, narrow, shallow flake scars
Stage 6	Formal Tool	4.1 to 6.0	25 to 45	Grinding occurs on hafting portion, retouch to sharpen and regularize the blade portion	Near exclusive parallel oblique flaking, co-medial is common, random rare, overshot absent	Lenticular to D-Shaped	Twisted profile, regular edge (can be curved)	Absent, narrow, shallow flake scars

Stage 1 - The blanks used in this production trajectory range from prismatic blades to flakes and/or blade/flakes. Prismatic blades are long thin flakes with a central ridge resulting in a cross-section which ranges from triangular to trapezoidal. Flake blanks are long, thin and relatively wide, while blade/flakes are long, thin and narrow. Production of both blades and blade/flake blanks requires the high quality Gunflint Formation chert. Blade/flake blanks seem to be disproportionately used in the production of the projectile points, while the blades were used for the manufacture of drills, scrapers and expedient

tools. If a blade/flake was not of sufficient length for reduction into a point it was either discarded, or reduced into a different tool.

Figure 6.32: Stage 1 Flake/Blade Trajectory blanks (Artifact #803, 51536).

Stage 2 – The edged blanks in this production trajectory often had little to no bifacial flaking. Flake removal was limited to refining the edge and may have been limited to platform preparation. It has been argued by Hinshelwood and Webber (1987) that such blanks entered the sequence in Stage 3, and then proceeded through the thinning and shaping sequence consistent with biface reduction. Andrefsky (1998) and Whittaker (1994) argue for a distinct blade/flake reduction trajectory. The edges were regularized where necessary through patterned pressure flaking. This was necessary to center the edge with the midline so that platforms could be prepared. It would appear that at Mackenzie I flake blanks did not enter the sequence at Stage 3 and were reduced in a different manner than biface blanks. The striking platform and the bulb of percussion may exhibit a greater degree of flaking if they are relatively thick, and if the striking platform is too large. Cross-sections of the blade/flake blanks are D-shaped, with a longitudinal curve and a lateral twist.

Figure 6.33: Typical Stage 2 Flake/Blade Trajectory bifaces from Mackenzie 1 (Artifact #51947, 52135, 82064).

Stage 3 – Primary thinning is limited to edge work with the blank more extensively worked on the dorsal surface. This dorsal flaking extends past the midline with limited edge work on the ventral face. The bulb of percussion is usually the only portion of the ventral surface that exhibits flaking across the midline. The cross-section of the points manufactured following this model, reinforces observations on the blanks. Reduction methods result in retention of the flake attributes and an exacerbation of the curved/twisted profile. Bulbs of percussion and striking platforms remain until Stage 4 thinning. Flake blanks with a curved and/or twisted longitudinal profile (Figure 5.7) had these attributes exacerbated through the dorsal flaking in this stage. The bevelling of the edges to aid in the dorsal flake removal also contributed to the increase of the curved/twisted profile. At this stage serial patterned pressure flaking is used to remove flakes which feather into each other across the midline. Reduction may include soft hammer direct percussion, but more likely utilized pressure flaking or indirect percussion methods. At this stage of production edge preparation is more evident than in the biface trajectory. It was necessary to grind the edges and use pressure retouch to isolate the platforms. The angle of removal resulted in long, shallow flakes, reducing the thickness without removing the width. The patterns range from co-medial to parallel oblique (or a combination of both), but are rarely random. On the ventral surface there may be parallel or oblique flakes on the bulb of percussion, but is normally limited to edge retouch used to bevel the edge.

Figure 6.34: Stage 3 Flake/Blade Trajectory bifaces (Artifact #51550, 52268).

Stage 4 – Secondary thinning like, the Stage 2 edge work may or may not be present. In most cases the Stage 3 dorsal thinning was sufficient to permit the piece to move directly to Stage 5. Thicker blanks would require another set of thinning flake removal. These specimens were flaked bifacially with the flakes extending past the midline. Initial shaping of the piece was done, with the tip being slightly more defined. Pressure flaking was used to remove this set of flakes, but may have been executed using indirect percussion. Edge preparation was prevalent in this stage using a combination of grinding and pressure retouch to create a bevelled edge. Angles of removal were again shallow to reduce the thickness.

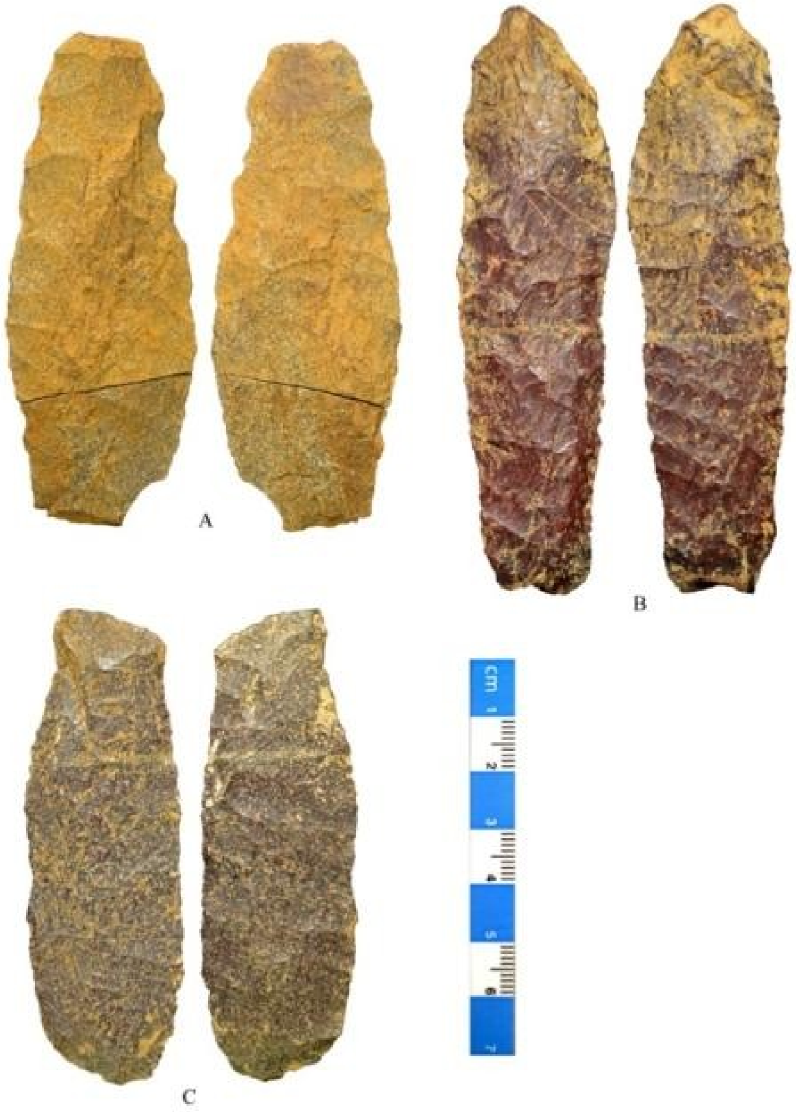


Figure 6.35: Stage 4 Flake/Blade Trajectory bifaces (Artifact #17681/51436, WHS-00179, 52158).

Stage 5 – The manufacture of the preform proceeded either directly from Stage 3 or from Stage 4 depending on the nature of the initial blank. The preform was shaped in this stage using pressure flaking to continue the parallel oblique flaking pattern. The knife preforms were bi-pointed with rounded ends, while the point preforms have a defined tip and constricting to straight basal portion. The drill preforms have isolated platforms and a less refined working bit. Platforms can remain, resulting in a slightly denticulate edge, though not as prominent in earlier stages.

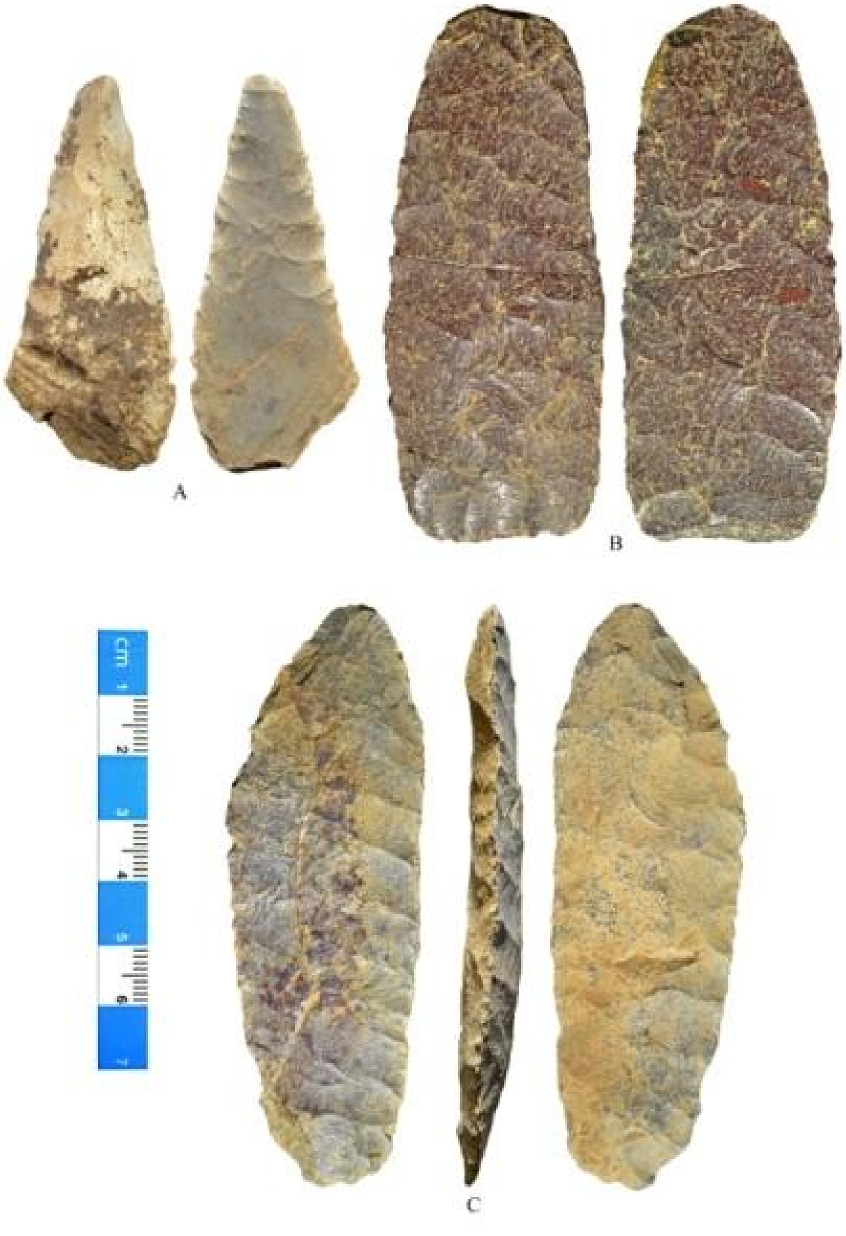


Figure 6.36: Stage 5 Flake/Blade Trajectory preforms (Artifact #29447, 49109, WHS-24310).

Stage 6 – Finished tools include all the points that were analyzed by Markham (2013) any points which were not available at the time of her analysis, and all other tool forms including adzes and large chopping tools, drills, gouges, and knives. For a more detailed analysis of the features of the Lakehead

Complex projectile assemblage see Markham (2013). Finishing the formal tools involves refining and dulling the hafting portion on hafted tools, the refining of the working end and edges, and the sharpening of the edges for all biface tool forms. Non-hafted bifacial tools were ground on the back edge. Larger scrapers would have been hafted as well, and though unifacial were manufactured using by-products of the bifacial reduction sequence. Individual tool types are discussed in greater detail below.

Adzes

Adzes are present at Mackenzie I and at other Lakehead Complex sites indicating that this tool type may be part of the Paleoindian toolkit of the Lakehead Complex. The manufacture of these tools begins with the selection of a suitable blank that would appear to be tabular, of sufficient length that may initially have a spatulate form. Following blank selection the edges were chipped, resulting in a piece that is morphologically similar to a typical Stage 2 edge blank. The base narrows considerably while the working bit is left broad. There is minimal flaking done to prepare the edges, while flake scars that are present extend to or across the midline on both faces. Overshot flaking is present on some specimens. The goal of flake removal is to obtain a thick lenticular or trihedral cross-section. The lenticular adzes have a broad working bit and a constricted proximal end while the trihedral adzes are straight sided. The hafting portion has been heavily ground and is generally located in the center of the piece. Fracture patterns on these tool types consist of a transverse hinge fracture on a slight angle following the directionality of the strike. There is a single adze that could be classified as trihedral and was subjected to residue analysis by Cook (2014). However no residue was present on this specimen. It is not clear whether this suggests the tool was discarded without use, or that any residues were destroyed by extended deposition in harsh sedimentary conditions.

The rest of the adze assemblage analyzed by Cook (2014) derive from several sites, and revealed the presence of conifer (could represent contamination). The majority of these adzes were classified as the typical trihedral form (Fox, 1975) and range in location from Lac Seul to the west, Dog Lake in the north, and Lake Nipigon to the east. A smaller proportion of them had a more hexagonal or thick lenticular cross-section which also exhibited the presence of white pine.

Figure 6.37: Range of adzes found at Mackenzie I (Artifact #5957, 12180, 21452, 40936/43458, 48491, 51584, 51585, 51586, 51593, 52017, 52210, 52250, G1, L182).

Gouges

The Gouges were manufactured following the biface trajectory. A tabular blank or thick tabular flake blank may have been used to produce these tools. The presence of extensive dorsal and ventral flaking, combined with the lack of a significant twist, indicates that a thin flake/blade would not have been useful. Due to the likely use wear observed on these tools, they likely were systematically produced from a thick solid piece of stone. The gouges largely exhibit oblique to parallel flaking on the ventral face to obtain a flatter surface. On the dorsal surface, co-medial flaking emphasized the humped D-shaped cross-section. The working end is produced using a plunging flake scar to create the ventrally angled working bit. There is a single complete gouge which exhibits a blunted heavily ground base with a slight construction. Further examination of the assemblage may result in the refits being located for the other tools of this type.

Figure 6.38: Gouges found at Mackenzie I (Artifact #37685/WHS-06074, 51699, 51740, 51810, L122).

Knives and Projectiles

Knives and projectiles were manufactured following both trajectories of reduction observed at Mackenzie I. Differences can be observed in the cross-sections, the degree of twisting in the longitudinal profile and the extensiveness of the work on the ventral face. The alternate edge bevelling which has been observed as an edge preparation method can result in a twisted profile. The differences are observed on the degree of twisting and the presence or absence of remnant flake attributes. The longitudinal profile of flakes remains curved with a slight pronouncement on one end as a remnant of the bulb of percussion. In rare cases the striking platform is still evident on either the edge or one end. Those which followed the biface trajectory will have a slight twist and an offset lenticular cross-section that is largely due to the presence of the alternate edge bevelling and the parallel oblique flaking patterns. Artifacts in the flake/blade trajectory have a more severe twist due to the morphology of the initial blank, and often exhibit a slight to pronounced curve as well. The cross-section is also indicative of the use of a thin blade-flake as a blank. It is normally D-shaped due to the flat ventral surface which required little to no working. The extensiveness of the flaking is the final indicator of the difference between the trajectories. Artifacts in the flake/blade trajectory will have more extensive working, ranging from parallel oblique to co-medial or a combination, on the dorsal surface when compared to the ventral surface. This manner of flaking results in an exacerbation of the morphology of the flake blank. The artifacts manufactured following the Biface trajectory exhibit the same degree of flaking on both surfaces.

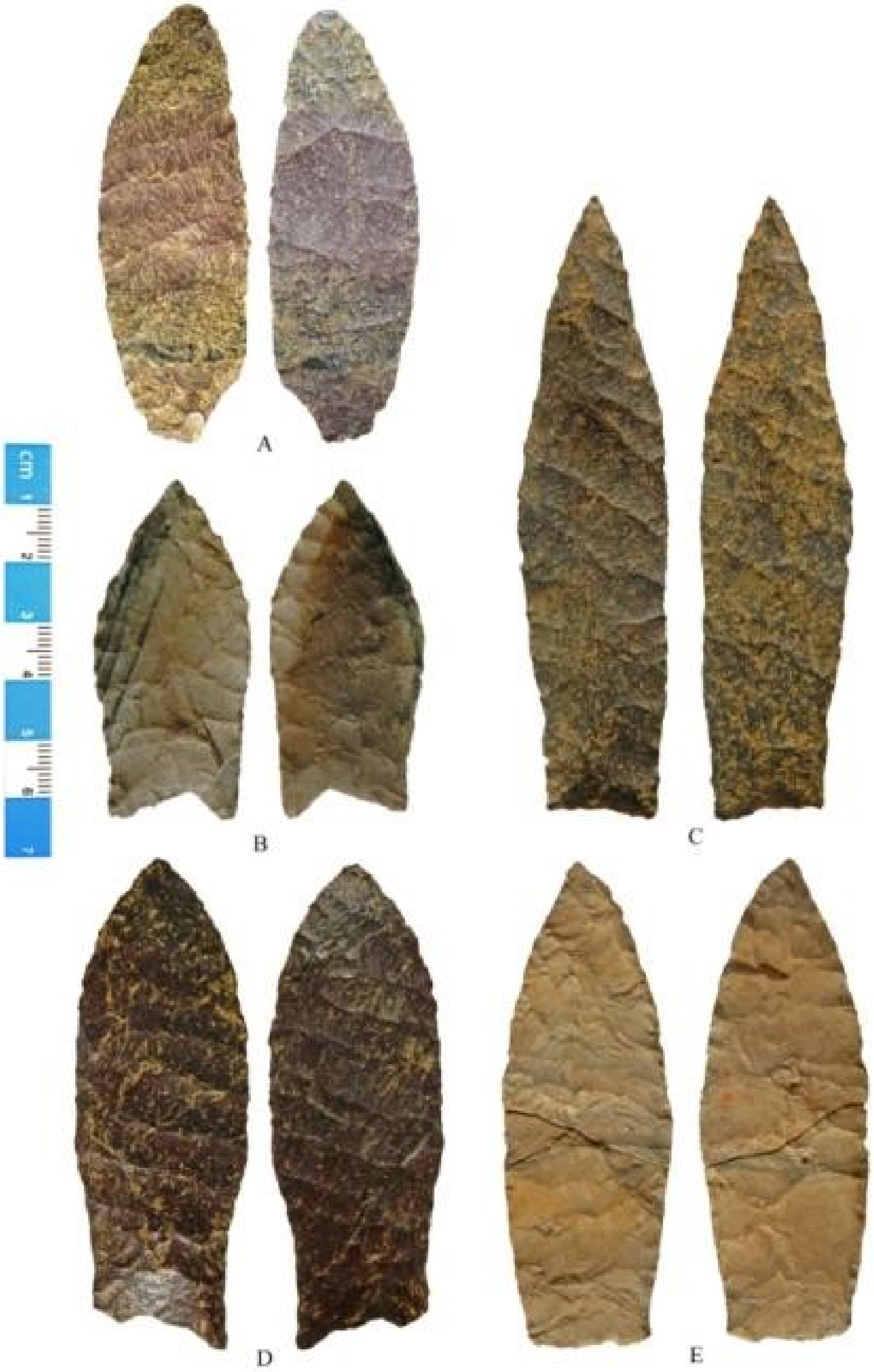


Figure 6.39: Knife following the Flake/Blade trajectory A (Artifact #51581) and Projectile points following the Flake/Blade trajectory B-E (Artifact #WHS-13986 modified after Markham (2013), WHS-06074 modified after Markham (2013), WHS-04846 modified after Markham (2013), WHS-09560/09560 modified after Markham (2013)) Dorsal surface on the right, Ventral surface on the left.

The knives and projectiles in the biface trajectory are largely lenticular in cross-section. The flaking is uniform on both faces ranging from parallel oblique to co-medial, or a combination. A slight twist can be present and is likely explained by alternate edge bevelling as a method of platform preparation. Not all the projectiles have an offset bevel present, but they do exhibit parallel oblique flaking. This may be explained by the relative thickness of the piece once it entered Stage 5. In some cases bevelling would result in a thickening of the edge and may cause the piece to be rejected. A thin non-bevelled edge with carefully prepared platforms can easily be finished with the oblique pattern. Pieces that do not constrict in the hafting portion or those with ears retain remnants of the bevelled fracture used as platform. The ends of the ears and the portion on either side of the concavity have a flat plane which reveals the nature of the manufacture. It is also apparent that in rare cases a large thin overly long preform was broken into two or more fragments which were then each finished into a formal tool. The style of knife utilized by Lakehead Complex groups is a bi-pointed knife with a curved working edge they are slightly lunate with a sharp convex edge and ground/dulled straight edge.

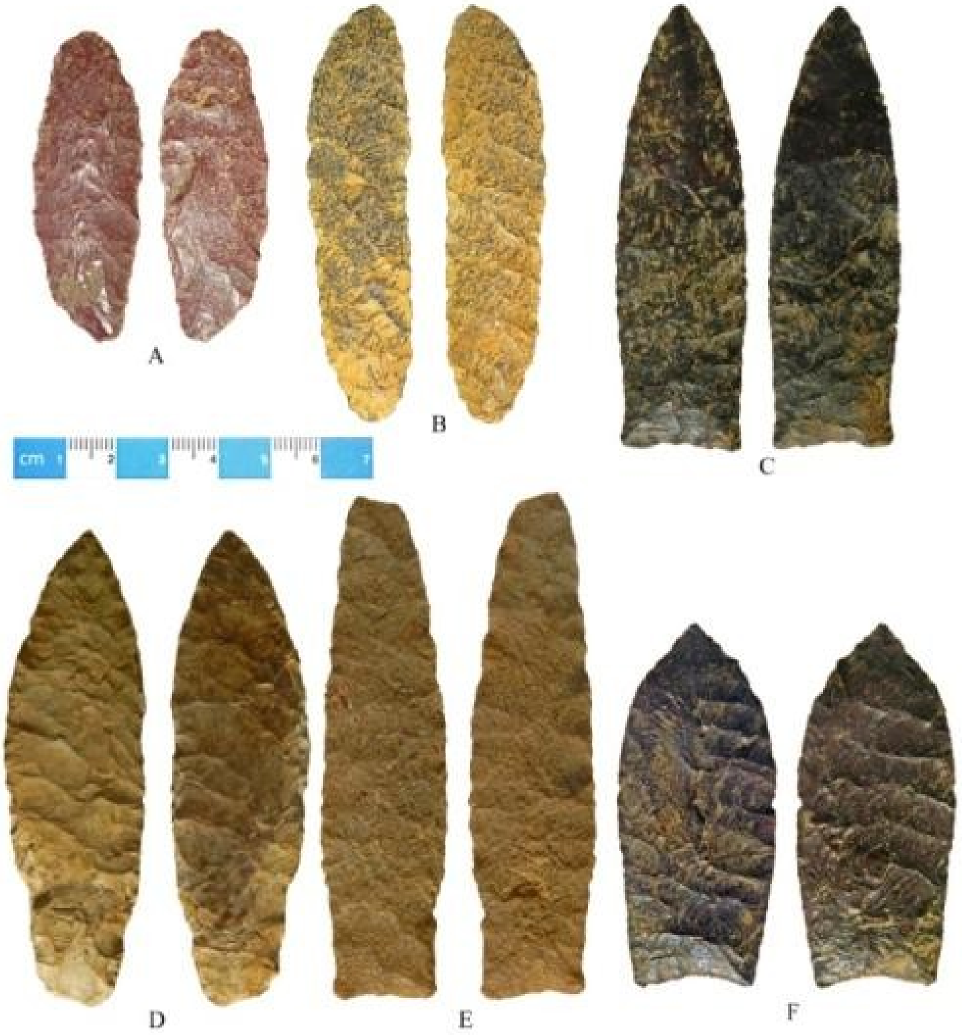


Figure 6.40: Knives following the Biface Trajectory Artifact # A) 52254, B) 52305 and Projectile points following the Biface trajectory Artifact # C) 5586 modified after Markham (2013), D) WHS-06988 modified after Markham (2013), E) WHS-06455 from modified after Markham (2013), F) WHS-03568 modified after Markham (2013).

There are two interesting basal fragments from Mackenzie I which require a brief discussion. These bases are very narrow and extremely thin and exhibit carefully executed parallel oblique flaking on both faces. The narrowness of these pieces and the lack of a refitted blade portion begs the question as to what the purpose of these tools were. Markham (2013) analyzed one of these specimens in her analysis of the projectile points. The second was recently discovered and exhibits near identical morphological traits to the one analyzed by Markham the only major difference being that this piece was manufactured from high quality Gunflint Formation chert.

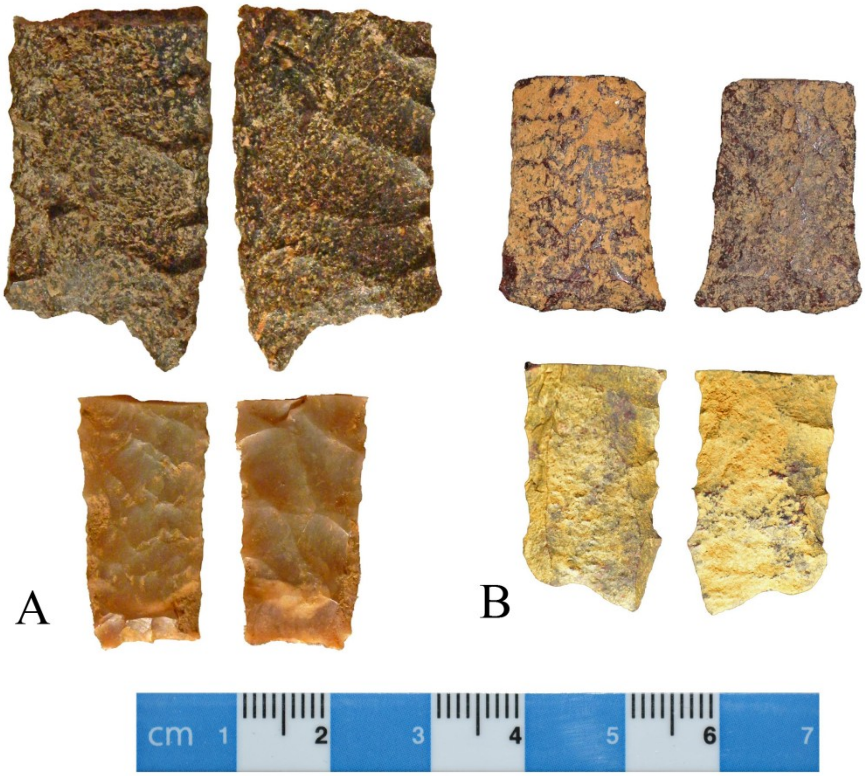


Figure 6.41: Extremely narrow basal portions from Mackenzie I A) Narrow basal portions analyzed by Markham (2013) (WHS-13986, WHS-20080 modified after Markham (2013) B) Narrow basal portions identified as drills (Artifact #40573, 51852).

Drills

Drills were manufactured using either a prismatic blade or a distally narrowing flake. There is some evidence of reworking of other tool fragments into a drill. Those manufactured from a prismatic blade exhibit a flat ventral surface with a dorsal surface that is either D-shaped or trapezoidal depending on the morphology of the blank (Figure 6.39). The edge is regularized on some specimens to create a more lenticular cross-section. The drills are generally not twisted though a few Mackenzie I specimens exhibit a slight twist. Drill preforms can be 'placed' in the trajectory breakdowns above. There is also some evidence of reworking of lateral edge fragments of bifaces into drills (Figure 6.40)

Figure 6.42: Selection of Drills found at Mackenzie I (Artifact #5119, 21153/21266, 21372, 51606, L123, 32412/36403).

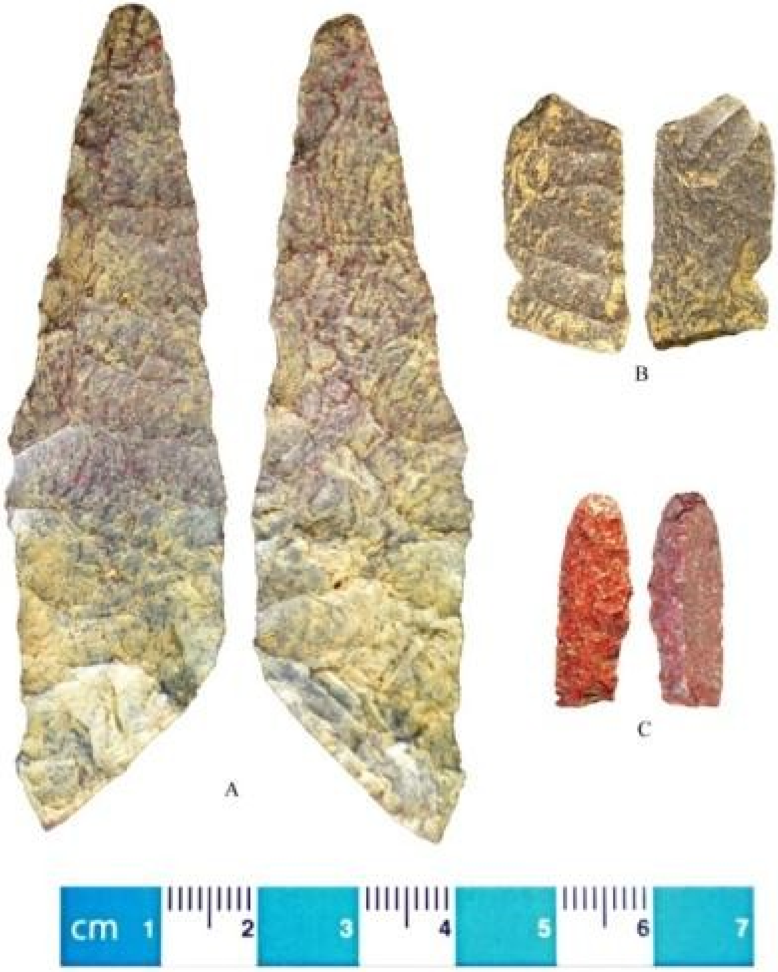


Figure 6.43: Drills manufactured from biface fragments A) narrow point/knife preform which was bevelled and narrowed on the edges (Artifact #12314), B) lateral portion of a point/knife which has been narrowed following fracture (Artifact #51604), C) lateral edge of a biface which broke along an internal joint plane and was repurposed as a drill (Artifact #52070).

Scrapers and informal tools

The manufacture of scrapers and the informal tools do not follow either trajectory as they are unifacial or expedient tools, since they are produced from useable flakes which are by-products of bifacial reduction. Useable flakes for the manufacture of scrapers or for expedient tools can be detached from specific cores or throughout the early stages of biface manufacture (Figure 6.44). There is also evidence of blades used in the production of scrapers. These blades would be produced using the same process to obtain blanks for the drills. They would have been too short and narrow for the production of projectiles and knives, and too thin and wide for drills. These blades were quickly pressure flaked into a thumbnail scraper. While there is not much evidence of recycling at the site, the most notable exception is bifacial tool fragments which have been reworked into scrapers. This includes large mid-stage biface fragments (Figure 6.45: A) and projectile point fragments (Figure 6.45: B).

Figure 6.44: Scrapers found at Mackenzie I manufactured directly from large flakes (Artifact #5062, 52035, 13554, 14875, 43185, 74960).

Figure 6.45: Scrapers manufactured from bifacial tool fragments A) manufactured from early to mid-stage biface fragments (Artifact #41520/41521, 52120, 48500) B) manufactured from formal tool fragments (Artifact #5221, 24554, 36707, 44122, 51592, 51718, WHS-03224, WHS-07264).

6.4.3 Mackenzie I Blade Technology

There is significant evidence for the presence of a blade technology industry within the Mackenzie I assemblage that will have implications for other Lakehead Complex assemblages. A specialized conical or polyhedral blade core was not identified from Mackenzie I, but there is a significant presence of blades and tools manufactured from blades within the assemblage. Further analysis of the assemblage may reveal that blade cores were present, but not recognized during cataloguing. The Blade technology from Mackenzie I could also be described as rudimentary blade technology (Fox, 1975) Blade manufacture requires high quality material and a specially prepared core (Collins, 1999). The Gunflint Formation cherts have bands of high quality material, allowing for the manufacture of both blades and blade/flakes. Joint planes on the top of the tabular blocks act as a natural striking platform. The blocks are square or rectangular with natural ridges on the corners that allow for a natural starting point. Usually, initial blade removal from cores requires the manufacture of a ridge through specialized preparatory flake removal, creating the iconic conical blade core (Figure 4.13). The initial blades removed from the corner of the Gunflint Formation tabular blocks mitigate the need to create this specialized ridge. There is evidence of use wear on some blades and would be classified as informal tools (Figure 6.46). The RLF site (DdJf-13) located less than 1 km west of Mackenzie I further supports the presence of a blade technology within the Lakehead Complex. A large core was found with what appeared to be a blade scar on one face, further examination revealed that there was an additional 2 to 3 flakes removed in close proximity. A blade that was too thin and narrow to manufacture into a formal tool was also discovered nearby, and refitted to the core. These objects are discussed further in the RLF site report (Lints, 2013) and also by Langford (2014). See Figure 6.47 for the core and the refitting of the blade.

Figure 6.46: Blades from Mackenzie I which have not been worked any further (Artifact #803, 2996, 3798, 51601/51602).

Figure 6.47: RLF blade core and blade refitting to the core, picture courtesy of Langford, 2014.

Drill preforms exhibit attributes indicating that many of them were the product of initial blade removal from the corner of a core. These specimens exhibit a narrow thin trihedral cross-section with the ventral surface and/or one or both edges being a joint plane. The dorsal surface has a ridge that represents a flake scar left from the removal of other blades. The edges are then worked using serial pressure flaking, shaping the piece into one or more drill profiles (Figure 6.48).

Figure 6.48: Drills made from blades (Artifact #13954/18031, 51277, 51597, 51603).

The small thumbnail scrapers (a unifacial tool) are a product of the blade technology, while the broad, robust scrapers are produced from thick spatulate flakes. Certain blades that would have been too thin and broad to manufacture a working drill were selected for the manufacture of endscrapers. It may be that they were initially used as an informal tool and following use fracture a piece was then made into a scraper (Figure 6.46).

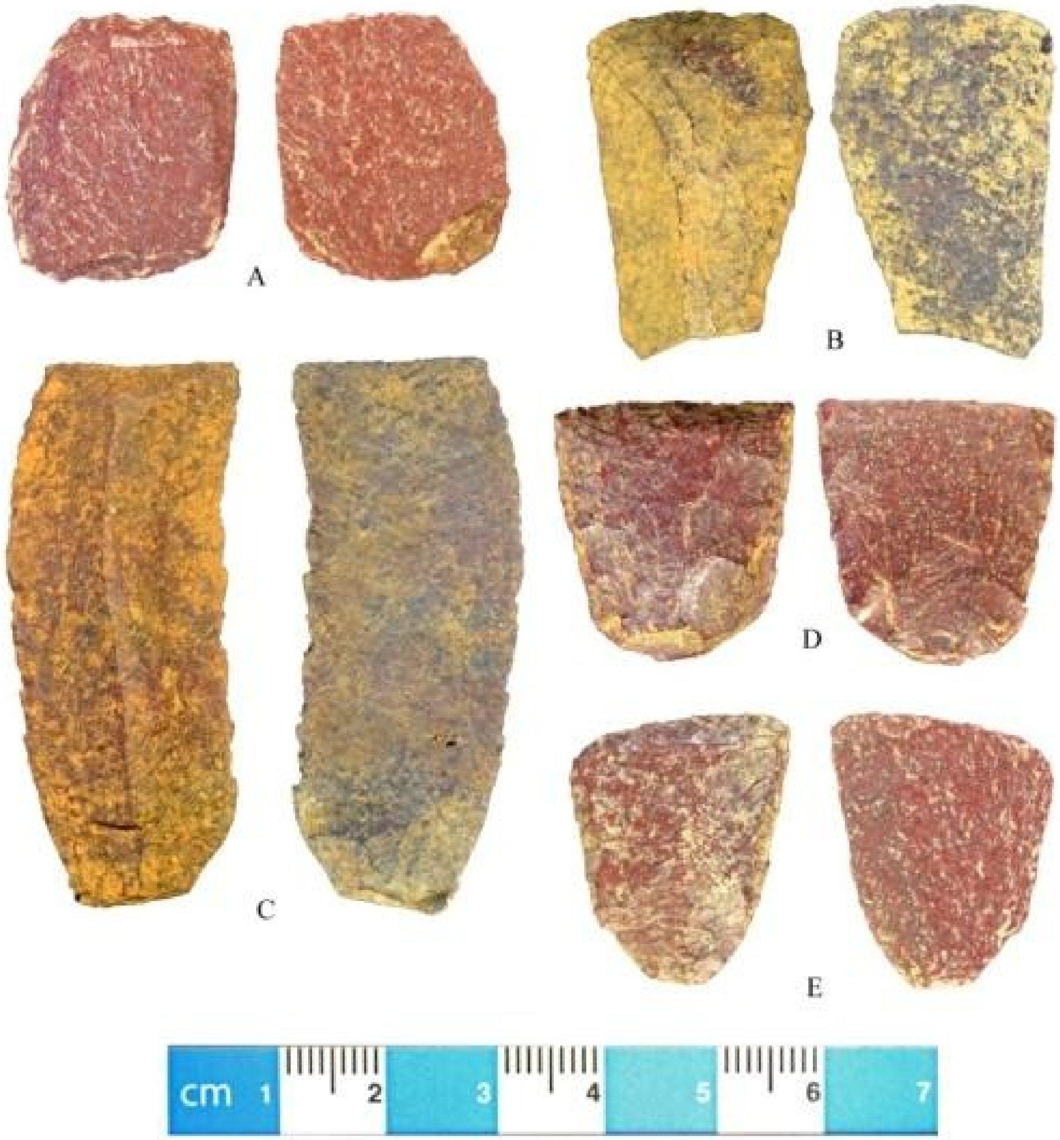


Figure 6.49: Scrapers made from blades (Artifact #26053, 46892, 48740, 51631, 60101).

The presence of a blade technology at Mackenzie I indicates the presence of a northern expression of Paleoindian blade technology. Collins (1999) indicates that Paleoindian blade technology was limited to southern Plains Clovis. The discovery of Paleoindian blade caches and blade technology at sites outside of the southern United States indicates that this was far more prevelant both across time and space. Blade technology has been identified at Paleo Crossing in Ohio (Brose, 1994; Tankersley and Holland, 1994; Eren et al. 2005), the Martins site in Missouri (Kay and Martens, 2004), and at the Pelland Cache in Minnesota (Schneider, 1982; Stoltman, 1971; Kilby and Huckell, 2013. Kilby and Huckell

(2013) summarize the presence of blade technology throughout the United States including East Wennatchee in Washington, the Anzick site in Montana and the Beach site in North Dakota. The presence of a Paleoindian blade technology in northwestern Ontario further increases the time and space distribution of this aspect of lithic manufacture techniques.

6.5 OVERALL TRENDS IN ATTRIBUTE EXPRESSION

The non-metric attributes that aid in determining the stages of manufacture as well as the cultural affiliation are discussed in greater detail. These include the degree and methods of platform preparation, the intentional use of overshot flaking to aid in thickness reduction, and the methods of basal manufacture. The raw material is discussed in greater detail since the quality and uniformity varies so greatly within the Gunflint Formation that understanding the raw material greatly aids in the determination of manufacture trajectory. The use of overshot/full-face flaking is often combined with longitudinal flakes in an attempt to remove medial ridges that plague the material. Overshot/full-face flaking methods and longitudinal flake removals were used to fix errors caused by the nature of the raw material. Step stacks and stacks created by the quality of the raw material can only be removed by cutting under the flaw from either the end of the piece or the opposite edge.

6.5.1 Flaking Patterns Present

It has been previously noted that the parallel oblique flaking pattern is a distinguishing attribute found on Lakehead Complex projectile points. Random flaking and co-medial flaking patterns have been observed on the projectile points, albeit rarely. The question that has arisen is when the parallel oblique pattern appears in the reduction sequence. The flaking patterns were observed as exclusively present, or whether they appeared in combination. Table 6.9 shows the presence of individual flaking patterns, while Table 6.10 shows the presence of the combinations of flaking patterns.

Table 6.11: Breakdown of Individual Flaking Patterns, observed on the Mackenzie I biface assemblage Co-Medial (CM), Parallel Oblique (PO) Random (R) Indeterminate (IND) and Overshot (OV)

	Flaking Pattern				
	CM	PO	R	IND	OV
Stage 1	0	0	9	0	0
Stage 2	4	0	95	0	20
Stage 3	41	7	167	0	62
Stage 4	30	15	60	0	32
Stage 5	19	50	6	0	6
Stage 6	47	229	27	4	0
ANM	4	0	9	1	1

Table 6.12: Breakdown of Combined Flaking Patterns, observed on the Mackenzie I biface assemblage PO/CM (Parallel Oblique and Co-medial, PO/R (Parallel Oblique and Random), PO/CM/R (Parallel Oblique, Co-medial and Random, CM/R (Co-medial and Random)

	Flaking Pattern			
	PO/CM	PO/R	PO/CM/R	CM/R
Stage 1	0	0	0	0
Stage 2	1	0	0	3
Stage 3	3	1	0	6
Stage 4	14	1	0	8
Stage 5	17	6	0	4
Stage 6	78	74	6	7
ANM	1	0	0	1

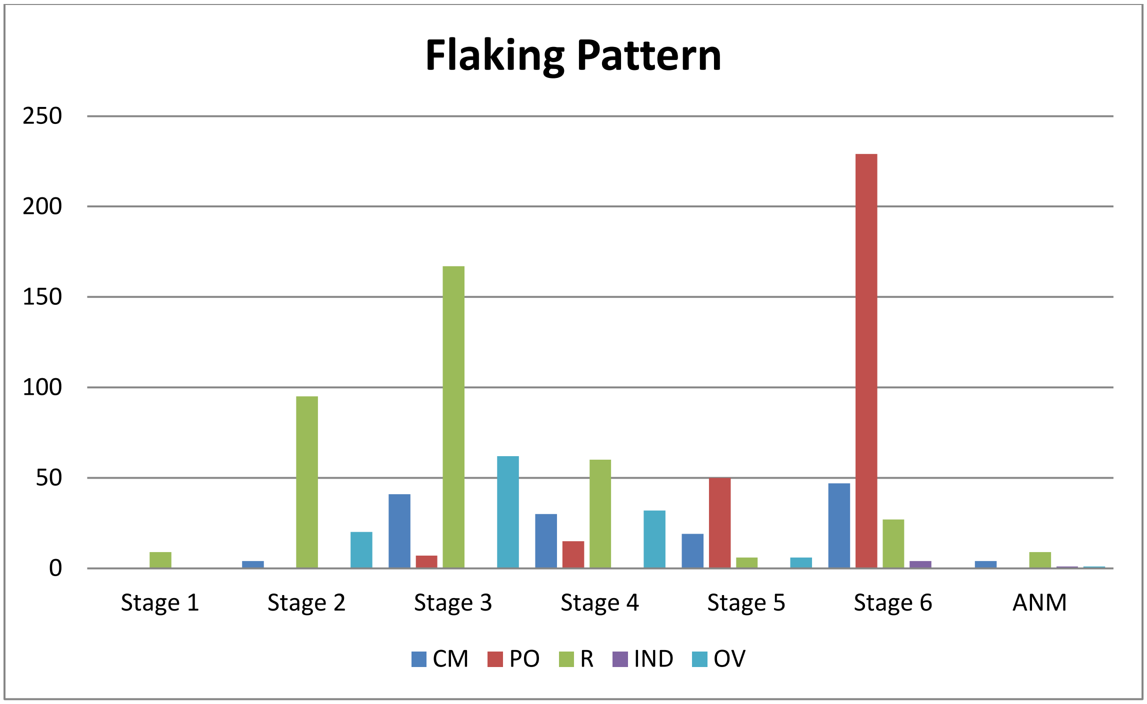


Figure 6.50: Bar graph illustrating the overall flaking patterns observed at Mackenzie I: Co-medial flaking (CM), parallel oblique flaking (PO), random flaking (R), indeterminate flaking (IND), and overshot flaking (OV).

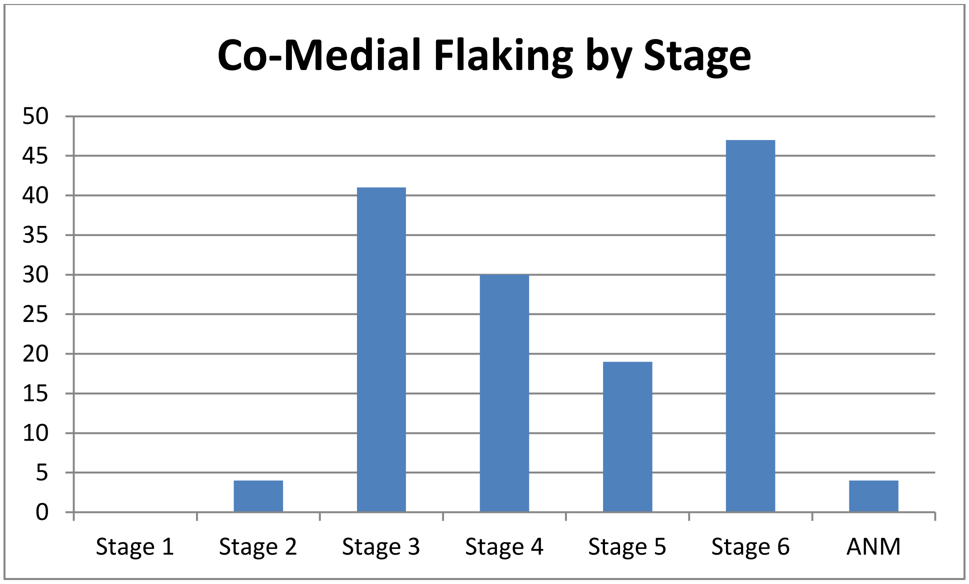


Figure 6.51: Bar graph demonstrating the frequency of co-medial flaking by Stage.

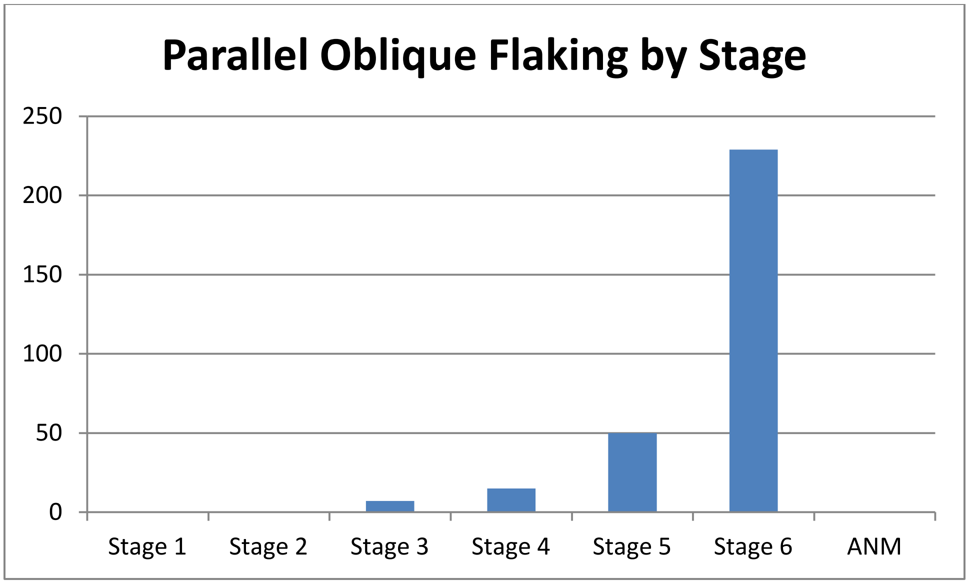


Figure 6.52: Bar graph demonstrating the frequency of parallel oblique flaking by Stage.

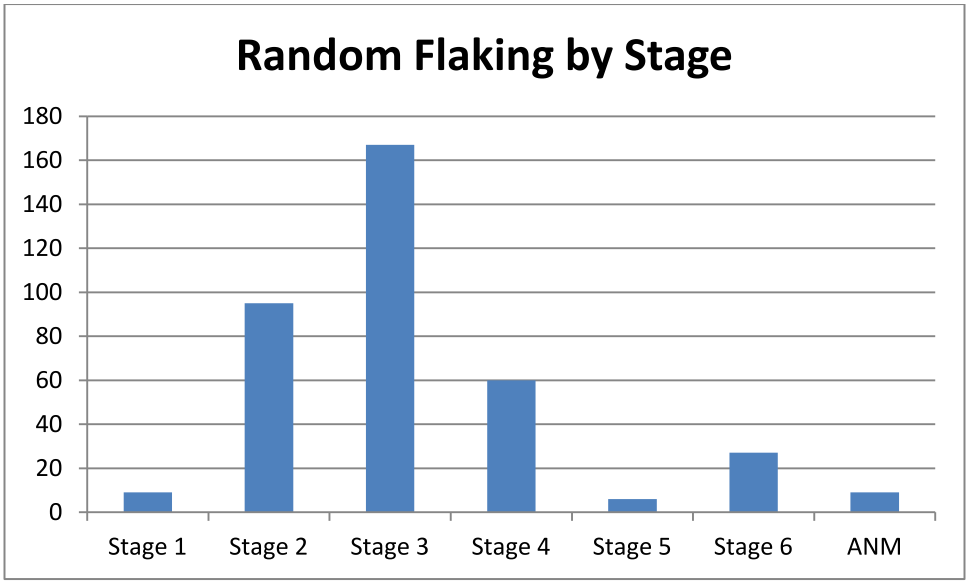


Figure 6.53: Bar graph demonstrating the frequency of random flaking by Stage.

As per Markham (2013) the presence of parallel oblique flaking has been observed on the majority of the formal tools. This has been a trait of the Lakehead Complex since MacNeish (1952) excavated a portion of the Brohm site, and following the identification of this complex by Fox (1975). The question of where it enters the reduction sequence has lingered.

Analysis of the bifaces has demonstrated that parallel oblique flaking patterns are observed first at Stage 3. Exclusively parallel oblique flaking is observed on only 7 bifaces in Stage 3. It is observed as being present in combination with co-medial (n=3) and random (n=1) in Stage 3 bifaces (see Table 6.11). A combination of parallel oblique flaking is observed with co-medial flaking on a single Stage 2 specimen (see Table 6.12). The presence of this pattern of flaking increases dramatically in the latter stages of manufacture, doubling in Stage 4 (n=15) and tripling in Stage 5 (n=49) while in Stage 6 it was present on 231 specimens. Combinations of the flaking patterns followed much the same pattern, with the presence of parallel oblique flaking increasing as the biface was reduced and the presence of random flaking decreasing as reduction proceeded as can be observed in Table 6.12.

The observed flaking patterns on the Mackenzie I material are Co-Medial (CM), Parallel Oblique (PO), and Random (R). Overshot (OV) flaking was observed as being present or absent rather than as a part of the flaking pattern. Pressure flaked edge retouch is also used throughout the sequence becoming more prevalent in Stage 3 (Figure 6.50). Initial flake removal in Stage 2 (Figure 6.20) and Stage 3 (Figure 6.21) were random and followed what the stone was telling the knapper. The Gunflint Formation cherts are difficult to work and initial reduction needs to proceed based on the quality of the material. Once the edge is regularized and edge preparation becomes more prevalent knappers can better assert their will on the stone. There are times where even careful edge preparation will result in a flaw which has to be removed. In these cases overshot and longitudinal flake removal is employed along with random flake removal, again doing what the stone will allow.

The analysis of the Stage 2 bifaces (n=102) revealed that there was co-medial flaking present individually on 5 (5%), while Random flaking was present on 92 (90%), as a combination there was 1 (1%) with PO/CM and 4 (4%) with CM/R (Figure 6.50). Overshot flaking was observed on 19 (19%) Stage 2 bifaces while the remaining 83 (81%) had no evidence of this type of flake removal. See Figures 6.2, 6.25, and 6.31 for highlighted Stage 2 flaking patterns.

