Rethinking the significance of the microlith for hunting in the terminal Pleistocene / Holocene: A comparative study

WALKER, JAMES,WILLIAM,PADDISON

WALKER, JAMES,WILLIAM,PADDISON (2014) *Rethinking the significance of the microlith for hunting in the terminal Pleistocene / Holocene: A comparative study*, Durham theses, Durham University. Available at Durham E-Theses Online: http://etheses.dur.ac.uk/11073/

Rethinking the significance of the microlith for hunting in the terminal Pleistocene / Holocene: A comparative study

James William Paddison Walker

A thesis presented for the degree of
Doctor of Philosophy

Department of Archaeology
University of Durham
England
2014

Rethinking the significance of the microlith for hunting in the terminal Pleistocene / Holocene: A comparative study

James William Paddison Walker

Abstract

Microliths are small cutting implements made from stone and found around the world in a variety of prehistoric contexts. It is assumed without question, due to their size, that these pieces were made with the intention of being hafted. Their presence in the prehistoric record is often interpreted as indicative of multi-component composite toolkit designs. While the possibility of alternative functions cannot be ruled out of consideration, they have traditionally been, and are still most commonly interpreted as having served as armatures for hunting weaponry. As a global phenomenon, the term microlith encompasses a great deal of regional variation. Traditionally, studies of microlithic assemblages have been insularly rooted within the particular research frameworks of these regions. It is only recently that the potential for comparative assessment has been highlighted as a significantly underexplored avenue for further establishing the values that made microlithic technology desirable in different times and places.

This research focusses on three study regions with strong distinct trends of microlithic technology, primarily associated with hunting weaponry: northern Spain, southern Africa and interior Alaska. Using a small sample of sites from each region, variation in microlithic assemblages was assessed over time in each area relative to contemporary trends in ungulate fauna and environmental proxies. This facilitated discussion of how microlithic based hunting practices related to particular prey or conditions, or changes in these factors. Overall, the study found that it is difficult to singularly characterise conditions associated with microlithic technology, even in individual regional analyses. This supports the notion that an important virtue of microlithic armatures is their versatility, allowing for flexible weapon designs that could accommodate variable risk related stresses.

Statement of Declaration

I, the author of this thesis, declare that this thesis and the work presented herein are my own. No part of the work has been submitted in support of an application for any other degree in this university or any other. Where other sources of information have been used, they have been acknowledged.

Signature:

James William Paddison Walker

Statement of Copyright

The copyright of this thesis rests with the author. No quotation from it should be published without the author’s prior written consent and information derived from it should be acknowledged.

Table of Contents

List of Figures

List of Tables

List of Appendices

(DVD attachment)

Acknowledgements

There are many people whose friendship, kindness and advice deserves my thanks, but of the friends I have had the privilege of knowing throughout my PhD, the following in deserve special thanks: Dr Arthur Anderson, Annie Anderson, Dr Michaela Binder, Emily Blake, Dr Brian Buchannan, Francesc Conesa, Dr Chris Davis, Michel de Vreeze, Gregory Finkelstein, Gavin Flack, Jenna Flack, Dr Robert Harris, Dr Chris Harrison, Maria Lahtinen, Dr Ophelie Lebrasseur, Ian McKone, Dr Aaron Mills, Dr Alice Mills, Dr Lucy Moorcraft, Marco Nebbia, Thomas Muskett-Ford, Thomas Nelson, Dr Louise Nelson, Dr Rebecca Norris, Dr Jonathan Prior, Rune Rattenborg, Dr Julie Thye, Sofia Turk and Lucy Welch.

In particular I am grateful to Gao Qian and Olivia Stanca who both, in different ways, made the experience more fun when it was good, and more bearable when it was not. I am especially indebted to Marisa Plater, whose support, kindness, friendship, and immense patience was unfailing to the end.

Lastly out of my colleagues and friends, I would like to thank David, Ann, Tristan and Aurelia Clinnick. The kindness they have shown me is beyond measure and repay. They kept me going.

I would also like to thank my Aunt Heather who was an inspiration to me growing up. You will be truly missed.

Professionally, I am grateful to Dr Sarah Wurz, Dr Adrian Evans and Dr Ana Belen Marìn-Arroyo for kindly sharing research that was either unpublished or in press with me, Karl Lee and especially David Clinnick for providing helpful discussion, Simon Baker and Marisa Plater for her assistance in compiling the final document. I would also like to thank Dr Christopher Welander for inspiring me to begin learning archaeology, and Dr Tom Moore for inspiring me to continue learning. I am thankful to the AHRC for funding my research and I am of course, above all, hugely grateful for the support, guidance and patience of my supervisors Professor Peter Rowley-Conwy and Professor Mark White who enabled me to conduct this research.

Finally, whatever words I write could not approach the thanks my parents deserve.
This thesis is for them.

1 Introduction

Microliths are small, deliberately made cutting implements, almost universally understood to have been hafted as elements of multi-component tools (Burdukiewicz 2005). Archaeological evidence suggests that these small stone insets may have served in a number of capacities (Torrence 2002), but the popular view maintained by many researchers (Elston and Kuhn 2002), combined with the majority of evidence relating to their function suggests that their main use was most often as armatures for hunting weaponry. In this capacity, they are usually envisioned as functioning as projectile tips, laterally hafted cutting edges, and barbs designed to further damage or secure the projectile upon impact. Industries considered to be microlithic have been recovered from around the world, and this trend appears to have been a widespread technological adaptation at various times throughout the late Pleistocene and early Holocene.

Their small size means that they are often regarded as synonymous with projectile technology, i.e. hunting weaponry that is thrown or launched as opposed to a thrusting spear. While hand thrown weaponry has not been readily encountered in recent ethnographic surveys (Churchill 1993), it is generally believed that microlithic armatures were likely components of atlatl / spear-thrown darts, or bow and arrow weapon designs. The stone armatures sometimes used to equip the shafts of these weapon systems, often made from wood, bone or antler, are often the only components that preserve archaeologically, although notable exceptions to this rule from areas with fortuitous conditions for organic preservation do exist (e.g. Hare et al. 2004; Larsson and Sjöström 2011). Unfortunately, efforts to distinguish weapon delivery systems from these armatures have proved unsuccessful (Nuzhnyi 1990; Dockall 1997; Cattelain 1997) or remain largely inferential (Shea 2006) rather than observable or quantifiable.

Projectile weapon systems allow hunters to target their prey from a distance, and it is assumed that different weapon-systems would be suited to different hunting strategies (Churchill 1993). Indeed, while the efficacy of the tool-kit is of undoubted concern, it has long been recognised that knowledge of prey behaviour is often the more important consideration for many hunters (Laughlin 1968). Nevertheless, it may be expected that archaeologically observable changes in hunting weaponry may have also entailed a shift in the general strategies employed by their users (Churchill 1993), which in turn may be reflected by changes in their subsistence economy.

1.1 Aims

Despite the fact that microlithic industries have been identified on nearly every continent, and have received attention from a wide variety of researchers, the advantages they offer as a technological adaptation remain poorly understood. Until the development and implementation of more modern, rigorous methods of excavation and recording, microliths were relatively neglected. Sometimes occurring in overwhelmingly large quantities, many assemblages have been inadequately quantified or detailed, with investigative attention focussing on more visually diagnostic forms. Attitudes have substantially improved with the potential significance of these pieces being better appreciated in recent years. It is clear from surveying the geographically and chronologically disparate archaeological instances of this technology that the term microlith encompasses a significant amount of variability. A volume compiled and edited by Elston and Kuhn (2002) showcases this fact through a collection of regionally focussed articles providing overviews and details of themed investigations by a variety of archaeologists who may be considered authorities on their respective periods and regions. The variability highlighted throughout this volume suggests that if the term *microlith* is to mean anything more than a superficial descriptor used as a generalisation, then research must further attempt to target what commonalities and differences are apparent in these different regional characterisations.