The analysis of the Stage 3 bifaces (n=225) revealed that there was co-medial flaking present individually on 41 (18%), parallel oblique was present on 7 (3%) while Random flaking was present on

167 (74%), with 1 (.5%) being indeterminate, as a combination there was 3 (1%) with PO/CM, 1 (.5%) with PO/R and 6 (3%) with CM/R (Figure 6.50). Overshot flaking was observed on 62 (28%) Stage 3 bifaces while the remaining 163 (72%) had no evidence of this type of flake removal. See Figures 6.5, 6.26, and 6.32 for highlighted Stage 3 flaking patterns.

The analysis of the Stage 4 bifaces (n=130) revealed that there was co-medial flaking present individually on 30 (23%), parallel oblique was present on 15 (12%) while Random flaking was present on 62 (48%), as a combination there was 14 (11%) with PO/CM, 1 (1%) with PO/R and 8 (6%) with CM/R (Figure 6.50). Overshot flaking was observed on 32 (25%) Stage 4 bifaces while the remaining 98 (75%) had no evidence of this type of flake removal. See Figures 6.9, 6.27 and 6.33 for highlighted Stage 4 flaking patterns.

The analysis of the Stage 5 bifaces (n=102) revealed that there was co-medial flaking present individually on 20 (20%), parallel oblique was present on 49 (48%) while Random flaking was present on 6 (6%), as a combination there was 17 (17%) with PO/CM, 6 (6%) with PO/R and 4 (4%) with CM/R (Figure 6.50). Overshot flaking was observed on 6 (6%) Stage 5 bifaces while the remaining 96 (94%) had no evidence of this type of flake removal. See Figures 6.13, 6.28 and 6.34 for highlighted Stage 5 flaking patterns.

The analysis of the Stage 6 bifaces (n=482) revealed that there was co-medial flaking present individually on 48 (10%), parallel oblique was present on 231 (48%) while Random flaking was present on 34 (7%), with 5 (1%) being indeterminate, as a combination there was 77 (16%) with PO/CM, 74 (15.3%) with PO/R, 6 (1.3%) with PO/CM/R, and 7 (1.4%) with CM/R (Figure 6.50). Overshot flaking was not observed on any of the Stage 6 bifaces. The flaking pattern was broken down by tool type as well to further illustrate where the parallel oblique flaking was most commonly used and to show the discrepancy observed with the 34 formal tools that had random flaking. Table 6.13 reveals that knives and points have the majority of the parallel oblique flaking pattern while the drills are largely all flaked co-medially. The formal tools that exhibit random flaking patterns include only 7 projectiles and the 12 of the 13 adzes. The scrapers which are present are those that are bifacially worked, either being mid stage fragments reworked into scrapers on the transverse hinge fracture, or projectile point fragments that have been re-purposed as a scraper. See Figures 6.35-6.40 and 6.42 for highlighted Stage 6 flaking patterns.

Table 6.13: Flaking Patterns breakdown in the Biface Trajectory, Co-Medial (CM), Parallel Oblique (PO) Random (R) Mixed flaking with parallel oblique (MPO) Mixed flaking with Co-Medial (MCM)

	Flaking Pattern				
	CM	PO	R	MPO	MCM
Stage 1	0	0	0	0	0
Stage 2	3	0	74	1	1
Stage 3	35	4	140	3	4
Stage 4	16	5	45	4	4
Stage 5	1	19	3	10	0
Stage 6	3	31	17	35	0
ANM	4	0	6	1	1

Table 6.14: Flaking Patterns breakdown in the Flake/Blade Trajectory, Co-Medial (CM), Parallel Oblique (PO) Random (R) Mixed flaking with parallel oblique (MPO) Mixed flaking with Co-Medial (MCM)

	Flaking Pattern				
	CM	PO	R	MPO	MCM
Stage 1	0	0	0	0	0
Stage 2	1	0	21	0	2
Stage 3	6	3	27	1	2
Stage 4	14	10	15	11	4
Stage 5	18	31	3	12	4
Stage 6	43	81	3	55	6
ANM	0	0	1	0	0

Table 6.15: Breakdown of Flaking Patterns by tool type, Co-Medial (CM), Parallel Oblique (PO) Random (R) Indeterminate (IND) Not Available (N/A)

	Flaking Pattern							
	CM	PO	R	IND	PO/CM	PO/R	PO/CM/R	CM/R
Point	6	220	7	4	70	67	6	1
Knife	1	4	1	1	3	0	0	0
Drill	39	4	2	0	4	2	0	6
Adze	1	0	12	0	0	0	0	0
Gouge	0	0	2	0	0	3	0	0
Scraper	1	3	3	0	0	2	0	0

6.5.2 Platform Preparation Methods

Fox (1975) first noted the presence of platform preparation that is indicative of the Lakehead Complex. Hinshelwood and Webber (1987) expanded on what platform preparation methods are commonplace. These include grinding the edge to isolate a platform and pressure flaking to manufacture the alternate edge bevel. Platform preparation was observed as being ground (G), as having bevelled retouch (BR), or as a combination (G/BR).

Table 6.16: Breakdown of Platform Preparations Used: Ground (G), Retouched (R), Ground and Retouched (G/R)

	Platform Preparation			
	G	R	G/R	Absent
Stage 1	0	0	0	15
Stage 2	19	9	1	74
Stage 3	63	29	15	118
Stage 4	43	29	20	36
Stage 5	22	26	28	24

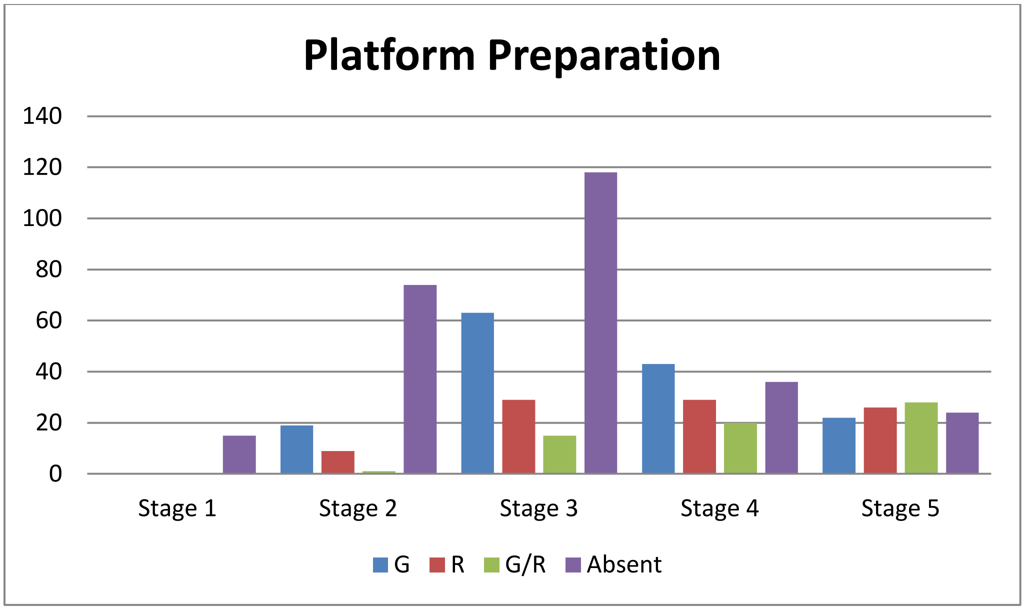


Figure 6.54: Bar graph illustrating the platforms preparation methods on the overall assemblage: Grinding (G), bevelled retouch (R), combination of grinding and beveled retouch (G/R).

Grinding and edge retouch for platform preparation is observed on Stage 2 (Figures 6.2, 6.25 and 6.31) pieces in both trajectories though it is rare (Table 6.14). Grinding is present in Stage 6 materials though this is largely the result of methods of hafting and preparation for use in non-hafted tools, while edge retouch is present as a methodof sharpening and recycling. For these reasons Stage 6 grinding and edge retouch were not included in the Platform Preparation discussion. As can be observed in Table 6.14 the presence of edge preparation increases as the biface becomes more refined. In the Stage 2 bifaces (n=102) this was present on 29 (28%) artifacts and absent on 73 (72%). The Stage 3 bifaces (n=225) exhibited edge preparation on 107 (48%) artifacts while 118 (52%) were absent of signs of edge preparation. The Stage 4 bifaces (n=130) exhibited edge preparation on 92 (71%) artifacts while 38 (29%) were absent of signs of edge preparation. The Stage 5 bifaces (n=102) exhibited edge preparation on 57 (56%) artifacts while 45 (44%) were absent of signs of edge preparation. Even though the stage 3 bifaces skew the data it does reveal a pattern of more extensive edge preparation in the latter stages of manufacture. The higher frequency of Stage 3 bifaces is explained earlier as the stage where the highest amount of failure is revealed (Figure 6.51). The presence of edge preparation was also broken down into the two manufacture trajectories.

The breakdown for the Biface Trajectory can be observed in Table 6.15 while Table 6.16 shows the breakdown for the Flake/Blade Trajectory. In the biface trajectory the Stage 2 bifaces (n=78) had edge preparation present on 24 (31%) artifacts and absent on 54 (69%). Stage 3 bifaces (n=186) there were 85 (46%) with edge preparation and 101 (54%) where it was absent. The Stage 4 bifaces (n=75) had it present on 51 (68%) and absent on 24 (32%) artifacts. The Stage 5 bifaces (n=34) had edge preparation present on 22 (65%) and absent on 12 (35%) artifacts. In the Flake/Blade Trajectory the Stage 2 bifaces (n=24) had edge preparation present on 5 (21%) artifacts and absent on 19 (79%). Stage 3 bifaces (n=39) there were 22 (56%) with edge preparation and 17 (44%) where it was absent. The Stage 4 bifaces (n=55) had it present on 41 (75%) and absent on 14 (25%) artifacts. The Stage 5 bifaces (n=67) had edge preparation present on 35 (52%) and absent on 32 (48%) artifacts. This further reinforces the pattern observed on the overall biface assemblage with an increase in edge preparation as the biface was reduced.

The data shows that in Stage 3 edge grinding first appears (Figures 6.5, 6.28 and 6.32), it increases in Stage 4 and is accompanied by alternate edge bevelling (Figures 6.9, 6.12, 6.27 and 6.33). Grinding is present in Stage 5 and is also accompanied by alternate edge bevelling but it is slightly obscured (Figure 6.13, 6.15, 6.28, and 6.34). This could be a result of more extensive use of Stage 5 bifaces resulting in edges which were uniform but had no signs of retouch or grinding. As a method used in the production of bifaces edge preparation is used to control the depth and extent of serial patterned flaking which explains its presence in the latter stages of manufacture where patterned flake removal is more prevalent.

The high point of the bevel was used as the platform to remove the first set of flakes. The alternating pattern was continued as the flakes travelled across the midline following a parallel oblique pattern. In some cases these travelled full face, for those that did not the opposite edge was retouched in order to feather flakes into the flake scar from the opposite edge thus completing the pattern. This method of edge preparation was largely observed in Stage 4 (Figure 6.12) and Stage 5 (Figure 6.15). In the biface trajectory, employing the alternate edge bevel resulted in a slightly twisted profile. In the Flake/Blade trajectory the twist, that was already present due to the morphology of the blank, was exaggerated through the process of edge bevelling.

Table 6.17: Biface Trajectory Platform Preparations: Ground (G), Retouched (R), Ground and Retouched (G/R)

	Platform Preparation			
	G	R	G/R	Absent
Stage 1	0	0	0	9
Stage 2	17	6	1	55
Stage 3	54	20	11	101
Stage 4	26	14	11	23
Stage 5	11	7	7	8

Table 6.18: Flake/Blade Trajectory Platform Preparations: Ground (G), Retouched (R), Ground and Retouched (G/R)

	Platform Preparation			
	G	R	G/R	Absent
Stage 1	0	0	0	6
Stage 2	2	3	0	19
Stage 3	9	9	4	17
Stage 4	17	15	9	13
Stage 5	13	18	21	16

6.5.3 Use of Joint Planes

Flaws in Gunflint Formation materials include joint planes, iron-oxide inclusions and quartz veins. These flaws are the main cause for failure in bifaces and can be a factor in both breakage and rejection of bifaces. The joint planes were used as striking platforms despite the propensity for failure. The nature of blank removal resulted in joint planes being present on one or both edges and often on the entire ventral surface. A corner would have been chosen for the initial strike and depending on the quality may have resulted in a blade or in a tabular blank. Joint planes on the edge of an early stage biface can be observed in Stage 2 (Figures 6.2 and 6.25), Stage 3 (Figures 6.7 and 6.26) and as a remnant in Stage 4 (Figure 6.12).

Joint planes present on an edge were often used as a platform for flake removal. In Stage 2 it was necessary to remove the flat blocky edge of the joint plane. It was never completely removed though, and can remain on Stage 5 Preforms. In some rare cases they have been observed on formal tools. Table 6.17 illustrates the presence of both cortex and joint planes on the Staged bifaces, a number of the un-staged fragments have joint planes on the edge. These pieces fractured off the biface along a joint plane which was present near the lateral edge. Where there is a joint plane noted as being present in the edge it was observed that this joint plane was also used as a platform for flake removal.

Table 6.19: Showing the presence of cortex and joint planes on bifaces by Stage. Cortex (C) Joint plane on Face (JF), Joint plane on End (JE), Joint plane used as a Platform (JP)

	Cortex/Joint Plane Present					
	C	JF	JE	Potlids	Absent	J/P
Stage 1	11	3	4	0	3	4
Stage 2	26	34	34	0	35	34
Stage 3	45	27	55	0	112	56
Stage 4	21	11	24	0	64	24
Stage 5	16	4	20	0	50	20
Stage 6	15	1	6	32	138	8
ANM	0	0	1	0	13	1

6.5.4 Overshot/Full-face and Longitudinal Flaking Methods

Overshot flaking was observed on specimens from the Mackenzie 1 assemblage. This manner of flake removal enables removal of very little of the width while rapidly thinning the specimen. This method has been observed throughout the Paleoindian period but arguments have arisen as to whether it was purposeful or expedient. Though it has been identified as being diagnostically Clovis (Collins, 1999; Callahan, 1979) this idea has been questioned as it has been observed throughout the Paleoindian period (Eren et al., 2011; Bamforth, 2009; Muniz, 2014; Bradley, 2009; 2010). Table 6.9 indicates the presence of overshot flaking and the stage of reduction they are observed on. In Stage 2 there were 19 specimens 18% that had observable overshot flaking (Figures 6.2 and 6.25). This number significantly increased in

Stage 3 (n=62) 28%, (Figures 6.7 and 6.26) it dropped to only 32 in Stage 4 25 % and was observable as remnants on 6 of the Stage 5 specimens 6%.

The increased frequency of overshot flaking at Stage 3 indicates that it was purposeful, perhaps to enable removal of accumulation of step-fractured material along the midline, or the opposite edge of the specimen. Its purposeful role in biface reduction is further supported by its appearance on specimens at Stage 4 (Figures 6.11 and 6.27) and also as a remnant trait in the Stage 5 specimens (Figure 6.28). That it is not observed on more than 30% of specimens in any stage indicates that it was not a method widely utilized but that it was a reduction method that was employed when the nature of the raw material required it. The usual method observed in Clovis age materials is to have a series of 2 to 3 overshot flakes on one or both faces to significantly thin the biface. The methods of utilization in the Mackenzie 1 assemblage seem to be that of carefully preparing a platform and removing a flake in an attempt to remove a natural or manufactured flaw on the surface of the specimen.

Overshot flaking was used in combination with longitudinal flaking as methods to remove flaws exposed during the reduction sequence. The longitudinal flaking is very similar to the removal of blades on prepared cores, as well as methods used by Clovis and Folsom groups to flute the projectile points. The end of the specimen was carefully prepared with a specific platform that was then ground and often bevelled to facilitate the removal of a long flake (Figures 6.25-6.28). The longitudinal flake scars are more like blade removal than flute removal, and would have resulted in detached flakes that are long, narrow and with a central ridge. The longitudinal flake removals were also used a basal thinning method in combination with retouch flaking and bevelling.

6.5.5 Basal Treatment Methods

Basal thinning methods are usually observed in the final stages of the manufacture sequence. The basal thinning methods were only observable on the specimens that were sufficiently complete to reveal the traits. Table 6.19 indicates the breakdown of the observed basal thinning methods both individually and in combination. These were observed as being present dorsally, ventrally or both. These were then observed as being present in combination with bevelling and which face the bevel was on. Bifaces lacking a basal end are observed as being not available (N/A). Where there is a basal end present and no observed basal thinning methods they are treated as being absent. The higher presence of basal thinning in the mid stages and its heavy representation at Stage 6 indicates that it was used in the preparation of the hafted bifaces. The bevelling appears to be a unique trait in the Mackenzie 1 reduction sequence. This method involves the deliberate fracture of one end of the specimen. Evidence suggests that this occurred at the end of Stage 4 manufacture or early in Stage 5. The basal end was fractured off, creating a bevelled fracture plane which was then used as a platform for basal thinning flake removal. See Figure 6.16 for the specific methods of basal treatment in Stage 5 to setup the base for thinning and shaping of the hafting portion.

The presence of a bevel was observed on only 3 Stage 3 specimens and 7 Stage 4 specimens. Basal thinning scars were observed on either the dorsal or ventral surface on all stages of manufacture. The combination of a bevelled end with thinning scars was observed to varying degrees. The bevel is largely present in combination with dorsal flake scars and a ventral bevel. While the reverse pattern was observed, it was less frequently observed. Thinning scars were present on both faces with the greatest number being on the Stage 6 specimens. It is unclear by this stage of manufacture whether there would have been a bevelled platform for the initial basal thinning scars. Of the Stage 6 bifaces only 5 specimens had an observable bevel with dorsal thinning scars, while the rest of the Stage 6 bifaces had only thinning scars.

The production of the projectile points requires basal thinning in order to facilitate hafting of the point (Markham, 2013). This can be observed within the reduction sequence earlier than the final stage of manufacture. In some cases it may be that there was a portion of the biface that was too thick, and required an extra degree of flaking.

The standard process is to reduce the thickness of one end while maintaining width, and then proceed with the retouch shaping of the base. On a number of bifaces it appears that the process may have involved the purposeful fracture of one end, or as in Agate Basin, the manufacture of an elongated preform which is then fractured into sections to be reduced into points. The biface trajectory resulted in bi-pointed Stage 3 and 4 bifaces while the majority of the Stage 5 preforms have a flat base and a pointed tip, except those which are clearly knife preforms that retain the bi-pointed features of the previous stages. Tables 6.21 and 6.22, show the breakdown of the basal thinning methods, by production trajectory. There is usually a correlation between those with a bevel and those that exhibit longitudinal basal thinning scars. Once the piece moves into the formal tool preparation both faces generally have evidence of thinning thus resulting in the absence of a bevel. A large portion of the projectile point assemblage consists of tips and midsection fragments for which a refit was not identified. This portion of the assemblage makes up the 250 pieces described as being Not Available (N/A) in Table 6.19. Table 6.20 illustrates the Stage 6 tool type breakdown within the basal thinning category. The 199 projectile points with an N/A for basal thinning include tips and midsections and refitted tips and midsections for which no base was identified. This applies to the 34 drills as well, the majority of which have no identified base. The 34 formal tools for which basal thinning was absent include 17 adzes which are a tool type with no basal thinning for hafting. The presence of scrapers is again due to reworking of bifacial tools into a scraper, the pieces which have basal thinning are the base of projectile points which were repurposed as a scraper.

Table 6.20: Basal thinning methods observed on the Mackenzie I biface assemblage. Not available (N/A), Bevelled (B), Dorsal thinning scars (D), Ventral thinning scars (V), Dorsal thinning scars with ventral bevel (B/D), Ventral thinning scars with Dorsal Bevel (B/V), Thinning scars on both faces (D/V).

	Basal Thinning							
	Absent	N/A	B	D	V	B/D	B/V	D/V
Stage 1	15	0	0	0	0	0	0	0
Stage 2	20	76	0	3	2	1	0	1
Stage 3	27	164	3	12	4	10	2	3
Stage 4	12	72	7	16	3	8	1	9
Stage 5	20	48	0	8	7	9	2	7
Stage 6	29	250	0	5	2	5	0	181
ANM	5	7	0	1	0	2	0	1

Table 6.21: Basal thinning methods by tool type. Not available (N/A), Bevelled (B), Dorsal thinning scars (D), Ventral thinning scars (V), Dorsal thinning scars with ventral bevel (B/D), Ventral thinning scars with Dorsal Bevel (B/V), Thinning scars on both faces (D/V).

	Basal Thinning							
	Absent	N/A	B	D	V	B/D	B/V	D/V
Point	4	199	0	0	0	0	0	175
Knife	4	5	0	1	0	0	0	0
Drill	4	39	0	3	1	4	0	7
Adze	12	1	0	0	0	0	0	0
Gouge	0	4	0	0	1	0	0	0
Scraper	1	5	0	1	0	1	0	3

Table 6.22: Basal thinning methods in the Biface Trajectory. Not available (N/A), Bevelled (B), Dorsal thinning scars (D), Ventral thinning scars (V), Dorsal thinning scars with ventral bevel (B/D), Ventral thinning scars with Dorsal Bevel (B/V), Thinning scars on both faces (D/V).

	Basal Thinning							
	Absent	N/A	B	D	V	B/D	B/V	D/V
Stage 1	15	0	0	0	0	0	0	0
Stage 2	16	57	0	3	1	1	0	1
Stage 3	17	140	2	10	3	9	2	3
Stage 4	7	44	3	10	1	6	0	3
Stage 5	2	17	0	4	3	3	0	4
Stage 6	17	11	0	0	1	0	0	57
ANM	4	5	0	0	0	2	0	1

Table 6.23: Basal thinning methods in the Flake/Blade Trajectory. Not available (N/A), Bevelled (B), Dorsal thinning scars (D), Ventral thinning scars (V), Dorsal thinning scars with ventral bevel (B/D), Ventral thinning scars with Dorsal Bevel (B/V), Thinning scars on both faces (D/V).

	Basal Thinning							
	Absent	N/A	B	D	V	B/D	B/V	D/V
Stage 1	15	0	0	0	0	0	0	0
Stage 2	4	19	0	0	1	0	0	0
Stage 3	10	24	1	2	1	1	0	0
Stage 4	5	28	4	6	2	1	1	6
Stage 5	18	30	0	4	4	5	2	4
Stage 6	11	60	0	5	1	5	0	106
ANM	0	0	0	1	0	0	0	0

6.5.6 Raw Material Quality

The raw material quality plays a very large role in the Lakehead Complex reduction sequence. As can be observed in Table 6.23 the vast majority of tools were manufactured using the local Gunflint Formation cherts and over 95% of the debitage is also of this raw material. The presence of Hixton Silicified Sandstone and Knife Lake Siltstone is largely in the form of completed formal tools, with very little debitage. The variable quality of the Gunflint Formation cherts appears to have contributed to the mix of manufacture methods employed (See Figure 3.7 and 3.8). Flake removal sets exhibit a serial pattern in the latter stages, but are far more *ad hoc* in the early stages (Table 6.24). The knapper made observations as to the fracture mechanics of the stone during the *ad hoc* flaking of the early stages of manufacture. The variability, discussed in Chapter 3 is a major limiting factor in determining the trajectory of manufacture and the methods of reduction. The flaws of either iron-oxide or quartz also put limitations on the flaking methods used in manufacture. It was observed that the coarser material, which included flaws and mixed material quality, were generally processed using the biface trajectory. The high quality silica-rich materials are generally more heavily utilized for flake/blade trajectory (comparison between Table 6.25 and Table 6.26). This was generally a result of the silica-rich material exhibiting better fracture mechanics resulting in a greater chance for the production of large blade flakes.

Table 6.24: Raw material present in the Mackenzie I Biface assemblage; Gunflint Formation cherts (GC), Siltstones (S), Hixton Silicified Sandstone (HSS), Hudson's Bay Lowland Chert (HBL)

	Material Type				
Stage	GC	S	HSS	HBL	Other
1	9	0	0	0	0
2	96	3	0	0	3
3	221	3	1	0	0
4	123	4	1	0	2
5	98	2	2	0	2
6	396	52	8	6	21
ANM	4	0	0	0	0
Unstaged	208	4		0	4

Table 6.25: Breakdown of the quality of the gunflint materials for all staged bifaces

	Quality of Gunflint Formation Material					
	Fine	Medium	Coarse	F/M	F/C	M/C
Stage 1	3	6	2	1	2	1
Stage 2	4	29	21	16	7	18
Stage 3	14	58	48	25	27	49
Stage 4	5	28	20	20	14	36
Stage 5	14	25	17	11	5	27
Stage 6*	68	72	46	25	8	9
ANM	2	2	1	1	0	1
*165 Point fragments were not analyzed						

Table 6.26: Breakdown of the quality of the gunflint materials for the Biface Trajectory

	Quality of Gunflint Formation Material					
	Fine	Medium	Coarse	F/M	F/C	M/C
Stage 1	1	5	1	0	2	0
Stage 2	3	18	17	11	7	16
Stage 3	8	48	40	22	24	41
Stage 4	2	16	10	8	8	25
Stage 5	3	8	6	2	2	11
Stage 6	8	9	31	4	1	1
ANM	1	1	1	1	0	1

Table 6.27: Breakdown of the quality of the gunflint materials for the Flake/Blade trajectory

	Quality of Gunflint Formation Material					
	Fine	Medium	Coarse	F/M	F/C	M/C
Stage 1	2	1	1	1	0	1
Stage 2	1	11	4	5	0	2
Stage 3	6	10	8	3	3	8
Stage 4	3	12	10	12	6	11
Stage 5	10	17	11	9	3	16
Stage 6	55	60	14	21	7	8
ANM	0	0	0	0	0	0

6.5.7 Recycling of Broken Biface Fragments

There is little evidence for recycling of broken biface fragments at Mackenzie I. Table 6.27 illustrates instances of recycling by stage. While it is possible that larger fragments were utilized as expedient tools after breakage or failure ,for the purposes of this analysis only those pieces that were clearly shaped into a different tool type are considered to be recycled. This holds true for the latter stages as they were clearly repurposed as a new tool type. Recycling in the earlier stages included attempts to salvage one or more fragments and continue reduction. Recycling in the latter stages involves re-tooling a biface fragment into another tool form. See Figure 6.40 and Figure 6.42 for examples of drills and scrapers reworked from other tools.

The bifaces were categorized as having recycling present, with a description of what the recycling entails (Appendix 1.3), absent, or not available (N/A). Those pieces categorized as N/A are complete pieces that were either rejected or discarded. It is possible that use-wear and/or residue analysis will reveal whether or not these pieces were utilized. There were 13 (13%) Stage 2 bifaces that showed evidence of recycling, while 12 (12%) were complete pieces. 6 edge blanks showed evidence of reworking the fragment into another tool form, while the remaining 7 pieces only show evidence of attempts to continue reduction post-breakage. 27 (12%) Stage 3 bifaces have evidence of recycling post-breakage and there were 11 (5%) that were complete. Of these 27 artifacts 3 have been clearly reworked

(1 scraper, 1 drill/perforator, 1 scraper preform), 5 have possible evidence of use-wear and/or retouch indicative of use as an expedient tool, while the remaining 19 artifacts have evidence of flaking post-breakage indicative of attempts to continue reduction. Only 6 (5%) of the Stage 4 bifaces showed evidence of reworking post-breakage while there were 14 (11%) that were complete and had no signs of re-working. Of the 6 pieces which have evidence of flaking post-breakage only 2 show attempts at reworking into another tool form, the remaining 4 all show evidence of attempts to salvage the piece and continue reduction until eventual rejection. The Stage 5 bifaces had 8 (8%) pieces that show evidence of recycling and 8 (8%) pieces that were complete and show no signs of reworking. Of the 8 specimens in this stage, 6 show clear evidence of reworking into another tool form (scrapers and drills) while the remaining 2 have evidence of possible use-wear and/or retouch on one portion of the biface. Of the Stage 6 bifaces there were 16 (3%) that show evidence of flaking post-breakage while there were 56 (12%) that were complete discarded/lost tools. All 16 of the Stage 6 fragments with evidence of recycling were reworked into another tool form with 13 being reworked into scrapers, 1 into a drill and the remaining 2 only showing evidence of retouch and/or use-wear.

Table 6.28: Breakdown of the recycling of biface fragments by stage at Mackenzie I on the left, breakdown of Stage 6 formal tool recycling on the right.

	Recycling		
	Absent	Present	N/A
Stage 1	13	2	0
Stage 2	77	13	13
Stage 3	187	27	11
Stage 4	110	6	12
Stage 5	86	8	8
Stage 6	402	16	54
ANM	9	2	5

	Tool Assemblage		
	Broken	Discard	Reworked
Point	339	39	9
Knife	5	5	0
Drill	51	5	3
Adze	6	7	0
Gouge	5	0	0
Scraper	38	60	11
Retouched Flakes	194	94	0

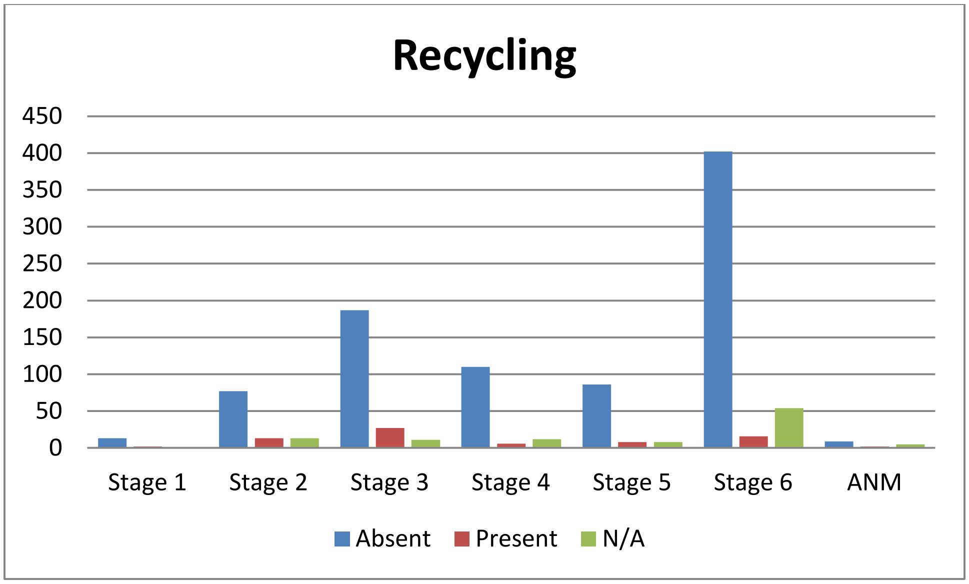


Figure 6.55: Bar graph illustrating the presence of recycling at Mackenzie I

6.6 SUMMARY

In summary the analysis of the Mackenzie I biface assemblage revealed that there were two trajectories of manufacture utilized to produce the tool kit. The Biface Trajectory follows that which was previously established for the Lakehead Complex by Hinshelwood and Webber (1987), Hinshelwood (1989), and Hinshelwood and Ross (1992). This method utilizes large tabular blanks and systematically reduces these into refined formal tools, including adzes, knives, projectile points and gouges. Adzes and other large chopping tools are produced using these blanks with the reduction halting before completion of Stage 3 thinning, while all other formal tool categories are fully reduced.

The Flake/Blade Trajectory utilizes thin flakes, blade-flakes (Callahan, 1979) and blades in the manufacture of specific formal tool types. These blanks are much thinner and regular methods of direct percussion flaking would result in a high degree of failure. For this reason these blanks were thinned using percussion flaking or indirect percussion. Knives, projectile points and drills were produced near exclusively using this method of manufacture. Hinshelwood and Webber (1987) noted the presence of blade-like blanks at Biloski (DcJh-16) and noted that these likely entered the sequence at Stage 3 as they were sufficiently thin. Since it appears that such blanks were not propitious accidents but the result of careful core selection and blank removal it would appear that there was a specific method of reduction used to handle these blanks.

The analysis of the assemblage revealed that the rudimentary blade technology (Fox, 1975) of the Lakehead Complex was in fact relatively complex. A large number of blades have been found within the Mackenzie I lithic assemblage. This includes utilized flakes, scrapers manufactured from blades and blades with no evidence of use or retouch. To date there have been no polyhedral blade cores identified as being part of the Mackenzie I assemblage but the overwhelming presence of blades would suggest that this method of flake removal was an understood part of the reduction process. The core assemblage largely remained with the debitage and was only given a cursory analysis while searching for bifaces misidentified as cores. It is possible that further analysis of the core assemblage will reveal that polyhedral cores are in fact present.

There is no large presence of recycled tools or of biface fragments in the Mackenzie I assemblage, indicating that raw lithic material was in abundant supply. The majority of recycled pieces include projectile point fragments reworked into scrapers, while a small number show reworking into drills or drill preforms. Projectile points manufactured from Hixton Silicified Sandstone show a high degree of re-sharpening with the intention of maintaining the projectile point functionality of the piece. This is in stark contrast to the projectile points manufactured from local Gunflint Formation cherts that often show little to no re-sharpening. In some cases Gunflint Formation chert projectile points appear to have been discarded without being utilized.

Comparisons to other Lakehead Complex sites indicate that there was a large portion of the reduction sequence missing from the previous sites. The Mackenzie I assemblage revealed the latter stages of manufacture which were largely just speculation based on the observable traits of a small number of formal tools from the other sites. Core selection and blank production was also poorly understood from the previous sites. It appeared that at Brohm many of the bifaces arrived on site as Stage

3 bifaces and were reduced from that point on site (Hinshelwood, 1989). At Biloski there was a small number of early stage bifaces but again the majority were from the mid-stages of manufacture indicating that formal tools were carried away and blanks were brought to the site as either Stage 2 or 3 specimens. The biface assemblage from Mackenzie I ran the entire sequence of the production stages and was well represented at each stage of manufacture. Formal tools were very plentiful at Mackenzie I allowing for increased comparisons between them and the specimens that failed to be reduced any further. This also allowed for increasing the understanding of the morphological traits of the Lakehead Complex projectile points (Markham, 2013). The comparison of the Mackenzie I assemblage to the rest of the Lakehead Complex is discussed further in Chapter 7.

CHAPTER 7

INTERPRETATION OF THE MACKENZIE I BIFACE ASSEMBLAGE

7.1 INTRODUCTION

After analysis of the Mackenzie I biface assemblage, the reduction sequence methods appear to be consistent with those common throughout the Paleoindian period. Late Paleoindian cultural affiliation is indicated by the general morphology and the parallel oblique flaking pattern of the projectile point assemblage. This chapter discusses the specific production methods observed by other researchers when considering Paleoindian lithic toolkits, and which ones have been observed in the Mackenzie I assemblage. This includes comparison to Paleoindian groups from southern Ontario and to other Lakehead Complex assemblages. While there has been much less research addressing Archaic reduction sequences, the Mackenzie I collection is briefly compared to a Kirk Corner notched assemblage and the Gerlach biface cache.

7.2 THE MACKENZIE I BIFACE ASSEMBLAGE

The Mackenzie I biface assemblage consists of a large number of formal tools coupled with bifaces representing the full range of manufacture stages. As presented in Chapter 6, the number of bifaces within each stage is significant. With the recovery of a large number of early stage bifaces (Stage 1 and 2), cores (N=442) and over 300,000 pieces of debitage, the site likely includes quarry/workshop functions. The overwhelming majority of the Mackenzie 1 lithic assemblage is derived from the Gunflint Formation. The nearest outcrop of this formation is about 10 – 15 km west of the site location and may not have been accessible during active Lake Minong beach formation. The nearest presently known Gunflint Formation outcrop that was accessible when Minong beaches were active is near the Current River site cluster to the west (Biloski is part of this cluster). This makes it unlikely that Mackenzie I was a primary quarry site. However, the large number of early stage artifacts demonstrates that manufacturing activities were undertaken on site. It is unclear where the raw material to support this level of production derives from. This is compounded by the generally high quality of Gunflint Formation chert represented in the Mackenzie I assemblage. The best known sources for the high quality raw material sources (that would have been accessible during Lake Minong lake phases) occur between 20 and 30 km to the west in the vicinity of the Cummins, Irene or McIntyre sites. The quality of the exposed Gunflint Formation lessens as one moves east from these sites, indicating they would have been an unlikely source for the high quality raw material (Surette and Vickruck, pers comm). This puzzling situation suggests either effective modes of transportation, or some hitherto unknown source of high quality Gunflint Formation chert much closer at hand to Mackenzie I.

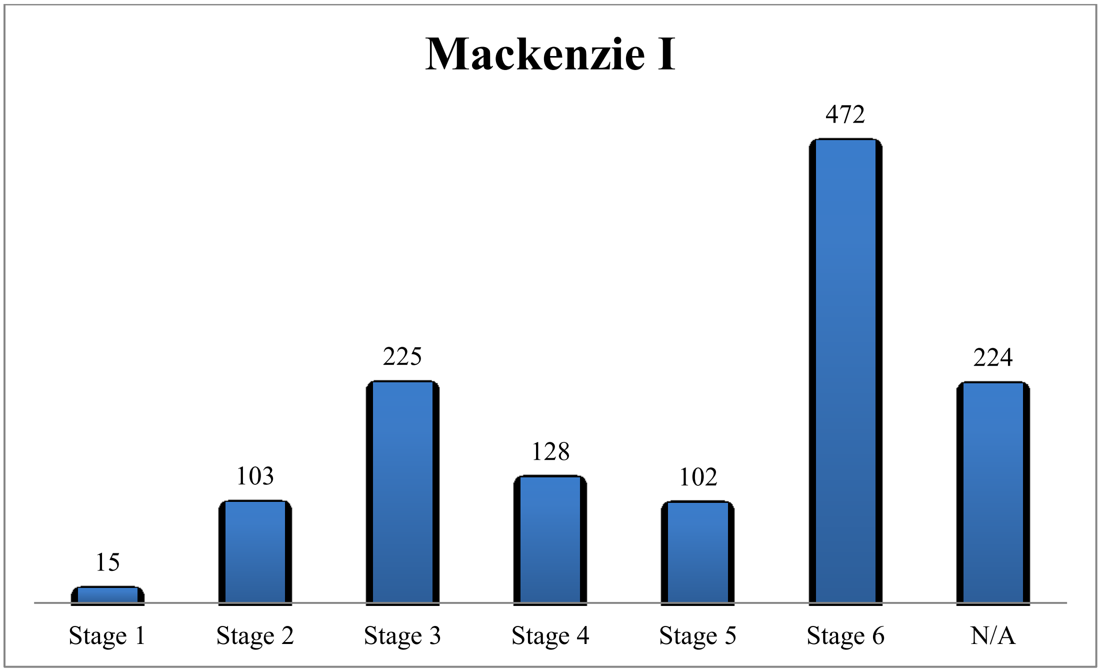


Figure 7.1: Bar graph depicting the stage identification for the Mackenzie I biface assemblage.

There is also an increased representation of both mid and late stage bifaces at Mackenzie I. The late stage bifaces indicate that the site was a habitation area where formal tools were finished, utilized and in some cases recycled into different tool forms. The very large sample of formal tools found at Mackenzie 1 indicates that there was intensive (most likely repeated) occupation and utilization of a variety of functional tool types. The largest percentage of the formal tool assemblage is by far the projectile points (n=387, 82%). The projectile point assemblage consists of tips, mid-sections, and bases (n=339), complete discards (n=39) and reworked fragments, usually bases (n=9).

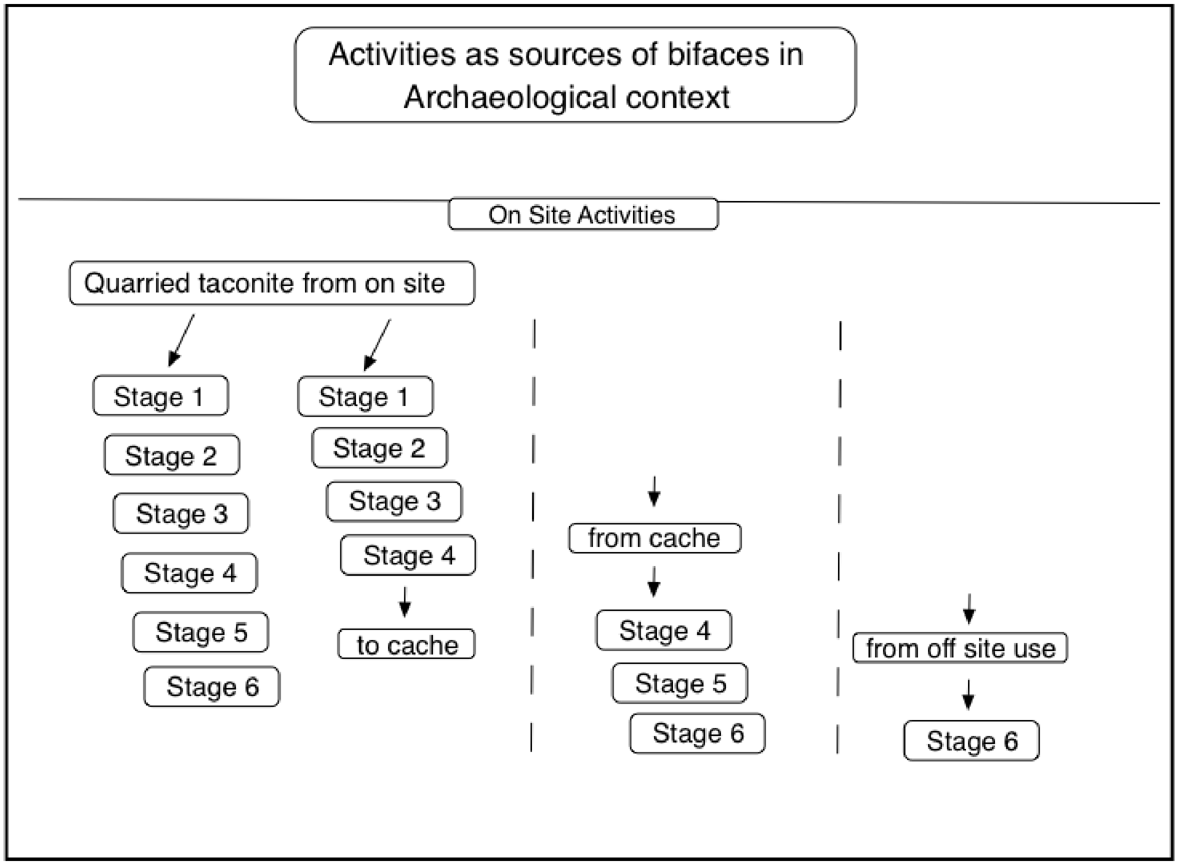


Figure 7.2: Schematic of the site activities which likely produced the Mackenzie I biface assemblage, (modified after Hinshelwood and Webber, 1987: Figure 37).

Comparison of the nature of the Mackenzie 1 assemblage to other Lakehead Complex sites suggests that a number of activities occurred at the site. It may be that the site was occupied at different times and for different functions, but only comprehensive spatial analysis of the artifact clusters can hope to reveal the overall site function. From a preliminary analysis of the available information regarding biface production sequences, Mackenzie I most closely resembles the Biloski assemblage. Comparison of these assemblages indicates the highest failure rates occur in Stage 2 and 3. If biface reduction proceeds past Stage 3 without breakage, there is a higher likelihood that reduction will proceed through to the last stages. No presently known Lakehead Complex site aside from Mackenzie I reveals the magnitude and intensity of effort representing the last half of the biface production sequence. Sites yielding significantly large collections of formal tools (Brohm and Cummins) have significantly fewer identified preforms, suggesting that these tools might have been manufactured elsewhere. In contrast, the preform assemblage from Mackenzie I is far larger (n=102), and includes forms that were likely destined to become projectile points, knives and drills. This suggests that Mackenzie I represents aspects of the entire biface tool production sequence. The Mackenzie I debitage assemblage aids in the understanding of the activities carried out on site. Preliminary analysis of this large portion of the lithic assemblage has revealed the presence of over 200 identified utilized flakes, a large presence of overshot flakes, and blades, as well as the presence of finishing flakes. These finishing flakes (Figure 7.3) were identified during the cataloguing process and were pulled due to the presence being unique.

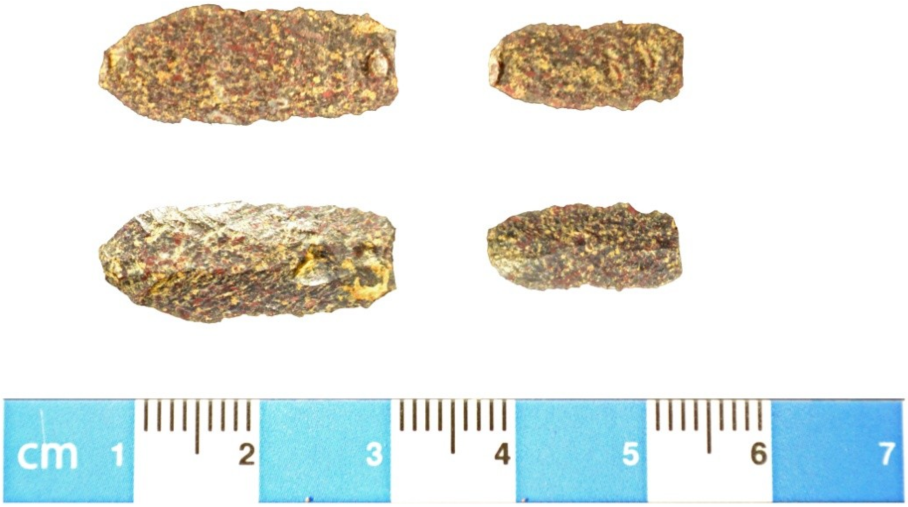


Figure 7.3: Finishing flakes from Mackenzie I, bottom is dorsal, top is ventral, note the narrowness and parallel sides and the remnant striking platform on the ventral faces (Artifact #22887).

7.3 COMPARISON OF MACKENZIE I TO OTHER PALEOINDIAN ASSEMBLAGES

The Paleoindian period is defined by various cultural groups that predominantly used bifacial reduction techniques. Some groups made use of a blade technology, ancillary to the bifacial reduction methods, to create expedient tools, or blanks for specific tool types (drills, scrapers, burins, gravers) (Stanford and Bradley, 2012). This differed sharply from the micro-blade technologies associated with early Arctic groups and many culture groups from north Asia and Siberia (Stanford and Bradley, 2012). This also differed from the early micro-blade traditions of the northwest coast of British Columbia and Alaska (Stanford and Bradley, 2012).

7.3.1 Clovis Attributes Observed at Mackenzie I

The initial stages of biface lithic reduction observed in the Clovis lithic manufacturing process represents a generalized reduction sequence that was widely used and remained relatively unchanged through time and space. This appears to have been the case with the early stages of biface reduction in the Mackenzie I assemblage as well. Specific Clovis manufacturing methods that were not employed by subsequent post-Clovis groups are related to the preparation and execution of basal flutes. Culturally unique flaking traits that help distinguish and differentiate between the various Paleoindian cultures appear at the final stages of finishing of the projectile points or other diagnostic tool types. While such distinctions were often associated with diagnostic hafting treatments, some deviations from the classic early stages of biface reduction were often in response to the quality and fracture mechanics of difficult raw material.

At Mackenzie I, blank selection was limited by the quality of the raw material. The blanks utilized were often tabular blocks with joint planes and the possibility of internal flaws. Methods of flake removal on tabular blocks and thick broad flakes are generally the same and follow a biface trajectory. Thin blade/flakes were reduced differently as methods of direct percussion used in the biface trajectory would result in a high degree of fracture. The reduction of blade/flakes was slightly different, as discussed by Callahan (1979), but was not defined as a separate trajectory until the mid-1990s (Whittaker, 1994; Andrefsky, 1998).

The distinct overshot flaking method was employed by Clovis groups to rapidly thin a biface, and was also used by several subsequent groups including the producers of the Mackenzie I assemblage. It has been argued that this flaking technique was not part of the cognitive methodology routinely used in lithic reduction (Bradley 2009; 2010). Rather, such late Paleoindian use of overshot flaking was often believed to be just incidental or propitious flake removal (Bradley, 2009; 2010). It is clear, however, that at the Mackenzie I assemblage it was an understood part of the methodology employed in lithic reduction (Table 6.7). It was observed on a number of bifaces in Stages 2 to 4 (Figure 6.2, 6.25, 6.7, 6.26, 6.11, and 6.27) and as a remnant on certain Stage 5 bifaces (Figure 6.28). Overshot flakes were also discovered within the Mackenzie I debitage collection. The use of overshot flaking in Lakehead Complex assemblages largely appears to have been used to resolve flaws discovered during the reduction sequence. The Gunflint Formation cherts (Taconite and Gunflint Silica) have high incidences of flaws and inclusions that could cause problems during the reduction sequence. The smallest error by the knapper caused serious and often irrevocable problems. To resolve these problems, on sufficiently thick bifaces the knapper sometimes attempted to undercut a flaw on the surface, or used overshot flaking to reshape an edge by removing the stacked/crushed edge (Figure 5.12). When utilized it would seem that it was a last resort as much of the time the use of overshot flaking caused the biface to fracture or fail.

The degree of force required to remove these flakes is significant and had to be applied at a precise angle to avoid fracture. The bifaces in the Mackenzie I assemblage with overshot flaking are largely Stage 3 broken or failed bifaces. This suggests instances of failure to successfully employ overshot as a reduction method. In these specimens the flake scar plunges deeply at the striking platform, travels across the face and plunges around the opposite edge. On those pieces that are broken the fracture is transverse and often bisects the overshot flake scar (Figure 7.4: A). Those pieces that failed have a flake scar that is clearly overshot, but as the force travelled through the piece it struck an internal joint plane and plunged down causing the piece to fail (Figure 7.4: B). This style of flaking was observed on a small number of the Stage 4 bifaces. Figure 7.4: C depicts a Stage 4 biface with an overshot scar which skidded over a joint plane and two other successful flake removals. The fracture of this biface is transverse oblique and may be the result of a weakening of the structural integrity due to the presence of the joint plane. On a small percentage of Stage 5 bifaces, remnant overshot scars are present and indicate that it was a method used with some degree of success (Figure 7.3: D). The presence of remnant overshot flake scars on Stage 4 and 5 bifaces at Mackenzie I indicate that there was a degree of success in utilizing this method of flake removal. The successful use of overshot flaking is more readily observed in the debitage assemblage.

Overshot flake scars are distinct in that they have a narrow striking platform, are very thin with a diffuse bulb of percussion and a broad distal termination that generally hooks around the edge (Figure 7.5: A). The complete Mackenzie I debitage assemblage was not yet processed or available for examination at the time of preparation of this thesis. Thus, the relative frequency of this flaking technique is not fully known. It was incidentally observed, by the author and others during the cataloguing process, that overshot flakes were present and a small number were removed from the debitage assemblage and photographed (Figure 7.5: B-D). These overshot flakes were sometimes used as expedient tools (Figure 7.5: C). There are several examples of overshot flaking techniques being used to rapidly thin bifaces, resulting in flakes that conform to the typical description of Clovis overshot flakes, including the removal of a portion of the opposite edge (Figure 7.5: D).

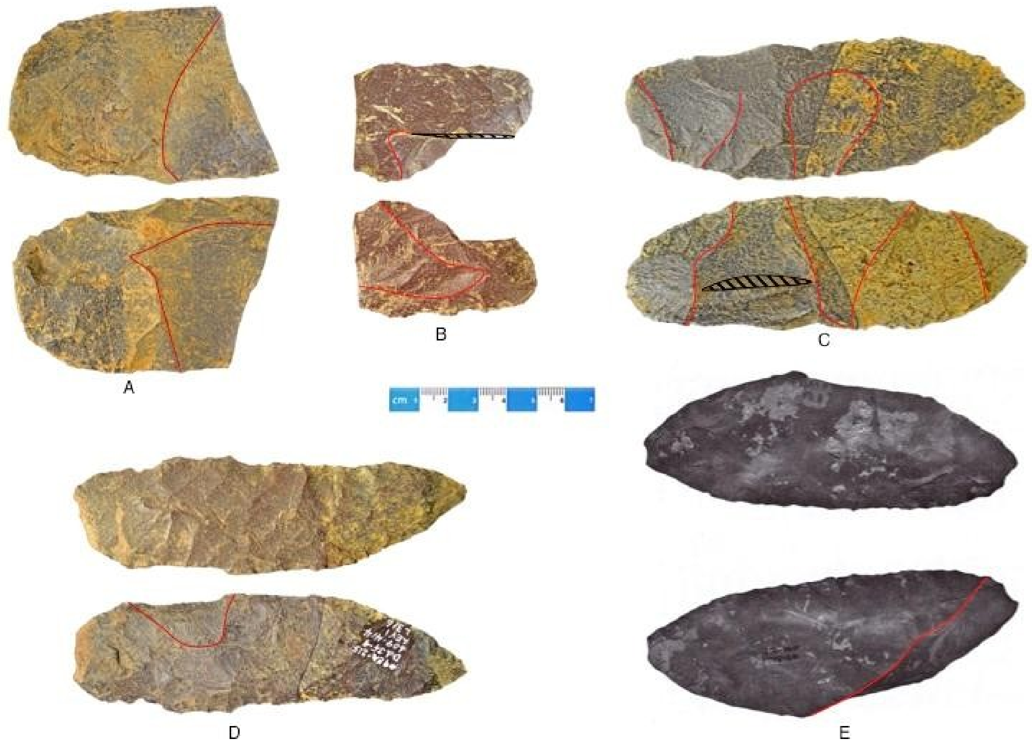


Figure 7.4: A) Stage 3 biface with a plunging overshot flake scar causing a transverse fracture B) Stage 3 biface with an overshot flake scar striking an internal joint plane causing the piece to fail C) Stage 4 biface with overshot flake terminating on an internal joint plane and an overshot flake causing the fracture D) Stage 5 biface with remnant overshot flake scar, largely obscured by subsequent flake removal E) Clovis mid-stage biface with perverse fracture caused by an overshot flake.

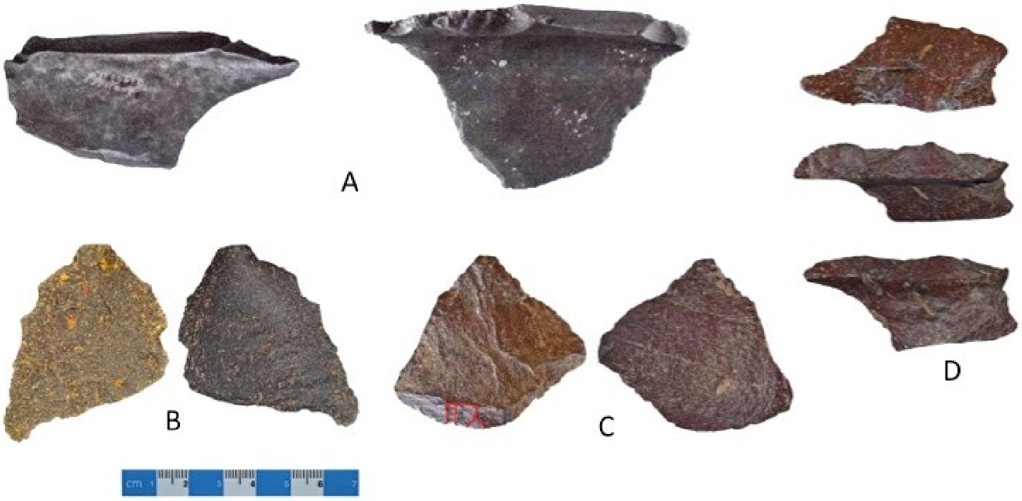


Figure 7.5: A) Clovis overshot flakes showing square edge removal B) overshot flake from the Mackenzie I collection C) Overshot flake used as expedient tool from Mackenzie I D) overshot flake from Mackenzie I showing square edge removal.

This method of flake removal was observed on a number of bifaces from the Mackenzie I assemblage. The highest incidence of overshot flaking was observed in Stage 3 (28%) reduction at Mackenzie I with Stage 4 (25%) having the second highest representation. The presence is not very high when compared to Clovis assemblages where there was an increased reliance of this method during the initial thinning (Stage 3) phase of manufacture. Further analysis of the extensive debitage collection may clarify the importance of deliberate use of overshot flaking as part of the Mackenzie I assemblage. Analysis of other sites within the Lakehead Complex indicates that overshot flaking was utilized as part of the reduction of blanks, and/or as part of the production of flakes useable as expedient tools. The Hodder East (DcJh-44) assemblage, examined by the author, revealed the presence of overshot flaking on a number of the large bifaces/bifacial cores and Stage 3 bifaces from the site. Preliminary analysis of the bifaces recovered from the Woodpecker sites (DdJf-11, 12 and 14) by the author in the field also revealed a limited presence of this manner of flake removal.

When not engaged in overshot flaking to rapidly thin bifaces, the emphasis was on thinning and shaping the bifaces to produce the desired projectile point. Clovis knappers utilized a combination of methods that resulted in a somewhat random-looking flaking pattern on some projectile points. These methods included co-medial flaking patterns as well as oblique flaking methods. Following the rapid thinning of the biface co-medial flaking was used to remove isolated platforms and regularize the edge. This was the final set of flake removals on some projectiles while others were obliquely flaked across much of the surface but not with the same finesse as the late Paleoindian projectile points with parallel oblique flaking (Bradley 2009; Bradley et al, 2010). These methods of oblique flake removal as a finishing technique utilized the same methods as that of the overshot flaking. When compared to mid-stage bifaces from Mackenzie 1 there are similarities in the Clovis oblique finishing techniques and the oblique thinning techniques present at Mackenzie I (Figure 7.6).

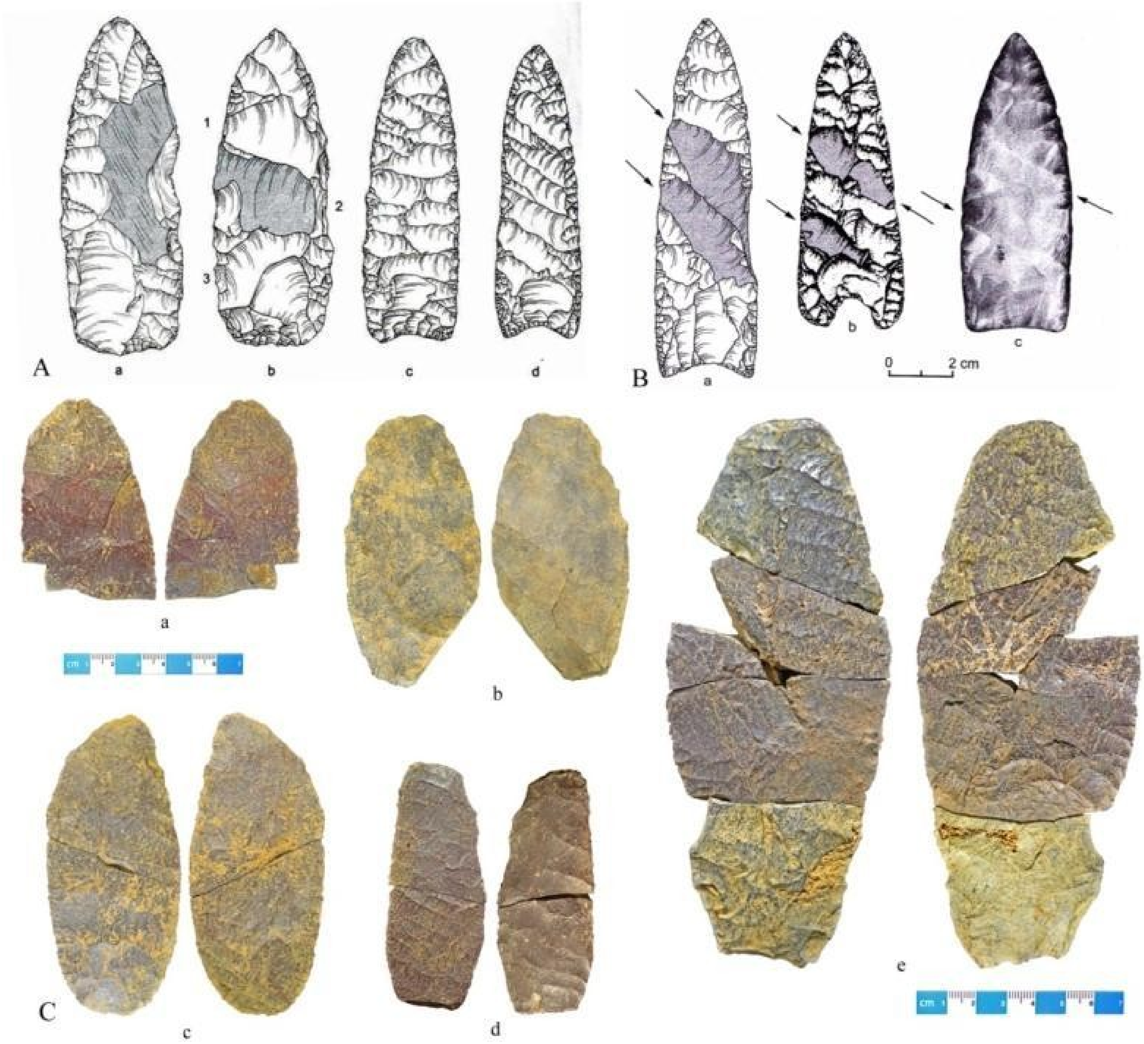


Figure 7.6: A) Clovis reduction sequence depicting co-medial flaking (c) and oblique finishing techniques (d) modified after Bradley 2009: Figure 9.5 B) examples of oblique flaking from Fenn (a), Colby (b) and Blackwater Draw (c) modified after Bradley, 2009: Figure 9.6 C) Mackenzie I bifaces with oblique thinning flakes similar to the Clovis finishing techniques, Stage 4 (a, b, and c) Stage 5 (d), anomaly (e).

Adzes have been identified within Clovis age assemblages. These tools have not been found to date on any kill/camps or in caches, they have however been identified at source camps (Bradley et al, 2010). One of the adzes from the Gault site, a major quarry/source camp, indicates that it was hafted and used to work wood (Figure 7.7: A). Choppers were also identified as being part of the Clovis tool kit, and are best described as being a parallel sided adze with a sharp working bit (Figure 7.7: B). Similar tools were recovered from Mackenzie I and other Lakehead Complex sites (Figure 6.3, Figure 7.7: C, D).

Figure 7.7: A) Clovis adzes from the Gault site modified after Bradley et al., 2010: Figure 3.7, B) Clovis choppers from the Gault site modified after Bradley et al., 2010: Figure 3.8 C) selection of the range of adzes recovered from the Mackenzie I site D) biface fragments from Mackenzie I that could be classified as choppers following the Clovis definition.

7.3.2 Folsom Attributes Observed at Mackenzie I

Clovis flake removal often involved overshot flaking to rapidly thin the bifaces. A series of overshot flakes were removed from both faces followed by flaking to refine the edges, remove isolated platforms and fill in any gaps. The edges were sharpened and regularized using a combination of light billet percussion and pressure flaking. During the subsequent Folsom period, pressure flaking became more widely utilized throughout the sequence and serial patterned flaking became more common. Clovis projectile points exhibit sharp lateral edges deriving from pressure flaking during reduction with a carefully defined tip and a fluted base. In contrast, the Folsom projectiles reveal a serial pattern of retouch pressure flaking to refine the edges and the tip. The more extensive use of refined serial pressure flaking combined with more extensive methods of edge preparation, coupled with more dramatic or extreme fluting, serve to distinguish Folsom reduction sequences from Clovis. During the subsequent Late

Paleoindian period, pressure flaking continued to be used as a finishing technique on the faces of the diagnostic tools. The stylistic, culturally specific, serial patterned flaking does not appear to make a difference in the functionality of a projectile point.

With Clovis lithic reduction there was significant edge preparation to establish platforms preparation for the removal of overshot flakes. During the Folsom period edge preparation began to include both abrasion (grinding) of the edge to isolate and refine platforms and pressure flaking to create a bevelled edge to aid in directing serial patterned flake removal sets. Folsom serial patterned flake removal involved the removal of narrow flakes that extended to the midline, thereby creating a central ridge that aided in the specific fluting diagnostic of Folsom projectiles. Flenniken (1972) noted that this ridge aided in directing the flute nearly the entire length of the projectiles. Latter groups made use of the methods of carefully prepared platforms and serial patterned flake removal, only altering the pattern. The Mackenzie I assemblage exhibits serial patterned parallel oblique to co-medial flaking on both faces of the formal tool assemblage. The methods of abrading and pressure retouch of the edges as methods of edge preparation are also observed on the Mackenzie I assemblage.

7.3.3 Agate Basin/Hell Gap Attributes Observed at Mackenzie I

The Agate Basin and Hell Gap reduction sequences are very similar, with observations by (Bradley, 2009; 2010) indicating that Hell Gap reduction was halted at an earlier stage than Agate Basin. Hell Gap projectiles have a defined shoulder separating the hafting portion from the blade and are slightly thicker than Agate Basin projectiles. During the manufacture of the preform, lateral edges were retouched to create an alternately bevelled edge platform for subsequent flake removal. Flakes were then removed from both faces, creating an offset lenticular cross-section (Figure 4.27). The use of pressure flaking to create a bevelled edge is similar to Folsom methods, but differs in that the edges are bevelled on opposing edges.

Mackenzie I preforms also exhibited this method of alternate edge bevelling and flake removal. This method was used in conjunction with random thinning scars and platform isolation more reminiscent of Clovis methods of preform manufacture methods. Both these methods were observed as being utilized in the Biface Trajectory while the alternate edge bevelling and serial flaking was observed almost exclusively in the Flake/Blade Trajectory. Semi-lunate knives with a backed (dulled) edge as observed in a number of Agate basin and Hell Gap assemblages were also present at Mackenzie I.

7.3.4 Cody Complex Attributes Observed at Mackenzie I

The variety of projectile point styles within the Cody complex and the lack of reduction continuity between sites make it hard to define methods specific to this complex (Bradley, 2009; 2010). The serial patterned co-medial flaking was present as a finishing technique and as the shaping technique on the preforms regardless of the quality of this flaking style. This manner of flaking was present on the diagnostic Cody knife as well, though it was slightly offset so as to create the distinct margin. Similar methods of finishing were observed on a small number of projectiles from the Mackenzie I site, while there was no evidence of the distinctive Cody knife style in the assemblage. Any knives identified within the assemblage bear a closer morphological similarity to the Agate Basin semi-lunate knives. Co-medial flaking was also used as a thinning/shaping method in certain Stage 4 and 5 specimens though it was generally limited to the material that is more chert-like. While there was some evidence of co-medial flaking on a number of the finished projectiles and in some of the preforms from Mackenzie 1, serial patterned parallel oblique flaking was more commonly observed as the final finishing technique. The overwhelming majority, of the drills in the Mackenzie I assemblage, exhibited near exclusive use of co-medial flaking to shape and sharpen the working bit.

7.3.5 Late Paleoindian/Plano Attributes Observed at Mackenzie I

Stylistic finishing methods shift in the Late-Paleoindian culture groups. These culture groups include Frederick, James Allen, Lusk, Angostura and Browns Valley in the Rocky Mountains and high plains. This serial patterned flaking is thought to be more widely used during Late Paleoindian period, perhaps as a result of adaptation to use of more brittle lithic raw material such as quartzite and basaltic material. These materials have different fracture mechanics than the cherts widely utilized by early Paleoindian groups. Lateral flaking patterns can result in a higher propensity for the flakes to terminate as step or hinges. A series of such step/hinge terminated flakes result in a step or stack and can create a flaw in the preform that is generally irreversible. Bradley (2009; 2010) hypothesizes that the shift to obliquely patterned flake removal reduced the chances of step/hinge terminations and therefore, would have resulted in more successful preform production. Rather than flakes following the grain of the material and hitting microscopic flaws or inclusions, the oblique flaking cross-cut the grains thereby reducing the likelihood of step terminating flakes.

At Mackenzie I parallel oblique flaking was observed on the majority of both faces of the completed finished tools. This pattern was observed on the knives and projectile points as well as on the basal portions of drills, and even some of the scrapers. There is significant debate as to how this distinct flaking pattern was produced on such a difficult material. It is possible to engage in such finely controlled flaking with an antler billet using direct percussion. Other methods include indirect percussion with one or two people, and pressure flaking using carefully prepared platforms. A number of modern knappers (Dan Wendt, Gary Wowchuck, Bill Ross, and Ernie Reichart) have attempted to replicate this flaking style on taconite with varying degrees of success. The gunflint cherts can be highly siliceous but remain hard and brittle, and contain internal structural flaws.

The biface assemblage from the Allen site, in Nebraska (see Chapter 4) (Bamforth, 2007) included tools identified as bevelled bifaces. This tool type was made using a biface reduction trajectory on a tabular blank (Figure 7.8: A) or on a flake blank (Figure 7.8: B). Two of the three bevelled bifaces (Figure 7.8: A, b and c) could easily be classified as adzes using the morphologically similar characteristics to Clovis adzes (Figure 7.7: A) and certain Mackenzie 1 adzes (Figure 6.3, 6.37 and 7.7:

C). The unifacial bevelled flake tools (Figure 7.8: B) would easily be classified as scrapers as would the first bevelled biface (Figure 7.8: a).

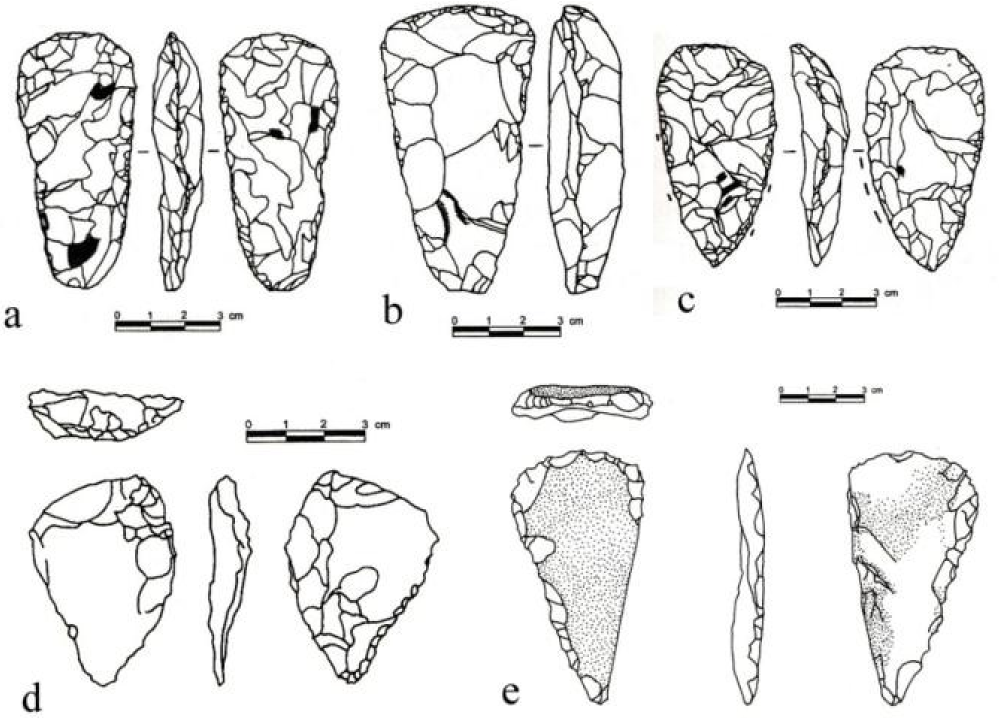


Figure 7.8: A) bevelled bifaces from the Allen Site B) bevelled flake tools from the Allen Site (modified after Bamforth and Becker, 2007: Figure 10.7 and 10.9, pp. 153 in Bamforth, 2007).

The drills observed at the Allen site bear a resemblance to a number of the drills and drill preforms from Mackenzie I. Drills recovered from the Allen site show a broad base and a straight to curved working end significantly narrower than the base (Figure 7.9: A). Drills recovered from the Mackenzie I site are largely miniature bi-pointed bifaces (Figure 7.9: B); there are several with a broad base, some of which are far more refined (Figure 7.9: C). The bifaces from Mackenzie I which most closely resemble these drills are drill preforms (Figure 7.9: D).

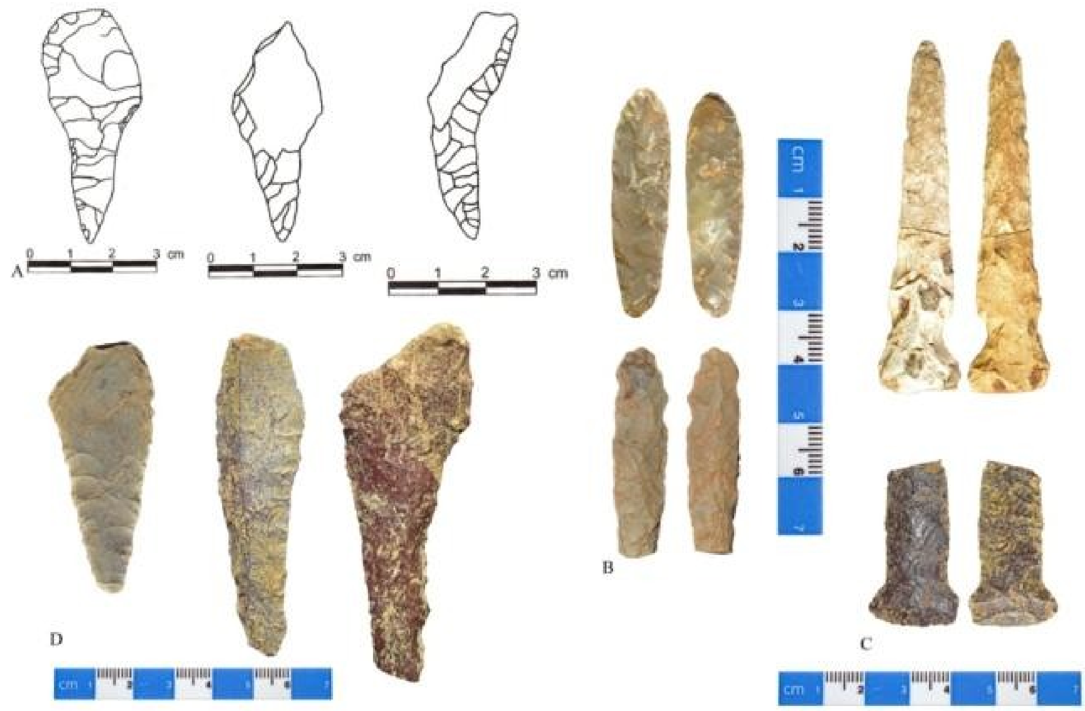


Figure 7.9: A) Drills recovered from the Allen site (modified after Bamforth and Becker, 2010: Figure 10.6, pp. 152 in Bamforth, 2010) B) bipointed drills from Mackenzie I C) expanding base drills from Mackenzie I D) drill preforms from Mackenzie I.

7.4 COMPARISON OF MACKENZIE I TO PALEOINDIAN ASSEMBLAGES IN SOUTHERN ONTARIO

Southern Ontario Paleoindian complexes include Holcombe, Parkhill, Hi-Lo and Crowfield. Currently the diagnostic tools in these complexes bear little morphological similarity to those found in the Lakehead Complex. The Southern Ontario complexes utilized a biface reduction strategy to obtain the lithic toolkit with the early stages conforming to the general Paleoindian reduction strategies. As with all post-Clovis cultures, technological distinctions that differentiate between discreet complexes were evident in the stone tool finishing techniques. While few of these technological distinctions characterizing the Southern Ontario complexes were evident in the Mackenzie I assemblage, one specimen (Figure 6.19) offered an interesting parallel. This specimen was refitted from multiple fragments that suggest deliberate or purposeful breakage of a completed biface, reminiscent of the ritually destroyed bifaces from the Caradoc site (Deller and Ellis, 2001). This specimen was the only example of apparently purposeful destruction of a biface in the Mackenzie I collection. The observable flaking patterns on the Mackenzie I specimen revealed parallel oblique flaking across a portion of both faces but was limited to the portions containing better quality Gunflint Formation chert. Notably, no evidence of parallel oblique flaking has been reported from southern Ontario Paleoindian sites.

7.5 COMPARISON OF MACKENZIE I TO OTHER ASSEMBLAGES WITHIN THE LAKEHEAD COMPLEX

The Lakehead Complex was initially defined on the basis of preference for Gunflint Formation chert (Taconites, Gunflint Silica and Kakabeka Chert) as the major material type. Site locations are often associated with a Lake Minong age beach ridge, and the general morphology of the projectile points are similar. The co-occurrence of these traits at the Mackenzie I site suggests a Lakehead Complex affiliation. Thus, this analysis was structured to be comparable to Hinshelwood and Webber's (1987) analysis of the Biloski site assemblage (a Lakehead Complex assemblage). The definitions of breakage patterns, platform preparation methods, flaking patterns and Stage identification were all used to remain consistent with the previous works. Only a select few sites from within the Lakehead Complex have been subjected to reduction stage analysis (Table 7.1).

Table 7.1: Breakdown of the Lakehead Complex sites that have had reduction stage analyses * Only includes the bifaces collected during the 1983 excavations.

Site Name	Un-Staged	Staged 1-5	Formal Tools	Total
Biloski	37	177	3	217
Brohm	22	44	20	86
Cummins*	14	106	17	137
Simmonds	2	17	3	22
Naomi	3	51	1	55
Mackenzie I	224	669	472	1436

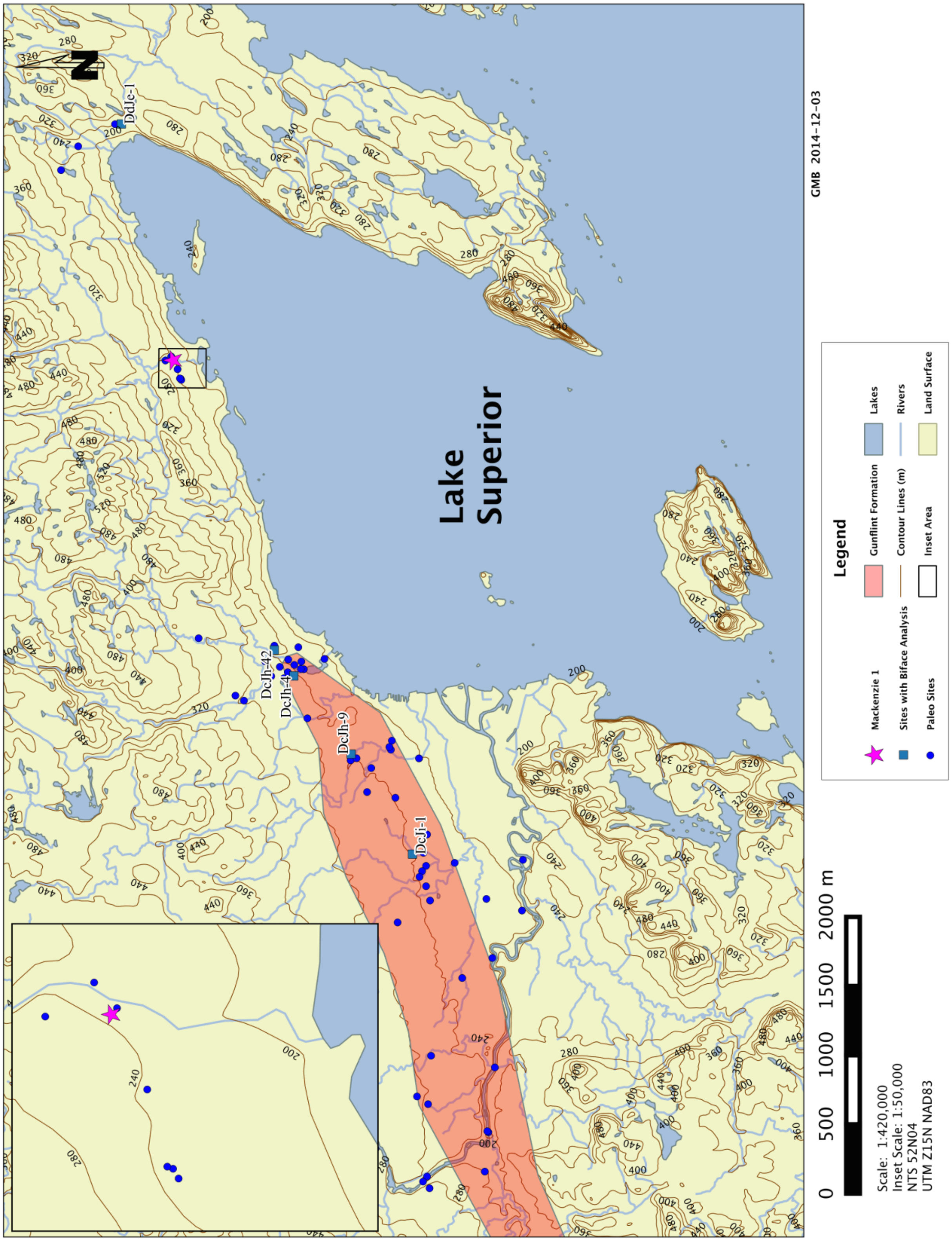


Figure 7.10: Location of the Mackenzie I site in relation to other sites that have been subjected to biface analyses.

7.5.1 Overall trends in the Lakehead Complex Assemblages

The parallel oblique flaking pattern on the finished tools has been observed as being a unique characteristic on completed Lakehead Complex projectile points. However, the dominance of this method of finishing was not apparent until the discovery of the Mackenzie I assemblage. Considerable variability in basal morphology and general stylistic outlines are evident in the literature, but the parallel oblique flaking pattern remains a constant. At Mackenzie I there were 472 complete and fragmentary formal tools. Table 6.11 shows the breakdown of the flaking patterns observed on the Mackenzie 1 formal tool assemblage and revealed that parallel oblique flaking was present on 388 (82%) of the formal tools. Since the complex was first identified the parallel oblique flaking pattern has been an identifying feature of the formal tool assemblage (Table 7.2). There is no indication that parallel oblique flaking was observed on any specimens in the early to mid manufacture stages (2-4). It is observed as being present on certain Stage 5 projectile point preforms (Cummins, and Brohm), but on any biface in the previous stages of manufacture it is notably absent (Hinshelwood and Webber, 1987; Hinshelwood, 1990; Hinshelwood and Ross, 1992; Adams, 1995; Julig, 1994; Halverson, 1992; Arthurs, 1986). Parallel oblique flaking was observed in a number of the bifaces which were placed into Stage 3 and 4. That this style of flaking is present in earlier stages of manufacture suggests that it was a method of reduction utilized to deal with a difficult raw material. The earlier execution of parallel oblique flakes (Stage 3 and 4) differs in that these flake scars were broader than those in the latter stages. Flake scars in the mid-stages of manufacture ranged from 10 – 15 mm wide while the finished tools and preforms have flake scars that measured under 5 mm wide.

Table 7.2: Table illustrating the presence of parallel obliquely flaked tools across a portion of the Lakehead Complex

	Tool Identification							
Site Name	**Knife**	**Point**	**Drill**	**Adze**	**Gouge**	**Total**	**PO**	**PO on Points**
Biloski	0	5	1	0	0	6	2	2
Brohm	0	16	4	0	0	20	11	11
Cummins	10	24	5	4	0	43	7	7
Simmonds	0	1	0	0	0	1	1	1
Naomi	0	2	1	0	0	3	1	1
Mackenzie I	10	387	59	13	5	472	388	357
Newton	0	1	0	0	0	1	1	1
Mackenzie II	0	1	0	0	0	0	0	0

Biface breakage patterns observed at Biloski (Hinshelwood and Webber, 1987) were used in subsequent site assemblage analyses (Hinshelwood, 1990; Julig, 1994). This analytic approach was also the basis for the interpretation of biface breakage observed at Mackenzie I and applied to the Hodder East site (Gibson, 2014) and the RLF site (Langford, ND). While the biface assemblages from Naomi (Adams, 1995) and Simmonds (Halverson, 1994) were also analyzed, the biface fragments were only considered as broken and not subjected to detailed analysis. Consideration of breakage patterns observed at the former sites demonstrates a clear distinction between specimens fractured through knapper's error ("Broken") versus those fractured due to flaws encountered in the material ("Failed"). At Mackenzie I the failure rate was highest in Stage 3 production while in the latter stages it becomes an insignificant factor in the breakage category (Table 6.4). This suggests that once the biface moved past Stage 3 thinning the majority of the flaws have been discovered and subsequent flaking proceeded with comparatively few failures attributable to the raw material. This may be the result of the shift to parallel oblique flaking as the full force of the strike would not have hit the flaw directly. The oblique angle would mean that the flaw was only struck with a portion of the force wave. During the manufacture of the preform it appears that the knapper's made a conscious effort to orient observed internal faults with the longitudinal axis of the biface. This set up the biface to be parallel obliquely flaked to avoid hitting the flaw with the full force of the pressure wave.

7.5.2 The Biloski Assemblage

The Biloski (DcJh-9) biface assemblage consists of a large number of broken or failed early stage bifaces. It is proposed that the raw material for these bifaces was either brought to the site from a nearby quarry or collected as cobbles from the nearby McIntyre River channel (Hinshelwood and Webber, 1987). The material was reduced with the purpose of finishing bifaces on site, caching them for later finishing either at the site or elsewhere (Hinshelwood and Webber, 1987). The nature of the finished tools recovered on site indicates that these were likely brought to the site rather than finished on site (Hinshelwood and Webber, 1987). Further evidence for the emphasis on the early stages of reduction is a stage 1 blank found within a tight concentration of debitage. A number of scenarios were suggested by Hinshelwood and Webber (1987) to explain the activities occurring at the site, and are summarized in Figure 7.12. This schematic illustrates the importance of the various reduction stages that occurred following the introduction of the raw material to the site. The high incidence of early stage manufacture biface fragments (broken, failed or rejected) indicates that Biloski served as a lithic workshop for the production of cache bifaces (Stage 4) for later finishing. Hinshelwood and Webber (1987) note that there is a possibility that there was a higher success rate in Stage 4 manufacture at Biloski, thereby accounting for the under-representation of bifaces in this stage.

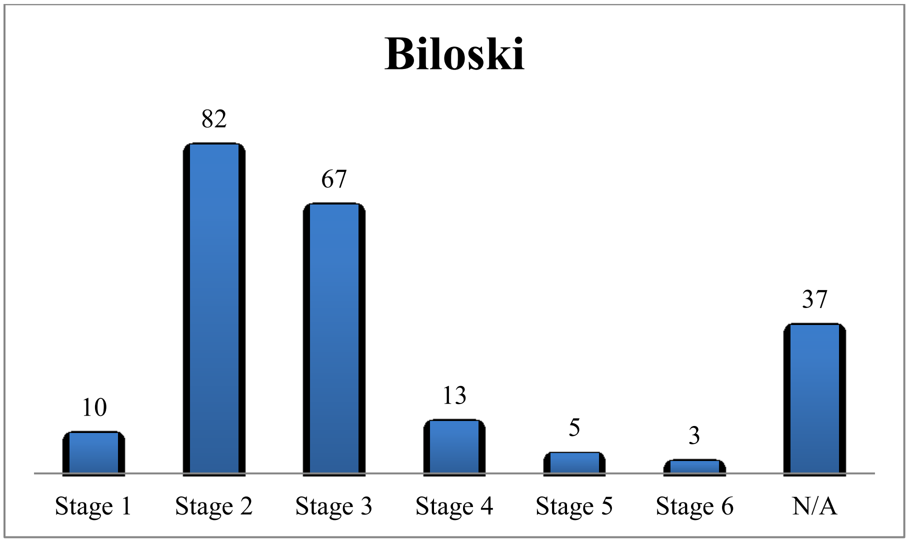


Figure 7.11: Bar graph depicting the stage identification of the Biloski biface assemblage.

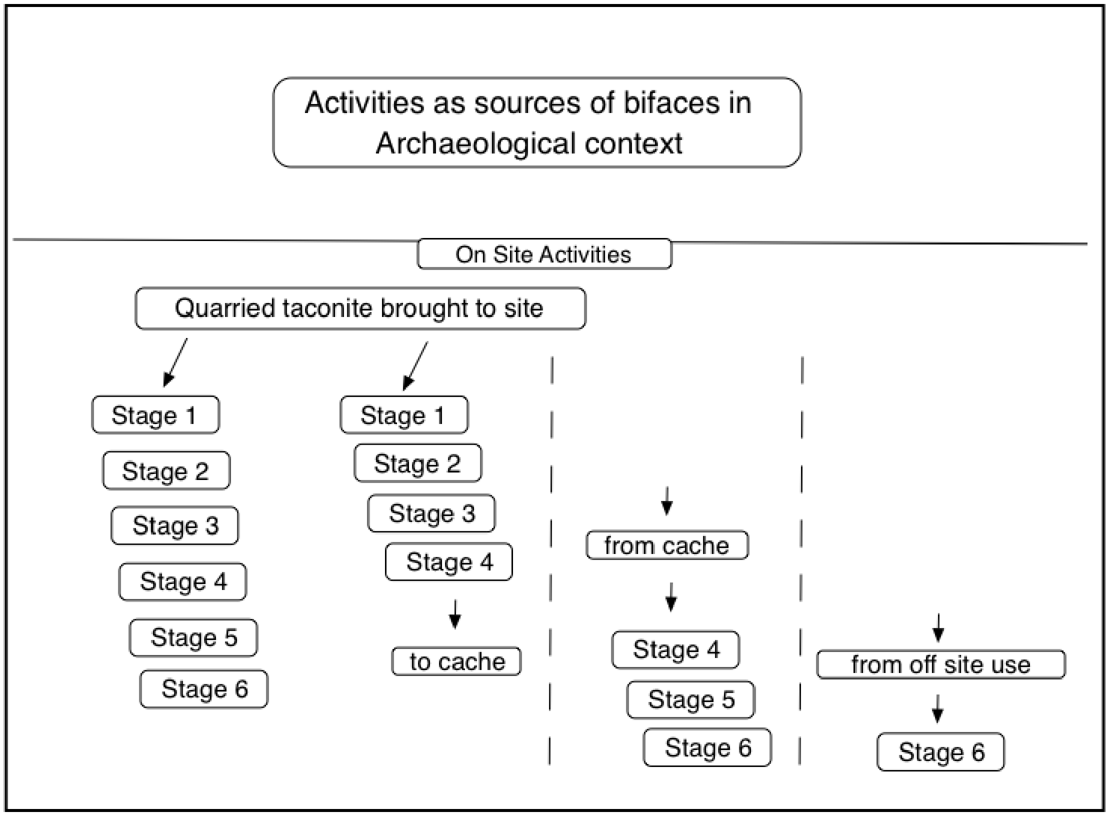


Figure 7.12: Schematic of the site activities which likely produced the Biloski biface assemblage, (modified after Hinshelwood and Webber, 1987: Figure 37).

7.5.3 The Brohm Assemblage

The longstanding functional interpretation of the Brohm site is that it was a seasonal procurement and processing site located along a former sand spit that connected two sections of the Sibley Peninsula divided by high glacial water levels. Caribou are thought to have habitually travelled along the Lake Minong storm beaches that formed below the cuesta headlands making up the Sibley peninsula that was above the Minong Lake levels (Fox, 1975; Dawson, 1983). If this was the case, than the assemblage should reflect activities associated with hunters waiting to intercept migrating herds at favoured ambush locations. This might have involved lithic procurement and processing while waiting, and should also involve, production, use, repair and discard of formal tools deriving from hunting activities. This might include deposition of projectile points, scrapers and knives, the latter associated with processing of a successful kill. Debitage should reflect the maintenance and rejuvenation of the formal tools

(Hinshelwood, 1990). Following the re-excavation of the Brohm locality the lithic assemblage was reanalyzed following the methods used by Hinshelwood and Webber (1987) at the Biloski site. This resulted in an improved understanding of the nature of the lithic assemblage and the site functionality. All bifaces from the original excavation (MacNeish, 1952) subsequent site visits and surface collections by Lee (1961), Quimby and Griffin (1961), and Wright (1963) and various private collections were reanalyzed. The previous collections were then compared to the bifaces recovered in the 1987 fieldwork (Hinshelwood, 1990).

The characteristics of the Brohm assemblage include a small number of refined tools (formal tools and preforms). Stage 3 bifaces are the most numerous with Stage 4 being a close second. Functionally complete Stage 6 tools could and likely were carried away from the site at the end of the seasonal occupation, skewing the sample (Hinshelwood, 1990). Fragments of the Brohm collection are spread out and not fully accounted for. This results in a number of formal tools being unavailable for analysis. A number of refined bifaces are known to be present in private collections and were not a part of the analysis carried out by Hinshelwood (1990). Based on the lack of formal tools, and the debitage characteristic of finishing and repair would indicate that intensive killing and processing at a known Caribou crossing did not take place at the site.

Contrary to the characterization of Brohm as a non-quarry/non-workshop site, the heavy representation of Stage 3 bifaces indicates that manufacture indeed took place on site. The functionality of the site is not unequivocally determined, and the Stage 3 bifaces do not absolutely indicate that manufacturing was a primary activity (Hinshelwood, 1990). The Stage 3 bifaces can readily be used as an unrefined cutting or chopping implement, as a biface core for flake production (expedient tools or blanks), or to be reduced into formal tools. Hinshelwood (1990) hypothesizes that the presence of Stage 3 bifaces at Brohm throws into question the idea that Paleoindian knappers saw Stage 4 as the time to shift to more refined flake removal leading either to caching or completion of formal tools. It was proposed that Stage 3 bifaces were carried to Brohm as cache bifaces for further use/processing (Hinshelwood, 1990). The nature of the debitage assemblage also supports the non-manufactory nature of the Brohm site. The collection methods previous to the 1987 field work may have resulted in a skewing of the nature of the debitage assemblage. Even the use of ¼" screens in the 1987 field season would have resulted in biface finishing flakes being missed during the excavations.

The range of tool implements indicates a range of activities, a number of which relate to animal procurement and processing. The tools recovered from the beach are predominately heavy rough bifaces, various scraper forms (one of which is parallel obliquely flaked dorsally) and possible gravers and drills. The number of tool implements recovered decreased in closer proximity to the shore, indicating the likelihood of less frequent site occupation as the lake level receded (Hinshelwood, 1990). Scenarios for the source of the bifaces within the Brohm assemblage include manufacture on site, brought to the site from a cache, or brought to the site as a complete tool (Figure 7.14).

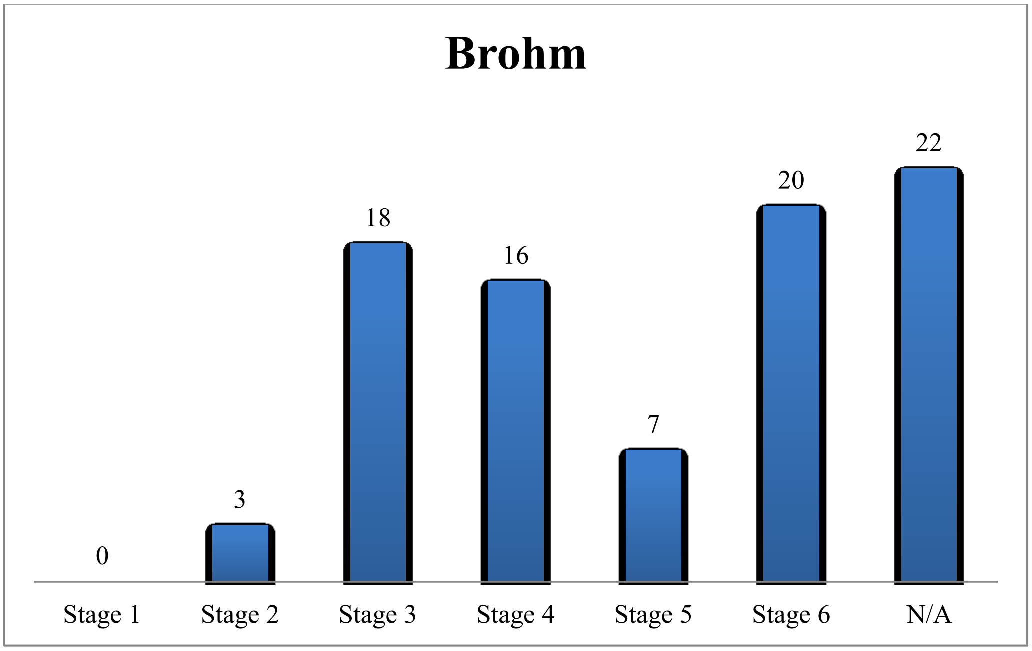


Figure 7.13: Bar graph depicting the stage identification of the Brohm biface assemblage.

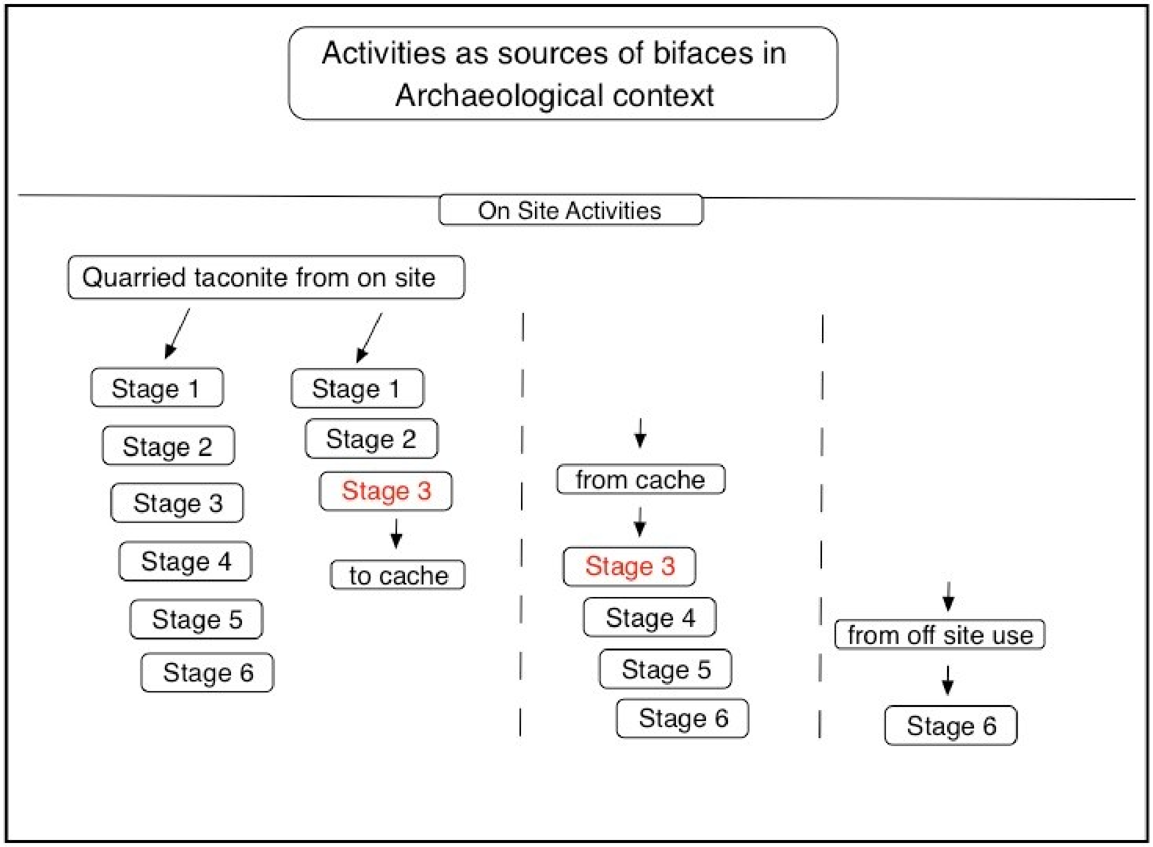


Figure 7.14: Schematic of the site activities which likely produced the Brohm biface assemblage, note the Stage 3 biface being the cache stage, modified after Hinshelwood and Webber, 1987: Figure 37.

7.5.4 The Cummins Assemblage

The Cummins site has been identified as a quarry/workshop site. It is in close proximity to an exposed outcrop of the Gunflint Formation located on a Minong age beach. Excavations were originally carried out by Wright and Dawson in 1963, but remain unpublished other than a brief discussion by Dawson (1983). A number of artifacts were recovered and were functionally characterized but have not been subjected to more detailed analysis leading to perpetuation of the quarry/workshop interpretation (Dawson, 1983). The biface assemblage from the 1983-1985 excavations was subjected to detailed analysis, but was not compared to previously recovered bifaces (Julig, 1994). This biface analysis supported the initial quarry/workshop identification. The assemblage is dominated by early stage bifaces, and with comparatively few preforms and Stage 6 formal tools. These latter objects may have been brought to the site in a finished state. The Cummins lithic assemblage consisted of 240 cores; of these, most are tabular/polyfaceted cores, with a smaller sample of thick flake cores (n=17) and two blade-like cores. Scrapers (N=149) and modified flakes (N=131) were also present. The debitage assemblage includes a large quantity of primary reduction debitage, supporting the assertion that the site was primarily a quarry/workshop (Julig, 1994).

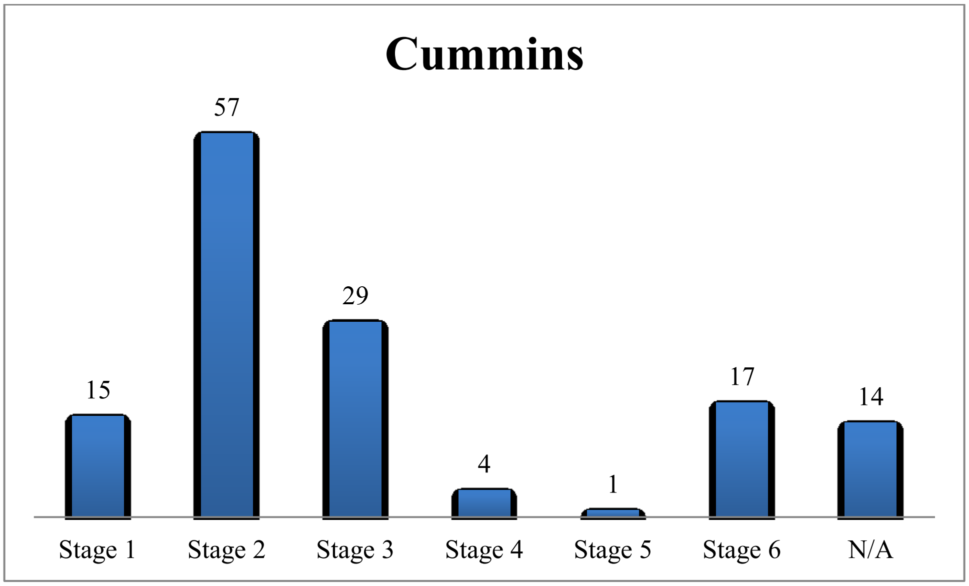


Figure 7.15: Bar graph depicting the stage identification of the Cummins biface assemblage.