With only a few exceptions (Torrence 2002; Hiscock et al. 2011), the value of cross-examining regional variability in microlithic technology, and more specifically the circumstances surrounding its adoption and use, remains surprisingly under-explored. In summarising the directions best advocated by the various contributions to Elston and Kuhn’s volume, Robin Torrence suggests that observing variations in the occurrence of behaviours through time is important for understanding how microlithic technology may have represented a common response in different historical trajectories (Torrence 2002, 182). A common approach used by archaeologists is to monitor changes in faunal and environmental data and see how they relate to changes in technology in order to assess whether these changes relate to functional adaptation or rather some other cause (Ibid 2002, 183; Burdukiewicz 2005, 348).

This thesis seeks to redress this issue by cross-examining archaeological variability associated with microlithic technology in three longitudinally, latitudinally and chronologically distinct traditions. These regional traditions include the final Upper Palaeolithic of Cantabrian Spain, the Howieson’s Poort of Southern Africa, and the earliest occupants of Interior Alaska during the terminal Pleistocene / Holocene transition. The evidence examined broadly comprise technological, faunal, and palaeoenvironmental datasets. In comparing and contrasting regional variability, this investigation ultimately aims to address whether a common or series of common explanations may be invoked for the selection of microlith based hunting technology in different times and places throughout human history.

This may be summarised as an attempt to relate macroscale interpretations of technological strategies (Torrence 2001) to specific archaeological examples. To achieve this end, the ultimate aim of the thesis entails two secondary aims. Firstly, as the nature and timing of changes in technological, faunal and environmental data is of primary concern, it will be possible to assess the extent to which a coherent pattern of archaeological variability associated with the selection of microlithic technology may be established for each individual study area. Secondly, through assessing these patterns of regional variability and the fertility of cross-regional comparison, this thesis will help illustrate some of the value and shortcomings of attempting to compare archaeological data in this manner.

1.2 Research Design

The study areas chosen for this investigation were selected for a number of reasons. Firstly, they represent locations from a broad longitudinal and latitudinal range that is truly transcontinental in scope (Figure 1). Secondly, while two of the case-studies overlap chronologically, the time-spans encompass broadly different periods. Thirdly, with the nature of the data gathered for each site entirely dependent upon existent research, regions were picked where the archaeological techno-complexes associated with microlithic assemblages have been well documented, and are accompanied by some combination of faunal and environmental data.

Two of the case-studies, Cantabria and South Africa, afforded an archaeological record with “type-sites” that could be utilised in the construction of diagrams comparing variation in multiple strands of archaeological evidence over time. These sites, deemed to be of substantial influence in the broader prehistory of their respective regions, formed the centre of my assessment. With the deep chronology afforded by their stratigraphy, I was able to broadly assess data from other sites with more piecemeal investigations or less extensive stratigraphy. The type site for Cantabrian Spain was La Riera, and Klasies River for Southern Africa. Among the Interior Alaskan sites, Dry Creek is often regarded as a type-site for the Denali, but because the region is characterised by open air sites rather than the deeper cave and rockshelter deposits of Cantabria and Southern Africa, an alternative diagram catered to the breadth of multiple chronologically overlapping sites was adapted.

The section on Cantabrian Spain, and particularly La Riera, is afforded a preamble as it was the first site investigated, acting as something of a pilot study. Likewise, the section on Interior Alaska starts with an introductory prelude due to the restructuration of the design format as a result of the substantially different nature of the archaeological record. The structure of each case-study area varies according to the nature of the data available: the Southern African sites were arguably most similar, a small number of sites, all with relatively detailed excavation reports. This meant that investigation of Sibudu and Diepkloof followed a similar, if truncated and less detailed pattern, to that of Klasies River. The Cantabrian sites were more piecemeal in nature regarding the extent and nature of published details, excavation data, and time-period spanned in the site’s archaeology. Information from the Interior Alaskan sites was generally more regular, but invariably less detailed than sites from the other case-study areas with larger individual representations of chrono-stratigraphy.