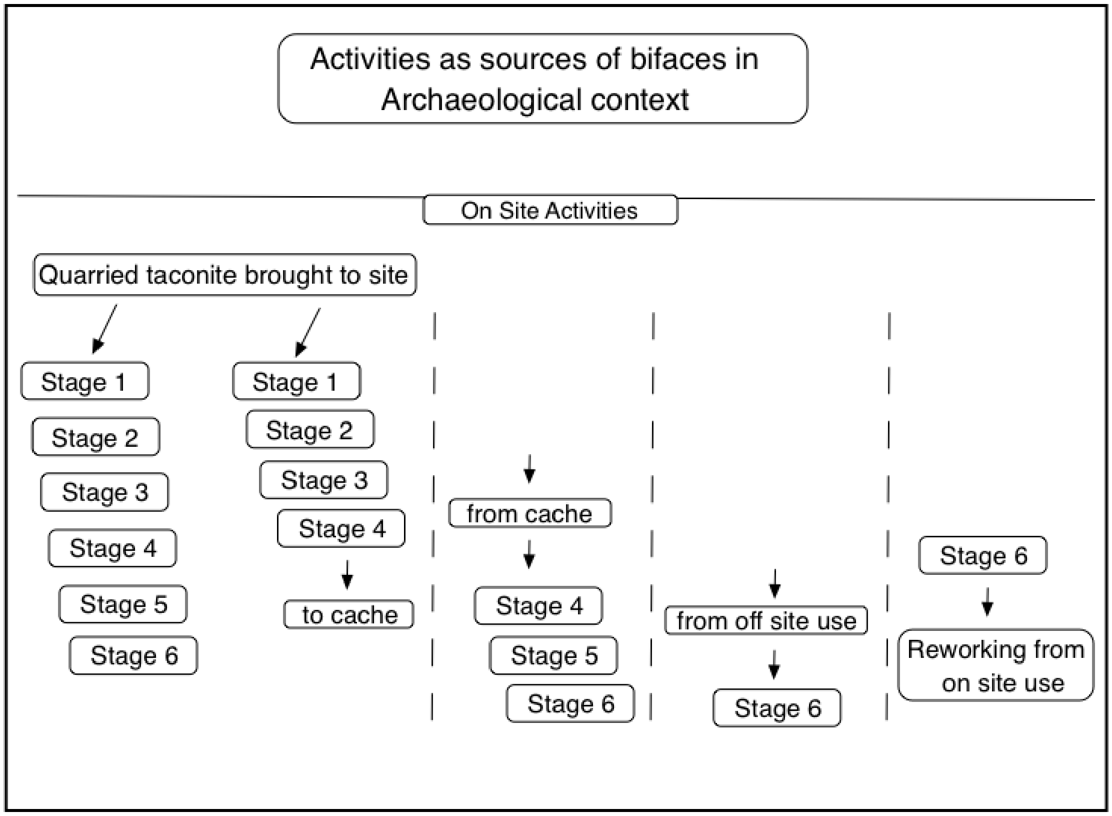


Figure 7.16: Schematic of the site activities which likely produced the Cummins biface assemblage, modified after Hinshelwood and Webber, 1987: Figure 37.

7.5.5 Other Sites within the Lakehead Complex

In order to offer points of contrast to the Mackenzie I assemblage, the Naomi site (DcJh-42), the Crane Cache (D), the RLF site (DdJf-13) and the Hodder East site (DcJh-44) are summarized to reveal how different sites (with different inferred functions) reveal different lithic technological organization profiles (Figure 7.17). Naomi was identified as a small lithic reduction area where quarry blanks were brought to the site and then reduced, to either Stage 3 or 4, and then removed elsewhere for further refinement (Adams, 1995). The RLF (Lints, 2012; Langford, 2014) and Hodder East (Gibson, 2014) sites have also been classified as small lithic workshop areas where quarry blanks were brought to the site, reduced to a mid stage level of biface reduction and then removed for finishing. The Crane Cache consists of two distinct biface caches nearly all of which can be metrically classed as Stage 3 thinned bifaces but have clear non-metric indictors placing them into Stage 4. Naomi, RLF and Hodder East biface assemblages indicate small lithic reduction areas where there was a determined stopping point in the reduction sequence. This can be observed in Table 7.3 and Figure 7.17 where the majority of these small biface assemblages cluster around the early stage of reduction. The small proportion of formal tools may have been produced on site but more likely were brought in from other sites and discarded or lost at these sites. At Naomi this is likely the case as there is a heavily re-sharpened HSS (Hixton Silicified Sandstone) projectile point that was possibly dropped on site or discarded due to the possibility that it could no longer remain functional in that state of curation. There is a lack of Stage 4 and 5 bifaces indicating that bifaces in these stages were either not produced at these sites or that they were and once completed they were carried away to be refined further at another locality. This fits with the observations from other sites where the highest degree of breakage occurs in Stage 2 and 3. The Crane Cache is clearly a different type of site, at this site bifaces were reduced to Stage 4 and cached. All the bifaces in this assemblage can readily be placed in Stage 4 and may have all been produced on site by a single individual (Ross, 2012). There is a significant debitage assemblage at this site indicating that some if not all bifaces were produced on site. The possibility does exist that some of these bifaces were brought to site and placed in the cache with those produced on site.

Table 7.3: Chart depicting the biface stage breakdown by site

	Site Breakdown by Stage			
	Naomi	**RLF**	**Crane**	**Hodder East**
Stage 1	0	6	0	6
Stage 2	3	16	0	27
Stage 3	17	22	0	16
Stage 4	23	4	153	2
Stage 5	8	1	0	1
Stage 6	1	1	0	1
N/A	3	2	0	15

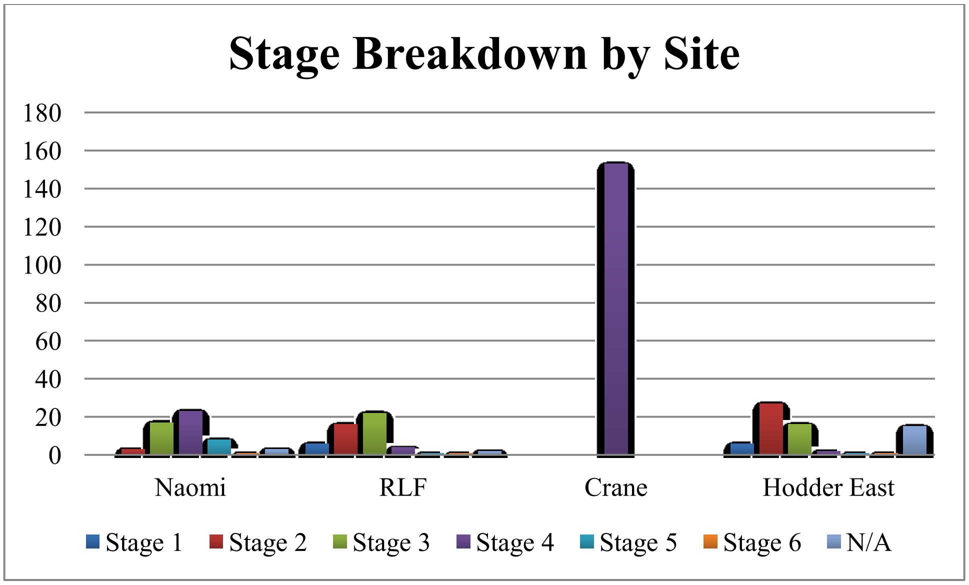


Figure 7.17: Bar graph showing the breakdown of Stage identifications for Naomi, RLF and Crane sites.

Table 7.4: Chart depicting the breakdown by stage of a selection of Lakehead Complex sites.

	Site Breakdown by Stage								
	Crane	**Cummins**	**Biloski**	**Simmonds**	**Naomi**	**Hodder East**	**RLF**	**Mackenzie I**	**Brohm**
Stage 1	0	15	10	0	0	6	6	15	0
Stage 2	0	57	82	4	3	27	16	103	3
Stage 3	0	29	67	7	17	16	22	225	18
Stage 4	153	4	13	4	23	2	4	128	16
Stage 5	0	1	5	2	8	1	1	102	7
Stage 6	0	17	3	3	1	1	1	472	20
N/A	0	14	37	2	3	15	2	224	22

Comparison of all sites within the Lakehead Complex that were subjected to biface analysis reveals that there is a significant difference between these sites and Mackenzie I. Significantly greater numbers of bifaces were recovered at Mackenzie I, total percentages of the early stage bifaces are similar across the sites. At Mackenzie I the greater presence of Stage 4 and 5 bifaces is notable. At no other site in the Lakehead Complex has there been such a presence of these stages of manufacture in conjunction with the early stages and such an amount of formal tools (Table 7.4 and Figure 7.18).

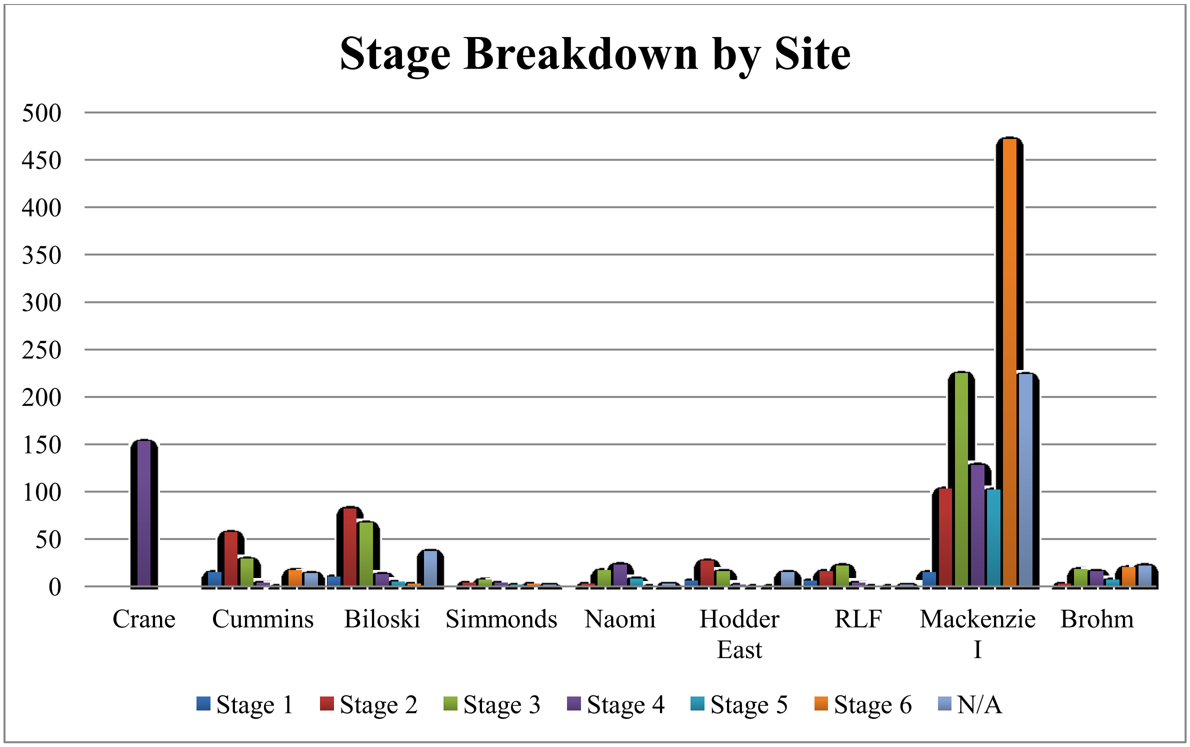


Figure 7.18: Bar graph depicting the stage breakdown by site for the Lakehead Complex sites with reduction stage analysis.

There is a significant difference in the extent of the sites that were excavated (Table 7.5) due in large part to the size of the sites and the changing nature of CRM archaeology. Over 7.3 hectares are protected at the Cummins site locality with only a portion of the site actually being excavated. Mackenzie I could not be protected and therefore the entire site area was excavated following the updated Standard and Guidelines for Consulting Archaeologists (2011). Following these new guidelines meant that a five-metre was to be excavated to contain all areas yielding more than 10 artifacts per square metre was required before an area could be considered fully excavated. For this reason alone the excavations at Mackenzie I was so much greater.

Table 7.5: Table illustrating the comparison of the square metres excavated by site.

Site Name	Square metres excavated
Brohm	73.5
Biloski	105
Cummins	244
Mackenzie I	2539
Neebing Sites	1000+

7.5.6 The Overall Lakehead Complex Toolkit Assemblage

The Lakehead Complex tool assemblage as defined by Fox (1975) consists of refined biface blades (preforms), projectiles, expanding base drills, broad blade thin bifaces, elongated bipointed bifaces, scrapers (bifacial and unifacial), and less formal tools (expedient flake tools). Based on the present understanding of the Lakehead Complex, it was hypothesized that a rudimentary blade-production technology will be discovered as more research is conducted (Fox, 1975). Julig (1994) further defined the tool assemblage following his analysis of the Cummins site. This analysis included a number of tool-types already reported plus other previously unidentified tool forms.

The overall tool assemblage remains consistent with other Lakehead Complex sites. Markham (2012; 2013) analyzed the projectile point assemblage from Mackenzie I and found that the large assemblage enabled assessment of the relative importance of stylistic varieties noted within the Lakehead Complex. That is, a range of point styles have been observed in sites assigned to the Lakehead Complex, but the sample size from any one site has been too small to offer a meaningful perspective on general trends (Figure 7.18). With a much larger sample available form Mackenzie I, Markham (2012; 2013) found that projectile point variation remains consistent with that observed in the much smaller assemblages deriving from other sites regardless of the raw material type. The larger assemblage also enabled Markham (2012) to offer generalizations about the stylistic trends within the Lakehead Complex (Figure 7.19). The general Lakehead Complex tool assemblage, consisting of drills, lunate knives, broad blade thin bifaces, gouges, scrapers, large chopping tools, and unifacially retouched flakes and blades were all represented at Mackenzie I. While knives were not present in high numbers at Mackenzie I, a large number of informal tools that could have served as cutting implements were recovered.

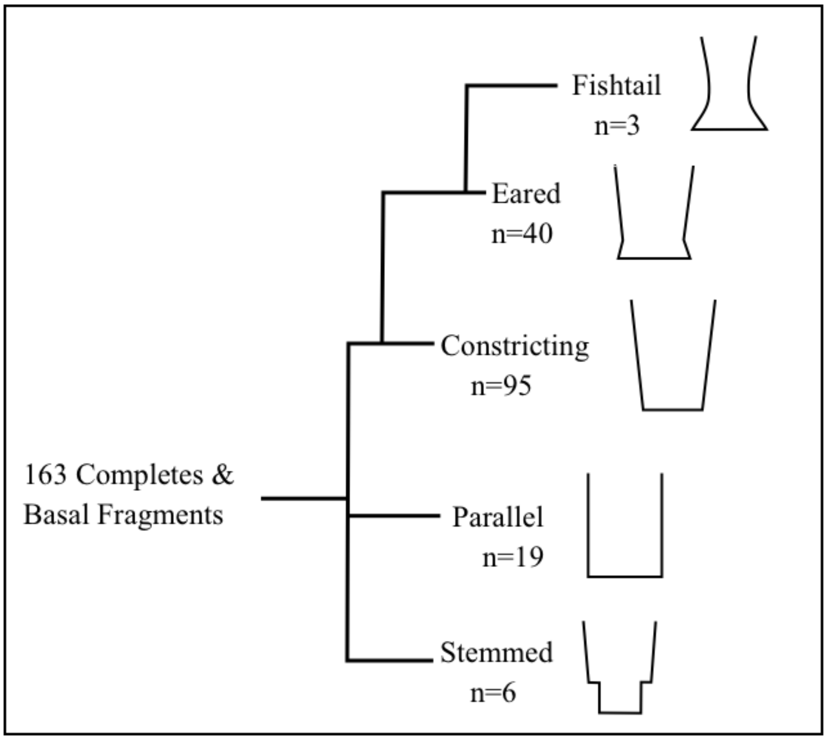


Figure 7.19: A dendrogram illustrating the overall basal morphology breakdown of the 163 projectile points with intact basal portions (Modified after Markham, 2013; Figure 6.10).

7.5.7 The Toolkit as present at Mackenzie 1

The overall Mackenzie I toolkit is presented in Table 7.6. The biface assemblage was the major focus of this analysis with only passing consideration of the uniface (scrapers and retouched/utilized flakes) assemblage. The production of uniface tools was ancillary to the production of the refined bifacial tools. The existing incomplete (and rather generic) catalogue was queried to calculate the frequency of scrapers and retouched flakes. This catalogue does not distinguish between type of scraper or the nature of the informal tool, but it does serve to expand the comprehensiveness of the tool inventory. The bifacial tool assemblage from Mackenzie I includes projectile points, knives, adzes, gouges and drills.

Table 7.6: Overall toolkit present at Mackenzie 1

	Tool Assemblage		
	Broken	Discard	Reworked
Projectile Point	339	39	9
Knife	5	5	0
Drill	51	5	3
Adze	6	7	0
Gouge	5	0	0
Scraper	38	60	11
Retouched Flakes	194	94	0

7.6 COMPARISON TO ARCHAIC ASSEMBLAGES

There have been very few Archaic sites located in the Thunder Bay region making it difficult for researchers to compare the Lakehead Complex to local Archaic groups. The closest in time to the late Paleoindian groups is the Kirk Corner Notched Complex. This complex consists of broad notched projectile points manufactured following a biface reduction strategy and has been found from Louisiana north into portions of southern Ontario. Analysis of a couple of KCN assemblages by Bradbury (2007) and Bursey (2012) revealed that overshot flaking and grinding/polishing of the platforms remains a part of the methodology for tool manufacture. Early stage bifaces (Figure 4.32: Plate A Image c, d and Plate B) could easily fit into a Paleoindian assemblage. The continued presence of platform preparation and overshot flaking indicate that, although the end product may look different, the overall process to get there remained very similar.

Bifaces from the Shield Archaic as defined by Wright (1972) would also indicate that there was a continuation of the methods used to produce the bifacial formal tools. Superficial visual similarities exist between bifaces identified as belonging to the Shield Archaic and bifaces from Mackenzie I and the

Lakehead Complex as a whole (Figure 4.33). However, the existing literature does not offer any indication whether platform preparation was a part of the Shield Archaic reduction process. Thus, it is not currently possible to state the degree of similarity based upon platform preparation between Lakehead Complex biface reduction (as defined by the Mackenzie I assemblage) and the Shield Archaic tradition without directly analyzing Shield Archaic artifacts.

While such a comparative analysis is beyond the scope of this thesis, some preliminary insight is possible by considering the Gerlach collection, a possible Archaic biface assemblage from northern Ontario. The Gerlach assemblage was found east of Thunder Bay and contains a number of oval bifaces manufactured from Hudson's Bay Lowland chert. These bifaces are reminiscent of Stage 3 or 4 as defined above, although the edge angles are somewhat too steep to be consistent with Stage 4 bifaces. These bifaces also reveal some use of overshot flaking and some grinding on remnant platforms, indicating that edge preparation remained a part of the reduction process (Figure 4.34). The thickness and nature of the flaking patterns on these biface may indicate their use as bifacial cores.

7.7 MACKENZIE 1 SITE FORMATION PROCESSES

The timing of occupation at Mackenzie I was difficult to determine. This large site occupies a relic beach ridge associated with Glacial Lake Minong at an elevation of about 246 m asl (Figure 7.20). The timing and temporal duration of occupation is unclear. A small number of the recovered artifacts (far less than 1%) (n=24) reveal possible evidence of water rolling. This makes it unlikely that occupation debris was subjected to reworking while the beach was being actively subjected to wave action, and implies that occupation occurred at a time of declining water levels. Due to the proximity of the Mackenzie River there is also the possibility of fluvial reworking of the sediments. The lack of water rolled debris combined with the preliminary spatial analysis carried out in this thesis and the refined spatial analysis carried out by McCulloch (2014) indicates that fluvial action did not affect the artifacts. Sedimentological studies carried out by Shultis (2012) and Gilliland (2012) also do not indicate the likelihood of fluvial action disturbing the sediments or the artifacts. It is, therefore, possible that the occupation of the site may have occurred after Lake Minong levels had dropped significantly and the Mackenzie River began to downcut the gorge. Due to bioturbation and aeolian reworking of the beach sediments it is difficult to confidently state what depositional conditions were present during site occupation.

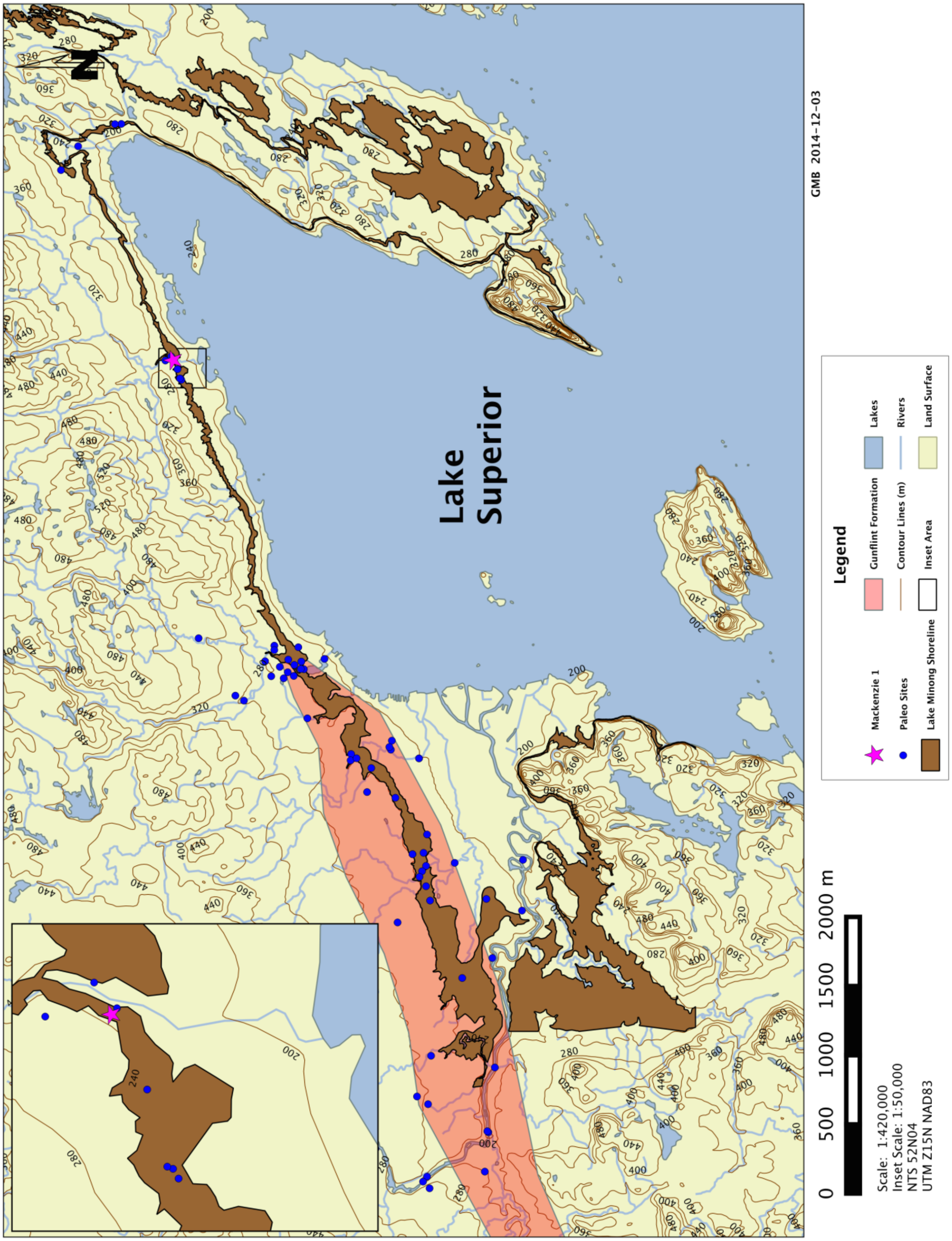


Figure 7.20: Map showing the Lake Minong levels and the extent of the Gunflint Formation.

The habitation/lithic workshop site functions at Mackenzie I are indicated by the vast debitage assemblage, specimens representing the various biface reduction stages, and the diversity and abundance of formal and informal tools. The presence of both primary reduction materials and the large bifacial tool assemblage indicates the site had a special significance to the manufacture of formal tools. The minimal presence of reworking of broken biface fragments indicates that the availability of lithic raw material was not a concern. The question remains where this raw material came from. There is no presently known direct source of Gunflint Formation chert in close proximity to Mackenzie I, or any of the sites within the Mackenzie cluster of Lakehead Complex sites (Figure 7.23). The presence of this amount of material would indicate that it was brought to the site since there is no outcrop in close proximity. Whether a large amount of quality material was present in the glacial till or there was a significant amount of travel between the quarry sites to the west and the Mackenzie and Pass Lake site clusters. The sheer amount of material recovered from the sites in the Mackenzie cluster would indicate that a large amount of raw material was carried east over a significant period of time.

Due to the proximity of the Mackenzie River to glacial Lake Minong also suggests the possibility that the site was an ambush kill site for migrating caribou herds. The recovery of numerous broken projectiles would indicate an ambush/kill site was near at hand, or that the site served as a home base and processing area where damaged spears were re-armed. The nature of the projectile point assemblage would seem to support this assumption. Of the 387 projectile points there were 35 complete points likely lost during transport or manufacture. There were 142 basal fragments, indicating the possibility that these fractured during use and were removed from the shaft to be replaced. The 133 tips, 101 mid-section and 12 lateral edge fragments, indicate the possibility of fracture during use in attempts kill nearby prey animals, or were removed from carcasses brought to the habitation area for processing.

The presence of scrapers, expedient tools and knives would also indicate that there was a significant industry for the processing of hides, bone and meat. The presence of reworked tools is minimal but important to interpretations of the site function. Those tools that were reworked largely include basal fragments of projectile points that were made into scrapers on the distal fracture plain.

The presence of adzes and gouges would seem to indicate that there was a degree of woodworking being done at the site as well. Whether the adzes are contemporaneous with the Paleoindian occupation of the site is unclear at this point. The functionality of the tools identified as drills ranges in possibility. It has long been assumed though that this tool type was used to make holes in bone, wood and leather. Regardless of whether they were used as projectiles, drills or perforators they are present on the site and share a general morphology.

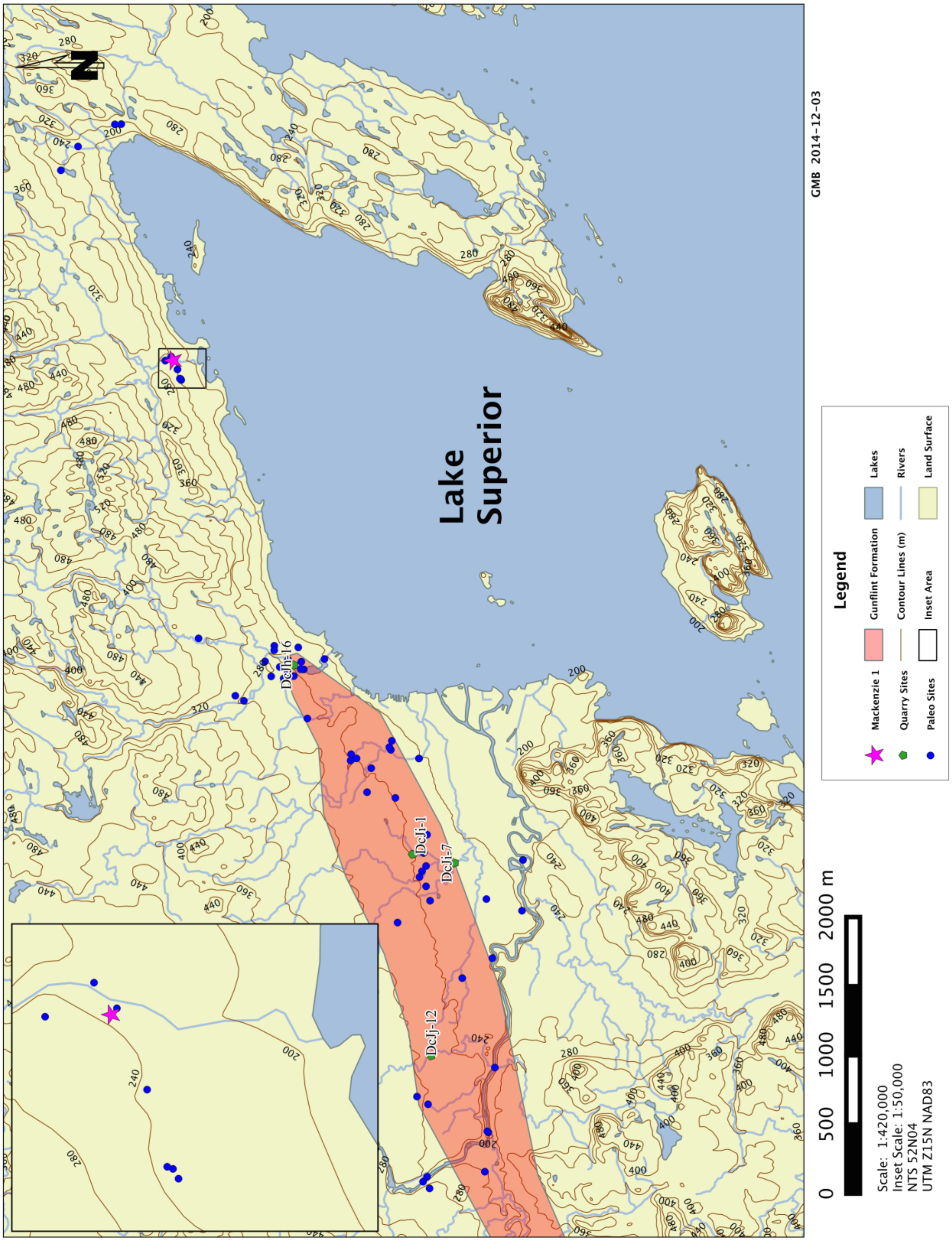


Figure 7.21: Map showing the location of the identified quarry sites within the Lakehead Complex, the extent of the Gunflint Formation and the location of the Mackenzie cluster of sites.

7.8 SUMMARY

The nature of the Mackenzie I assemblage indicates a long occupation history of the immediate site area. The range of biface stages encompassing all stages of manufacture indicates that the site was a workshop for the production and maintenance of formal hunting tools. That there is no quarry nearby indicates that the material was carried from as far as 30 km away. It is clear that large blocks of raw material were brought to the site for the purpose of tool manufacture. The extremely high numbers of formal tools indicates that there was a significant amount of tools being manufactured and used in close proximity to the main site area. The length of habitation, season of occupation and exact range of activities being carried out is unclear. Further analysis of the debitage assemblage may aid in narrowing down the nature of activity areas on the site.

CHAPTER 8

MACKENZIE I SITE FUNCTIONALITY FROM A BIFACE TOOL PERSPECTIVE

8.1 INTRODUCTION

This chapter summarizes the results of the rudimentary spatial analysis carried out as part of this thesis. This was done in order to determine what type of movement (taphonomic, past human agency or modern disturbance) caused the biface refits to be separated. Presented here are the maps illustrating the results of this attempt at spatial analysis. Discussion of what the maps indicate and what this means in terms of site functionality, integrity and post-depositional activities follows.

The bifaces were mapped as part of this analysis but were not subjected to detailed spatial analysis. Field-mapped bifaces were precisely plotted on the site plan, while other bifaces were placed randomly within their 50 cm wide collection quads using an algorithm within the cataloguing program (Figure 7.22). Once plotted, refitted biface fragments were linked with lines to document the drift of the refits. It would appear that some bifaces experienced a significant degree of lateral drift (Figure 7.23). Whether this is the result of taphonomic processes or through human agency during the occupation of the site is unclear. An understanding of the broad spatial location of the bifaces, the formal tools and the unifacial tools aids in understanding site functionality.

8.2 REFIT SPATIAL ANALYSIS OF THE MACKENZIE I BIFACE ASSEMBLAGE

Spatial analysis is not part of thesis, but is being undertaken elsewhere (McCulloch, 2014). In this thesis the spatial distribution of bifaces and tools was briefly considered in order to document the extent of lateral drift of refitted pieces, and to determine if recent soil testing disturbance in the center of the site caused any of this drift. These disturbances derive from gravel testing by engineers prior to the salvage excavations. When all the bifaces were plotted on the site map, a series of confusing clusters of material is evident that is superficially suggestive of discrete encampment/lithic deposition areas (Figure 8.3).

The four areas of disturbance are labelled with numbers in Figure 8.1. One purpose of the rudimentary refit-based spatial analysis carried out in this thesis was to determine what affect, if any, these disturbances had on the bifaces. Spatial mapping indicates that the conditions observed in Area 2 and Area 3 had a profound effect on the distribution of artifacts in these areas of the site. These disturbances appear to have pushed all artifacts to the periphery of the disturbed area, with clusters of artifacts on the north and south edges of Area 2 and the southwest edge of Area 3 (Figure 8.1). This was very different from the distribution of artifacts in Area 4 where it appears that artifacts remain distributed throughout the disturbance area (Figure 8.1). There is even some evidence of biface refitting within the disturbance that remains in the same unit showing minimal lateral movement (Figure 8.3 and 8.5).

The refit mapping revealed that lateral movement of the artifacts likely was not as a result of the disturbances or of taphonomic processes. Artifacts that remain within or in close proximity to Areas 2 and 4 refit to other fragments some distance away. Figure 8.2 shows the location of the Stage 1 and 2 bifaces, the biface anomalies and the unstaged fragments. The large biface reminiscent of those from the Caradoc site (Figure 6.10, and Figure 7.3 C) e) has one portion within the Area 4 with the most southerly piece remaining within a cluster of other bifaces (Figure 8.2). The Stage 1 and 2 bifaces as well as the unstaged fragments revealed minimal lateral drift. The Stage 3 and 4 refits were mapped in Figure 8.3, and indicate greater lateral drift occurred more frequently at these stages of manufacture. Nonetheless, several such bifaces reveal minimal movement (Figure 8.3). This pattern holds true for the Stage 5 and 6 bifaces as well (Figure 8.4), with a number of refitted specimens showing a considerable amount of lateral drift, but again the was unlikely caused by taphonomic processes.

The refits were mapped separately on the topographic map of the site produced by Dr. Scott Hamilton prior to the salvage excavations (Figure 8.5). This map suggests a possible southwest to northwest orientation of low beach strand lines originating from the exposed bedrock surface in the southeast corner of the site area. Hamilton speculates about possible ‘long shore’ movement and accumulation of sediment along the leeward side of this bedrock exposure. He also proposes that the gully-like orientation of the contour lines immediately west of the bedrock knoll might suggest a former stream bed. Given the dense concentration of biface fragments immediately to the north of the bedrock knoll, one would expect downslope taphonomic displacement from this cluster along this swale, or alternatively along the northwest/southeast orientation of the possible beach strands. The majority of refits deriving from the dense cluster identified in Figure 8.5 do not reflect either orientation. A single projectile point refit does point southwest, but a cluster of Stage 3, Stage 5 and Stage 6 bifaces are located to the southwest of this projectile and are mostly oriented east-west or angling southeast (Figure 8.5).

There is significant clustering within some of the larger clusters identified in Figure 8.1. The spatial analysis of the refits was also done in order to determine the degree of movement between the clusters. The subsequent refit maps (Figure 8.2 – 8.5) show that within the clusters more refined analysis may reveal the possibility of distinct knapping areas and/or activity areas. A number of the refits have one fragment located within a cluster of bifaces with the other piece located some distance away. This phenomenon is more readily observed beginning in Stage 3 production and continuing to Stage 6. It is hypothesized that this is a result of knapper's frustration rather than taphonomic processes. As has been previously discussed it would appear that the known disturbance events and the possible fluvial disturbances in the past did not affect the distribution of artifacts. Two possible explanations remain to explain this degree of lateral movement. The first is that the greater the amount of time spent on reduction the greater the amount of frustration there will be if the biface fails. Following the fracture of the biface one piece may have fallen directly to the ground while the other piece was thrown in frustration in the direction the knapper was facing at the time. The second explanation is that the biface fractured in a reduction area and was carried to another activity area for further reduction, reworking into a new tool, or use as is. As can be observed in Figures 8.2 - 8.5 some refits do have one piece in one cluster of bifaces and the refit or refits within another cluster of bifaces indicating the likelihood of the second scenario. Others however, have one piece located in an area void of identified tools and bifaces, indicating that the first scenario could have occurred as well.

The orientation of the biface refits can give some indication as to whether or not taphonomic processes were the main agent for lateral movement of the bifaces (Figure 8.5). It is understood that within a boreal environment there will be some horizontal and vertical movement of artifacts as a result of bioturbation. This does not explain the movement of artifacts greater than five metres and up to 40 m away. Fluvial action can result in the movement of artifacts great distances if the rate of flow is great enough to suspend larger pieces of lithic material.

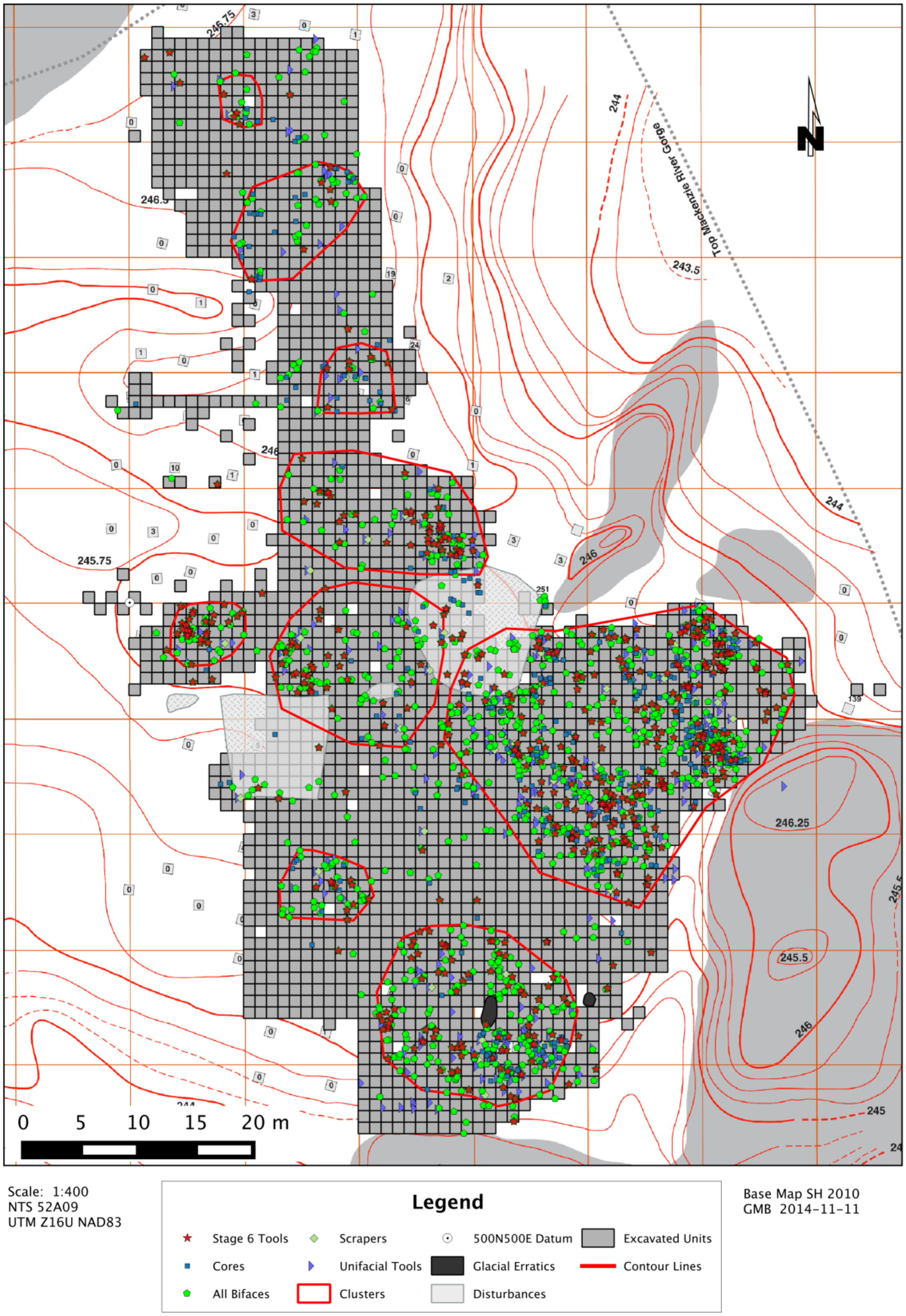


Figure 8.1: Mackenzie 1 Site map showing the location of all bifaces, tools (bifacial and unifacial) and cores, definable clusters are indicated by the red polygons.

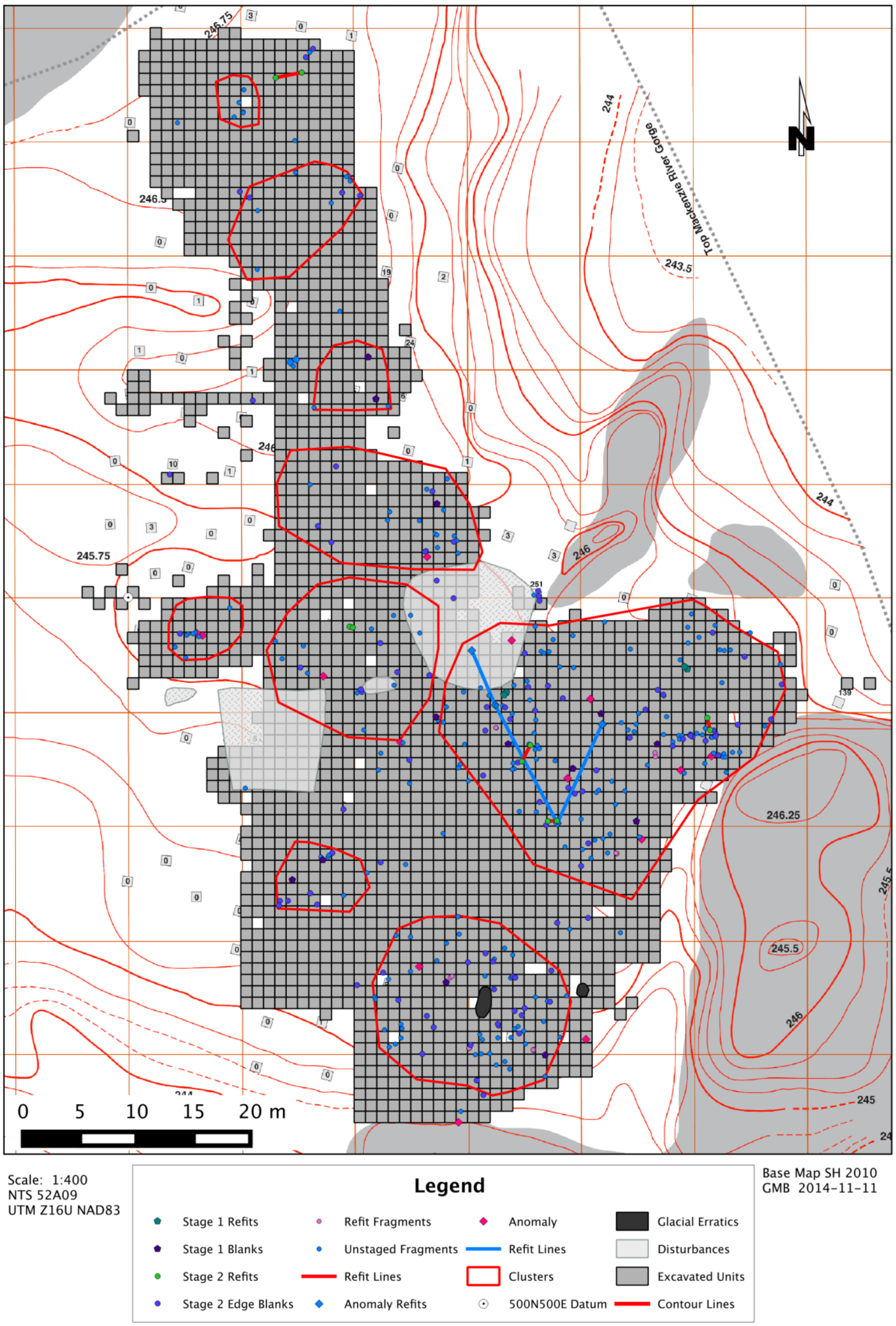


Figure 8.2: Mackenzie I site map of the Stage 1, Stage 2, Anomaly and Unstaged biface refits, within the identified clusters.

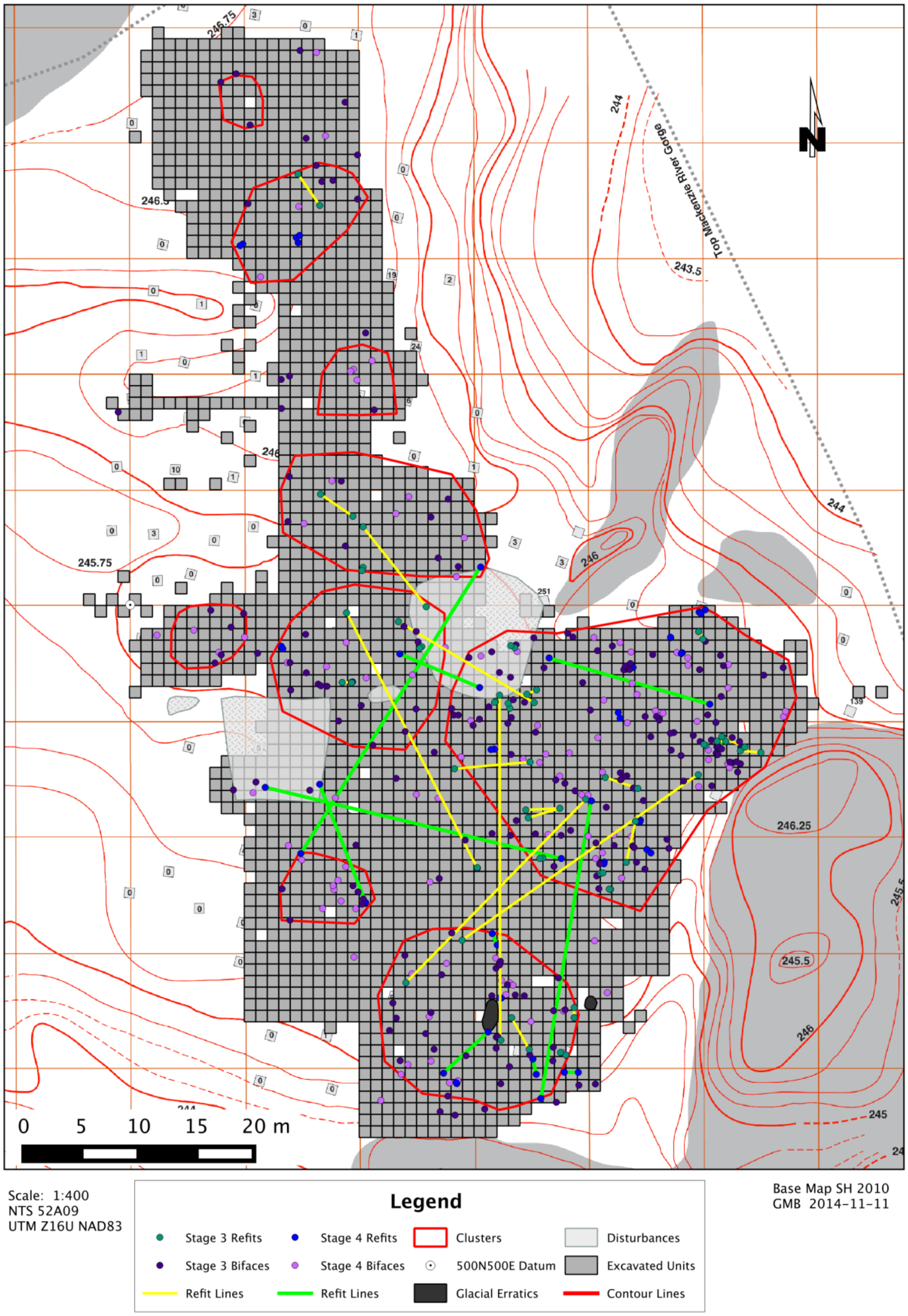


Figure 8.3: Mackenzie I Site map with the location of the Stage 3 and 4 biface refits, within the identified clusters.

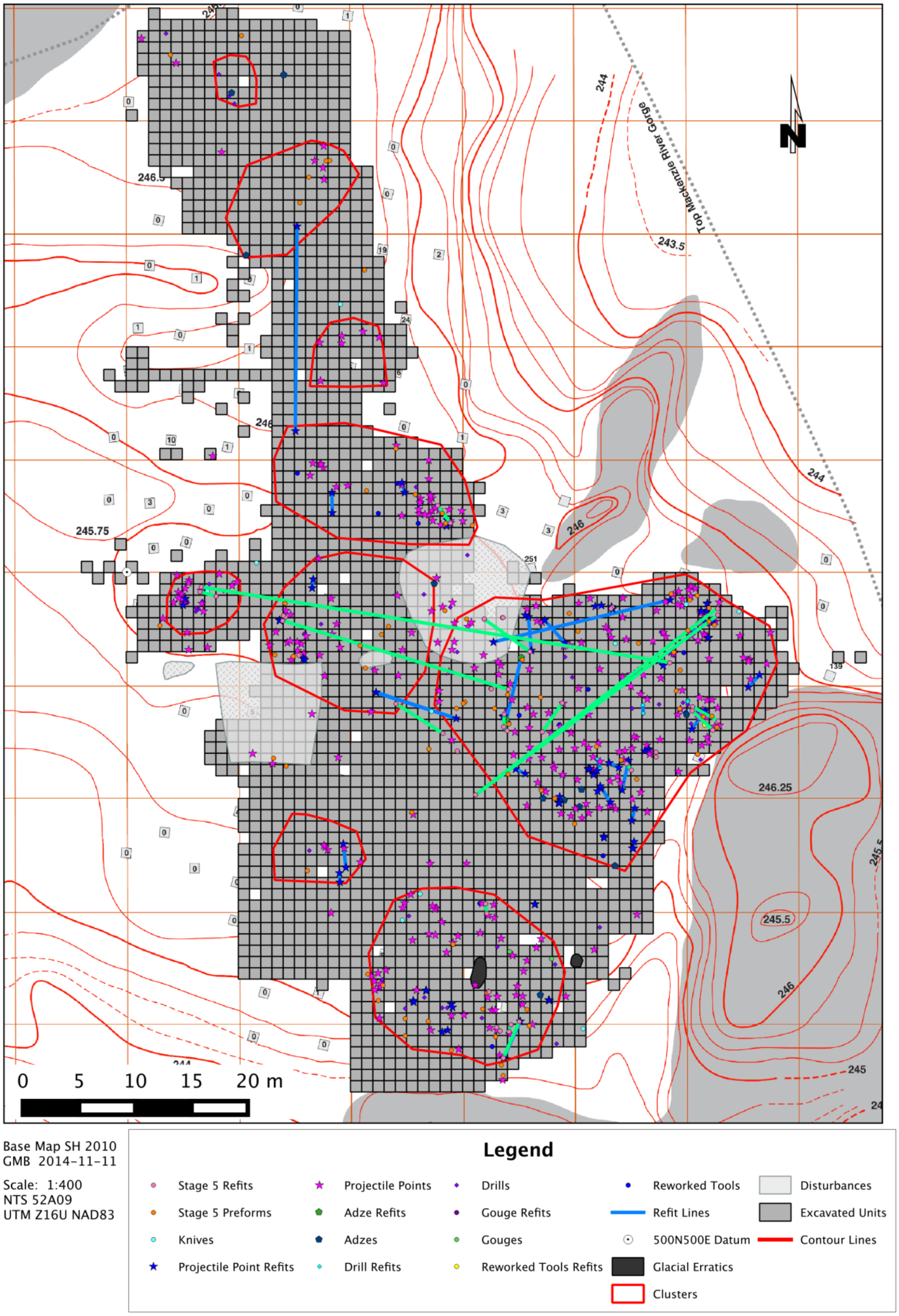


Figure 8.4: Mackenzie I site map of the Stage 5 and 6 biface refits, within the identified clusters.

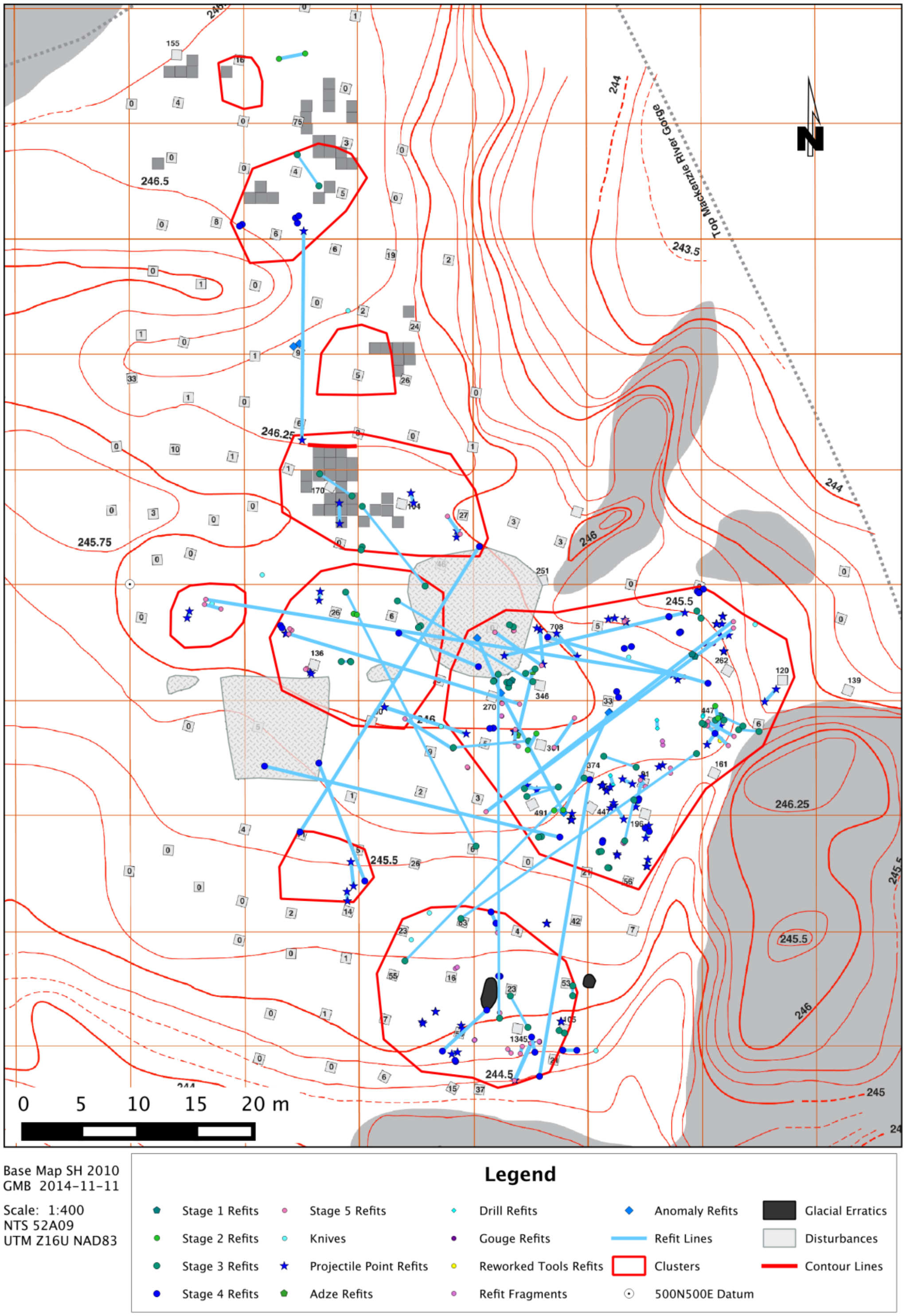
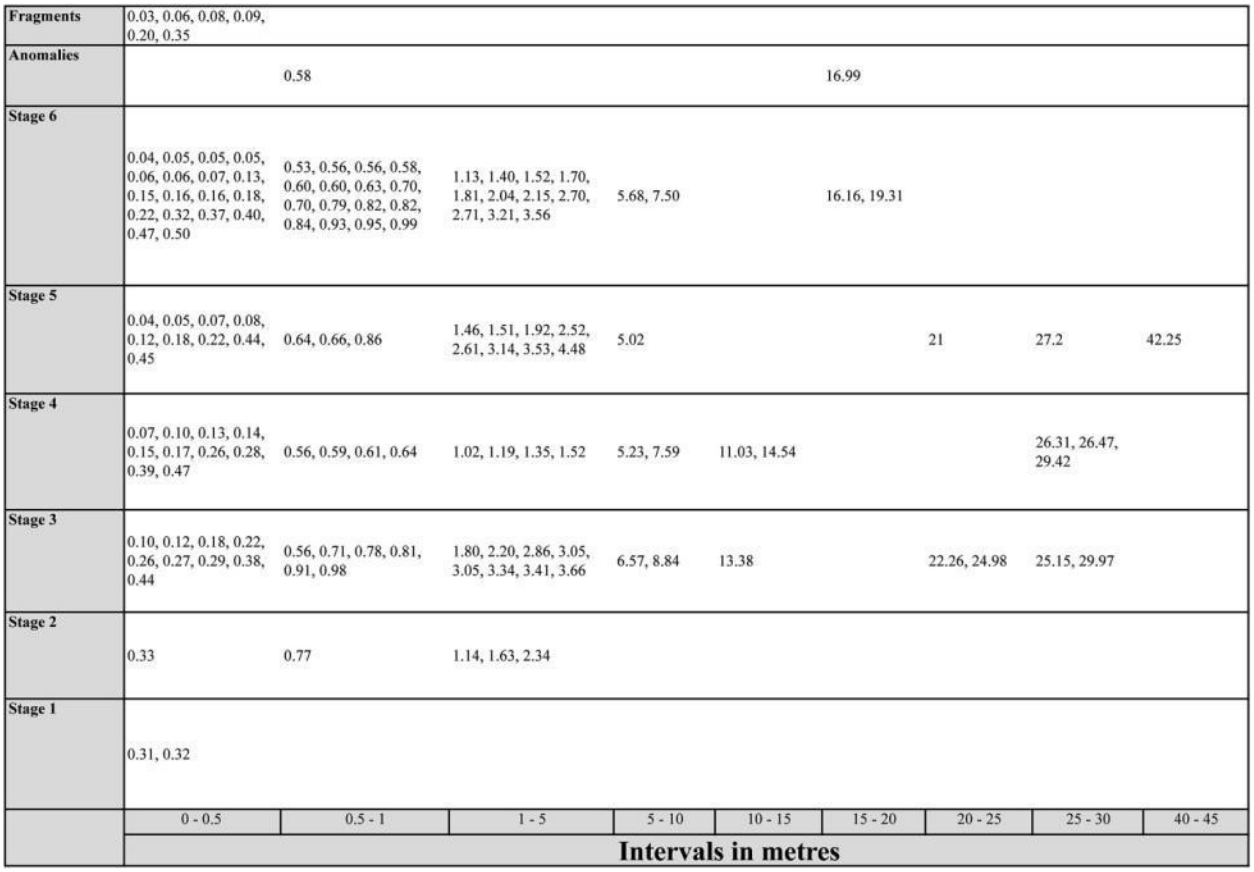


Figure 8.5: Mackenzie I site map of the refitted bifaces on the micro-topography contour lines, Stage 3 units are indicated by the numbered grey squares.

The refitted bifaces were measured to reveal the distances between the refits (Table 8.1). The majority of the refitted biface fragments were found within one metre of each other, with the number of biface refits declining rapidly over distances greater than five metres (Table 8.2). Using this chart the biface refit frequencies were plotted on a line graph (Figure 8.6). Even those bifaces found to be in the 1-5 m block the majority of these bifaces were between one and three metres away (Table 8.1). This suggests that the significant lateral drift in the refitted bifaces apparent in Figures 8.1 to 8.5 might be a false impression whereby the more distant refits visually dominate at the expense of the more frequent short-distance refits. While the refit exercise demonstrates some degree of lateral drift, it appears rather modest, and likely reflects modest taphonomic displacement, and a rather constrained drop/toss zone of failed and broken biface fragments. The more extreme distances may reflect the intention of the knapper to reuse a biface fragments as a number of these long distance refits are between defined clusters.

Table 8.1: Distance of Mackenzie I biface refits by Stage.



Fragments	0.03, 0.06, 0.08, 0.09, 0.20, 0.35								
Anomalies		0.58				16.99			
Stage 6	0.04, 0.05, 0.05, 0.05, 0.06, 0.06, 0.07, 0.13, 0.15, 0.16, 0.16, 0.18, 0.22, 0.32, 0.37, 0.40, 0.47, 0.50	0.53, 0.56, 0.56, 0.58, 0.60, 0.60, 0.63, 0.70, 0.70, 0.79, 0.82, 0.82, 0.84, 0.93, 0.95, 0.99	1.13, 1.40, 1.52, 1.70, 1.81, 2.04, 2.15, 2.70, 2.71, 3.21, 3.56	5.68, 7.50		16.16, 19.31			
Stage 5	0.04, 0.05, 0.07, 0.08, 0.12, 0.18, 0.22, 0.44, 0.45	0.64, 0.66, 0.86	1.46, 1.51, 1.92, 2.52, 2.61, 3.14, 3.53, 4.48	5.02			21	27.2	42.25
Stage 4	0.07, 0.10, 0.13, 0.14, 0.15, 0.17, 0.26, 0.28, 0.39, 0.47	0.56, 0.59, 0.61, 0.64	1.02, 1.19, 1.35, 1.52	5.23, 7.59	11.03, 14.54			26.31, 26.47, 29.42	
Stage 3	0.10, 0.12, 0.18, 0.22, 0.26, 0.27, 0.29, 0.38, 0.44	0.56, 0.71, 0.78, 0.81, 0.91, 0.98	1.80, 2.20, 2.86, 3.05, 3.05, 3.34, 3.41, 3.66	6.57, 8.84	13.38		22.26, 24.98	25.15, 29.97	
Stage 2	0.33	0.77	1.14, 1.63, 2.34						
Stage 1	0.31, 0.32								
	0 - 0.5	0.5 - 1	1 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	40 - 45
	Intervals in metres								

Table 8.2: Frequency chart of Mackenzie I biface refits broken down into distance categories.

	0 - .5 m	.5 - 1 m	1 - 5 m	5 - 10 m	10 - 15 m	15 - 20 m	20 - 25 m	25 - 30 m
Stage 1	2	0	0	0	0	0	0	0
Stage 2	1	1	3	0	0	0	0	0
Stage 3	9	6	8	2	1	0	2	2
Stage 4	10	4	4	2	2	3	0	0
Stage 5	9	3	8	1	0	0	1	1
Stage 6	17	17	11	2	0	2	0	0
ANM	0	1	0	0	0	1	0	0
Fragments	6	0	0	0	0	0	0	0

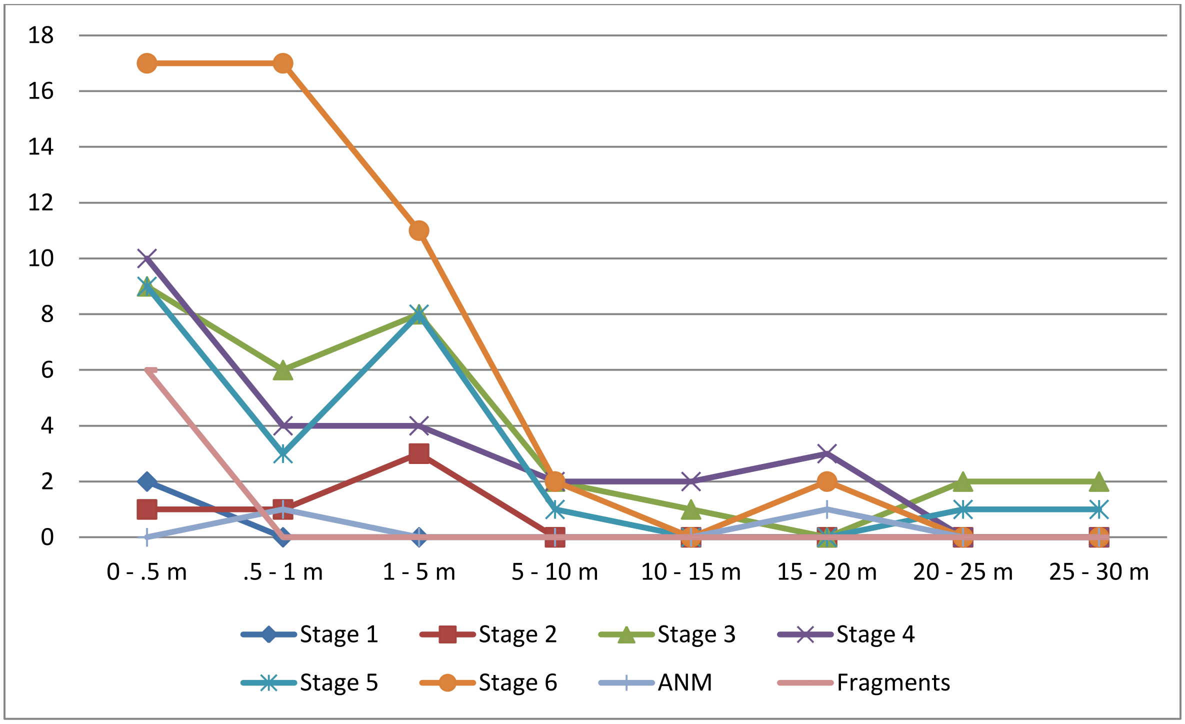


Figure 8.6: Line graph of the frequency of Mackenzie I biface refits broken down into distance categories.

8.3 SUMMARY

The refit-based spatial analysis revealed that taphonomic processes had little effect on the lateral movement of the bifaces. Intensified analysis of the refits using the vertical data may reveal that taphonomic processes (bioturbation and cryoturbation) resulted in a certain degree of vertical movement of biface fragments within the sediments. The areas of disturbance as a result of soil testing by engineers prior to the Stage 2 investigation of the site indicate that one area suffered a great deal of disturbance while the other centralized disturbance appears to have been more of a spoil heap. Analysis of the bifaces in this section using the depth of recoveries may indicate that there was compression of the sediments as a result of the weight of sediment and tree debris in this area.

This analysis also revealed that the lateral drift observed in the latter stages of manufacture was likely the result of human agency at the time of manufacture rather than post-depositional disturbances. The micro-topography of the site indicates that there was likely wave action at some point along the southern edge of the site and that there was the possibility of fluvial action along the western flank of the large bedrock outcrop to the southeast (Figure 8.5). The directionality of the refits in these areas was not consistent with the direction of fluvial movement or the wave action. This would indicate that the drift was a result of a portion of the biface being tossed away from the main reduction area by the knapper. It is also possible that during the reduction process a fragment was removed post-breakage from the reduction area to be utilized elsewhere on site.

CHAPTER 9

SUMMARY AND CONCLUSION

9.1 SUMMARY

Previous analyses of Lakehead Complex biface assemblages revealed that most sites yield items reflecting the early stages of manufacture, with little evidence of the finishing stages. They also suggest that there was a high degree of breakage in the early reduction stages, but this may be influenced by the underrepresentation of the final stages. The Brohm and Biloski site analyses revealed that metric attributes associated with Callahan's (1979) reduction stages are not directly applicable to Lakehead Complex materials (Hinshelwood and Webber, 1987; Hinshelwood, 1990). These analyses indicate that the width/thickness ratios and edge angle measurements place bifaces in earlier stages of manufacture than the extent of flake removal would suggest. For example, joint planes and flaws on the edges of a biface give measurements that would suggest a Stage 2 biface while the actual extent and nature of the flaking suggest a Stage 3 biface. Hinshelwood and Ross (1992) speculate that this is suggestive of the consequences of technological challenges associated with the raw material employed. Given this possibility, analysis of the Mackenzie I biface assemblage included a more qualitative approach that employs both metric and non-metric attributes in determining the reduction stage.

Mackenzie I is a large site that was likely repeatedly used over time. Problematic and limited absolute dating, combined with the standard Boreal Forest taphonomic problems make it impossible to consider site reoccupation from a stratigraphic perspective. Since the depositional context is inadequate to address the occupation sequence, this raises questions about the consistency of cultural affiliation and duration of occupation. However, as with other sites in the region, there is sufficient evidence to say that Lakehead Complex defines the primary occupants of Mackenzie I on the basis of the general lanceolate projectile point form with parallel oblique flaking, the overwhelming use of Gunflint Formation chert and other technological similarities.

All of the bifaces were examined and were first assigned to a production stage following the prescribed measurements for width/thickness ratio and edge angles (metric attributes). Once this was completed the nature and extent of the flake scars was observed, and the stage of manufacture was reassessed and refined on the basis of these non-metric attributes. Metric attributes for the latter stage bifaces generally matched those of Callahan (1979). When considering the early stage bifaces, a pattern consistent to that observed by Hinshelwood and others was observed. That is, the quality of the raw material coupled with the frequency of joint planes resulted in Stage 3 bifaces generally having metrics that would indicate a Stage 2 biface. Furthermore, a small number of Stage 4 bifaces, actually had metric attributes that were consistent with Stage 3 specimens despite their more advanced flaking. Bifaces in the latter stages (5 and 6) did show some evidence of steeper edge angles, but was observed to be the result of offset beveling used to set up striking platforms.

Once the bifaces were all staged, observations were made about the presence or absence of non-metric attributes, and what that signifies when considering the manufacture stages. These attributes included the flaking pattern with specific emphasis on the parallel oblique flaking patterns, edge/platform preparation, basal treatment methods and biface morphology (cross-section and longitudinal profile).

As discussed more fully in Chapter 6, these observations led to the proposition that two trajectories of manufacture were present at Mackenzie I. The first step in the sequence involved production of blanks from the stone blocks, and depending on the nature and quality of these blanks, they were reduced following a specific trajectory. Thick tabular pieces of poor or mixed quality material were reduced following a conventional Biface reduction trajectory, while thin flakes and Blade/Flakes were reduced following a Flake/Blade reduction trajectory. Once the morphological characteristics of each trajectory were determined, the formal tool assemblage was re-analyzed in greater detail to determine if these tools could be placed within one or the other trajectory. Only a portion of the projectile point assemblage (completes, complete-refits and basal portions) was subjected to this level analysis, while all other available formal tools were analyzed.

Table 6.3 and 6.4 offers a summary of the Biface and Flake/Blade Trajectory representation by stage and by functional tool type. This analysis revealed that the Flake/Blade Trajectory was more extensively used for the production of projectile points and drills. The Biface Trajectory was also used in the production of these tools, but to a lesser degree. Tools used for chopping were generally all produced following the Biface Trajectory. Actual bifacial knives (n=10) are poorly represented at Mackenzie I, with most cutting tools likely being represented by the over 200 identified expedient tools.

9.2 EXTRA-REGIONAL COMPARISONS: NORTH AMERICAN IMPLICATIONS

The Mackenzie I site has significant implications for North American archaeology, not only because of the density of tool recovery, and typological similarity of the projectile point assemblage to named complexes, but also due to the nature and size of the biface assemblage. Markham (2013) observed that, if one applies a typological approach to the Mackenzie I projectile point assemblage traits associated with Goshen, Plainview, Dalton, Cumberland, Suwannee, Simpson, Scotsbluff, Eden, and Jimmy Allen/Frederick/Angostura are observed. The biface assemblage as well contains methods that are observed singly or as part of the wider Paleoindian tradition. This includes methods of rapid thinning and shaping observed in Clovis reduction sequences, alternate edge-beveling as observed in Agate Basin and Hell Gap, finishing techniques as observed in Cody Complex and Jimmy Allen/Frederick/Angostura projectiles, and refined pressure flaking as first observed in Folsom reduction.

9.2.1 North American Influences

Methods of bifacial reduction as observed in the fluted traditions include the use of overshot flaking, refined methods of platform preparation and patterned pressure flaking. Clovis reduction sequences included the use of refined platform preparation methods and extensive use of overshot flaking, used to rapidly thin a biface. Overshot flaking has been observed in subsequent reduction sequences but not to the same degree as in Clovis. Edge preparation and platform isolation is a trait that is necessary for successful flake removal and is observable on any lithic assemblage. Clovis knapper utilized pressure flaking to refine the edges and in some cases to prepare platforms but it was not used as a finishing technique. Clovis projectile points were generally finished with patterned flake removal either parallel or on a slightly oblique angle. The general morphology of bifaces in Stage 1 through to 4 remains consistent throughout the Paleoindian period. Culture-specific divergence in biface reduction generally occurs in Stage 5, but can occur in Stage 4. This is most dramatically apparent in tool finishing methods, particularly in divergent hafting strategies.

Folsom knappers made more extensive use of pressure flaking to create a central ridge that runs up the midline of both the dorsal and ventral face. This ridge was a necessary precondition for point completion, specifically for the detachment of the distinct Folsom flute that tended to follow the ridge. Given the length of the flute normally associated with Folsom, these ridges often dominated the entire length of the biface. Folsom knappers employed finely patterned pressure flaking as a final finishing technique following successful completion of the fluting.

The latter Paleoindian groups are considered to be part of the non-fluted traditions. The general morphology of the early stages of reduction remains consistent with those of the fluted traditions, but with important shifts occurring in the finishing stages. There is a decreased presence of overshot flaking in the non-fluted traditions. Overshot flaking has been observed, but due to its comparatively low frequency of occurrence, many researchers are unsure whether it was intentional or just a propitious flake removal. Refined methods of platform preparation continue to be a part of the reduction sequence, with patterned pressure flaking becoming increasingly present in the finishing stages of tool production.

Agate Basin and Hell Gap knappers utilized a more refined method of platform preparation to aide in the final shaping and finishing of their projectile points. They utilized an offset bevel to create an edge that allowed for the removal of serial patterned flaking. This required little extra work to prepare individual platforms as the edge was already prepared. Cody complex knappers finished their projectile points using co-medial flaking patterns and refined pressure flaking to create a definable stem on the hafting portion. These edge preparation and finishing methods have been observed on the Mackenzie I biface assemblage. The latter Paleoindian groups, defined by the presence of the parallel oblique flake patterns, clearly had a direct influence on the Mackenzie I assemblage. Observations by Bradley (2010) indicate that the parallel oblique flaking method was used to deal with hard, brittle raw material. The execution of oblique flakes across the grain of the material resulted in less chance of fracture as a result of the material quality. This indicates that the parallel oblique flaking observed on the Mackenzie I biface assemblage may be functional due to the hard brittle nature of Gunflint Formation chert and the frequency of flaws.

9.3 BIFACE ANALYSIS OBSERVATIONS

The Mackenzie I biface assemblage offers the most comprehensive insight to date on how the Lakehead Complex toolkit was manufactured. These observations reinforce what was previously known about the Lakehead Complex reduction sequence. However, limited samples from previous sites resulted in information gaps in the reduction sequence. These gaps included a poor understanding of the production and selection of blanks, when the parallel oblique flaking pattern entered the sequence, whether the parallel oblique flaking was functional or stylistic and how the parallel oblique pattern was produced on such a difficult raw material. Based on previous understandings it was believed that blade-flake blanks entered the reduction sequence at Stage 3 and were reduced much the same as a regular biface would have been. At Mackenzie I it was determined that the toolkit was produced using conventional Biface reduction methods as well as Flake/Blade reduction methods. These reduction trajectories were utilized depending on the quality of the raw material, which directly influenced the morphology of the blank and the fracture mechanics of the stone.

The Biface Trajectory was used to reduce large tabular blanks, thick tabular flakes, and bifacial cores into refined formal tools. Knives, projectile points, gouges, drills and adzes were all produced using this reduction method. In Stage 2 reduction certain edge blanks would be subjected to intensified flaking and result in a narrow proximal end and a broad beveled working bit at the distal end. These objects are often referred to as adzes. This style of adze is present throughout the Paleoindian period (Figure 7.4) and may explain the adze-like Stage 2 specimens identified by Hinshelwood and Webber (1987) at the Biloski Site (Figure 6.3). Generally the quality of raw material was medium to coarse grained with inclusions of iron, quartz and internal joint planes. Banded material is strongly represented in this stage of manufacture, and was generally a mix of medium and coarse-grained materials. Fine-grained specimens were present in this trajectory but to a lesser degree. Following the analysis of the Mackenzie I assemblage it was determined that the biface reduction methods helped compensate for many of the natural flaws in the material. Heavy percussion flaking exposed joint planes and internal flaws allowing the knapper to make decisions as to how the flaking should proceed or if the blank should just be discarded. Percussion flaking was used throughout the manufacture sequence in conjunction with pressure flaking to prepare platforms and refine the edges. In the final stages of reduction, pressure flaking and/or indirect percussion was used to complete the pattern, shape the blade and define the hafting portion.

The Flake/Blade Trajectory was used to reduce thin flakes, parallel-sided blade-flakes and blades into specific tool forms. These blanks were already relatively thin and would not have been usable as heavy chopping tools but could easily be utilized as cutting tools. Knives, projectile points and drills were all produced following this trajectory with the possibility of some gouges also being produced from these blanks. The quality of the raw material is generally fine-grained with a lesser presence of medium or coarse-grained materials. Banded material was present and was predominantly fine-grained, with a lesser portion of coarse-grained material. Relatively few flaws were present in these material types so there was less need to test the fracture mechanics of these pieces by hard hammer percussion. The lack of flaws and internal joint planes in the parent material allowed for the production of blade-flakes and blades. Percussion thinning, if used at all, would have been limited to the use of a light antler billet and would only have been used to quickly reduce the dorsal hump, in Stage 2 and 3. Indirect percussion and pressure flaking, were likely the main methods of flake removal in this reduction trajectory and the exclusive methods of removal in Stage 4 to 6.

One of the longstanding questions associated with Lakehead Complex lithic technology has been when the parallel oblique flaking methods enter the reduction sequence. Ancillary to this is determining what purpose this style of flaking served. Due to the under-representation of later stage bifaces at the other Lakehead Complex sites, these questions have remained unanswered. The Mackenzie I site yielded a large amount of Stage 2 and 3 bifaces (consistent with other sites in the region), but also an uncharacteristically high frequency of Stage 4 and 5 bifaces. This filled in a large information gap. The Mackenzie I assemblage includes parallel oblique flaking observed in some Stage 3 specimens (Figure 6.28) (following the biface trajectory) and with increasing frequency in Stage 4 (Figure 6.29) and Stage 5 (Figure 6.30) (Table 6.9). Interestingly, the Stage 4 bifaces, along with the small suite of Stage 3 bifaces with parallel oblique flaking exhibit broader oblique flake scars than the norm (Figure 7.3). This has also been observed as a finishing technique on Clovis projectile points (Figure 7.3). However, the Stage 5 bifaces demonstrate a clear shift to the refined parallel oblique flaking that is so prevalent on the Mackenzie I projectile point assemblage (Figure 6.30 and 6.36). Parallel oblique flaking is also observable on a large portion of the Stage 3 specimens produced using the Flake/Blade Trajectory. However, this flaking pattern is mostly limited to the dorsal surface of these specimens (Figure 6.34). When parallel oblique flaking is observed on the ventral surface of Stage 3 flake/blade specimens, it coincides with specific morphological characteristics of the original blank. If the bulb of percussion is very pronounced it was often slightly thinned using parallel oblique flaking, while diffuse bulbs can remain unmodified by flaking until Stage 5. Alternate edge beveling was used to prepare the entire edge, platforms were isolated and the first pass of parallel oblique flakes was removed. The biface was then flipped and the second set of flakes was removed on the opposite edge. Once these were completed shorter parallel oblique flakes were feathered into the existing flake scars to complete the pattern giving the illusion that a single flake was removed (Markham, 2013).

Markham (2013) observed that a number of the Mackenzie I projectile points had a D-shaped cross-section with a pronounced longitudinal twist and/or curve. It was proposed that this was a result of the alternate edge beveling used in platform preparation. This was in part true, but a number of blanks and early stage bifaces deriving from the Flake/Blade Trajectory are also characterized by a D-shaped cross-section with a slight curve/twist (Figure 6.32). On these blanks and early stage bifaces the alternate edge beveling, exacerbated these features. Some of the projectile points that followed the Biface trajectory did exhibit a slightly flattened cross-section bordering on D-shaped, but to a lesser degree. On these projectile points it was the alternate edge beveling edge preparation methods that resulted in these characteristics. The gouges did exhibit a clear D-shaped cross-section but was more the result of the reduction methods used to produce this tool type. The dorsal surface was flaked co-medially to create a domed central ridge, while the ventral surface was flaked to create a flat surface (Figure 6.38).

9.4 CONCLUSION

The recovery of the 'missing' stages of manufacture at Mackenzie I combined with the large number of projectile points, allowed for a much more comprehensive understanding of the Lakehead Complex reduction sequence. It revealed two trajectories of reduction were employed, and enabled clarification of when parallel oblique flaking entered the reduction sequence (notably much earlier than first thought). This analysis has also offered substantive insight into the extent of edge platform preparation by stage, unique basal treatment methods, and the presence of a blade technology as part of the overall lithic technological organization.

The persistence of aspects of lithic reduction observed in Clovis supports the notion that some degree of technological continuity occurred throughout the Paleoindian period, and perhaps also into the Early Archaic. It remains uncertain whether this technological continuity reflects adaptation to the use of a difficult raw material, or as a result of stylistic preference. Early stage bifaces from Mackenzie I show little morphological variation from assemblages recovered from other Lakehead Complex sites, and also other Paleoindian culture groups across North America. The overshot flaking observed as being integral to Clovis lithic reduction is present in the Mackenzie I assemblage and appears to be an understood part of the lithic reduction sequence. Certain Clovis bifaces exhibit oblique overshot flaking, a trait observed on mid-stage bifaces in the Mackenzie I assemblage. The alternate edge beveling of Agate Basin and Hell Gap assemblages is observed as being present at Mackenzie I, and contributes to the twisted profile observed on the projectile points.

The presence of two trajectories of manufacture and the presence of a blade technology indicate the degree to which the Lakehead Complex group was familiar with the Gunflint Formation chert. These people had the knowledge and ability to work a very difficult material into finely manufactured formal tools. The skill of these people is evident with examples of projectile points with parallel oblique flaking that is uninterrupted by iron-oxide flaws bisecting the tool (Figure 6.40: F). The production of blades and flake/blades on such a difficult material also reveals the high level of skill. These were not just happy accidents produced as a result of the normal methods of biface reduction strategies. Blocks of Gunflint Formation chert appear to have been selected as candidates for blade production based on the relatively high silica content, and the apparent lack of structural flaws. A corner was selected as the starting point for blade removal as this created a natural ridge for the force to follow. If this was successful further blades and/or blade/flakes were removed until the piece was exhausted. Following this the core was likely reduced following the biface trajectory into a formal tool or was used as a core for non-blade flake tools. Further analysis of the complete Mackenzie I lithic assemblage may reveal the presence of blade cores and further aid in the determinations of the importance of both blade technology and overshot flaking in the Lakehead Complex.

Detailed analysis of the debitage and core assemblage was not part of this thesis due to time constraints. It is possible that analysis of the remainder of the lithic assemblage will increase our understanding of the reduction sequence observed at Mackenzie I. This will result in a better understanding of the place overshot flaking holds in the methods used in the Biface Trajectory. Further understanding of the nature of the Blade Technology at Mackenzie I will result as the cores are analyzed for the presence of blade scars. The number of blades will also increase as the debitage assemblage is further analyzed. A greater understanding of how the parallel oblique flaking was produced will come from increased analysis of the debitage assemblage as cataloguing has resulted in the identification of finishing flakes (Figure 7.17). It will be necessary for the complete debitage and core assemblage to be analyzed before a more complete understanding of the Mackenzie I reduction sequence is possible.

CHAPTER 10

REFERENCES

Adams, N.R. 1993. An Archeological Assessment of Highway 11/17, Current River to Highway 527. (W.P. 7831-92-01, District 19, Thunder Bay). Report prepared for the Ontario Ministry of Transportation.

Adams, N. R. 1995. *A Preliminary Report on an Archaeological Excavation at the Naomi Site (DcJh-42) Thunder Bay, Ontario*

Adams, N. R. 1995. Biface Reduction in Northern Ontario: A Late Paleo-Indian Case Study, *Annual Archaeological Report Ontario* Volume 6.

Adovasio, J.M., Gunn, J.D., Donahue, J., and Stuckenrath R. 1978. Meadowcroft Rock Shelter, 1977: An Overview. *American Antiquity* 43(4):632-651.

Adovasio, J.M., Donahue, J. and Stuckenrath, R. 1990. The Meadowcroft Rock Shelter Radiocarbon Chronology 1975-1990, *American Antiquity* 55(2):348-354.

Agogino, G.A. 1961. A New Point Type from Hell Gap Valley, Eastern Wyoming. *American Antiquity* 26(4): 558-560.

Agogino, G.A. and Frankforter, W.D. 1960. A Paleo-Indian Bison-Kill in Northwestern Iowa. *American Antiquity*, 25(3):414-415.

Ahler, S. A. 1989. Mass analysis of flaking debris: studying the forest rather than the tree. *Archeological Papers of the American Anthropological Association*, *1*(1), 85-118.

Anderson, T.W. and Lewis, C.F.M. 1992. Climatic Influences of Deglacial Drainage Changes in Southern Canada at 10 to 8 ka Suggested by Pollen Evidence. *Geographie physique et Quaternaire* 46(3): 255-272.

Anderson, D.G., and Gillam, J.C. 2000. Paleoindian Colonization of the Americas: Implications from an examination of Physiography, Demography, and Artifact Distribution. *American Antiquity* 65(1): 43-66.

Andrefsky Jr., W. 1991. Inferring Trends in Prehistoric Settlement Behavior from Lithic Production Technology in the Southern Plains. *North American Archaeology* 12(2): 129-144.

Andrefsky Jr., W. 1998. Lithics: Macroscopic Approaches to Analysis, Cambridge University Press, Cambridge.

Andrefsky Jr., W. ed. 2001. Lithic Debitage: Context Form Meaning, The University of Utah Press, Salt Lake City, Utah.

Andrefsky Jr., W. 1994. Raw-Material Availability and the Organization of Technology. *American Antiquity* 59(1): 21-34.

Andrefsky Jr., W. 1997, Thoughts on Stone Tool Shape and Inferred Function, Journal of Middle Atlantic Archaeology 13:125-144

Andrefsky Jr., W. 2006. Experimental and Archaeological Verification of an Index of Retouch for Hafted Bifaces. *American Antiquity* 71(4): 743-757.

Andrefsky Jr., W. 2007. The Application and Misapplication of Mass Analysis in Lithic Debitage Studies. *Journal of Archaeological Science* 34:392-402.

Andrefsky Jr., W., 2009. The Analysis of Stone Tool Procurement, Production, and Maintenance. *Journal of Archaeological Research* 17: 65-103.

Arthurs, D. 1986. Cascades Site II: An Archaeological Conservation Project on the Current River. *Ontario Ministry of Citizenship and Culture, North Central Region Report* 22.

Bamforth, D.B. 1986. Technological Efficiency and Tool Curation. *American Atiquity* 51:38-50.

Bamforth, D.B. 1991. Technological Organization and Hunter/Gatherer Mobility: A California Example. *American Antiquity* 56:216-234.

Bamforth, D.B. ed. 2007. The Allen Site: A Paleoindian Camp in Southwestern Nebraska, University of New Mexico Press, Albuquerque.

Bamforth, D.B and Becker, M. 2007. The Allen Site Lithic Assemblage. In Bamforth, D.B. (ed.) The Allen Site: A Paleoindian Camp in Southwestern Nebraska, University of New Mexico Press, Albuquerque.

Bar-Yosef, O., and Van Peer, P. 2009 The chaîne opératoire approach in Middle Paleolithic archaeology. *Current Anthropology* 50(1): 103-131.

Binford, L. 1973. Interassemblage Variability—The Mousterian and the "Functional" Argument. In Renfrew, C. (ed.) *The Explanation of Culture Change*. London: Duckworth, pp. 254-277.

Binford, L.R. 1977. Forty-seven Trips. In Wright, R.V.S. (ed.), *Stone Tools as Cultural Markers* Canberra: Australian Institute if Aboriginal Studies pp. 24-36.

Binford, L.R. 1979. Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35(3):255-73.

Binford, L.R. 1980. Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.

Binford, L.R. and Binford, S.R. 1966. A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies. *American Anthropologist*, New Series 68(2), Part 2: Recent Studies in Paleoanthopology, pp. 238-295.

Bever, M.R. 2001. Stone Tool Technology and the Mesa Complex: Developing a Framework of Alaskan Paleoindian Projectile Points. *Arctic Anthropology* 38(2): 98-118.

Bever, M.R. 2006. Too Little, Too Late? The Radiocarbon Chronology of Alaska and the Peopling of the New World. *American Antiquity* 71(4): 595-620.

Bjorck, S. 1985. Deglaciation Chronology and Revegetation in Northwestern Ontario. *Canadian Journal of Earth Sciences* 22 (850-871).

Bleed, P. 2001. Trees or Chains, Links or Branches: Conceptual Alternatives for Consideration of Stone Tool Production and Other Sequential Activities. *Journal of Archaeological Method and Theory*, 8(1), pp. 101-127.

Bleed, P. 2011. Loosening our Chaines: Cognitive Insights for the Archaeological Application of Sequence Models. in Special Issue: Reduction Sequence, *Chaine Operatoire*, and Other Methods: The Epistemologies of Different Approaches to Lithic Analysis, PaleoAnthropology: pp. 297-304.

Boëda, E. 1995. Caractéristiques techniques des chaînes opératoires lithiques des niveaux micoquiens de Külna (Tchécoslovaquie). *Paléo. Supplément* 1(1): 57-72.

Bonnichsen, R. and Young, D.E. 1984. Understanding Stone Tools: A Cognitive Approach. *Peopling of the Americas Process Series*: Vol. 1, Center for the Study of Early Man, Orono.

Booth, R.K., Jackson, S.T., and Thompson, T.A. 2002. Paleoecology of a Northern Michigan Lake and the Relationship among climate, vegetation and Great Lakes water levels. *Quaternary Research* 57(1): 120-130.

Bordes, F. 1961. Mousterian Cultures in France. *Science*, 134(3482), pp. 803-810.

Bordes, F., and de Sonneville-Bordes, D. 1970. The Significance of Variability in Paleolithic Assemblages. *World Archaeology*, 2(1), pp. 61-73.

Bordes, F., Kelley, J. and Cinq-Mars, J. 1969. Reflections on Typology and Techniques in the Palaeolithic. *Arctic Anthropology*, 6(1), pp. 1-29.

Borradaile, G. J., S. A. Kissin, J. D. Stewart, W. A. Ross & T. Werner 1992. Magnetic and Optical Methods for Detecting the Heat Treatment of Chert, Journal of Archaeological Science, Vol 20, No. 1, Academic Press, pp 57-66

Bourguignon, L., Faivre, J.P., and Turq, A 2004. Ramification des chaînes opératoires: une spécificité du Moustérien. *Paléo* 16: 37-48.

Boyd, M. 2003. Paleoecology of an ealry Holocene wetland on the Canadian Prairies. *Ge'og phys et Quat* 57: 139-149.

Boyd, M. 2007. Paleoindian Geoarchaeology of the Assiniboine Delta of Glacial Lake Agassiz. *Canadian Journal of Archaeology* 31(3): 198-221.

Boyd, M., Teller, J.T., Yang, Z., Kingsmill, L., and Shultis, C. 2012. An 8,900-year-old Forest Drowned by Lake Superior: Hydrological and Paleoecological Implications, *Journal of Paleolimnol* 47: 339-355.

Bradbury, A.P. and Franklin J.D. 2000. Material Variability, Package size and Mass Analysis. *Lithic Technology* 25:45-58.

Bradbury, A.P. 2007. Lithic analysis of an Early Archaic Knapping Area. *Midcontinental Journal of Archeology* 12(1), pp. 47-70.

Bradford, G. 1976. *Paleo Points: An Illustrated Chronology of Projectile Points, Volume one.* Preston, Ontario: Self-Published.

Bradley, B.A. 1975 Lithic Reduction Sequences: A Glossary and Discussion. In Swanson, E.H. (ed.) *Lithic Technology: Making and Using Stone Tools*, pp. 5-15, Mouton and Co. Publishers, The Hague, Netherlands.

Bradley, B.A. 1982. Flaked Stone Technology and Typology. In Frison G.C. and Stanford, D.J. (eds.), *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains*. pp. 181-208. Academic Press.

Bradley, B.A. and Frison, G.C. 1996. Flaked-Stone & Worked-Bone Artifacts from the Mill Iron Site. In Frison G.C. (ed.), *The Mill Iron Site*. pp. 43-69. University of Mexico Press.

Bradley, B.A. 2009. Bifacial Technology and Paleoindian Projectile Points. In Larson, M.L., Kornfeld, M. and Frison, G.C. (eds.) Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies, The University of Utah Press, Salt Lake City, Utah, pp.259-273

Bradley, B. A. 2010 Paleoindian Flaked Stone Technology on the Plains and in the Rockies. In Kornfeld, M., Frison, G.C., and Larson, M.L. (eds.) Prehistoric Hunter-Gatherers of the High Plains and Rockies Third Edition, Left Coast Press, Walnut Creek, California. pp 463-499.

Bradley, BA., Collins, M.B., and Hemmings, A. 2010. *Clovis Technology*. International Monographs in Prehistory, Archaeological Series 17, Ann Arbor, Michigan

Bradley, B. A. and Frison, G.C. 1987. Projectile Points and Specialized Bifaces from the Horner Site in Frison, G.C. (ed.) The Horner Site: The Type Site of the Cody Cultural Complex pp. 199-231

Bradley, B. and Stanford, D. 2004 The North Atlantic ice-edge Corridor: A Possible Palaeolithic Route to the New World, *World Archaeology*, Vol. 36, No. 4, Debates in World Archeology (Dec. 2004), pp. 459-478

Bradley, J. W. Spiess, A.E., Boisvert, R.A., and Boudreau, J. 2008. What's the Point? Modal Forms and Attributes of Paleoindian Bifaces in the New England-Maritimes Region. *Archaeology of Eastern North America* 36:119-172

Breckenridge, A. 2007. The Lake Superior varve stratigraphy and implications for eastern Lake Agassiz outflow from 10,700 to 8,900 cal BP (9.5-8.0 ^{14}C ka). *Palaeogeography Palaeoclimatology, Palaeoecology* 246: 45-61.

Broecker, W.S. 2007. Was the Younger Dryas Triggered by a Flood? *Science* 312: 1146-1148.

Broecker, W.S., Denton, G.H., Edwards, R.L., Cheng, H., Alley, R.B., and Putnam, A.E. 2010. Putting the Younger Dryas event into Context. *Quaternary Science Reviews* 29: 1078-1081.

Brose, D. S. 1994. Archaeological investigations at the Paleo Crossing site, a Paleoindian occupation in Medina County, Ohio. *The First Discovery of America: Archaeological Evidence of the Early Inhabitants of the Ohio Area*, 61-76.

Broyles, B. J. 1971 Type Descriptions of Projectile Points from the Kanawha Valley, *Second preliminary report: The St. Albans site, Kanawha County, West Virginia. Report of Archaeological investigations,* No.3. West Virginia Geological and Economical Survey, Morgantown.

Buckmaster, M and Paquette, J. 1988. The Gorto Site: Preliminary Report on a Late Paleo-Indian Site in Marquette County, Michigan. *Wisconsin Archaeologist* 69(3): 101-124

Buchner, A. P. 1979 The Prehistory of East-Central Manitoba including the final report on the 1978 Caribou Lake Project. *Papers in Manitoba Archaeology, Final Report* 8. Historic Resources Branch, Manitoba Department of Tourism and Cultural Affairs, Winnipeg.

Buchner, A.P. 1980. Cultural Response to Altithermal (Atlantic) climate along the eastern margins of the North American Grasslands 5500 to 3000 B.C. *National Museum of Man Mercury Series* 97. Archaeological Survey of Canada, Ottawa.

Buchner, A.P. 1981. Sinnock: A Paleolithic camp and kill site in Manitoba. *Papers in Manitoba Archaeology, Final Report* 10. Department of Cultural Affairs and Historical Resources Branch. Winnipeg, Manitoba.

Burke, A. 2006. Paleoindian ranges in northeastern North America based on lithic raw materials sourcing. *Notions de Territoire et de Mobilité. Exemples de L'Europe et des Premières Nations en Amérique du Nord Avant le Contact Européen*, 77-89.

Burke, A. 2007. Quarry Source Areas and the Oganization of Stone Tool Technology: A View from Quebec. *Archaeology of Eastern North America* 35: 63-80.

Bursey, J. A. 2012. Early Archaic Lithic Technology: A Case Study from Southern Ontario. *Archaeology of Eastern North America* 40:107-130.

Burwasser, G.J. 1977. Quaternary Geology of the City of Thunder Bay and vicinity District of Thunder Bay. Ontario Geological Survey Report GR164, 99pp.

Callahan, E. 1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts, Archaeology of Eastern North America 7(1)

Carr, D.H. 2005. Oganization of Late Paleoindian Lithic Procurement Strategies in Western Wisconsin. *Midcontinental Journal of Archaeology* 30(1): 3-36.

Carr, D.H., and Boszhardt, R.F. 2010. Silver Mound, Wisconsin: Source of Hixton Silicified Sandstone. *Midcontinental Journal of Archaeology* 35(1): 5-36.

Carr, P.J. (ed.) 1994 *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, International Monographs in Prehistory, Ann Arbor, MI.

Carr, P. J. and Bradbury, A.P. 2011 Learning from Lithics: A Perspective on the Foundation and Future of the Organization of Technology, in Special Issue: Reduction Sequence, *Chaine Operatoire*, and Other Methods: The Epistemologies of Different Approaches to Lithic Analysis, PaleoAnthropology: pp. 305-319

Clayton, L., and Moran, S. R. 1982. Chronology of late Wisconsinan glaciation in middle North America. *Quaternary Science Reviews*, *1*(1), 55-82.

Clayton, L. 1983. Chronology of Lake Agassiz drainage to Lake Superior. In Teller, J., and Clayton, L. (eds.) *Glacial Lake Agassiz*. Special Paper 26, Geological Association of Canada, 291-307.

Coe, J. L. 1964. The Formative Cultures of the Carolina Piedmont *Transactions of the American Philosophical Society* New Series Vol. 54, Part 5

Collins, M.B. 2002. Clovis Blade Technology, University of Texas Press, Austin.

Cook, R. *n.d.* Unpublished Master of Environmental Studies Thesis. Lakehead University: Thunder Bay, Ontario.

Crabtree, D. E. 1966 A Stoneworker's Approach to Analyzing and Replicating the Lindenmeier Folsom, *Tebiwa* 9(1):3-39

Crabtree, D. E. 1972 An Introduction to Flintworking *Occasional Papers of the Idaho State University Museum*, No. 28

Crabtree, D. E. 1973 Experiments in Replicating Hohokam Points, *Tebiwa* 16: 10-45

Daniel, I.R. 1998. *Hardaway Revisited: Early Archaic Settlement in the Southeast.* The University of Alabama Press, Tuscaloosa.

Dawson. K.C.A. 1973. Simmonds Site DeJj-1, in Archaeological Report, Kaministikwia River 1973, Report on file at the Ontario Ministry of Culture and Communications, Thunder Bay.

Dawson, K.C.A. 1983a. Cummins Site: A Late Palaeo-Indian (Plano) Site at Thunder Bay, Ontario. *Ontario Archaeology* 39: 1-29.

Dawson, K.C.A. 1983b. *Prehistory of Northern Ontario.* Thunder Bay Historical Museum. Thunder Bay: Guide Publishing and Printing.

Dawson, K.C.A. 1983c. Prehistory of the Interior Forest of Northern Ontario. In Steegman Jr., A.T. (ed.), *Boreal Forest Adaptations: Algonkians of Northern Ontario*. New York: Plenum Press, pp 55-84.

Deller, B.D. 1979. Paleo-Indian Reconnaissance in the Counties of Lambton and Middlesex, Ontario. *Ontario Archaeology* 32: 3-20.

Deller, B.D. 1983. Crowfield AfHj-31: A Paleo-Indian Ritual Feature in Southwestern Ontario. Paper presented at the Forty-Eighth Annual Meeting of the Society for American Archaeology. Pittsburgh, Pennsylvania.

Deller, B.D., and Ellis, C.J. 2001. Evidence for Late Paleoindian Ritual from the Caradoc Site (AfHj-104), Southwestern Ontario, Canada. *American Antiquity* 66(2): 267-284.

Dibble, H.L. and Bernard, M.C. 1980. A Comparative Study of Basic Edge Angle Measurement Techniques. *American Antiquity* 45(4): 857-865.

Dillehay, T.D., Pino, M., Davis, E.M., Valastro Jr., S., Varela, A.J., and Casamiquela, R. 1982. Monte Verde: Radiocarbon dates from an early-man site in South-Central Chile. *Journal of Field Archaeology 9: 547-550.*

Dixon, E.J. 1985. Cultural Chronology of Central Interior Alaska. *Arctic Anthropology* 22(1): 47-66.

Dixon, E.J. 1999, *Bones, Boats and Bison: Archaeology and the First Colonization of North America.* New Mexico: University of New Mexico Press.

Dixon, E.J. 2001. Human Colonization of the Americas: Timing, Technology and Process. *Quaternary Science Review* 20(1-3): 277-299.

Drexler, C.W., W.R. Farrand and J.D. Hughes 1983. Correlation of Glacial Lakes in the Superior Basin with Eastward Discharge events from Lake Agassiz. In J.T. Teller and Lee Clayton eds *Glacial Lake Agassiz* Geological Association of Canada Special Paper 26: 261-290.

Driver, J.C., Handly, M., Fladmark, K.R., Nelson, D.E., Sullivan, G.M., and Preston, R. 1996. Stratigraphy, Radiocarbon Dating and Culture History of Charlie Lake Cave, British Columbia. *Arctic* 49(3): 265-277.

Dumond, D.E. 2001. The Archaeology of Eastern Berngia: Some Contrasts and Connections. *Arctic Archaeology* 38(2): 196-205.

Dyke, A.S. 2004. An Outline of North American deglaciation with emphasis on central and northern Canada. In: Ehlers, J., and Gibbard, P.L. (Eds.), *Quaternary glaciations – extent and chronology, part II: North America*, Vol 2b. Elsevier, Amsterdam. pp. 373-424.

Dyke, A.S. and Prest, V.K. 1987. Late Wisconsinan and Holocene History of the Laurentide Ice Sheet. *Geographie physique et Quaternaire*, 41(2): 237-263.

Dyke, A.S., Andrews, J.T., Clark, P.U., England, J.H., Miller, G.H., Shaw, J., and Veilette, J.J. 2002. The Laurentide and Innuitian ice sheets during the Last Glacial Maximum. *Quaternary Science Reviews* 21: 9-31.

Eid, P. 2012. La recherche des intentions et des choix économiques a traverse les chaînes opératoires lithiques. Paper presented at the Canadian Archaeological Association conference. Montreal, Ontario.

Ellis, C. 2004. Understanding "Clovis" Fluted Point Variability in the Northeast: A Perspective from the Debert Site, Nova Scotia. *Canadian Journal of Archaeology/Journal Canadien d'Archéologie* 28: 205-253.

Ellis, C.J., and Deller, D.B. 1982. Hi-Lo materials from Southwestern Ontario. *Ontario Archaeology* 38: 3-22.

Ellis, C.J., and Deller, D.B. 1997. Variability in the Archaeological Record of Northeastern Early Paleo-Indians: A View from Southern Ontario. *Archaeology of Eastern North America* 25: 1-30.

Ellis, C.J., and Deller, D.B. 2000. *An Early Paleo-Indian Site Near Parkhill, Ontario*. Quebec: Canadian Museum of Civilization.

Ellis, C.J., and Ferris, N. (eds.) 1990. *The Archaeology of Southern Ontario to A.D. 1650*. London: Occasional Publications of the London Chapter, Ontario Archaeological Society Inc.

Ellis, C.J., and Payne, J.H. 1995. Estimating Failure Rates in Fluting Based on Archaeological Data: Examples from NE North America. *Journal of Field Archaeology* 22(4): 459-474.