Figure 1: World Map with Case Study Areas Shown in Red

The chronological span of the sites included for investigation is intended to provide a window of time within which variation in microlithic technology will be apparent, along with known climatic fluctuations that likely impacted upon local environment and faunal populations. The sites from Cantabrian Spain span the end of the Late Glacial Maximum through to the Younger Dryas (c. 20kya – 10kya). Microlithic assemblages at two of the sites from Southern Africa likely pertain to either the end of OIS 4 or the beginning of OIS 3 with various estimates broadly falling between 70 and 55 kya (Tribolo et al. 2005). The third site, Diepkloof Rockshelter, has a more extensive and older Howieson's Poort sequence that extends through OIS 4, stretching as far back as the later OIS 5 sub-stages (Tribolo et al. 2013). The earliest occupation of Alaska meanwhile spans the Pleistocene / Holocene transition, including the Younger Dryas (c. 13,000-8000 kya).

The geographical area for each case-study varies according to the resolution of sites. Cantabrian Spain is a naturally confined ecological niche, much of it surrounded by various mountain ranges and bordering the sea to the north. Six sites are included alongside La Riera that occupy various positions within the landscape and add, in various ways, to the wealth of information gathered from the type site. The Howieson's Poort case-study covers a substantially larger area and includes a small number of sites due to the poor geographically discrete resolution of archaeological sites from this period. The small number of sites compensate by spanning the known geographical extent of the phenomenon and each providing deeply stratified deposits with a good breadth and depth of archaeological data. The area delimited for Interior Alaska is dictated by the location of the earliest well dated sites with good stratigraphic integrity. The number of sites utilised for this case-study is higher than the others due to the lack of a clear type site with continuous stratigraphy and the fact that generally less information has been made available. These sites mostly occupy lowland floodplain promontories or foothill settings (Hoffecker 2001; Holmes 2001).

Faunal and environmental data were selected as the primary datasets for investigation alongside technological variability. These categories of data collection are the most universally understood and undertaken in general prehistoric archaeological investigation. The categorisation of data in this manner reflected the desire to consider the selection of microlithic technology from a functional perspective of adaptation, corresponding changes in technology with changes in conditions and results (Torrence 2002, 183). Faunal data is regarded as indicative of subsistence economy, and environmental data indicates changes in the habitat of the site and the prey being hunted, which over time may favour different species or hunting strategies (Rozoy 1989; Bergman 1993; Churchill 1993; Burdukiewicz 2005).

In particular, medium-large prey species (mostly ungulates) were considered as the main economic base. While acknowledging that these species are not always the most important, they are generally the most visible and are believed to account for a significant portion of subsistence focus. Furthermore, ethnographic research has shown that stone-tipped points are nearly always reserved for such prey, with organic armatures preferred for smaller fauna (Ellis 1997). Information regarding the quantification of technological, faunal and environmental data from these sites is integrated where possible, along with considerations of other recorded details and investigations deemed to be pertinent (for example the results of use-wear analyses). Through this approach it is hoped that a broad picture of how change in technology, subsistence and environmental conditions may be reconstructed for each study area.

1.3 Research Context

While a conventional literature review is unnecessary due to the historical grounding provided through the presentation of each of the regional case-studies, it is important to acknowledge and detail some of the other issues of pertinence to the investigation. This section summarises the unique nature of the archaeological periods selected for investigation, considers the question of regionally variable definitions regarding what constitutes a microlith, and finally elaborates upon some of the technological concepts used later in the thesis.

1.3.1 Historical Significance

While there may be many instances when microlithic technology was selected for at times that otherwise appear to be relatively un-notable archaeologically, Kuhn and Elston observe that there are many that coincide with periods of economic, climatic and demographic stress that have come to be seen as defining periods in human history (2002). The three case-studies chosen for this investigation are ideal examples of this. The survival of a hospitable landscape along the Cantabrian Plain was, along with a handful of other glacial refugia, vital for the survival of humans in Europe during the harshest conditions of the LGM (Straus 1991). Throughout this time, the coastal plain of Cantabria likely experienced an increase in population density as people were forced out of much of Europe (Ibid 2000). The Howieson's Poort of Southern Africa is widely regarded as one of the earliest archaeologically visible flourishes of precociously modern appearing material culture that, according to some scholars, may also have represented the beginnings of an early expansion out of Africa (Mellars 2006). The reasons behind it remain mysterious, though climatic stress and upheavals in population demographics have both been suggested (Lombard 2008b; Ambrose and Lorenz 1990). Finally, microblade technology was clearly of great importance to the earliest occupants of Alaska, who presumably faced numerous challenges while colonising new and unexplored territories (Coutouly 2012; Holmes 2011; Hamilton and Goebel 1999). In this light, each of the case-studies selected can be seen to show microlithic technology of varying nature having played an important technological strategy during formative periods of human history.