Ellis, C., Goodyear, A.C., Morse, D.F., Tankersley, K.B. 1998. Archaeology of the Pleistocene-Holocene Transition in Eastern North America. *Quaternary International* 49/50: 151-166.

Eren, M. I., Redmond, B. G., & Kollecker, M. A. 2005. Unifacial stone tool analyses from the Paleo Crossing site (33-ME-274), Ohio. *Current Research in the Pleistocene*, *22*, 43-45.

Eren, M.I., Vanderlaan, S. and Holland, J.D. 2011. Overshot Flaking at the Arc Site, Geness County, New York: Examining the Clovis-Gainey Connection. *The Open Anthropology Journal* 4: 40-52.

Fagan, B. 2000. *People of the Earth: An Introduction to World Prehistory.* New Jersey: Prentice Hall.

Fagan, B. 2005. *Ancient North America: the archaeology of a continent, 4th ed.* New York: Thames and Hudson.

Farrand, W.R. and Drexler, C.W. 1985. Late Wisconsinan and Holocene History of the Lake Superior Basin. In Karrow, P.F., and Culkin, P.E. (Eds.) *Quaternary Evolution of the Great Lakes*. Geological Association of Canada, Special Paper 30, 18-32.

Fedje, D.W., and Christensen, T. 1999. Modeling Paleoshorelines and Locating Early Holocene Coastal Sites in Haida Gwaii. *American Antiquity* 64(4): 635-652.

Ferring, C. R. 2001. *The archaeology and paleoecology of the Aubrey Clovis site (41DN479) Denton County, Texas*. UNIVERSITY OF NORTH TEXAS DENTON CENTER FOR ENVIRONMENTAL ARCHAEOLOGY.

Fiedel, S.J. 1999. Older Than We Thought: Implications of Corrected Dates for Paleoindians. *American Antiquity* 64(1): 95-115.

Fisher, T.G., and Whitman, R.L. 1999. Deglacial and Lake Level Fluctuation History Recorded in Cores, Beaver Lake, Upper Peninsula, Michigan *Journal of Great Lakes Research* 25(2): 263-274.

Fisher, T.G., Loope, W.L., Pierce W., and Jol, H.M. 2007. Big Lake records preserved in little lake's sediment: an example from Silver Lake, Michigan, USA. *Journal of Paleolimnol* 37: 365-382.

Fitting, J. E. 1963 Thickness and Fluting of Paleo-Indian Projectile Points American Antiquity 29(1):105-106

Fitting, J. E., Devisscher, J., and Wahla, E.J. 1966. *The Paleo-Indian Occupation of the Holcombe Beach*

Fladmark, K.R. 1979. Routes: Alternate Migration Corridors for Early Man in North America. *American Antiquity*. 44(1): 55-69.

Flakne, R. 2003. The Holocene vegetation history of Isle Royale National Park, Michigan, U.S.A. *Canadian Journal for Research* 33: 1144-1166.

Flenniken, J.J. 1978. Reevaluation of the Lindenmeier Folsom: A Replication Experiment in Lithic Technology. *American Antiquity*, 43(3):473-480.

Flenniken, J.J. 1984. The Past, Present and Future of Flintknapping: An Anthropological Perspective. *Annual Review of Anthropology* 13: 187-203.

Flenniken, J.J. and Raymond, A.W. 1986. Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. *American Antiquity* 51(3): 603-614.

Fowler, M.L. 1959a. Summary Report of Modoc Rock Shelter 1952, 1953, 1955, 1956. *Illinois State Museum, Report of Investigations* 8, Springfield, Illinois.

Fowler, M.L. 1959b. Modoc Rock Shelter: An Early Archaic site in Southern Illinois. *American Antiquity* 24(3):257-270.

Fox, W.A. 1975. The Palaeo-Indian Lakehead Complex. In *Canadian Archaeological Association Collected Papers* March 1975 (P. Nunn, editor): 29-53. Ontario Ministry of Natural Resources, Historic Sites Branch, *Research Report 6*.

Fox, W.A. 1976. The Trihedral Adze in Northwestern Ontario. In Collected Archaeological Papers (D.S. Melvin, editor): 113-126. Ontario Ministry of Culture and Recreation, *Archaeological Research Report 13*.

Fox, W.A. 1980. The Lakehead Complex: New Insights. *Data Box Research Manuscript Series*, Historical Planning and Research Branch, Ontario Ministry of Culture and Recreation, pp. 1-22.

Fries. M. 1962. Pollen Profiles of the Late Pleistocene and Recent Sediments at Weber Lake, northeastern Minnesota. *Ecology* 43:295-308.

Frison, G.C. 1968. A Functional Analysis of Certain Chipped Stone Tools. *American Antiquity* 33(2): 149-155.

Frison, G.C. 1974. *The Casper Site: A Hell Gap Bison Kill on the High Plains*. New York: Academic Press, Inc.

Frison, G.C. 1975. Man's Interaction with Holocene Environments on the Plains. *Quaternary Research* 5: 289-300.

Frison, G.C., 1978. Prehistoric Hunters of the High Plains. New York: Academic Press, Inc.

Frison, G.C. 1984. The Carter/Kerr-Mcgee Paleoindian Site. *Cultural Resource Management and Archaeological Research*, 49(2):288-314.

Frison, G.C. 1991. The Goshen Paleoindian Complex: New Data for Paleoindian Research. In Bonnichsen, R., and Turnmire, K.L. (eds.), *Clovis: Origins and Adaptations*. pp. 133-151. Corvallis: Center for the Study of the First Americans.

Frison, G.C. 1996. *The Mill Iron Site.* Albuquerque: University of New Mexico Press.

Frison, G.C. 1998. Paleoindian large mammal hunters on the plains of North America. *Proceedings of the National Academy of Science* 95: 14576-14583.

Frison, G.C. and Bradley, B.A. 1980. Folsom Tools and Technology at the Hanson Site, Wyoming, University of New Mexico Press, Albuquerque

Frison, G.C. and Todd, L.C. 1986. *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming*. Albuquerque: University of New Mexico Press.

Frison, G.C. and Todd, L.C. 1987. *The Horner Site: The Type Site of the Cody Cultural Complex*. New York: Academic Press.

Frison, G.C. and Stanford, D.J.1982. *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains*. New York: Academic Press.

Frison, G. C. and Walker, D. N., 1984: The Dead Indian Creek site: An Archaic occupation in the Absaroka Mountains of northwestern Wyoming. The Wyoming Archaeologist, 27:11-13.

Funk, R.E. 1978. Post Pleistocene adaptations. In Northeast, Vol. 15, Bruce Trigger, editor, *Handbook of North American Indians*, William C. Sturtevant, editor, Washington D.C.: Smithsonian Institution. pp. 16-27.

Funk, R.E. 1982. Introduction. In Gramly, R.M., *The Vail Site: A Palaeo-Indian encampment in Maine. Bulletin of the Buffalo Society of Natural Sciences 30*. Buffalo, New York.

Gibson, T. 2013. Stage 4 Archaeological Assessment of the Hodder East site (DcJh-44) P330-002-2011, Southeast corner of Highway 11/17 and Hodder Avenue, City of Thunder Bay, Manuscript on file with MTO and MTCS.

Gilliland, K. 2012. Lakehead Complex Site, Thunder Bay, Ontario. Geoarchaeological Working Paper 1: Preliminary Description and interpretation of chronometric dates in stratigraphic context.

Gilliland, K., Adderley, P., Gibson, T., and Norris, D. 2012. *Context, Chronology, and Culture: Problem-based Geoarchaeology at the Lakehead Complex sites, Thunder Bay*. Paper presented at the 2012 Canadian Archaeological Association annual Meeting. Montreal, Quebec.

Gilliland, K. and Gibson, T.H. 2012. *What's with these dates? Expanding discussions of culture and landscape at the Lakehead Complex sites near Thunder Bay, Ontario*. Paper presented at the 2012 Manitoba Archaeological Society annual meeting. Sioux Lookout, Ontario.

Goodyear, A.C. 1982. The Chronological Position of the Dalton Horizon in the Southeastern United States. *American Antiquity* 47(2): 382-395.

Goodyear, A.C. 2005. Evidence of Pre-Clovis Sites in the Eastern United States. In Paleoamerican Origins: Beyond Clovis, Center for the Study of the First Americans, pp 103-112.

Grayson, D.K., and Meltzer, D.J. 2002. Clovis Hunting and Large Mammal Extinction: A Critical Review of the Evidence. *Journal of World Prehistory* 16(4): 313-359.

Gryba, E 1968. A Possible Paleo-Indian and Archaic Site in the Swan Valley, Manitoba. *Plains Anthropologist* 13:218-277.

Gryba, E 1980. The Early side-notched point tradition on the central and northern plains. In *Directions in Manitoba Prehistory, papers in honour of Chris Vickers*, L. Pettipas, editor. Manitoba Archaeological Society, pp. 37-64.

.Hall, C.T. and Larson, M.L. eds. 2004. *Aggregate Analysis in Chipped Stone*. Salt Lake City: The University of Utah Press.

Halverson, C. 1992. The 1991 Excavations of the Simmonds Site (DcJh-4): A Late Palaeo-Indian Site on the Current River. *Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, Northern Region No. 30.* Thunder Bay.

Hamilton, J.S. 1996. Pleistocene landscape features and Plano archaeological sites upon the Kaministiquia River Delta, Thunder Bay District. LU monographs in Anthropology #1: Lakehead University.

Hamilton, J.S. 2000. Archaeological Predictive Modelling in the Boreal Forest: No Easy Answers. *Canadian Journal of Archaeology* 24(1): 41-76.

Hamilton, M.J. and Buchanan, B. 2007. Spatial Gradients in Clovis-Age Radiocarbon Dates across North America Suggest Rapid Colonization from the North. *Proceedings of the National Academy of Sciences of the United States of America* 104(40): 15625-15630.

Hanks, C. 1985. The Early Archaic north of Lake Huron. Paper presented at Ontario Archaeological Society Twelfth Annual Symposium "The Archaeology of the Lake Huron and Georgian Bay Drainage Basins". London, Ontario.

Hannus, L.A. 1986. Report on 1985 Test Excavations at the Ray Long Site (39FA65), Angostura Reservoir, Fall River County, South Dakota. *South Dakota Archaeology* 10:48-105.

Hayden, B., Franco, N., and Spafford, J. 1996. Evaluating Lithic Strategies and Design Criteria. In Odell, G. (ed.) *Stone Tools, Theoretical Insights into Human Prehistory*. pp. 9-45 Plenum, New York.

Haynes, C.V. 1980. Paleoindian Charcoal from Meadowcroft Rockshelter: Is Contamination a Problem? *American Antiquity* 45(3):582-587.

Haynes Jr, C. V. 1991. Geoarchaeological and paleohydrological evidence for a Clovis-age drought in North America and its bearing on extinction. *Quaternary Research*, *35*(3), 438-450.

Haynes, C. V. 2008. Younger Dryas "black mats" and the Rancholabrean termination in North America. *Proceedings of the National Academy of Sciences*, *105*(18), 6520-6525.

Haynes, C. V., Donahue, D. J., Jull, A. T., & Zabel, T. H. 1984. Application of accelerator dating to fluted point Paleoindian sites. *Archaeology of Eastern North America*, 184-191.

Hill, C.L. 2007 Geoarchaeology and Late Glacial Landscapes in the Western Lake Superior Region, Central North America. *Geoarchaeology: An International Journal*, 22(1):15-47.

Hill, M.G. 1994. Paleoindian Projectile Points from the Vicinity of Silver Mound (47JA21), Jackson County, Wisconsin. *Midcontinental Journal of Archaeology,* 19(2):223-259.

Hinshelwood, A. and Webber, E. 1987. Testing and Excavation of the Ozbolt Property, Part of the Biloski Site (DcJh-9), A Late Palaeo-Indian Archaeological Site, Thunder Bay, Ontario. *Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, North Central Region No. 25.* Thunder Bay.

Hinshelwood, A. 1990. Brohm Site Archaeological Project: 1987. *Conservation Archaeology Report. Ontario Ministry of Citizenship and Culture, North Central Region No. 27*. Thunder Bay.

Hinshelwood, A. 1993. Archaeological Assessment Report: Phase 1 Mitigation, DcJi-15/16, Ministry of Transportation Project W.P. 906-78-01, Highway 11/17 (New). Manuscript on file with MTO and MCTR.

Hinshelwood, A. 1994. Salvage Excavations at Late Paleoindian Sites DcJi-15/16. Canadian Archaeological Association Newsletter, 14(2): 11-12.

Hinshelwood, A. 2004. Archaic Reoccupation of Late Palaeo-Indian Sites in North Western Ontario. In Jackson, L.J. and Hinshelwood, A. Eds. *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*. Quebec: Canadian Museum of Civilisation, Mercury Series, Archaeology Paper 165, p. 225-250.

Hinshelwood, A. and Ross, W. A. 1992. *Lakehead Complex Lithic Reduction Sequence: A Synthetic Approach*. Paper presented at the Canadian Archaeological Association Conference. London, Ontario.

Hodder, I. ed. 2001 *Archaeological Theory Today*. Polity Press: Cambridge.

Hoffecker, J.F. 2002. *Desolate Landscapes*. Rutgers University Press: New Brunswick, NJ.

Holder, P. and Wilke, J. 1949. The Frontier Culture Complex, a Preliminary Report on a Prehistoric Hunter's Camp in Southwestern Nebraska. *American Antiquity* 14:260-66.

Holliday, V.T., Johnson, E., and Stafford Jr., T.W. 1999. AMS Radiocarbon Dating of the Type Plainview and Firstview (Paleoindian) Assemblages: The Agony and the Ecstasy. *American Antiquity* 64(3): 444-454.

Holmes, W.H. 1890 A Quarry Workshop of the Flaked-Stone Implement Makers in the District of Columbia, American Anthropologist 3(1): 1-26

Holmes, W.H. 1894 a. *An Ancient Quarry in Indian Territory.* Government Printing Office, Washington, D.C.

Holmes, W.H. 1894 b. Natural History of Flaked Stone Implements, in Wake, C.S. ed. *Memoirs of the International Congress of Anthropology*. Chicago: The Schulte Publishing Company. pp. 120-140.

Holmes, W.H. 1919. Handbook of Aboriginal American Antiquities. Smithsonian Institution Bureau of American Ethnology Bulletin 60, Government Printing Office, Washington, D.C.

Howard, C.D. 1990. The Clovis Point: Characteristics and Type Description. *Plains Anthropologist* 32: 255-262.

Huckell, B.B. 1978. Hudson Meng Chipped Stone. In Agenbroad, L.D. (ed.) *The Hudson Meng Site* pp. 153-189. University Press of America, Washington, D.C.

Hunter, R.D., Panyushkina, I.P., Leavitt, S.W., Wiedenhoeft, A.C., and Zawiskie, J. 2006. A multiproxy environmental investigation of Holocene wood from a submerged conifer forest in Lake Huron, USA. *Quaternary Research* 66: 67-77.

Husted, W. M. 1969. *Bighorn canyon archeology* (No. 12). Lincoln, Nebraska: River Basin Surveys, Museum of Natural History, Smithsonian Institution.

Irwin, H.T. and Wormington, H.M. 1970. Paleo-Indian Tool Types in the Great Plains 35(1):24-34.

Irwin-William, C., Irwin, H., Agogino, G., and Haynes, C.V. 1973. Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18: 40-53.

Jackson, L.J., Ellis, C., Morgan, A.V., and McAndrews, J.H. 2000. Glacial Lake Levels and Eastern Great Lakes Palaeo-Indians. *Geoarchaeology* 15(5): 415-440.

Jackson, L. J. and Hinshelwood, A. Eds. 2004. *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*. Quebec: Canadian Museum of Civilisation, Mercury Series, Archaeology Paper.

Jackson, L. J. 2004. Changing Our Views of Late Palaeo-Indian in Southern Ontario. In Jackson, L.J. and Hinshelwood, A. Eds. *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*. Quebec: Canadian Museum of Civilisation, Mercury Series, Archaeology Paper 165, pp.

Johnson, J.K. 1993. North American Biface Production Trajectory Modeling in Historic Perspective. *Plains Anthropologist*, 38(143): 151-162.

Julig, P.J. 1984, Cummins Paleo-Indian Site and its Paleoenvironment*,* Thunder Bay, Canada. In R.M. Gramly, Ed., *New Experiments upon the Record of Eastern Palaeo-Indian Culture*, pp. 192-209, *Archaeology of Eastern North America 12.* Publ. Eastern States Archaeological Federation Washington. Conn.

Julig, P.J. 1991. Late Pleistocene Archaeology in the Great Lakes Region of North America: Current Problems and Prospects. *Revista de Arqueologia Americana* 3: 7-30.

Julig, P.J. 1994. The Cummins Site Complex and Paleoindian Occupations in the Northwestern Lake Superior Region. *Ontario Archaeological Reports 2.* Ontario Heritage Foundation, Toronto.

Julig, P.J., McAndrews, J., and Mahaney, W.C. 1990. Geoarchaological Investigation at the Cummins Paleoindian Site, Thunder Bay, Ontario. *Current Research in the Pleistocene* 3: 79-80.

Julig, P.J., Pavlish, L.A., and Hancock, R.G.V. 1989. Aspects of Late Paleoindian lithic technological organization in the Northwestern Lake Superior region of Canada. In *Eastern Paleoindian Lithic Resource Use,* ed. Christopher J. Ellis and Jonathan C. Lothrop, 293-322. Boulder: Westview.

Justice, N.D. 1987. *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States: A Modern Survey and Reference*. Indianapolis: Indiana University Press.

Karrow, P.F. 2004. Ontario Geological Events and Environmental Change. . In Jackson, L.J. and Hinshelwood, A. (Eds.) *The Late Palaeo-Indian Great Lakes: Geological and Archaeological Investigations of Late Pleistocene and Early Holocene Environments*. Quebec: Canadian Museum of Civilisation, Mercury Series, Archaeology Paper 165, p. 1-24.

Kay, M., & Martens, R. E. 2004. Clovis Scrapers from the Martins Site.*Missouri Archaeologist*, *65*, 44-67.

Kelly, R.L. 1985 *Hunter-Gatherer Mobility and Sedentism: A Great Basin Study*, Ph.D. dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

Kelly, R.L. 1988 The Three sides of a biface *American Antiquity* 53:717-734

Kelly, R.L. and L.C. Todd 1988 Coming into the Country: Early Paleoindian hunting and mobility *American Antiquity* 53:231-244

Kenyon, I. 1980. Crawford Knoll Points. *KEWA* 80(3):3.

Kenyon, I. 1981. Brewerton Corner-Notched Points. *KEWA* 81(8):11.

Kilby, J. D., & Huckell, B. B. 2013. Clovis Caches: Current Perspectives and Future Directions. *Paleoamerican Odyssey*, 257-272.

Kimball, L.R. 1996. Early Archaic Settlement and Technology: Lesson from Tellico. In Anderson, D.G. and Sassaman, K.E. (eds.) *The Paleoindian and Early Archaic Southeast*. pp. 149-186. The University of Alabama Press, Tuscaloosa

Kingsmill, L. 2011. *Middle Holocene Archaeology and Paleoenvironments of the Thunder Bay Region, Lake Superior Basin*. Unpublished MES Thesis, Lakehead University, Thunder Bay, Ontario.

Kinnaird, T.C., Sanderson, D.C.W., Gilliland, K., Adderley, P. 2012. Luminescence dating of sediments from the Western Heritage excavation of archaeological sites at Thunder Bay (Ontario, Canada). Scottish Universities Environmental Research Centre: East Kilbride, Glasgow, United Kingdom.

Kissin, S. A., G. J. Borradaile, J. D. Stewart, W. A. Ross & T. Werner 1992. Magnetic and Petrographic Detection of Heat Treatment in Gunflint Cherts, Proceedings of the Institute on Lake Superior Geology, 38th annual meeting, Vol 38, Part 1, Hurley, Wisconsin

Kivett, M.F. 1962 Archaeological Field Report. *Plains Anthropologist* 7(16):77.

Klippel, W.E. 1971 Graham Cave Revisited: A Reevaluation of its Cultural Position During the Archaic Period. *Missouri Archaeological Society Memoirs* 9. Columbia.

Knudson, R. 1982. Organizational Variability in Late Paleo-Indian Assemblages. *Reports of Investigations, No. 60*. Laboratory of Anthropology Washington State University, Pullman.

Kolhatker, M. 2012. Loosening the bonds of technical practice: the chaîne opératoire as a flawed metaphor. Paper presented at the Canadian Archaeological Association conference, Montreal, Quebec.

Kooyman, B.P. 2000. *Understanding Stone Tools and Archaeological Sites*. Calgary: University of Calgary Press.

Kornfeld, M., and Larson, M.L. 2008. Bonebeds and other myths: Paleoindian to Archaic transition on North American Great Plains. In, Emery, J.F., Gotz, C.M., Hill, M.E., Arroyo-Cabrales, J. (eds.), *Zooarchaeology of the Late Pleistocene/Early Holocene in the America and Zooarchaeological Evidence of the Ancient Maya and their Environment. Quaternary International* 19(1): 18-33.

Kornfeld, M., Frison, G.C., and Larson, M.L. 2010. *Prehistoric Hunter-Gatherers of the High Plains and Rockies Third Edition*. Left Coast Press Inc.: California.

Kuehn, S.R. 1998. New Evidence for Late Paleoindian-Early Archaic Subsistence Behavior in the Western Great Lakes, *American Antiquity,* 63(3): 457-476.

Kuhn, S. L. 1994. A Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity*, 59(3):426-442.

Lahren, L. A. 1976. The Myers-Hindman site: An exploratory study of human occupation patterns in the upper Yellowstone Valley from 7000 BC to AD 1200.

Langford, D. *n.d.* Unpublished Master of Environmental Studies Thesis. Lakehead University: Thunder Bay, Ontario.

Larson, G., and Schaetzl, R. 2001. Origin and evolution of the Great Lakes. *Journal of Great Lakes Research* 27(4): 518-546.

Larson, M.L., Kornfeld, M., and Frison. G.C. eds. 2009. *Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies*. The University of Utah Press: Salt Lake City.

Lee, T. 1958. Northern Survey. *Ontario History* 50(1): 44.

Lee, T. 1971. Some comments on the Brohm site of northern Ontario. *Anthropological Journal of Canada* 9(3): 14-18. Ottawa.

Leroi-Gourhan, A. 1964 *Le geste et la parole I, technique et langage*, Albin Michel, Paris

Leverington, D.W. and Teller, J.T. 2003. Paleotopographic reconstructions of the eastern outlets of glacial Lake Agassiz. *Canadian Journal of Earth Science* 40: 1259-1278.

Lewis, T.M.N. and Lewis, M.K. 1961 *Eva, An Archaic Site*. University of Tennessee Press, Knoxville.

Lewis, C.F.M., and Anderson, T.W. 1989. Oscillations of levels and cool phases of the Laurentian Great Lakes caused by inflows from glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2: 99-146.

Lewis, C.F.M., Heil Jr., C.W., Hubeny, J.B., King, J.W., Moore Jr., T.C., Rea, D.k. 2007. The Stanley unconformity in Lake Huron Basin: evidence for a climate-driven closed low stand about 7900 ^{14}C BP with similar implications for the Chippewa low stand in Lake Michigan basin. *Journal of Paleolimnology* 37: 435-453.

Lindenberg, S. and Rapp, G. 2000. Source Characterization of Lithics from the Western Lake Superior Region. *The minnesota Archaeologist* 59: 93-108.

Lints, A. 2012 Stage 2 Archaeological Assessment of Highway 11/17, Four-laning from 5 km West of Highway 587, Easterly 6.3 km, Areas Not Tested in 2011, GWP 125-90-00. Manuscript on file with MTO and MTCS.

Lints, A. 2013. Stage 4 Archaeological Assessment of the RLF Site (DdJf-13) P330-012-2011 and P330-013-2011. Manuscript on file with Western Heritage, St. Albert and Thunder Bay.

Logan, W.D. 1952 Graham Cave, an Early Archaic Site in Montgomery County, Missouri. *Missouri Archaeological Society Memoir* 2, Columbia.

Lowell, T.V., Larson, G.J., Hughes, J.D., and Denton, G.H. 1999. Age Verification of the Lake Gribben forest bed and the Younger Dryas Advance of the Laurentide Ice Sheet. *Canadian Journal of Earth Science* 36: 383-393.

Lowell, T.V., Fisher, T.G., Comer, G.C., Hajdas, I., Waterson, N., Glover, K., Loope, H.M., Schaeffer, J.M., Rinterknecht, V., Broecker, W., Denton, G., and Teller, J.T. 2005. Testing the Lake Agassiz Meltwater Trigger for the Younger Dryas, *EOS* 86(40): 365-373.

Macdonald, D.H. 2008 The Role of Lithic Raw Material Availability and Quality in Determining toolkit size, tool function and degree of retouch: A Case Study from Skink Rockshelter (46NI445), West Virginia. In Andrefsky Jr., W. (ed.), *Lithic Technology: Measures of Production, Use, and Curation*, Cambridge University Press, Cambridge, pp. 216-232.

MacNeish, R.S. 1952. A Possible Early Site in the Thunder Bay District, Ontario. *National Museum of Canada, Bulletin* 120: 23-47.

Mandryk, C.A.S., Josenhans, H., Fedje, D.W., and Mathewes, R.W. 2001. Late Quaternary Paleoenvironments of Northwestern North America: Implications for Inland versus Coastal Migration Routes. *Quaternary Science Review* 20: 301-314.

Markham, S. 2012 An Introduction to the Paleoindian Projectile Point Assemblage Recovered from the Mackenzie I Site near Thunder Bay Ontario *The Minnesota Archaeologist* Vol. 71:60-74.

Markham, S. 2013. *Projectile Point Assemblage Variability at the Paleoindian Mackenzie 1 Site, near Thunder Bay, Ontario.* Unpublished MES Thesis, Lakehead University, Thunder Bay, Ontario.

Martin, P.S. 1973. The Discovery of America: The first Americans may have Swept the Western Nemisphere and decimated its fauna within 1000 years. *Science* 179: 969-974.

Martinón-Torres, M. 2002 Chaîne Opératoire: The concept and its applications within the study of technology. *Gallaecia* 21: 29-44.

Mason, R.J. 1962. The Paleo-Indian Tradition in Eastern North America. *Current Anthropology* 3(3):227-278.

Mason, R.J. 1963. Two Late Paleo-Indian Complexes in Wisconsin. *The Wisconsin Archaeologist.* Vol. 44(4): 199-211.

Mason, R.J. 1981. *Great Lakes Archaeology.* New York: Academic Press.

Mason, R.J. 1997. The Paleo-Indian Tradition. *The Wisconsin Archaeologist* 78: 78-110.

Mason, R.J., and Irwin, C. 1960. An Eden-Scottsbluff Burial in Northeastern Wisconsin. *American Antiquity.* 26(1): 43-57.

Mason, R.P. 2011. The Kamrath Site (47WN105), A Paleoindian/Archaic Site in Winnebago County, Wisconsin. *The Wisconsin Archaeologist* 92(2):27-84.

McAndrews, J.H. 1981.Late Quaternary Climate of Ontario: temperature trends from fossil pollen record. In Mahaney, W.C. (ed.) *Quaternary Paleoclimate.* Geoabstracts Ltd. Norwich, England

McAndrews, J.H. 1982. Holocene environment of a fossil bison from Kenora, Ontario. *Ontario Archaeology* 37: 41-51.

McKusik, M. 1964 *Men of Ancient Iowa*. Iowa State University Press, Ames.

McLeod, M. 1978. *The Archaeology of Dog Lake, Thunder Bay: 9,000 Years of Prehistory.* A report submitted to the Ontario Heritage Foundation, June 1978. Lakehead University, Thunder Bay.

McLeod, M. 1981. The Early Prehistory of the Dog Lake Area, Thunder Bay. *Manitoba Archaeological Quarterly* 5(2): 12-37.

McLeod, M. 1982. A re-evaluation of the Palaeo-Indian perception of the boreal forest. *Manitoba Archaeological Quarterly* 5(2): 12-37.

McCulloch, B. *n.d.* Unpublished Master of Environmental Studies Thesis. Lakehead University: Thunder Bay, Ontario.

Meltzer, D.J. 1997. Monte Verde and the Pleistocene Peopling of the Americas. *Science* 276(5313):754-755.

Meltzer, D.J. 2009. *First Peoples in a New World.* University of California Press: Berkeley.

Meltzer, D.J. Grayson, D.K., Ardila, G., Barker, A.W. Dincauze, D.F., Haynes, C.V. Mena, F. Nunez, L., and Stanford, D.J. 1997. On the Pleistocene Antiquity of Monte Verde, Southern Chile. *American Antiquity,* 62(4):659-663.

Meltzer, D.J., Todd L.C. and Holliday, V.T. 2002, The Folsom (Paleoindian) Type Site: Past Investigations, Current Studies. *American Antiquity* 67(1): 5-36.

Ministry of Tourism Culture and Sport, 2012. Standards and Guidelines for Consultant Archaeologists. Toronto: Ministry of Tourism Culture and Sport.

Morlan, R.E. 2003. Current Perspectives on the Pleistocene archaeology of eastern Beringia. *Quaternary Research* 60: 123-132.

Morrow, J.E. 1995. Clovis Projectile Point Manufacture: A Perspective from the Ready/Lincoln Hills Site, 11JY46, Jersey County, Illinois. *Midcontinental Journal of Archaeology* 20(2): 167-191.

Morrow, J.E., and Morrow, T.A. 1999. Geographic variation in fluted projectile points: A hemispheric perspective. *American Antiquity* 64(2): 215-230.

Morse, D.F. 1973 Dalton Culture in northeast Arkansas. *Florida Anthropologist* 26:23-28, Gainesville.

Mothersill, J.S. 1988. Paleomagnetic Dating of Late Glacial and Postglacial Sediments in Lake Superior. *Canadian Journal of Earth Sciences* 25: 1791-1799.

Mulholland, S.C., Hill, C.L. and Mulholland, S.L. 2011 The Third Lake Cache, St. Louis County, Minnesota, *Current Research in the Pleistocene* 28:121-123

Mulholland, S.C., Mulholland, S.L., Peters, G.R., Huber, J.K. and Mooers, D. 1997. Paleo-Indian Occupations in Northeastern Minnesota: How Early?, *North American Archaeologist* 18(4): 371-400.

Muniz, M.P. 2013 Exploring the Paleoindian Occupation of Knife Lake, Superior National Forest, Minnesota, *The Minnesota Archaeologist,* 72:113-157

Murton, J.B., Bateman, M.D., Dallimore, S.R., Teller, J.T., and Yang Z. 2010. Identification of Younger Dryas outburst flood path from Lake Agassiz to the Arctic Ocean. *Nature* 464:740-743.

Muto, G.R. 1971 A Technological Analysis of the Early Stages in the Manufacture of Lithic Artifacts. Master's Thesis, Washington State University.

Nelson, J. 2003 A Post-Fire Surface Archaeological Survey of the Canadian Side of Knife Lake (Mookomaan Zaaga'igan) *Conservation Archaeology Report Northern Region Report 34*

Newby, P., Bradley, J.W., Spiess, A., Shuman, B., and Leduc, P. 2005. A Paleoindian response to Younger Dryas climate change. *Quaternary Science Reviews* 24:141-154.

Newman, M. and Julig. P. 1989. The Identification of Protein Residues on Lithic Artifacts from a Stratified Boreal Forest Site. *Canadian Journal of Archaeology* 13: 119-132.

Newcomer, M.H. 1971. Some Quantitative experiments on Handaxe Manufacture. *World Archaeologist* 3(2): 85-94.

Newton, B.M. and Engelbert, P. 1977. Thunder Bay Urban Survey 1976. Data Box 347, Ontario Ministry of Culture and Recreation.

Norris, D. 2011, Stage 4 Archaeological Mitigation: Mackenzie 2 Site (DdJf-10), on file with the Ministry of Culture Tourism and Sport, Ontario.

Norris, D. 2012, Current Archaeological Investigations in Ontario: The Discovery of and Preliminary Information Regarding Several Paleoindian Sites East of Thunder Bay, *The Minnesota Archaeologist* Vol. 71: 45-60.

Odell, G.H. 1980 Toward a More Behavioral Approach to Archaeological Lithic Concentrations, *American Antiquity*, 45(3): 404-431

Odell, G.H. 2003. *Lithic Analysis*. New York: Springer Science and Business Media Inc.

O'Shea, J.M., Lemke, A.K., and Reynolds, R.G. 2013. "Nobody knows the way of the Caribou": *Rangifer* hunting at 45^{o} North Latitude. *Quaternary International*

O'Shea, J.M., and Meadows, G.A. 2009. Evidence for early hunters beneath the Great Lakes. *PNAS*

Overstreet, D. F. 2005. Late-glacial ice-marginal adaptation in southeastern Wisconsin. *Paleoamerican origins: beyond Clovis. College Station, TX: Center for the Study of the First Americans*, 183-195.

Overstreet, D.F. and Kolb, M.F. 2003. Geoarchaeological contexts for Late Pleistocene Archaeological sites with Human-Modified Woolly Mammoth Remains in Southeastern Wisconsin, U.S.A. *Geoarchaeology* 18(1): 91-114.

Painter, F. 1965. The Cattail Creek Fluting Tradition. *Chesopiean* 3(1): 11-18.

Parry, W.J. and R.L. Kelly 1987. Expedient core Technology and Sedentism. In Johnson, J.K., and Morrow, C.A. (eds), *The Organization of Core Technology,* Westview Press, Boulder, CO, pp. 285-304.

Peers, L. 1985. Ontario Paleo-Indians and Caribou Predation. *Ontario Archaeology* 43: 31-40.

Pépin, Y. 2012. La production et l'oganization technologique de la pierre polie dans les campements de la moyenne vallée du Saint-Laurent, 5500-3000 AA. Paper presented at the Canadian Archaeological Association Conference. Montreal Quebec.

Pettipas, L.F. 1970. Early Man in Manitoba. In *Ten Thousand Years: Archaeology in Manitoba*, W.M. Hlday, editor. D.W. Frieson and Sons, Ltd., Altona, Manitoba. pp. 5-28.

Pettipas, L.F. 1977. The Agate Basin-Angostura Continuum. *Saskatchewan Archaeology Newsletter* 52(2): 11-18.

Pettipas, L.F. and A.P. Buchner 1983. Paleo-Indian Prehistory of the Glacial Lake Agassiz Region in Manitoba, 11,500-6,500 B.P. In Teller, J.T. and Clayton, L. (eds.), *Glacial Lake Agassiz, Geological Association of Canada Special Paper* 26: 421-451.

Phillips, B.A.M. 1988. Paleogeographic Reconstruction of Shoreline Archaeological Sites around Thunder Bay, Ontario. *Geoarchaeology* Vol. 3(2). pp. 127-138.

Phillips, B.A.M. 1993. A Time-Space Model for the Distribution of Shoreline Archaeological Sites in the Lake Superior Basin. *Geoarchaeology* 8(2): 87-107

Phillips, B.A.M., and Fralick, P.W. 1994a. A post-lake Minong transgression event on the north shore of Lake Superior, Ontario: possible evidence of Lake Agassiz inflow. *Canadian Journal of Earth Sciences* 31: 1638-1641.

Phillips, B.A.M., and Fralick, P.W. 1994b. Interpretation of the Sedimentology and Morphology of Perched Glaciolacustrine Deltas on the Flanks of the Lake Superior Basin, Thunder Bay, Ontario. *Journal of Great Lakes Research* 20(2): 390-406.

Pitblado, B.L. 2003. *Late Paleoindian Occupation of the Southern Rocky Mountains: Early Holocene Projectile Points and Land Use in the High Country*, University of Colorado Press, Boulder.

Pitblado, B.L. 2007. Angostura, Jimmy Allen, Foothills-Mountain: Clarifying Terminology for Late Paleoindian Southern Rocky Mountain Spear Points. In Brunswig, R.H. and Pitblado, B.L. (eds.), *Frontiers in Colorado Paleoindian Archaeology*. University Press of Colorado, Boulder. pp. 311-337.

Platecek, E.P. 1965. A Preliminary survey of a Fowl Lakes site. *Minnesota Archaeologist* 27(2): 51-92.

Pollock, J.W. 1984. A Technological Analysis of Lake Abitibi Bifaces, PhD dissertation

Quimby, G.I. 1959. Lanceolate Points and Fossil Beaches in the Upper Great Lakes Region. *American Antiquity* 24(4): 424-426.

Quimby, G.I. 1960. *Indian Life in the Upper Great Lakes*. Chicago: University of Chicago Press.

Racher, P. 2006. Stage 1 Archaeological Assessment, Highway 11/17, 0.4 km West of Hodder Avenue, Easterly for 5.1 km, MacGregor Township, District of Thunder Bay, Ontario, GWP 334-94-00, P007-078-2006. Submitted to the Ministry of Transportation.

Racher, P. 2006. Stage 2 Archaeological Assessment, Highway 11/17, 0.4 km West of Hodder Avenue, Easterly for 5.1 km, MacGregor Township, District of Thunder Bay, Ontario, GWP 334-94-00, P007-078-2006. Submitted to the Ministry of Transportation.

Reid, C.S. 1980. Early Man in Northwestern Ontario: New Plano Evidence. *Ontario Archaeology* 33: 33-36.

Ritchie, W.A. 1961. *A Typology and Nomenclature for New York Projectile Points*. New York State Museum and Science Service, Bulletin 384. New York State, Albany.

Ritzenthaler, R.E. 1972. The Pope Site: A Scotsbluff Cremation? *Wisconsin Archaeologist* 53: 15-19.

Roberts, A.R. 1985. Preceramic Occupations along the North shore of Lake Ontario. *National Museum of Man Mercury Series, Archaeological Survey of Canada Paper* No. 132, Ottawa.

Roosa, W.B. 1965. Some Great Lakes Fluted Point Types. *Michigan Archaeologist* 11(3-4): 89-102.

Roosa W.B., and Deller, D.B. 1982. The Parkhill Complex and Eastern Great Lakes Paleo Indian. *Ontario Archaeology* 37: 3-15.

Ross, W.A. 1979. Additional Paleo-Indian Biface Variability in Northwestern Ontario. *Ontario Archaeology* 32: 21-25.

Ross, W.A. 1995. The Interlakes Composite: A Re-Definition of the Initial Settlement of the Agassiz-Minong Peninsula. *The Wisconsin Archaeologist* 76: 244-268.

Ross, W.A. 1982. *The Crane Site: A Preliminary Statement.* Paper presented to the 9th Annual Symposium, The Ontario Archeological Society, Thunder Bay.

Ross, W.A. 2011. The Crane Site: An Example of an Individual (?) from the Prehistoric Record. In *Visual Arts in the North, Lakehead University Centre for Northern Studies, Occasional Paper #20* edited by Patricia Vervoort.

Rozen, K.C. and Sullivan, III, A.P. 1989. The Nature of Lithic Reduction and Lithic Analysis: Stage Typologies Revisited. *American Antiquity* 54(1), pp. 179-184.

Rusch, L.A. and Penman, J.T. 1984. Transportation Archaeology in Wisconsin: The 1983 Field Season. *Wisconsin Department of Transportation Archaeological Report* 9 Madison, Wisconsin.

Saarnisto, M. 1974. The Deglaciation History of the Lake Superior region and its Climatic Implications. *Quaternary Research* 4:316-339.

Saarnisto, M. 1975. Stratigraphic Studies on the Shoreline Displacement of Lake Superior. *Canadian Journal of Earth Sciences* 12: 300-310.

Salzer, R.J. 1974. The Wisconsin North Lakes Project: A Preliminary Report. In Johnson, E (ed.), *Aspects of Upper Great Lakes Anthropology: Papers in honour of Lloyd A. Wilford.* St. Paul, Minnesota Prehistoric Archaeology Society, pp. 40-54.

Sassaman, K.E., 1994. Changing Strategies of Biface Production in the South Carolina Coastal Plain. In Carr, P.J. (ed.) *The Organization of North American Prehistoric Chipped Stone Tool Technologies*. Pp. 99-117. International Monographs in Prehistory, Archeological Series 7.

Sassaman, K.E., 1996. Early Archaic Settlement in the South Carolina Coastal Plain. In Anderson, D.G. and Sassaman, K.E. (eds.) *Paleoindian and Early Archaic Southeast*. pp.58-83. The University of Alabama Press, Tuscaloosa.

Schiffer, M.B. 1976. *Behavioral Archaeology*. Academic, New York.

Schneider, F. 1982. The Pelland and Moe site blades: Paleo-Indian culture history in the upper Midwest. *The Plains Anthropologist*, 125-135.

Sellet, F. 1993. Chaîne Opératoire: The concept and its applications. *Lithic Technology* 18:106-112.

Sellet, F. 1999. Beyond the point: Projectile manufacture and behavioral inference. *Journal of Archaeological Science* 31: 1553-1566.

Sellet, F. 2001. A Changing Perspective on Paleoindian Chronology and Typology: A View from the Northwestern Plains. *Arctic Anthropology* 38(2): 48-63.

Sharrock, F.W. 1966. Prehistoric Occupation Patterns in S.W. Wyoming and Cultural Relationships with the Great Basin and Plains Culture areas. University of Utah Department of Anthropology *Anthropology Papers*, No. 77.

Shay, C.T. 1971. *The Itasca Bison-Kill site, an Ecological Analysis*. Minnesota Historical Society, St. Paul, Minnesota.

Shelley, P.H., and Agogino, G. 1983. Agate Basin Technology: An Insight. *The Plains Anthropologist*: 115-118.

Shott, M.J. 1986. Settlement mobility and technological organization: An ethnographic examination *Journal of Anthropological Research* 42: 15-51

Shott, M.J. 1994. Size and Form in the Analysis of Flake Debris: Review and Recent Approaches. *Journal of Archaeological Method and Theory*. 1: 69-110.

Shott, M.J. 1996. An exegenisis of the curation concept. *Journal of Anthropological Research* 52: 259-280.

Shott, M.J. 2003. Chaîne Opératoire and Reduction Sequence. *Lithic Technology* 28(2): 95-105.

Shott, M.J. 2005. The Reduction Thesis and Its Discontents: Overview of the Volume. In Clarkson, C., and Lamb, L. (eds.) *Rocking the Boat: Recent Australian Approaches to Lithic Reduction, Use and Classification.* pp. 109-125. British Archaeological Reports International Series. Oxford, Archeopress.

Shott, M. J. 2007. The role of reduction analysis in lithic studies. *Lithic Technology*, 131-141.

Shott, M.J. and Ballenger, J.A.M. 2007. Biface Reduction and the Measurement of Dalton Curation: A Southeastern Unites States Case Study. *American Antiquity*, 72(1): 153-175.

Shott, M.J. and P. Sillitoe 2004. Modeling use-life distributions in archaeology using New Guinea Wola ethnographic data *American Antiquity* 69: 339-355

Shott, M.J. and P. Sillitoe 2005. Use Life and Curation in New Guinea experimental used flakes *Journal of Archaeological Science* 32: 653-663.

Shott, M. J., & Weedman, K. J. 2007. Measuring reduction in stone tools: an ethnoarchaeological study of Gamo hidescrapers from Ethiopia. *Journal of Archaeological Science*, *34*(7), 1016-1035.

Shultis, C. 2012. Quaternary Sedimentology East of Thunder Bay, Ontario; Implications for Five Paleoindian Sites. Unpublished M.Sc. Thesis, Department of Geology, Lakehead University, Thunder Bay, Ontario.

Simons, D.B., Shott, M.J., and Wright, H.T. 1984. The Gainey Site: Variability in a Great Lakes Paleo-Indian Assemblage. *Archaeology of Eastern North America* 12:266-279.

Skinner, E. and Ainsworth, P. 1991. Unifacial Bifaces: More than one way to Thin a Biface. *Journal of California and Great Basin Anthropology*, 13(2), pp. 160-171.

Slattery, S.R., Barnett, P.J., Long, D.G.F. 2007. Constraints on Paleo-lake levels, spillways and glacial lake history, north-central Ontario, Canada. *Journal of Paleolimnology* 37: 331-348.Smallwood, A.M. 2012. Clovis Technology and Settlement in the American Southeast: Using Biface Analysis to Evaluate Dispersal Models*, American Antiquity 77(4), pp. 689-713.*

Smallwood, A.M. 2010. Clovis Biface Technology at the Topper Site, South Carolina: Evidence for Variation and Technological Flexibility, Journal of Archaeological Science 37:2413-2425.

Smith, K.P., Engelbrecht, W.E., and Holland, J. 2010. Late Paleoindian Archaeology at the Eaton Site, Western New York. *Current Research in the Pleistocene* 27: 142-145.

Soressi, M. and Dibble, H.L. (eds.) 2003 *Multiple Approaches to the Study of Bifacial Technologies* University Museum Monograph 115, University of Pennsylvania, Philadelphia

Stanford, D. 1974. Preliminary report on the excavation of the Jones-Miller Hell Gap site, Yuma County, Colorado. *Southwestern Lore* 40: 30-36.

Stanford, D. 1978. The Jones-Miller Site: an example of Hell Gap bison procurement strategy. *Plains Anthropologist Memoir* 14: 90-97.

Stanford, D. 1974. Preliminary report on the excavation of the Jones-Miller Hell Gap site, Yuma County, Colorado. *Southwestern Lore* 40: 30-36.

Stanford, D.J. and Bradley, B.A. 2012. *Across Atlantic Ice: The Origins of America's Clovis Culture*. Berkeley: University of California Press.

Stanford, D.J. and Day, J.S. eds. 1992. Ice Age Hunters of the Rockies. University of Colorado Press, Denver.

Steinbring, J. 1974. "The preceramic archeology of Northern Minnesota." In *Aspects of Upper Great Lakes anthropology; papers in honour of Lloyd A. Wilford*, E. Johnson (Ed.) St. Paul, Minnesota: Minnesota Prehistoric Archaeology Society, pp. 64-73.

Steinbring, J., and Buchner, A.P. 1980. The Caribou Lakes Complex: A Provisional Definition. In Pettipas. L.F. (ed.), *Directions in Manitoba Prehistory.* Association of Manitoba Archaeologists and the Manitoba Archaeological Society, Winnipeg, pp. 25-35.

Stewart, A. 1983 Hell Gap: A Possible Occurence in South Central Ontario. *Canadian Journal of Archaeology* 7(1) 87-92.

Stewart, A. 1984 The Zander site: Paleo-Indian Occupation of the southern Holland Marsh region of Ontario. *Ontario Archaeology* 41: 45-79.

Stolman, J. B. 1971. Prismatic blades from northern Minnesota. *The Plains Anthropologist*, 105-110.

Storck, P.L.1983. The Fisher Site, Fluting Techniques and Early Palaeo-Indian Cultural Relationships. *Archaeology of Eastern North America* 11: 80-97.

Storck, P.L., and Spiess, A.E. 1994. The Significance of New Faunal Identifications Attributed to an Early Paleoindian (Gainey Complex) Occupation at the Udora Site, Ontario, Canada. *American Antiquity* 59(1): 121-142.

Surovell, T.A. ed. 2009. *Toward a Behavioral Ecology of Lithic Technology*. Tucson: The University of Arizona Press.

Tankersley, K. B., & Holland, J. D. 1994. Lithic Procurement Patterns at the Paleo Crossing Site, Medina County, Ohio. *Current Research in the Pleistocene*, *11*, 61-63.

Teller, J. 1985. Glacial Lake Agassiz and its influences on the Great Lakes. In Karrow, P., and Calkin, P. (eds.) *Quaternary Evolution of the Great Lakes.* Special Paper 30, Geological Association of Canada.

Teller, J.T. 1995. History and Drainage of Large Ice-Dammed Lakes Along the Laurentide Ice Sheet. *Quaternary International* 28: 83-92.

Teller, J.T., and Mahnic, P. 1988. History of Sedimentation in the Northwestern Lake Superior Basin and its Relation to Lake Agassiz Overflow. *Canadian Journal of Earth Sciences* 25:1660-1673.

Teller, J.T., Leverington, D.W., Mann, J.D. 2002. Freshwater outbursts to the oceans from glacial Lake Agassiz and their role in climate change during the last deglaciation. *Quaternery Science Reviews* 21: 879-887.

Teller, J.T., Boyd, M., Yang, J., Kor, P.S.G., Fard, A. 2005. The Alternative routing of Lake Agassiz overflow during the Younger Dryas: New Dates and a re-evaluation. *Quaternary Science Review* 24: 1890-1905.

Teller, J.T. and Thorleifson, L.H. 1983. The Lake Agassiz-Lake Superior Connection. In Teller, J.T. and Clayton, L. (eds.), *Glacial Lake Agassiz, Geological Association of Canada Special Paper* 26: 261-290.

Timmins, P. and Gardner, J. 2011. Stage 1-3 Archaeological Assessment, Highway 11/17 Four Laning between Mackenzie and Birch Beach Roads, Mackenzie Station Road New Alignment GWP 6120-03-00, MacGregor Geographic Township, Municipality of Shuniah, District of Thunder Bay. Manuscript on file with MTO and MCTS.

Trigger, B.G. 2008. *A History of Archaeological Thought 2nd Edition*. Cambridge: Cambridge University Press.

Tuck, J.A. 1974. Early Archaic Horizons in Eastern North America. *Archaeology of Eastern North America* 2(1): 72-80.

Waldorf, D.C. 1984. The Art of Flintknapping Third Edition.

Waldorf, D.C. 1987. *Story in Stone: Flint Types of the Central and Southern U.S.* Mound Builder Books, Branson, Missouri.

Wallace, I.J., and Shea, J.J. 2006. Mobility patterns and core technologies in the Middle Paleolithic of the Levant. *Journal of Archaeological Science* 33: 1293-1309.

Waters, M.R., Pevny, C.D., and Carlson, D.L. 2011. Clovis Lithic Technology: Investigation of a Stratified Workshop at the Gault Site, Texas. Texas A&M University Press, College Station.

Waters, M.R., and Stafford, T.W. 2007. Redefining the Age of Clovis: Implications for the Peopling of the America. *Science* 315: 1122-1126.

Waters, M.R., Forman, S.L., Jennings, T.A., Nordt, L.C., Driese, S.G., Feinberg, J.M., Keene, J.L., Halligan, J., Lindquist, A., Pierson J., Hallmark, C.T., Collins, M.B., Wiederhold, J.E., 2011. The Buttermilk Creek Complex and the Origins of Clovis at the Debra L. Friedkin Site, Texas. *Science* 331: 1599-1603.

Wedel, W. R., Husted, W., and Moss, J. 1968. Mummy Cave: Prehistoric Record from Rocky Mountains of Wyoming. *Science* 160:184-186.

Wendt, D. and Mulholland, S. 2013. Geoarchaeology of the Knife Lake Siltstone Quarry District, BWCAW/SNF, Lake County, Minnesota: 2012 Exploration of the U.S. Quarries. *The Minnesota Archaeologist* Vol. 72: 158-187.

Whitley, D.S., and Dorn, R.I. 1993. New Perspectives on the Clovis vs. Pre-Clovis Controversy. *American Antiquity* 58(4): 626-647.

Whittaker, J.C. 1994. *Flintknapping: Making and Understanding Stone Tools*. Austin: University of Texas Press.

Wilmsen, E.S. 1970. *Lithic Analysis and Cultural Inference: A Paleo-Indian Case* Anthropological Papers No. 16, University of Arizona Tucson.

Wilmsen, E.N. and Roberts Jr., F.H.H. 1979. *Lindenmeier, 1934-1974: Concluding Report on Investigations.* Smithsonian Contributions to Anthropology No. 24. Smithsonian Institution Press: Washington.

Wilson, M.C., and Burns, J.A. 1999. Searching for the earliest Canadians: wide corridors, narrow doorways, small windows. In, Bonnichsen, R., Turnmire, K.L. (eds.), *Ice Age Peoples of North America: Environemnts, Origins, and Adaptations of the first Americans.* Oregon State University Press: Corvallis. pp. 213-248.

Witthoft, J. 1952. A Paleo-Indian Site in Eastern Pennsylvania: An Ealry Huntinf Culture. *Proceedings of the American Philosophical Society* 96(4): 464-495.

Wormington, M. 1957. *Ancient Man in North America*. Popular Series No. 4. Denver Museum of Natural History.

Wright, H.T., and Roosa, W.B. 1966. The Barnes Site: A Fluted Point Assemblage from the Great Lakes Region. *American Antiquity* 31: 850-860.

Wright, J. V. 1963. *An archaeological survey along the north shore of Lake Superior*. National Museum, Ottawa. Department of Northern Affairs and National Resources.

Wright, J.V. 1972a. *Ontario Prehistory: An eleven-thousand-year archaeological outline*. Ottawa: National Museum of Man.

Wright, J.V. 1972b. The Shield Archaic. Ottawa: National Museum of Man.

Wright, J.V. 1976. *The Grant Lake Site, Keewatin District, N.W.T.* Mercury Series, Archaeological Survey of Canada Paper No. 47. Ottawa: National Museum of Man.

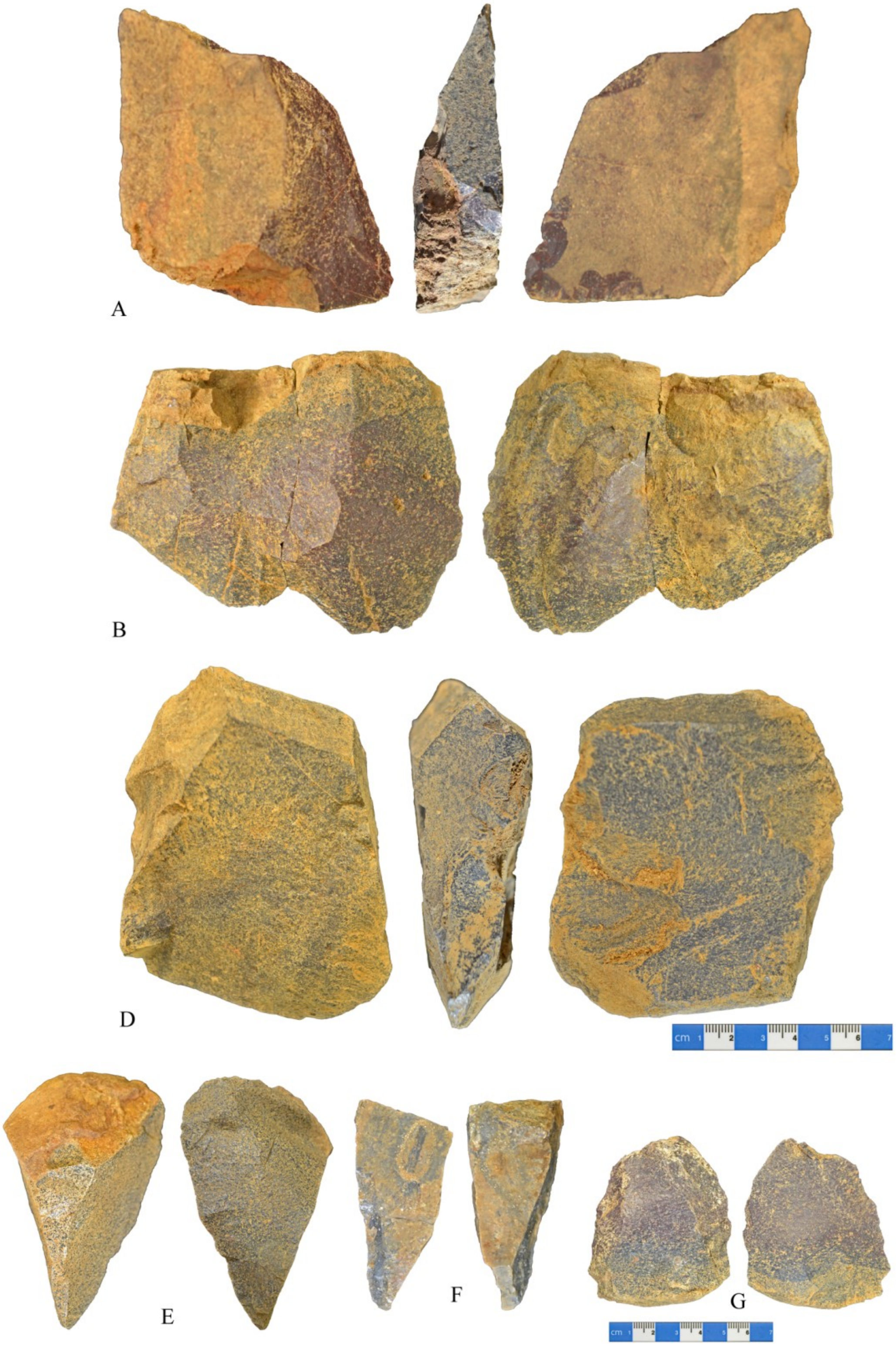
Wright, J.V. 1995. *A history of the Native people of Canada, Volume 1 (10,000-1,000 BC).* Canadian Museum of Civilization.

Yu, S., Colman, S.M., Lowell, T.V., Milne, G.A., Fisher, T.G., Breckenridge, A., Boyd, M., Teller, J.T. 2010. Freshwater Outburst from Lake Superior as a Trigger for the Cold Event 9,300 Years Ago. *Science* 328: 1262-1266.

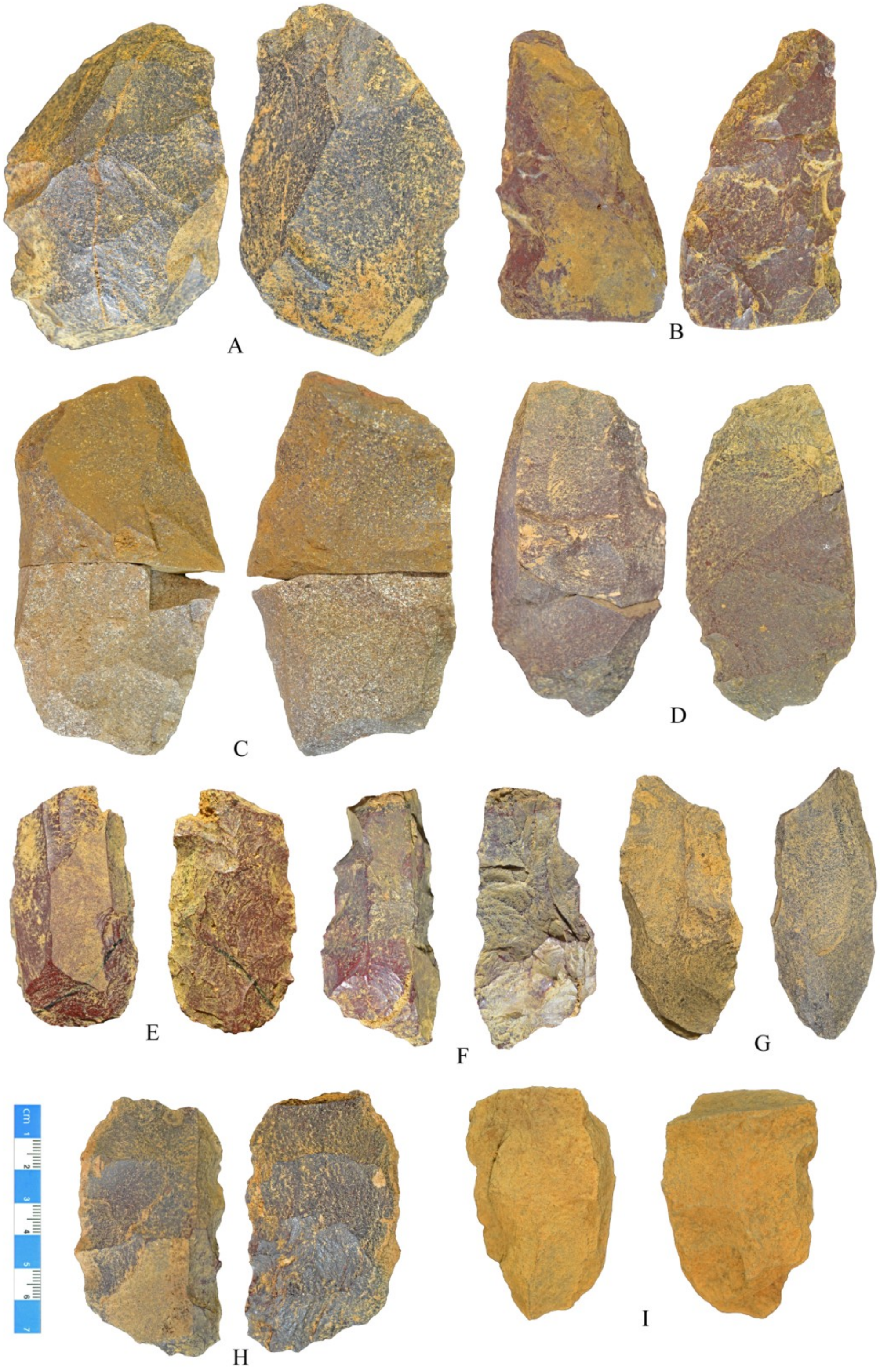
Zoltai, S.C. 1965. Glacial Features of the Quetico-Nipigon area, Ontario. *Canadian Journal of Earth Sciences* 2: 247-269.

Appendix 1: Images of Staged bifaces following the Biface Manufacture Trajectory

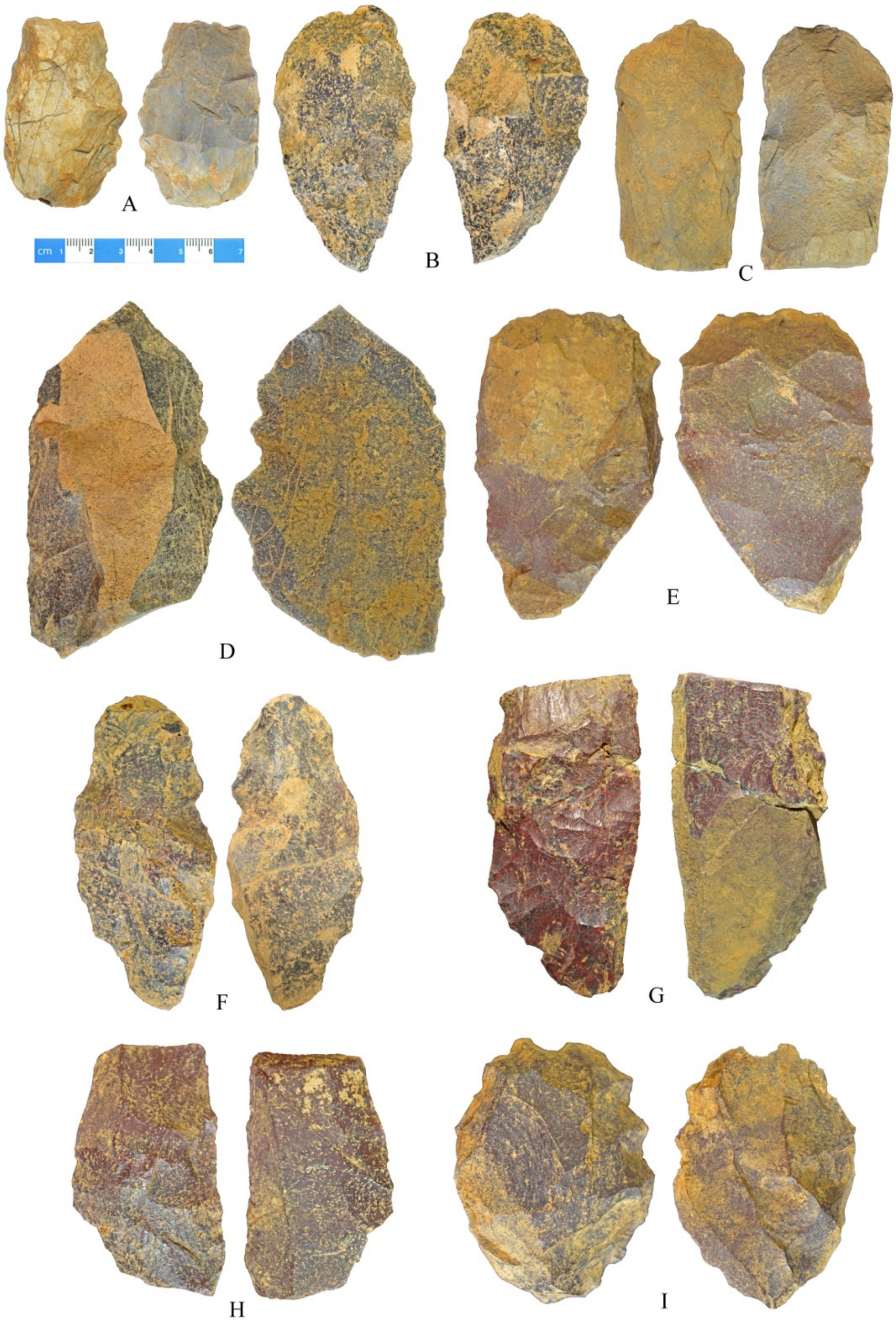
Stage 1 – Blanks from Mackenzie I



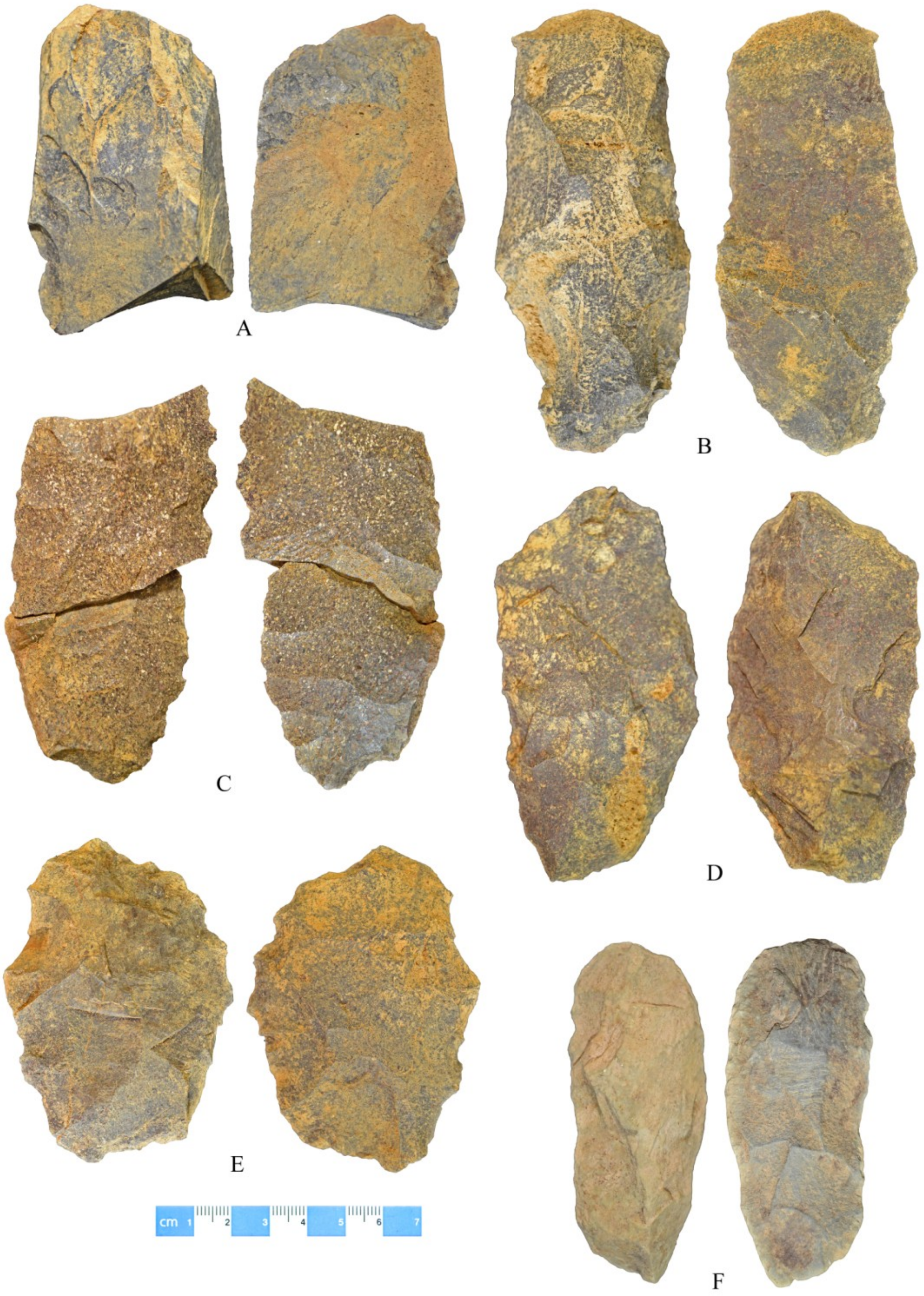
Stage 2 – Edge Blanks Complete and Refits 1



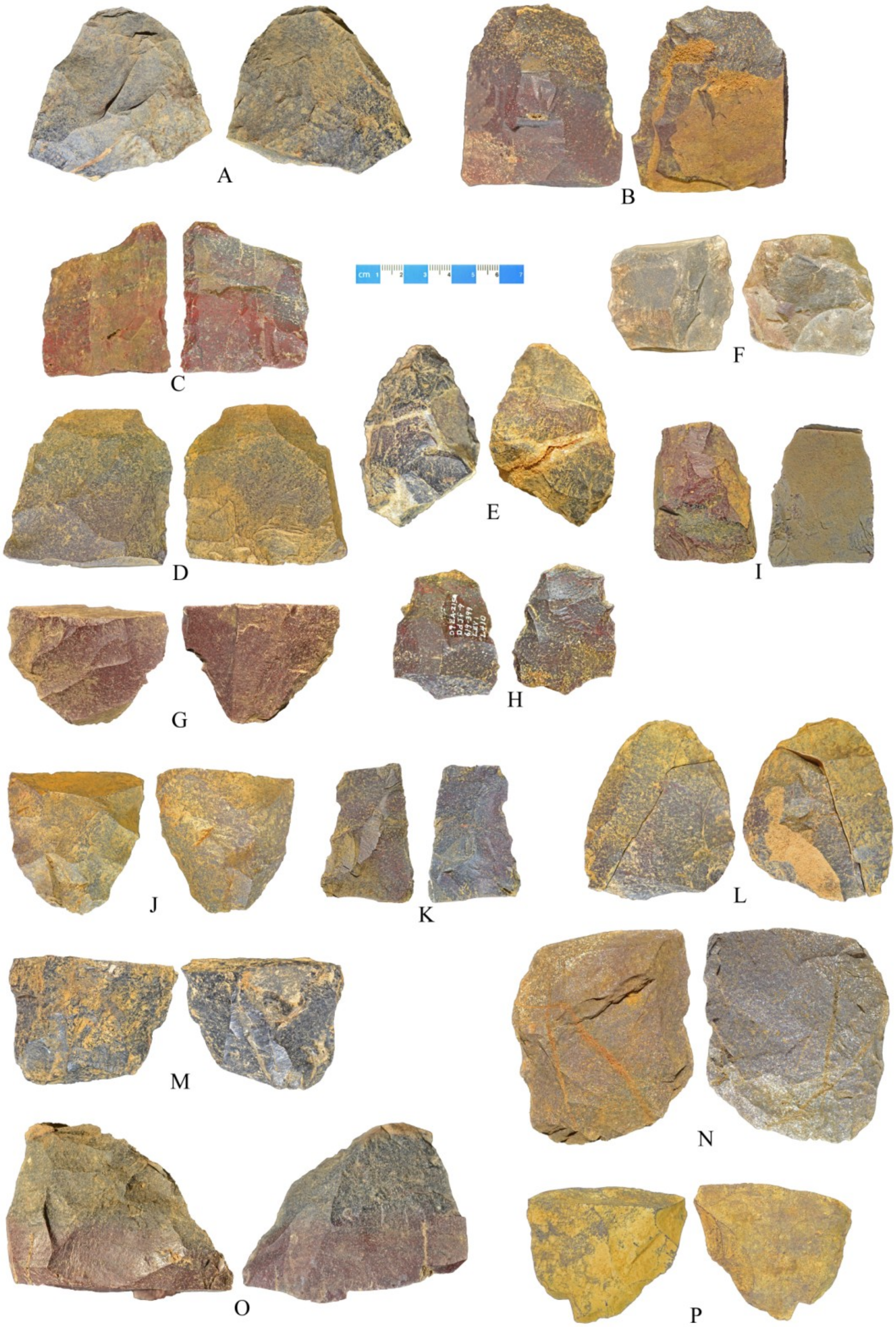
Stage 2 – Edge Blanks Complete and Refit 2



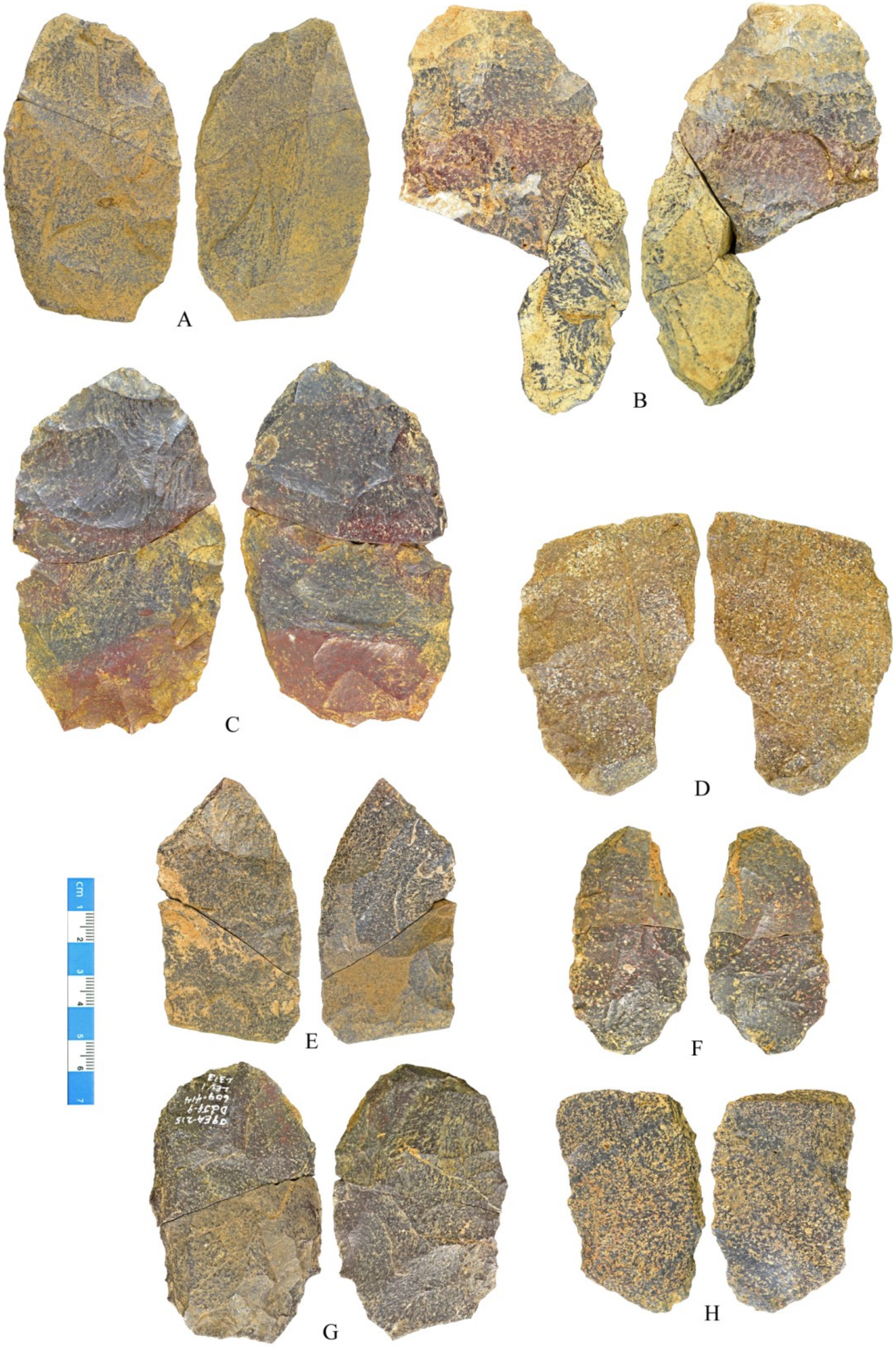
Stage 2 – Edge Blanks Complete and Refit 3



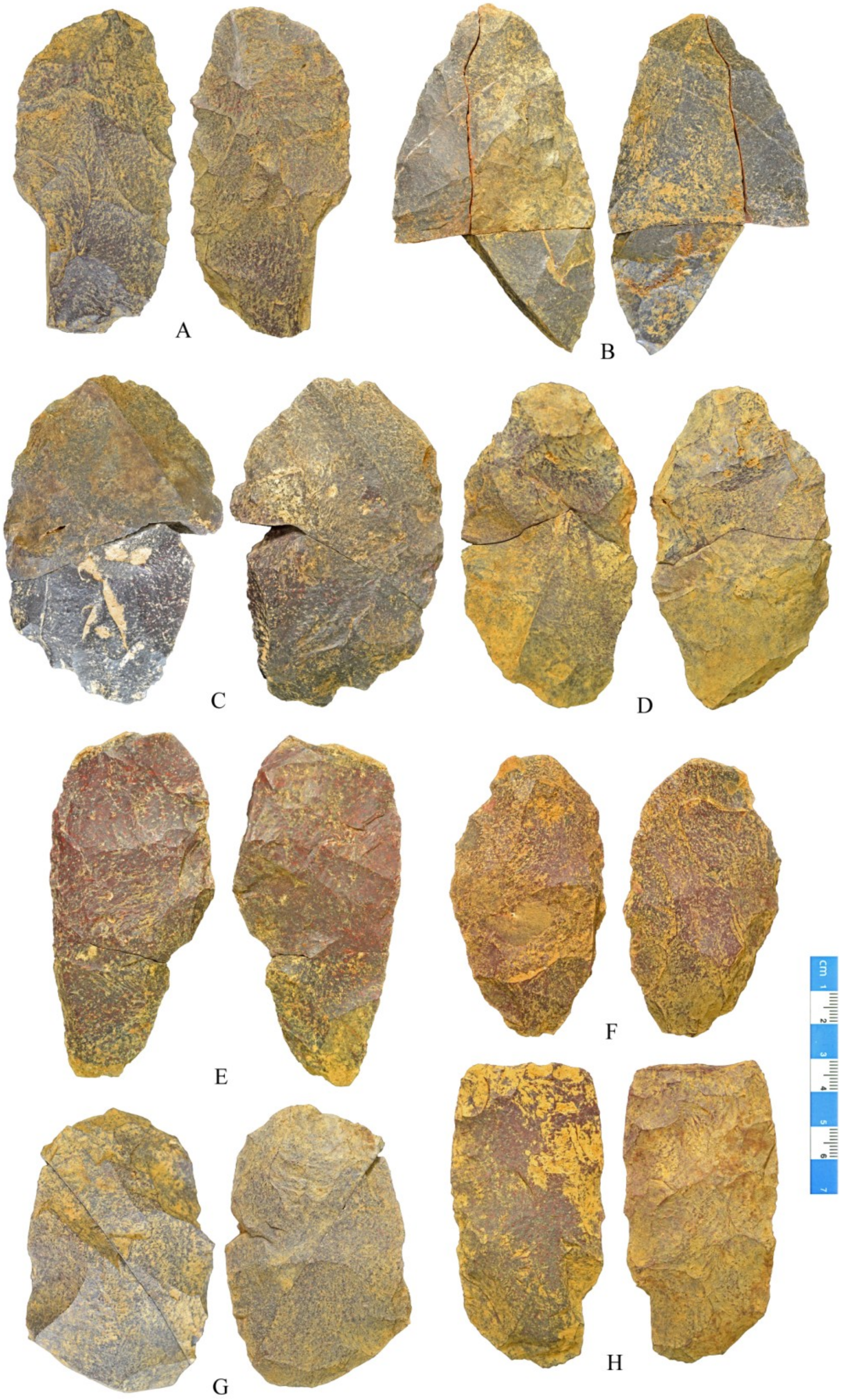
Stage 2 – Edge Blanks Fragments



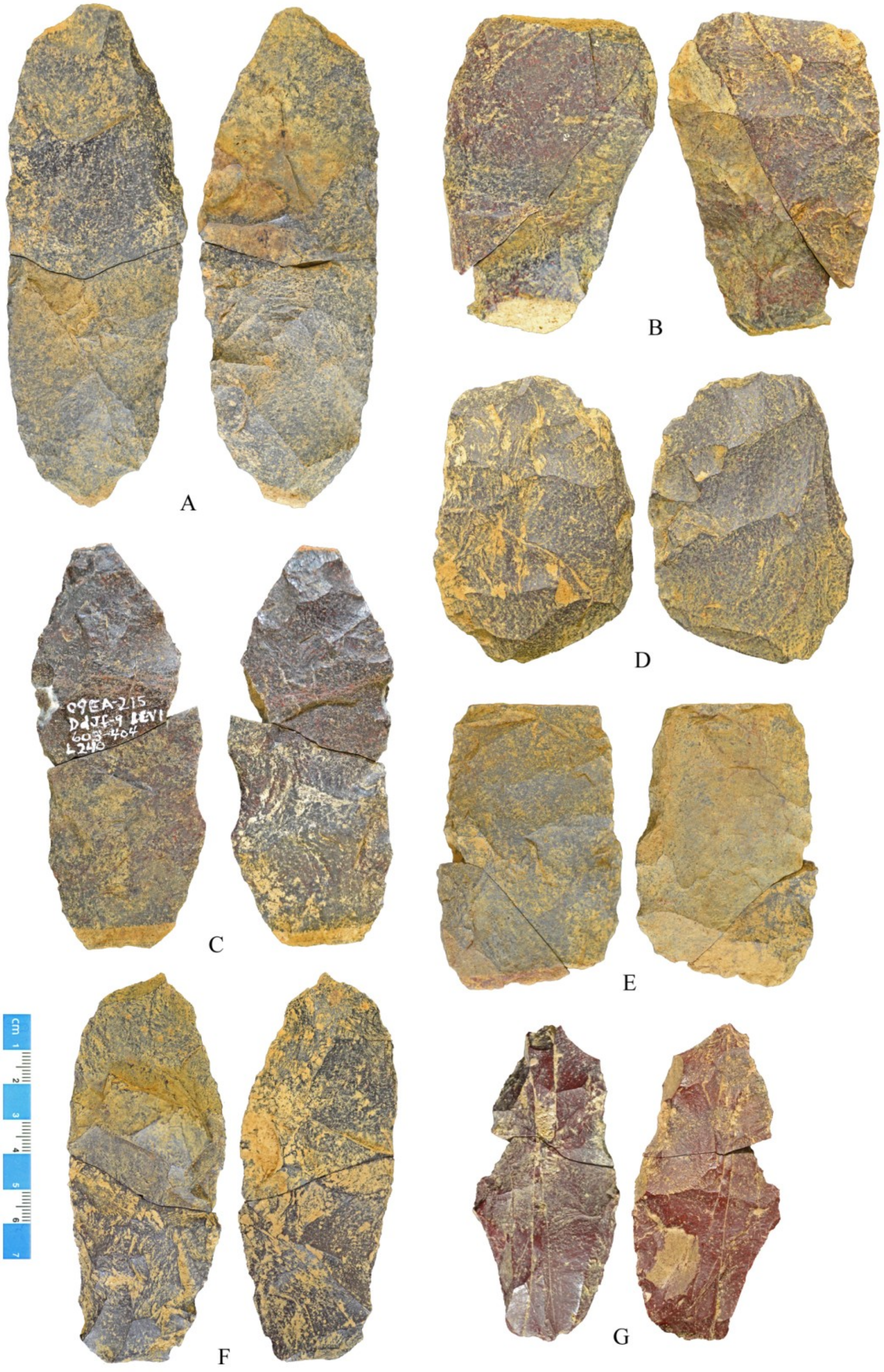
Stage 3 – Primary Thinning Complete and Refits 1



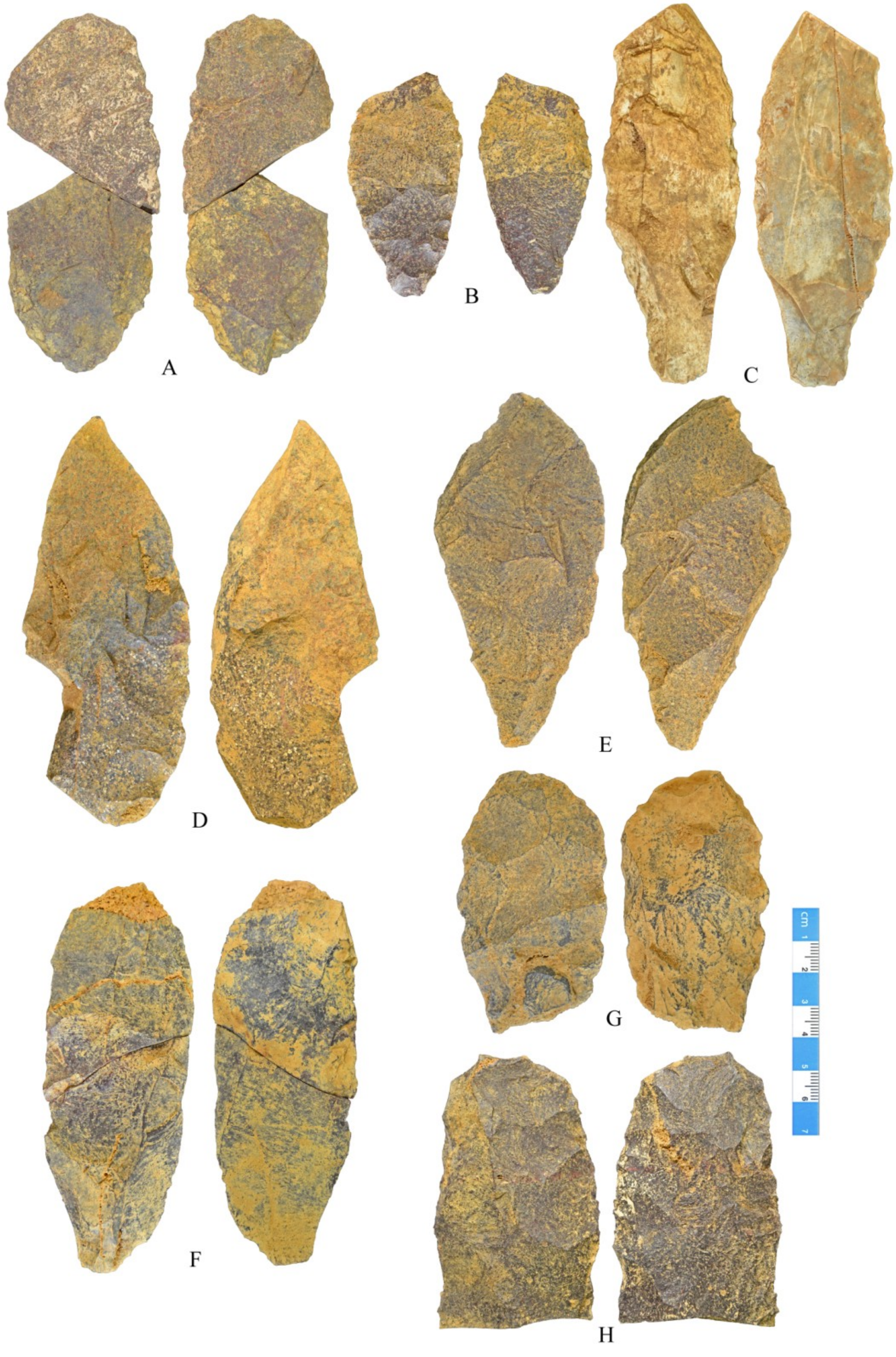
Stage 3 – Primary Thinning Complete and Refits 2



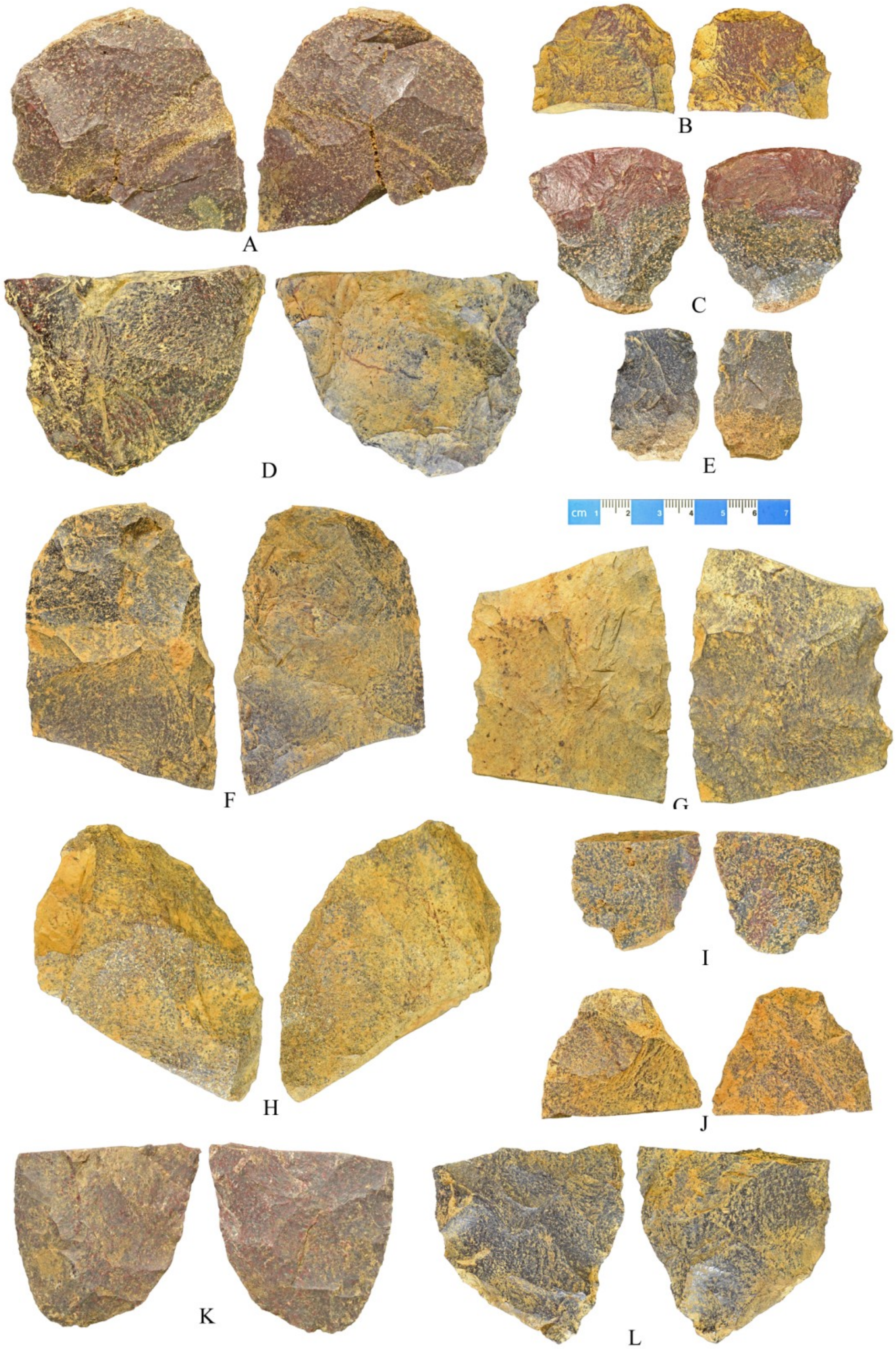
Stage 3 – Primary Thinning Complete and Refits 3



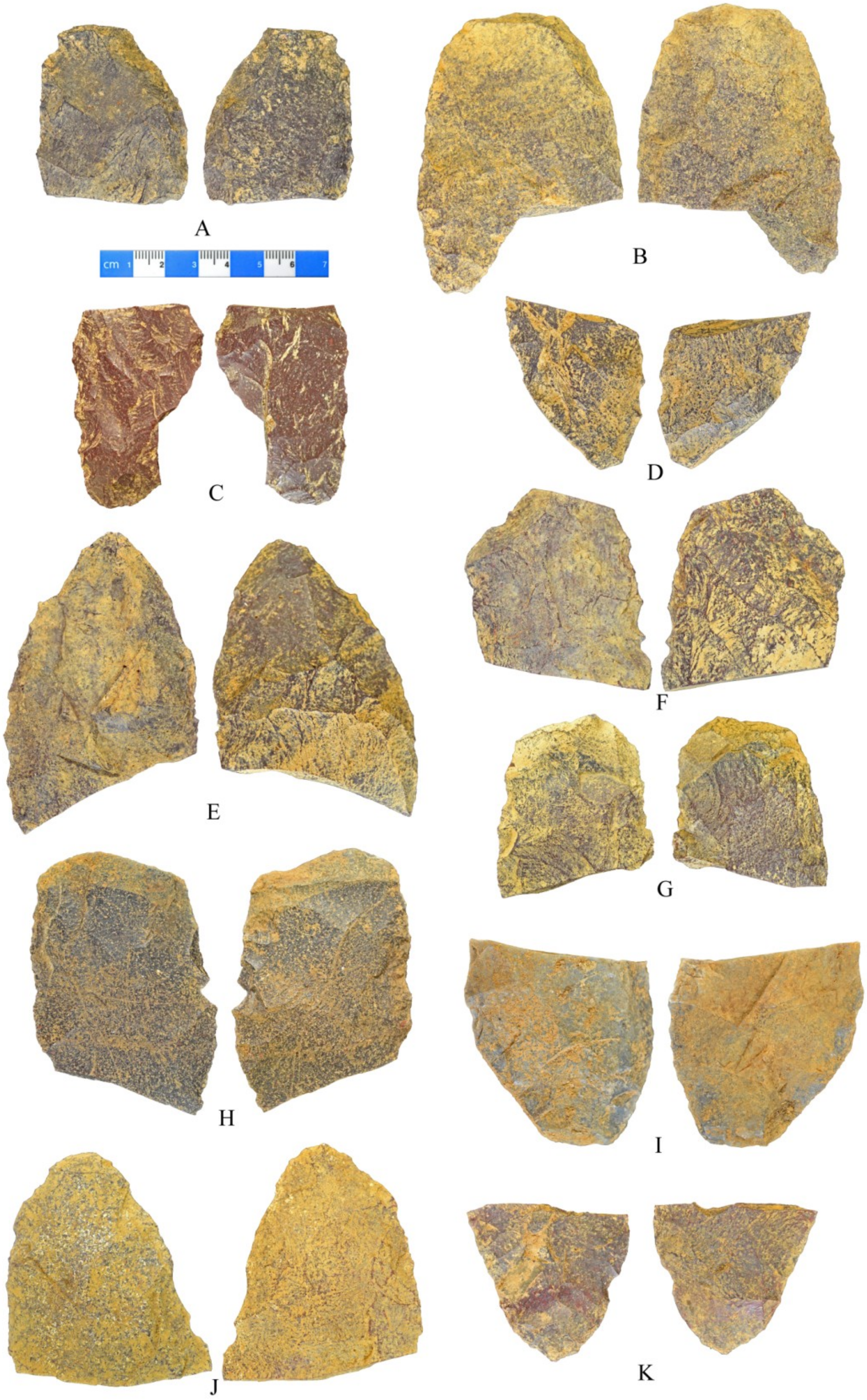
Stage 3 – Primary Thinning Complete and Refits 4