1.3.2 **Varying Definitions**

While as a concept the "microlith" is understood throughout the world among prehistorians, there is no unified definition of exactly what this technological type constitutes. As a result of this, in a global sense, the term microlith encompasses a variety of forms, criteria and terminology, greatly restricting the operative utlility of the word at such a broad resolution. At best, a microlith may be defined as a deliberately crafted small cutting edge, intended for hafting as part of a composite tool (Andrefsky 2005, 258; Torrence 2002, 181). Although standards and definitions of microlithic technology may be established within regionally insular research discourses as clearly evidenced by the multiple contributions in Elston and Kuhn's volume (2002), reconciling the various incompatibilities that arise from these necessarily specific research traditions may be problematic (Torrence 2002).

1.3.2.1 Form

Microliths may be differentiated from flakes by being made with a specific utility (almost universally assumed to involve hafting) and design in mind. Consequently, microliths are most often, although not exclusively (Ambrose 2002, 10), created using techniques of blade production (Kuhn and Elston 2002, 2). Through retouch it is possible to sharpen and blunt edges. Blunting of edges is usually referred to as backing and is almost universally assumed to be intended to facilitate hafting, though this is clearly not a necessary condition in all traditions. Retouch and snapping techniques also allows the shaping of a number of forms from these blanks (Bordaz 1971), most commonly rectangular (i.e. a more regular version of the basic blank form), crescent, trapezoidal and triangular. From these forms a number of regionally specific sub-variants may in turn be crafted, although the point at which variation in form transcends functional significance is the subject of debate (Rozoy 1989; Wadley and Mohapi 2008).

1.3.2.2 Terminology

In describing microlithic assemblages, a variety of different words may be used to describe similar forms. A good example of this relevant to the assessment of the Howieson’s Poort is the use of crescent and lunate segments to refer to the same type. Microlithic traditions that are dominated by particular types may not be identified as microliths *per se* but rather as the specific forms that dominate. Most commonly, in cases where pieces are not described as microliths, they are referred to as bladelets or microblades. Both “bladelet” and “microblade” refers to pieces that retain the basic laminar form of a blade/bladelet blank. “Microblade” is more commonly used in Asia and North America, while “bladelet” is more common in European and African writing. These terms are not necessarily interchangeable with one another though, as their appropriation is often inextricably tied to the regionally specific traits of the types they refer to. For example, Alaskan microblades are deemed to be created with a degree of standardisation that distinguishes them from bladelets (Wygal 2011), whereas in the Howieson’s Poort, Wurz advocates the distinction of bladelets from similar, earlier MSA forms on the grounds that they are made to be more standardised (Wurz 1999).

1.3.2.3 Criteria

Although microliths are universally understood as being small, there are no universally accepted criteria as to how small a piece must be in order to qualify as microlithic. A popular rule regarding the classification of bladelet and microblade pieces, indeed all blades microlithic or otherwise, is that their width measurement should not exceed that of half their length, though this statement is by no means rigidly adhered to. Quantifying length is problematic among bladelet and microblade assemblages due to issues relating to breakage and establishing a meaningful cut-off distinction between regular blades and their microlithic variant forms (Kaufman 1986). Various regionally specific criteria for size exist, with many of them surmised by Brown et al. (2012, 4 SOM). Many of the geometric backed pieces of the Howieson's Poort would be considered, strictly speaking, too large to qualify as microliths elsewhere. For the purposes of this study, the form and supposed function is attributed greater significance, and so all such pieces are indeed considered microlithic. Size is obviously a relative quality (Kuhn and Elston 2002), indeed some researchers even suggest that the use of such criteria for defining pieces as microlithic may be undesirable (Kuhn 2002, 84), or at least insignificant (Burdukiewicz 2005, 348).

1.3.2.4 Sample Variability

The microlithic traditions examined in this investigation include a variety of different types. For each study area there is one particular form that dominates. Research on microliths from Upper Palaeolithic assemblages from Cantabria mainly focus upon backed bladelets (Straus 2005) although a variety of variant forms, unretouched bladelets, and even occasional geometric pieces, have also been documented among these assemblages. The Howieson's Poort of the Southern African Middle Stone Age is characterised by geometric backed pieces, usually in the form of crescent and trapeze shapes along with other truncated variants (Ambrose 2002). In addition to these type-fossils, unretouched pieces sometimes referred to as bladelets or flake-blades are also found in the Howieson's Poort and other MSA deposits (Thackeray 1992). Unlike Cantabrian Spain and Southern Africa, where retouched forms have traditionally been the overwhelming focus of interest, microlithic assemblages from Alaska comprise almost exclusively unretouched microblades (Dixon 1985; 2011). Figure 2 compares examples of these pieces from the "type sites" of La Riera, Klasies River and Dry Creek.

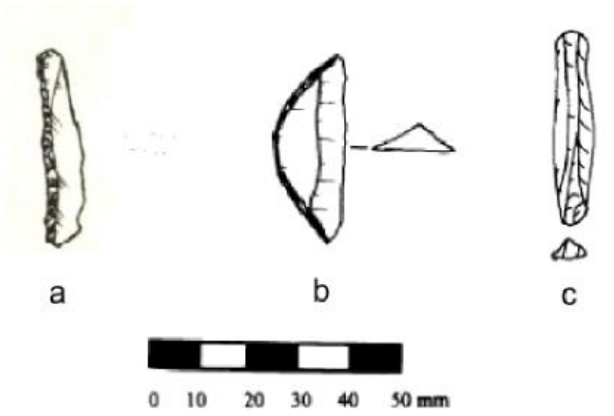


Figure 2 Characteristic Microlith Types from each Case Study Area: A = Backed Bladelet (La Riera), B = Backed Crescent (Klasies River), C = Microblade (Dry Creek)

1.3.3 Technological Concepts

Since Lewis Binford popularised such approaches in the 1970's with his model of technological organisation based around curated and expedient designs (Binford 1979), a variety of other means by which technological strategies and the factors that shape these strategies may be conceptualised have been developed through an extensive body of literature (Oswalt 1973; Winterhalder 1981; Torrence 1983; 1989a; Bleed 1986; 1997; Bamforth 1986; Bamforth and Bleed 1997; Shott 1986; 1996; Parry and Kelly 1987; Nelson 1991; 1997; Churchill 1993). These concepts are designed at a macroscale level (Torrence 2001) to facilitate the discussion and comparison of different technological strategies relative to particular concerns and stresses. Among the most important of these models for researchers interested in understanding variability in hunting technology are those that focus upon costs such as time, energy, and risk, and how these stresses may be conceptualised as a system that relates to the archaeological record (Winterhalder 1981; Torrence 1983; 1989b; Bousman 1993; Bleed 1996; 2002; Fitzhugh 2001; Bamforth and Bleed 1997; Elston and Brantingham 2002). Of particular interest are values attributed to different designs including reliability, maintainability and flexibility/versatility (Bleed 1986; Shott 1986; Nelson 1991) as briefly outlined below:

Reliability: Overdesigned with carefully fitted parts to reduce risk of failure, requiring specialist knowledge for creation and maintenance (Bleed 1986).

Maintainability: Light, portable, modular design that can be readily maintained during use and generally easily repaired (Bleed 1986).

Flexibility/Versatility: Flexibility is regarded as a variety of uses enabled by a changeable form, whereas versatility allows for this adaptability without the requirement of change (Nelson 1991).