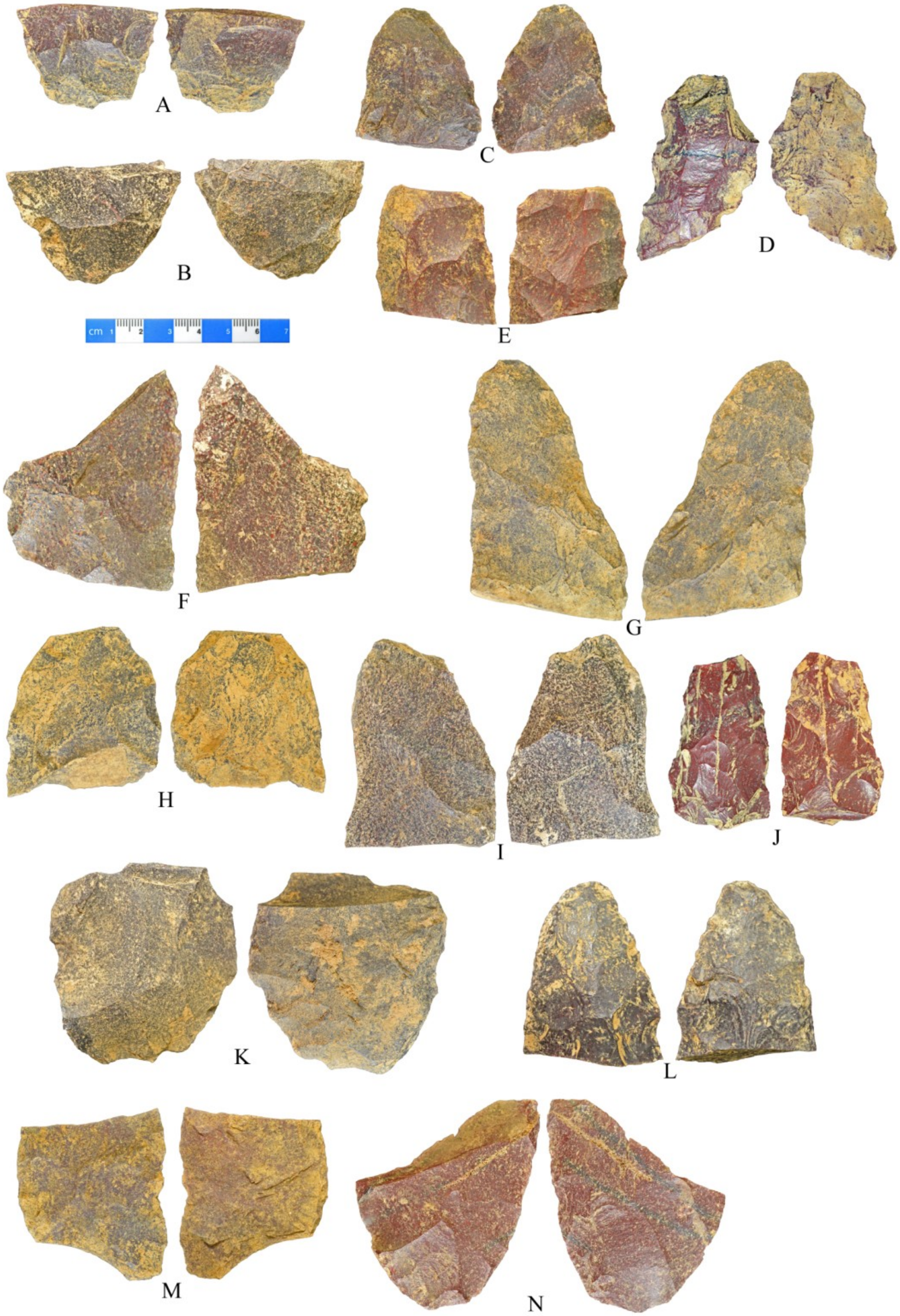
Stage 3 – Primary Thinning Fragments 1



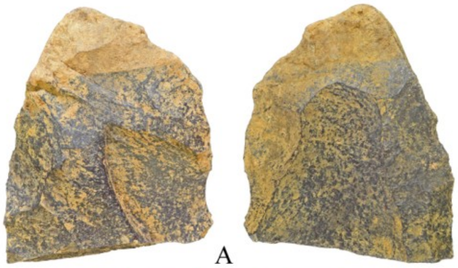
Stage 3 – Primary Thinning Fragments 2



Stage 3 – Primary Thinning Fragments 3

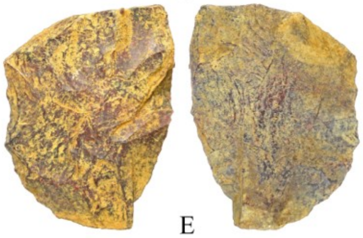


Stage 3 – Primary Thinning Fragments 4

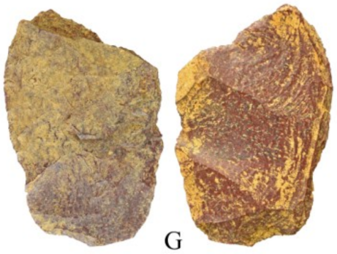


A

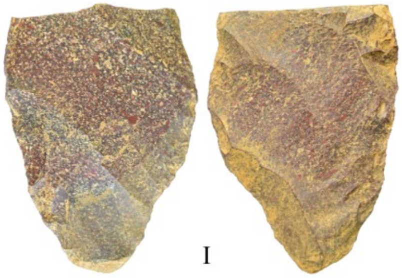
C



E

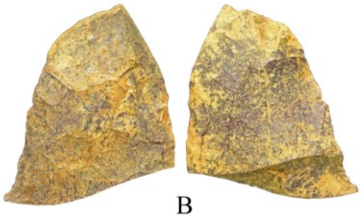


G

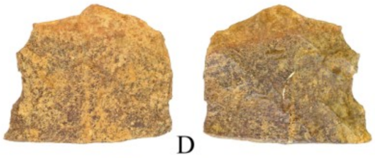


I

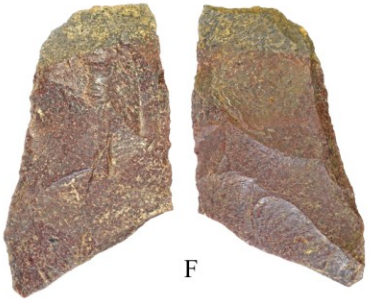
L



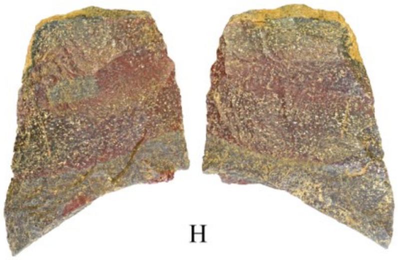
B



D



F



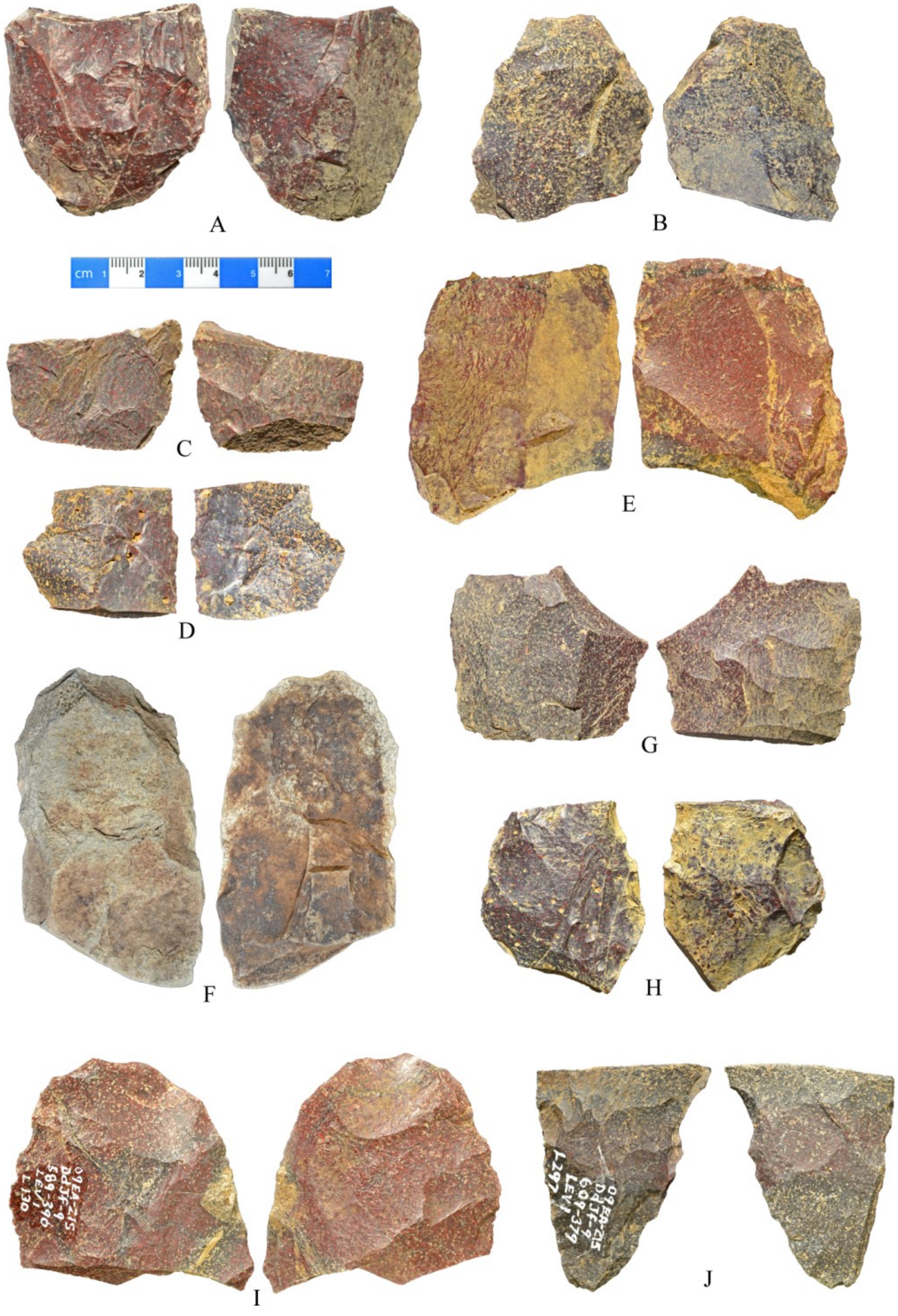
H

J

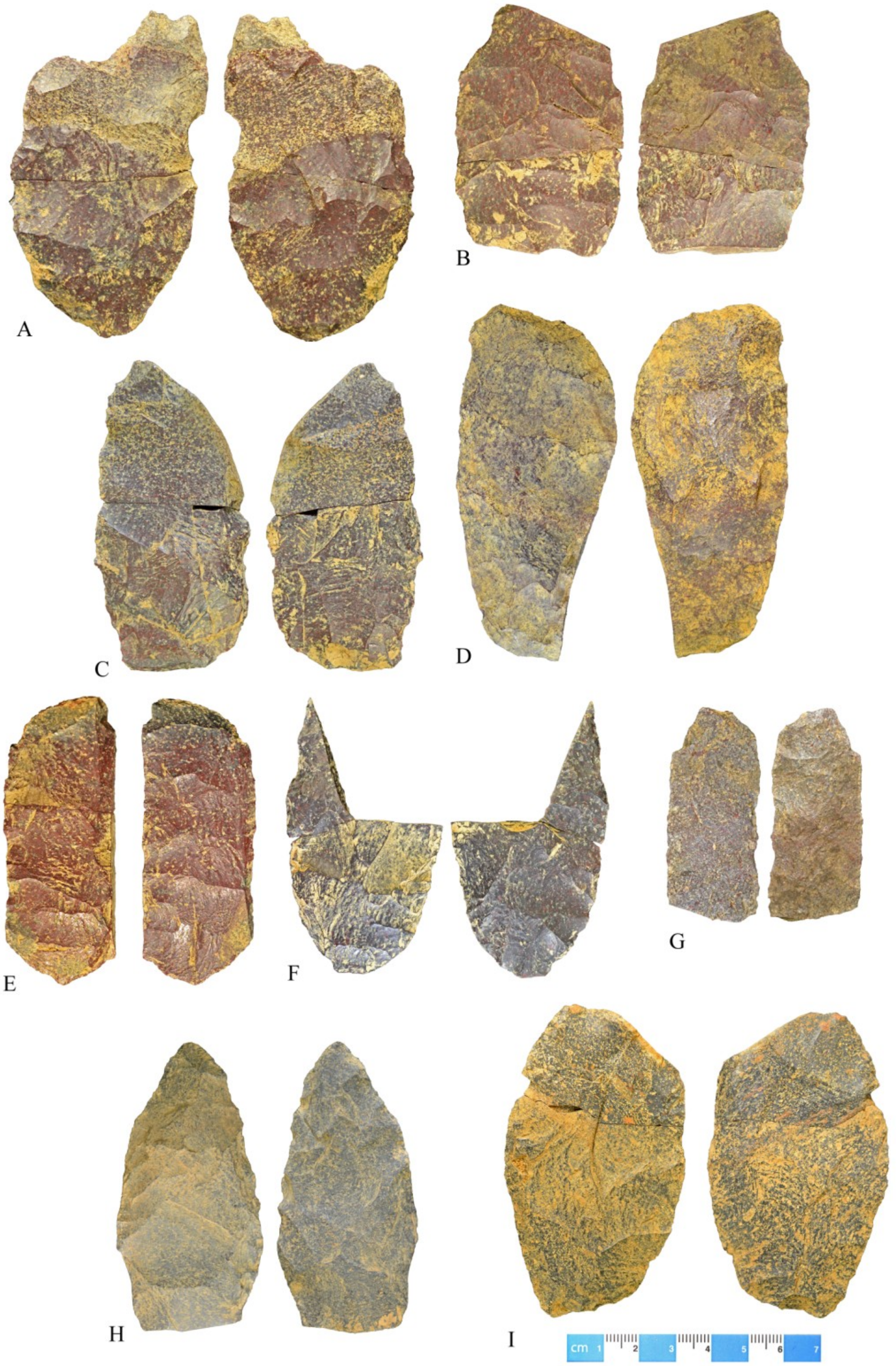
K

M

Stage 3 – Primary Thinning Fragments 5



Stage 4 – Secondary Thinning Complete and Refits 1



Stage 4 – Secondary Thinning Complete and Refits 2


A


B

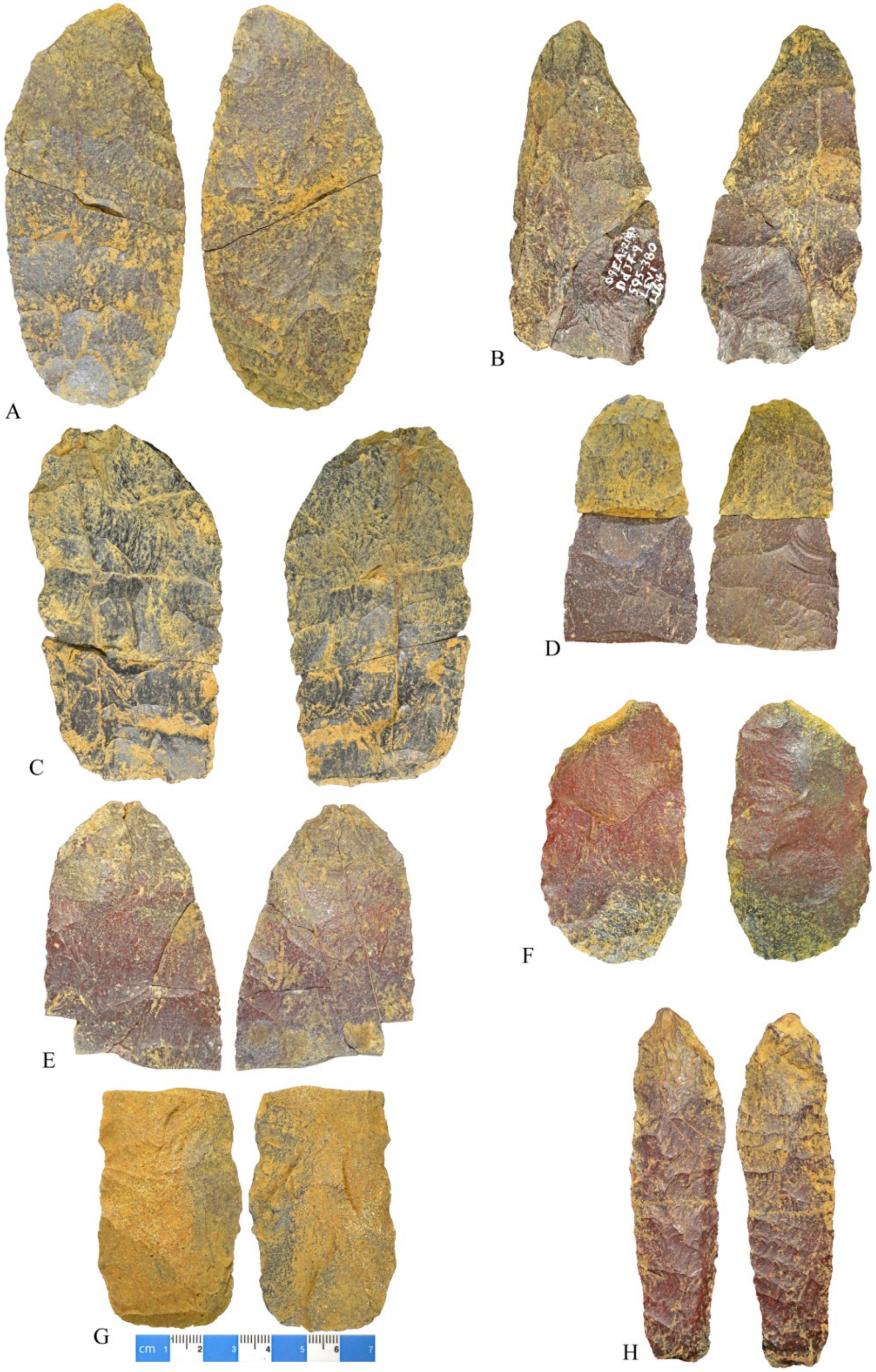

C


D

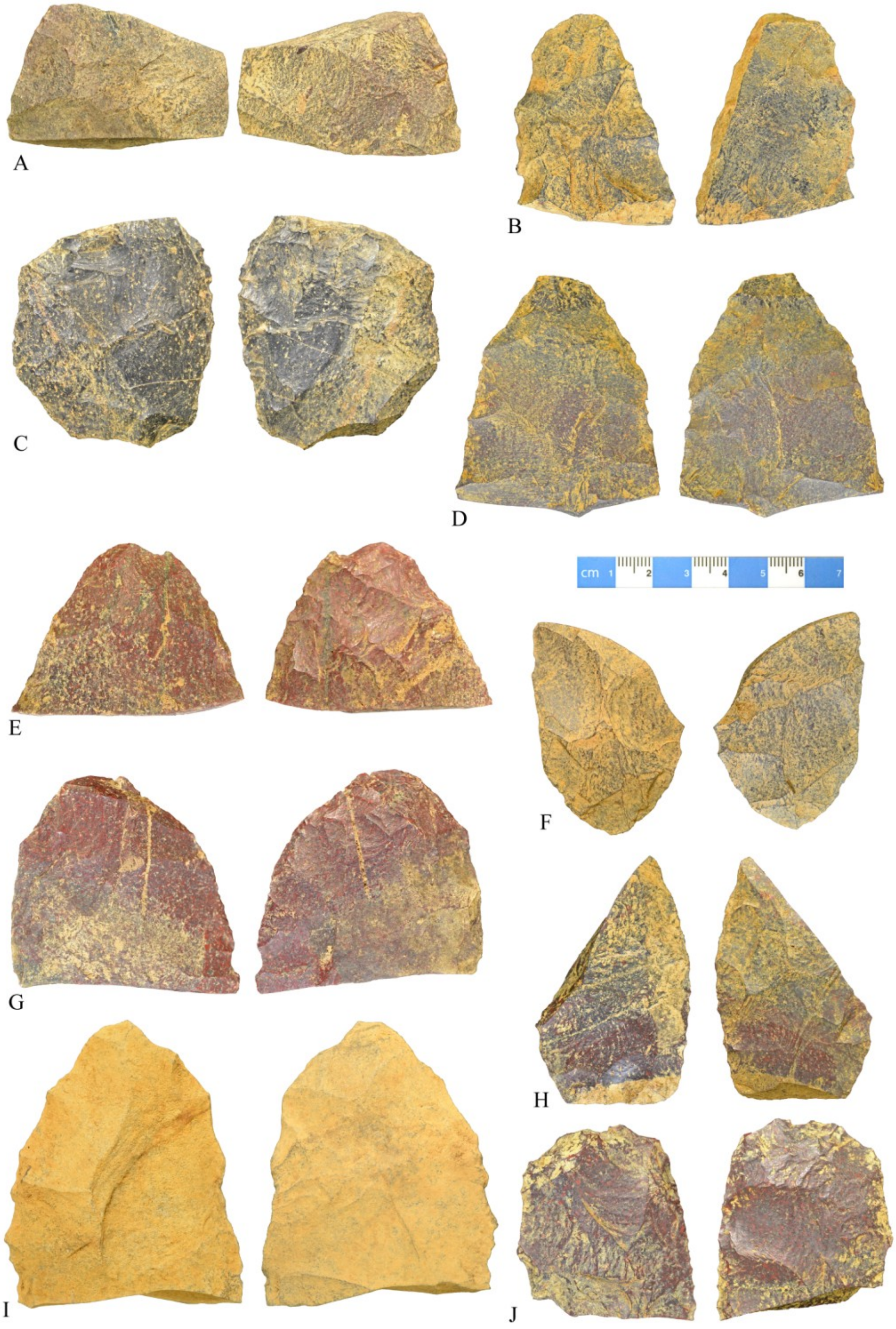

E


F

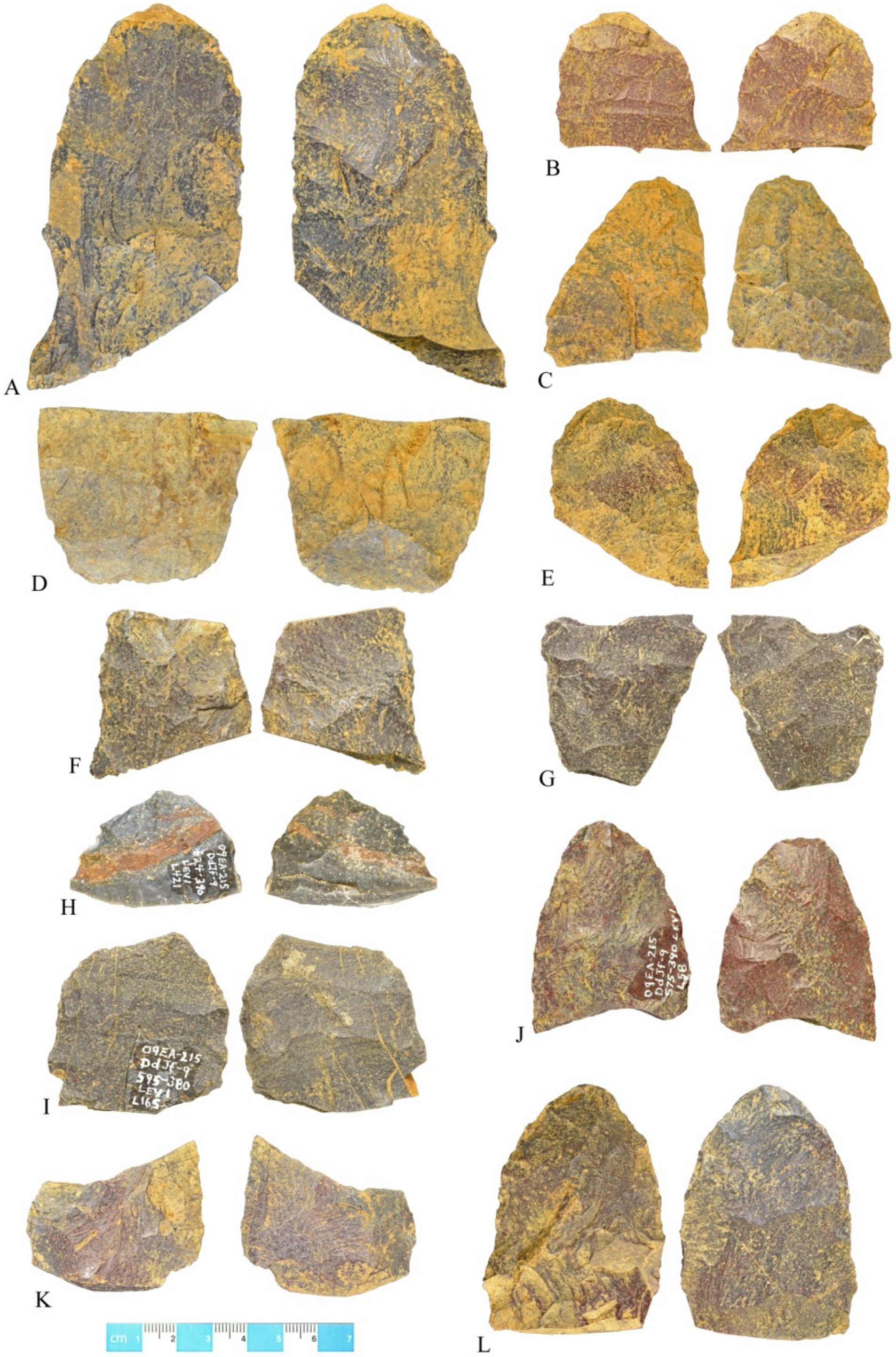
Stage 4 – Secondary Thinning Complete and Refits 3



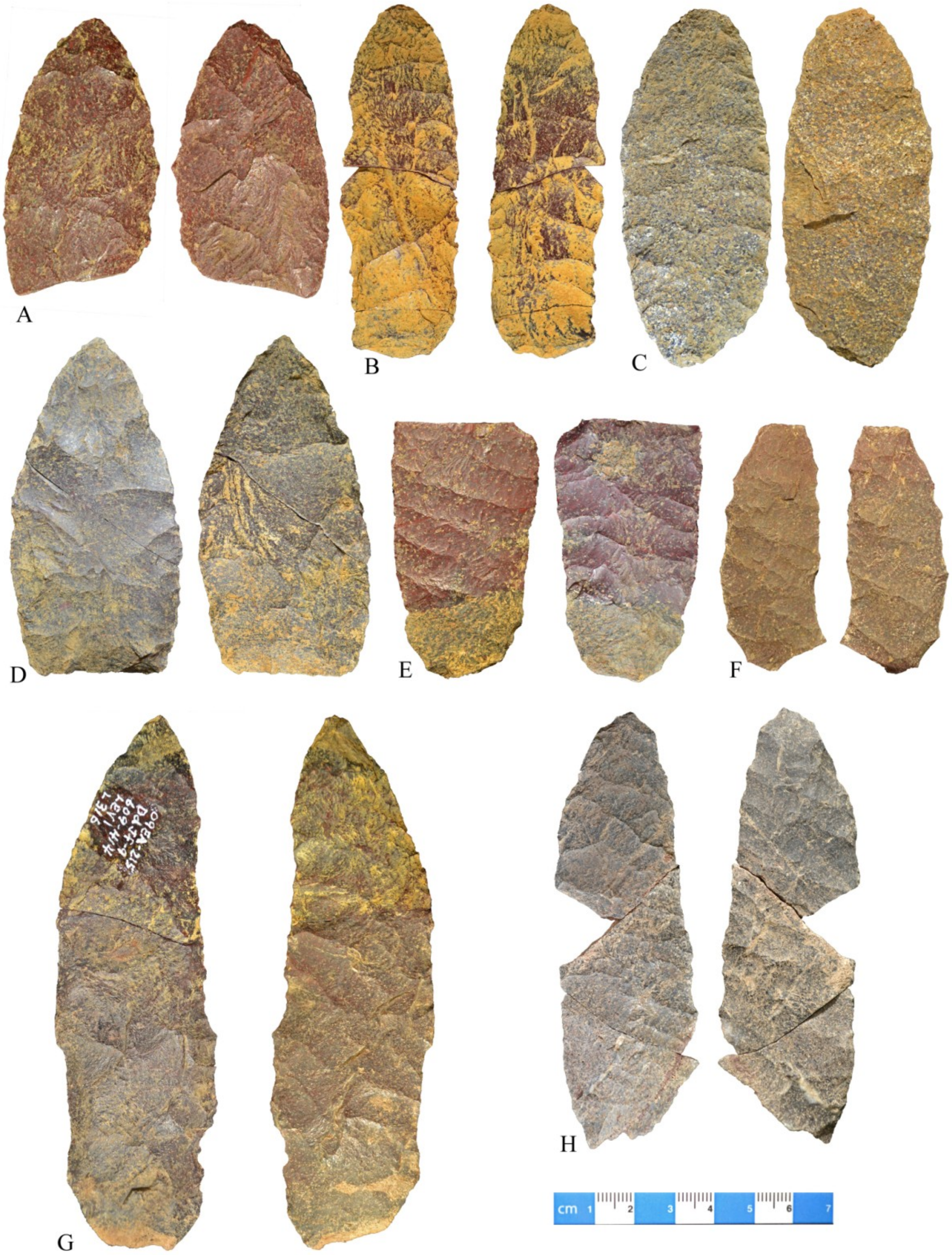
Stage 4 – Secondary Thinning Fragments 1



Stage 4 – Secondary Thinning Fragments 2

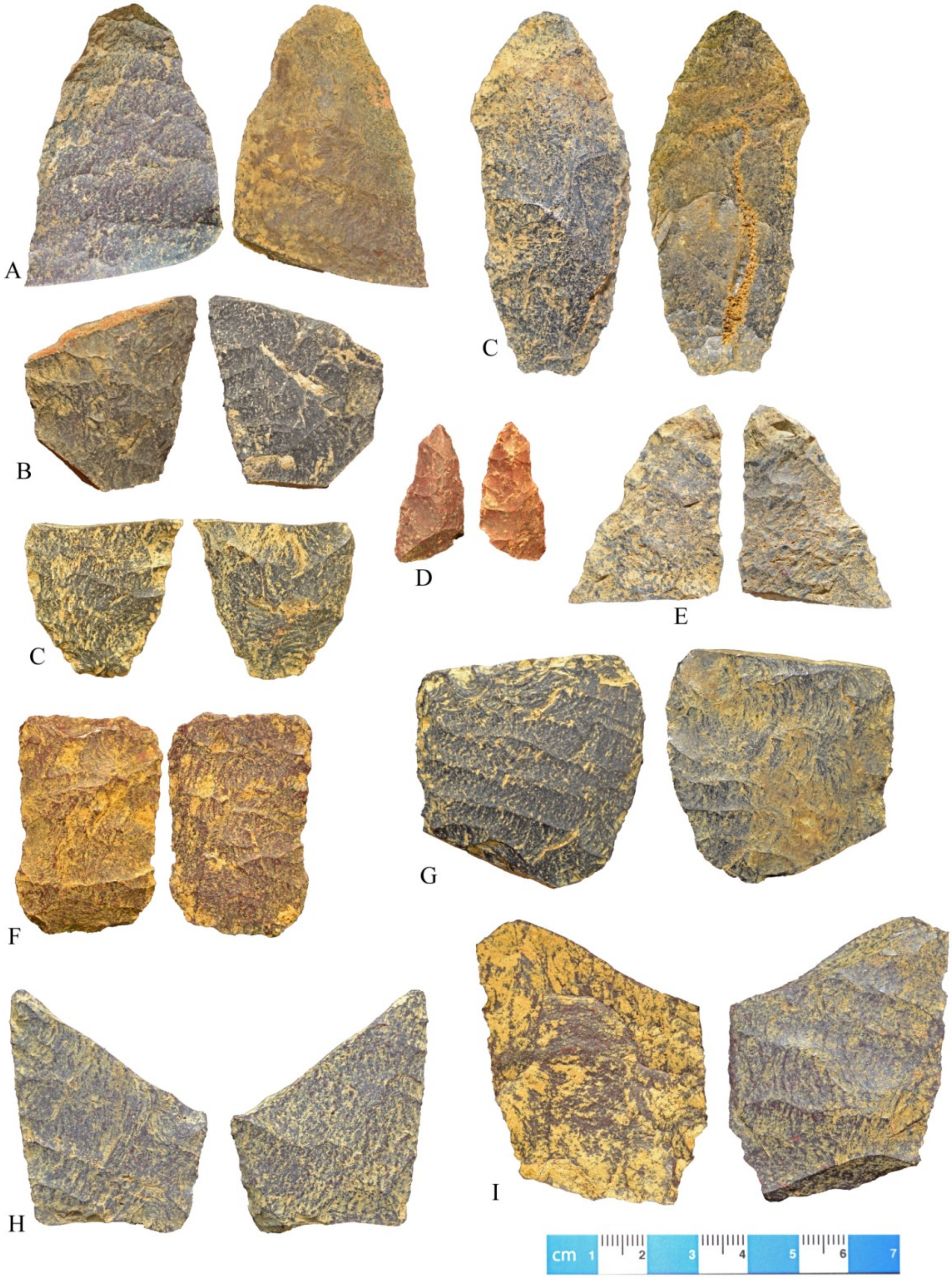


Stage 5 – Preforms Complete and Refits 1



Stage 5 – Preforms Complete and Refits 2

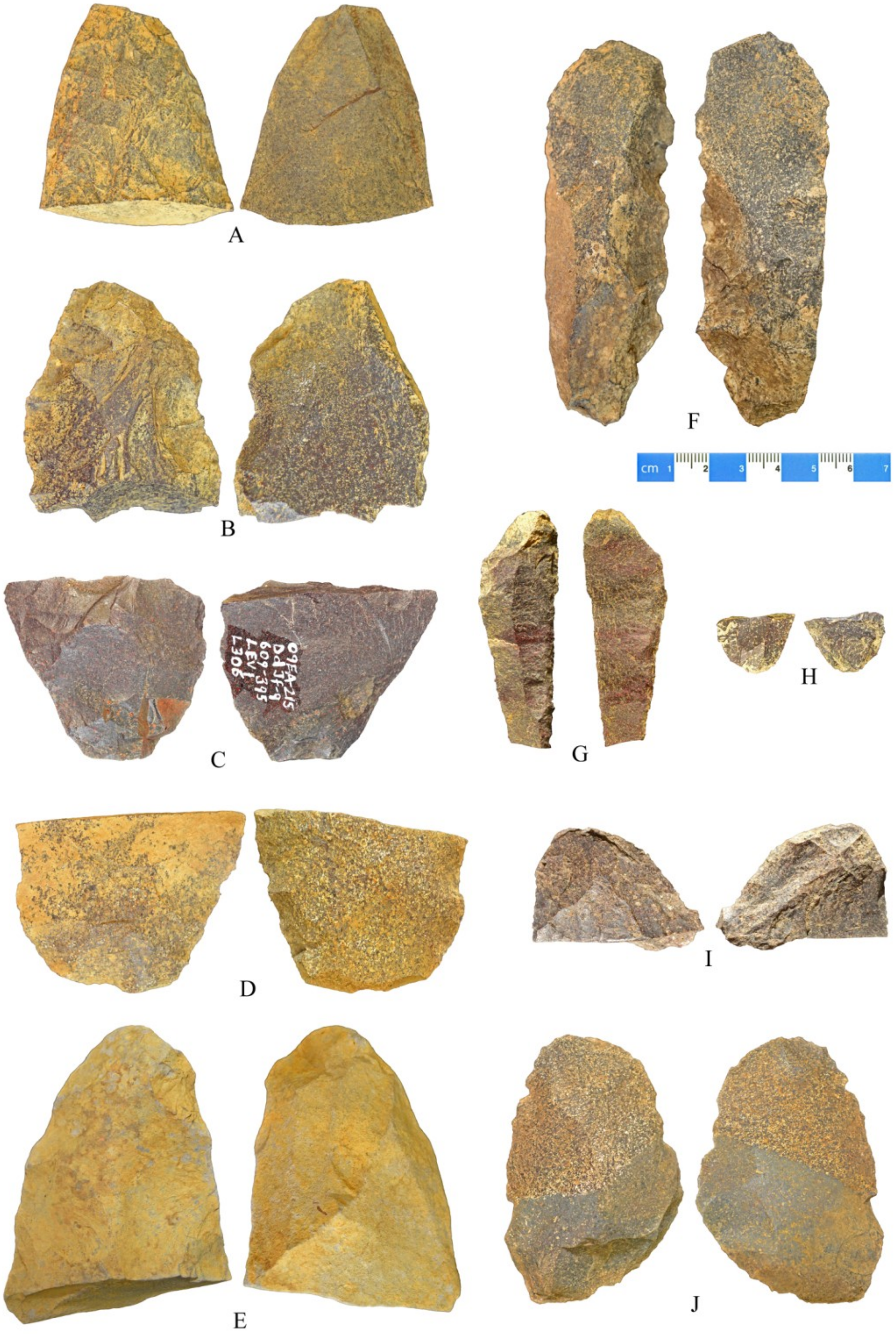
Stage 5 – Preforms Fragments 1



Appendix 2: Images of Staged bifaces following the Flake/Blade Manufacture Trajectory

Stage 1 – Blanks

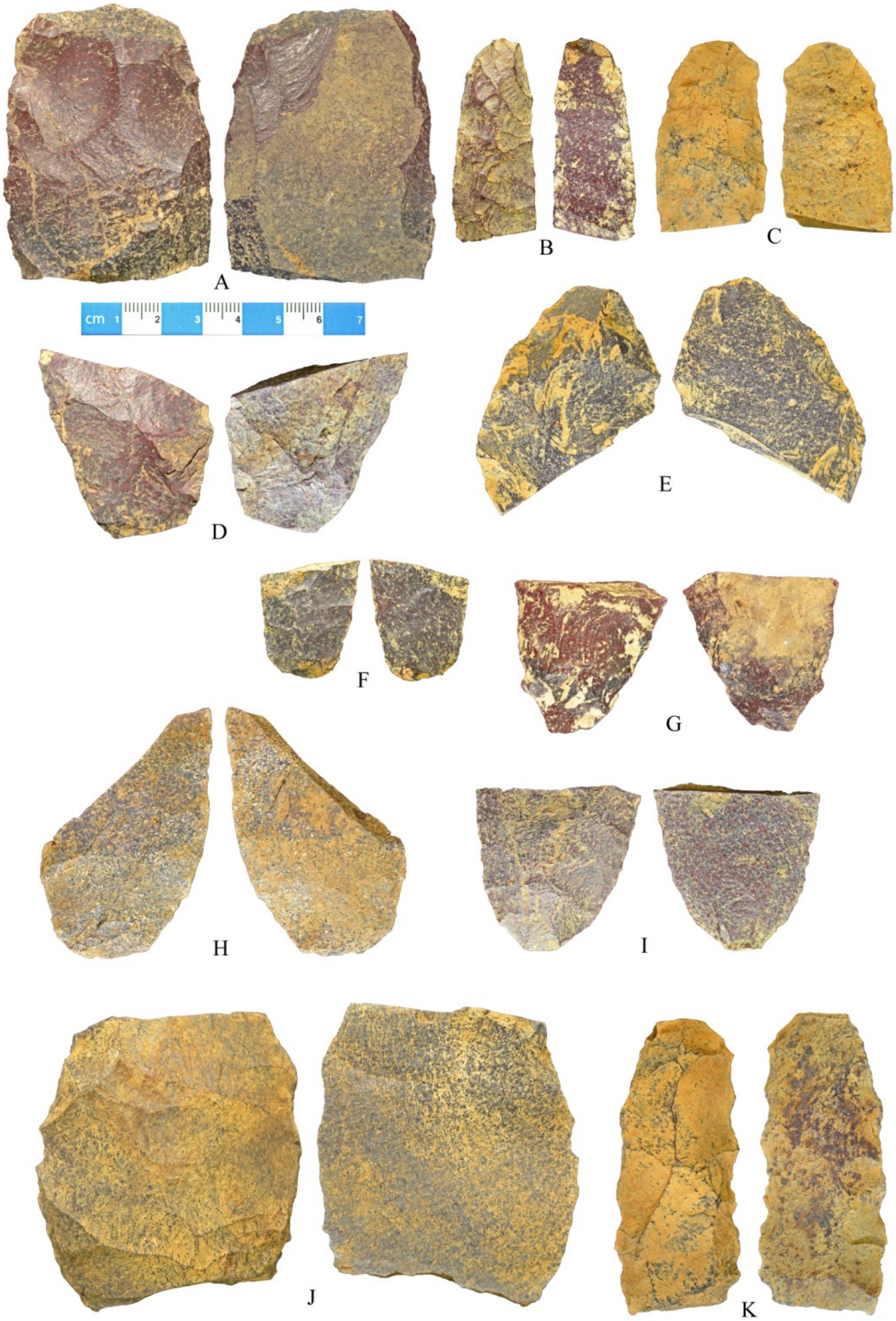
Stage 2 – Edge Blanks



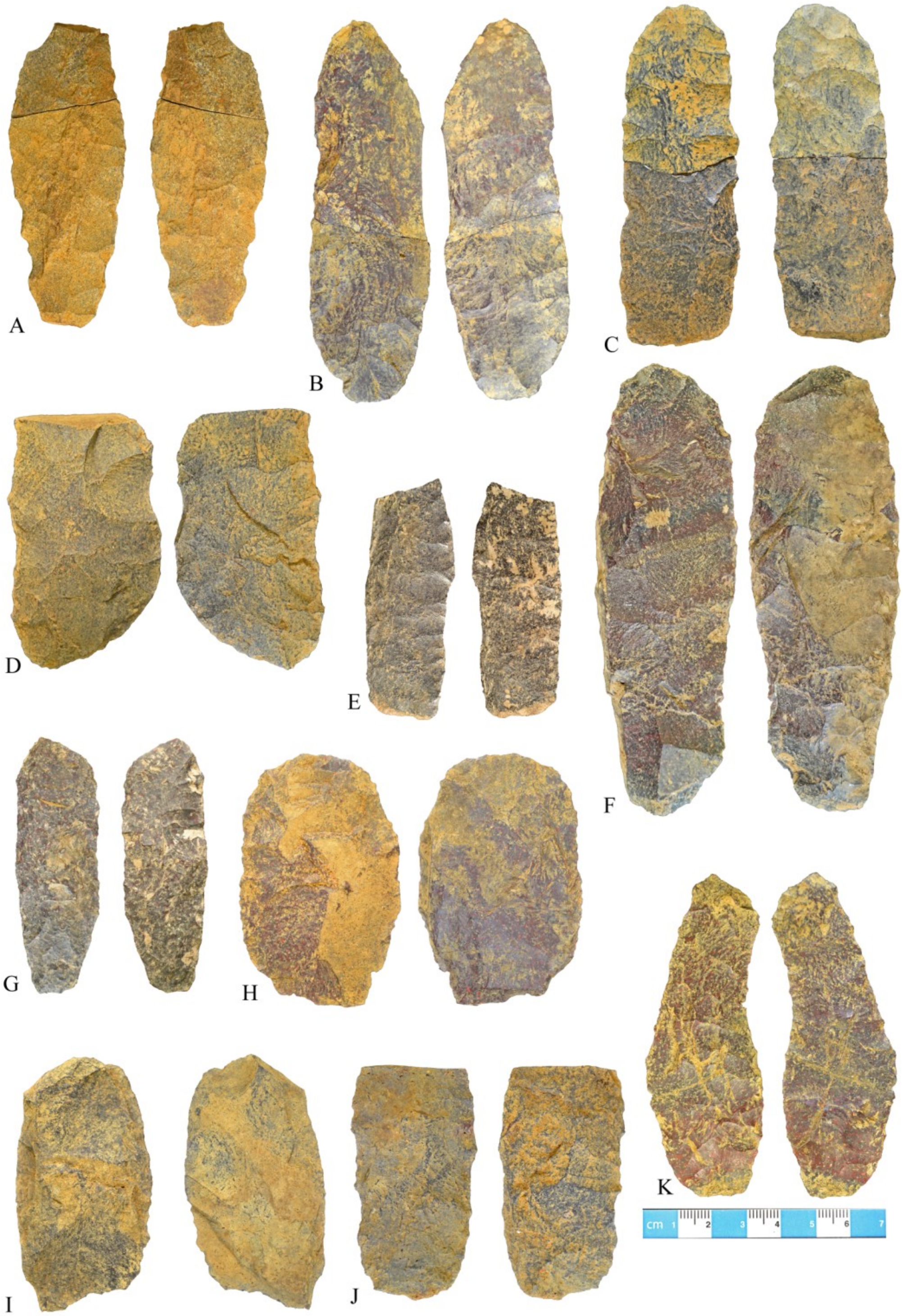
Stage 3 – Primary Thinning Complete and Refits 1

Stage 3 – Primary Thinning Complete and Refits 2

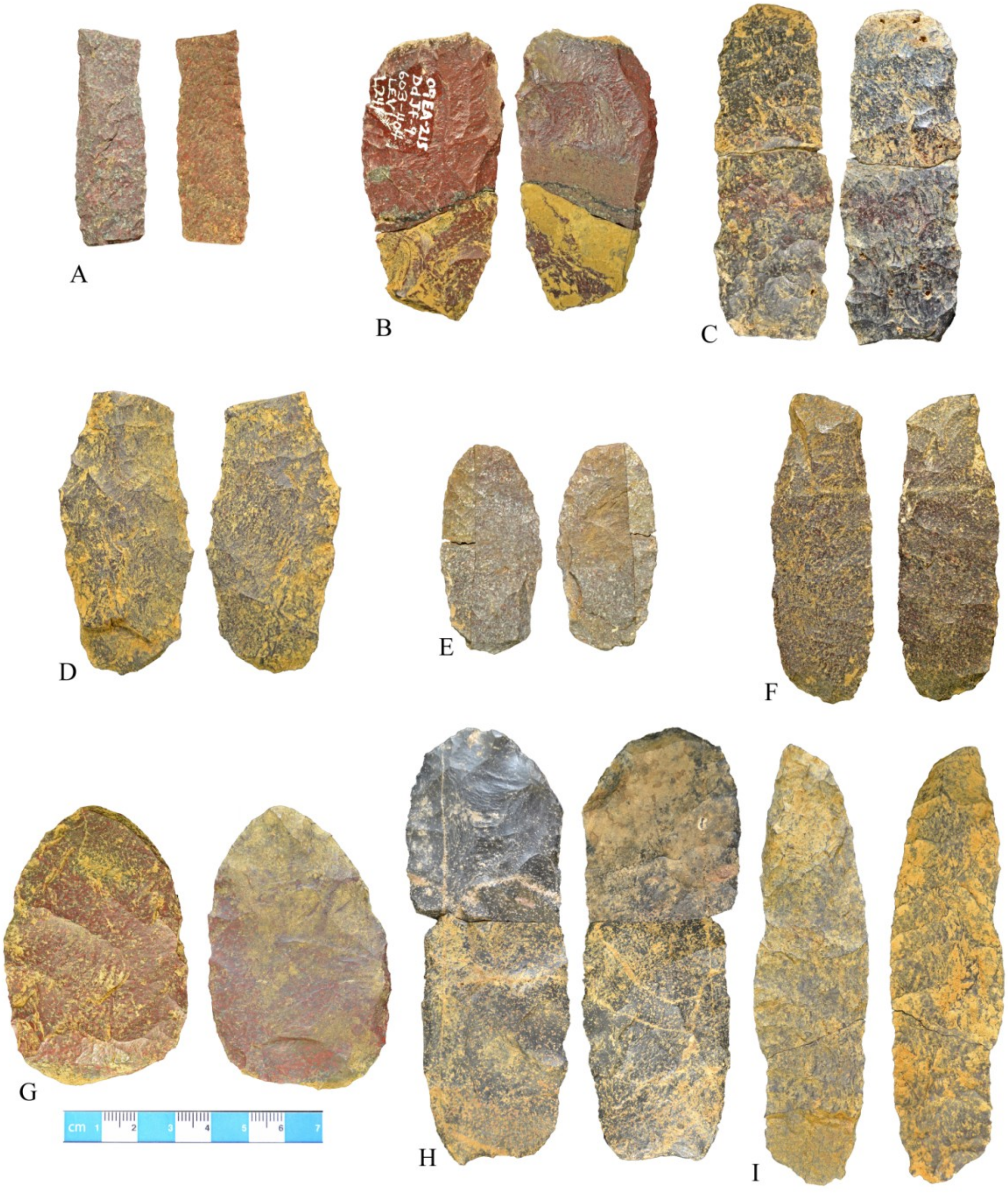
Stage 3 – Primary Thinning Fragments



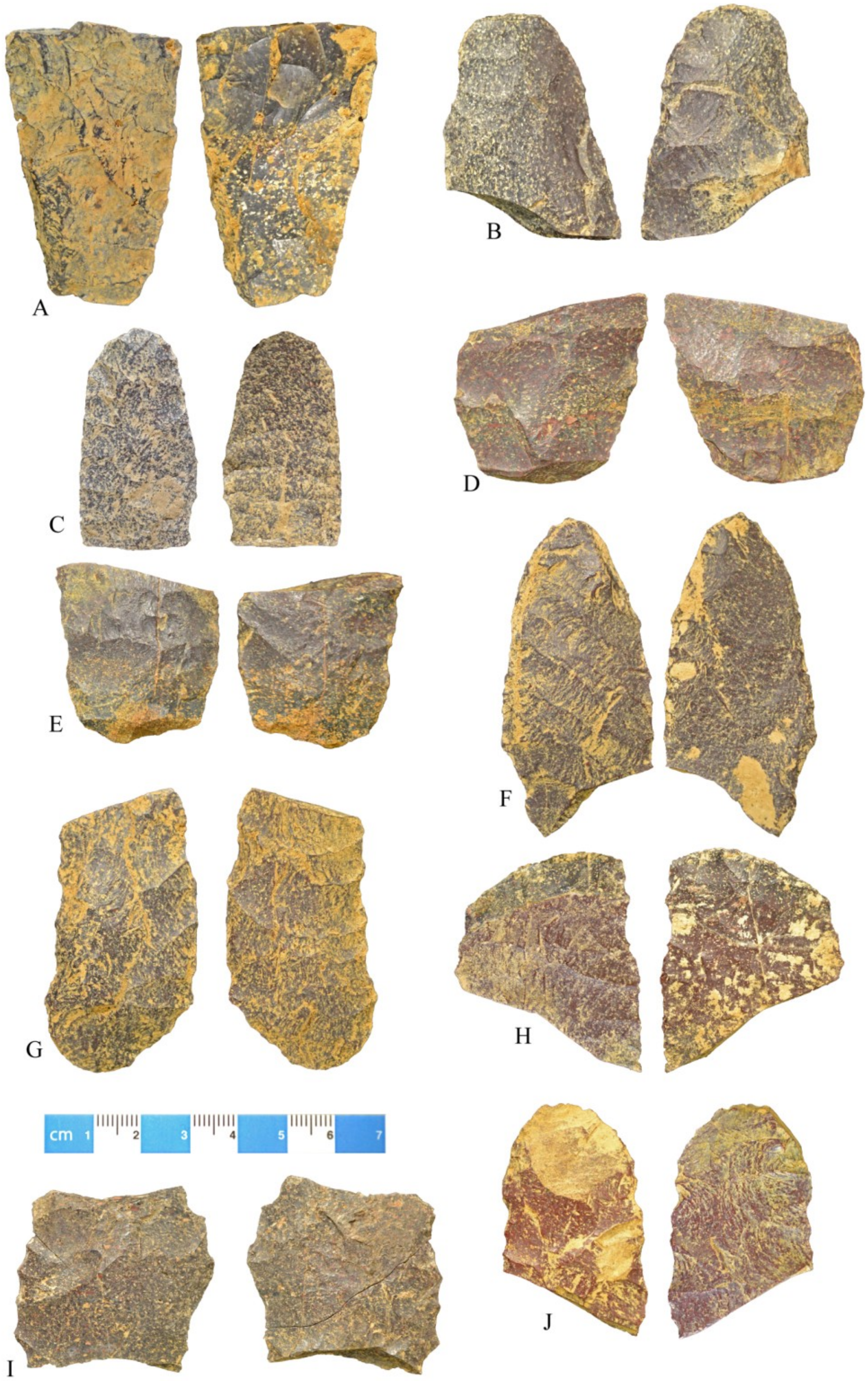
Stage 4 – Secondary Thinning Complete and Refits 1



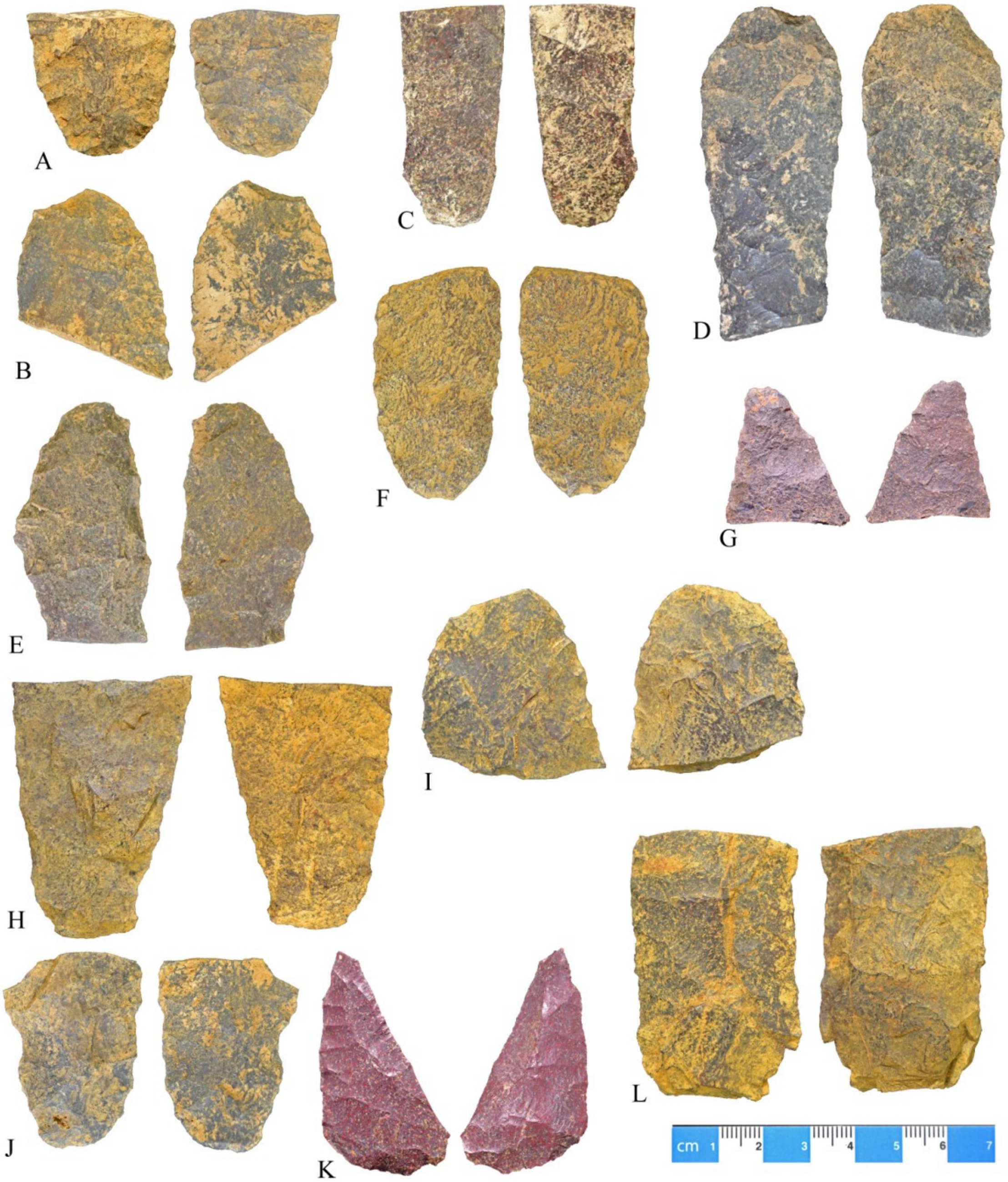
Stage 4 – Secondary Thinning Complete and Refits 2



Stage 4 – Secondary Thinning Fragments 1



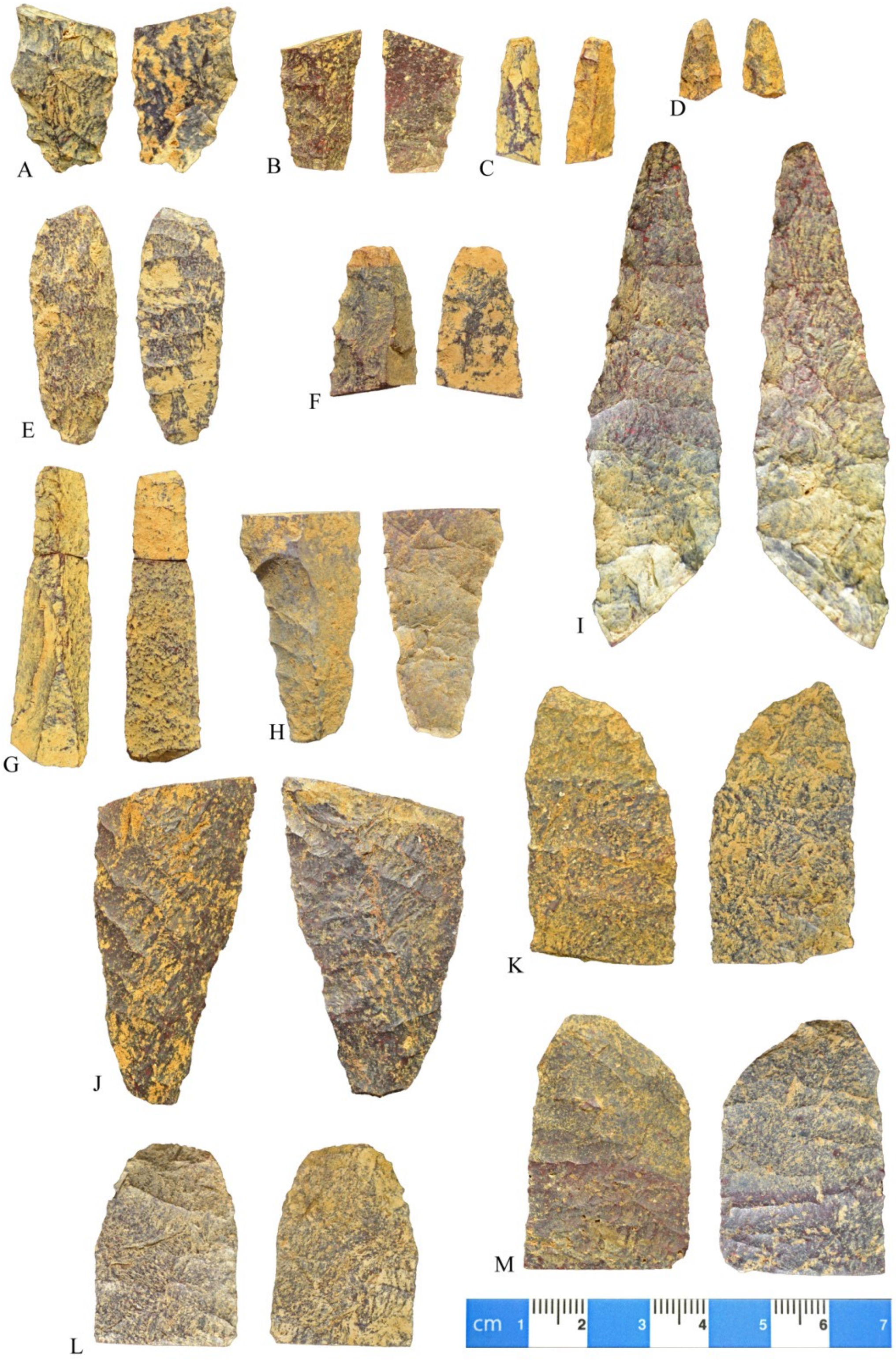
Stage 4 – Secondary Thinning Fragments 2



Stage 5 – Preforms Complete and Refits 1

Stage 5 – Preforms Complete and Refits 2

Stage 5 – Preforms Fragments 1



Stage 5 – Preforms Fragments 2