1.3.4 **The Value of Use-wear Investigations**

It has been suggested that researchers concerned with the function of microlithic assemblages should invest more greatly in use-wear analyses (Torrence 2002). Indeed, the application of these approaches to microlithic assemblages has generally been lacking (Evans 2009, 252), but they have recently been applied to Howieson's Poort materials, producing provocative results (Lombard 2011). Use-wear analyses clearly do hold great potential for any technological analyst, but I believe that there are a number of problems with these studies which have actually distorted the image many archaeologists now have regarding the functional properties of microlithic pieces. The results of various use-wear investigations that have been conducted form important considerations in my own work, but before beginning my data assessment, I have decided to elaborate on my views regarding interpretations of use-wear data, and in doing so justify why this route of analysis was not considered a viable method for my own investigation.

2 Discussion of Use-Wear Analyses and Interpretive Biases

Of all the analytical techniques developed over the last half a century for investigating functionality in stone tools, microwear analysis has had arguably the greatest impact upon lithic research. The study of stone tools for evidences of wear relating to use has an extensive history (Olausson 1980; Donahue 1994; Van Gijn 2014), but microwear studies, the use of microscopy to detect fractures, marks, abrasions, polishes and other visible evidences otherwise imperceptible to the naked eye, is a relatively young analytical procedure. Since the translation of Semenov's seminal work (1964) into English and the early development and popularisation of the technique among Anglo-American scholars by the likes of Lawrence Keeley (1980) and George Odell (1980) among others, microwear has divided opinion in the lithics research community. One of the biggest attractions of microwear as an investigative method is the ability to test assumptions of morphological form in relation to ideas of use, with the former often the single biggest influencing factor in the determination of the latter (Odell 1981).

2.1 Methodological Issues

Using different levels of magnification, microwear can be used to infer different details about the use-life of prehistoric tools, most commonly the materials they interacted or "worked" with, and the motion or manner of their application. The use of replicated experimental data as a comparative analogue for archaeological specimens is a central premise of all microwear analyses and blind testing is commonly used in efforts to eliminate observer bias when using comparative analogue data. Although the impact of microwear analyses on lithic research has undoubtedly been huge (Andrefsky 2005, 5), there remain a number of problems with these approaches.

There has been much debate over various methodological issues which have called the reliability of microwear studies into question, perhaps most notably with regard to the high magnification method pioneered by Lawrence Keeley (Newcomer et al. 1986; Newcomer et al. 1988; Hurcombe 1988; Moss 1987; Bamforth 1988; Bamforth et al. 1990). Through disputing methodological efficacy, the validity of the results from such analyses has also been thrown into question, contributing to the somewhat muted reception that microwear studies have received in the wider field of lithic research. Nevertheless, efforts to develop and refine methods in response to criticism have continued (Ibáñez and González 2003) and new analytical techniques have been formulated (e.g. Evans and Donahue 2008). Arguably the largest problem that continues to face analysts is the subjectivity of their investigations (Grace et al. 1985).

A substantial body of literature now exists on the methodological quandaries of the analytical techniques used in microwear investigations (see Evans et al. (2014a; b) and Van Gijn (2014) for further references in addition to those given throughout). Variability in raw materials, post-depositional alteration and the replicability of polish signatures are just some key examples of ongoing concerns that microwear analysts continue to face (Andrefsky 2005, 6; Evans et al. 2014a; Van Gijn 2014). The importance of blind-testing as a control for bias and ultimately credibility remains something of an agenda for microwear specialists (Evans 2014), as do continued calls for closer engagement with ethnographic data sets, the interpretive value of which has been stressed throughout the development of the technique (Olausson 1980; Ibáñez and González 2003; Rots and Williamson 2004; Van Gijn 2014).

2.2 Interpretive Biases

Ethnographic datasets allow microwear specialists to consider elements of technological systems that are often not preserved archaeologically, acknowledging that often their results are restricted to singular tool components rather than the whole tool itself. Thus the use of ethnographic information serves as one of the most apparent means by which archaeologists may facilitate a more elaborate theorisation of different tool-kits. It is in this manner, through consideration of different technological systems (e.g. Macdonald 2010, 24), that most microwear studies are now conducted. The benefits of adopting such an approach lies in the ability to potentially infer greater detail regarding the origin of indentified wears, and exercise greater caution through awareness of how variability in the life-history of a tool may influence the data from which we draw our interpretations of function.

It is perhaps surprising then, given the wealth and variety of archaeological literature dedicated to the use of microliths, that relatively little in the way of functional analyses have been conducted until quite recently (Evans 2009, 252). Accordingly, detailed theorisation of the tool to accompany such work has remained relatively modest. The ubiquity with which microliths occur across time and space throughout prehistory renders the invocation of specific ethnographic datasets problematic when informing archaeological interpretation. There is, however, a need to explicitly theorise, even if only generically, about possible explanatory factors behind observed evidences of wear. With regards to investigations concerning the function of microliths, there are two areas where our understanding of results may be bettered through such theorising.

1) Explaining why a significant proportion (in many cases a majority) of the analysed sample population are found to have wear resulting from indeterminable action, or no wear at all.

2) Explaining why some types of use are not well represented due to biases in the generation of identifiable wears. This issue can be of particular concern in assemblages where a large number of pieces are examined only to find functionally indeterminable wears, or an altogether absence of traces, as it may explain why so much of the assemblage is left unaccounted for.

Various tests have demonstrated that some tool-functions are rendered invisible through the lack of indelible trace (Newcomer, Grace, and Unger-Hamilton 1986). While such results may reflect a surplus to requirement in the production or caching of tool components, it is important to consider how certain aspects of technological systems may conspire with limitations in methodology to prevent the formation of identifiable wears. As an example of this, an overview of data compiled from microwear analyses conducted on microlithic assemblages from Mesolithic sites across the UK is presented below.

2.3 Review of Microwear Studies Conducted on UK Microliths

Data from microwear studies conducted on microliths from Mesolithic sites in the UK, has been synthesised by Adrian Evans (2009). At the time of collation, and including his own work, it is apparent that out of 852 microlithic pieces (microliths and fragments of microliths), only 212 have yielded wear patterns sufficient for determining function (Ibid 2009, 50; 221). This means that less than 25% of all microliths examined from Mesolithic sites across the UK have yielded positive results. While it should be stressed that this success rate is not universal (see for example Keeley 1988 as discussed later), it is also not restricted to UK based investigations (e.g. Crombé et al. 2001, 265). Deriving statements from amalgamated datasets in this fashion is problematic, but three of the constituent studies are highlighted for closer review. Separated by approximately ten years each, these particular investigations could be considered, for various reasons, to be the most notable to be conducted thus far in the UK. The studies focus on materials from the sites of Star Carr, North Yorkshire (Dumont 1988), Gleann Mor and Bolsay Farm, Southern Hebrides (Finlayson and Mithen 2000; 1997), and the sites of East Barns, North Park Farm, Runnymede Bridge and Malham Tarn Site A, located throughout the UK (Evans 2009).

From Dumont's study, the sample population, and certainly the number of microliths upon which evidences of use-wear were detected, was deemed prohibitively small for an effective functional interpretation. The investigations conducted on Bolsay Farm and Gleann Mor concluded that microliths likely served a variety of functions. Noting the scarcity of traces pertaining to use in projectile weaponry (Finlayson and Mithen 2000), it was suggested that plant processing technologies were likely the main function (Finlayson and Mithen 1997, 123) as advocated by Clarke (1976). Lastly, Evans' research, which, among other aims, sought to test for inter-site variability in function, identified wear relating to a variety of uses, although the majority of cases, certainly among smaller pieces, were suggestive of use in projectile weaponry (2009).

Out of thirty-one microliths and microlithic fragments examined from Star Carr, only 3 returned positive results, and only 1 bore traces that were suggested as pertaining to use (Dumont 1988, 120–121). From a sample of 120 microliths and microlithic fragments from Gleann Mor, 46 returned positive results, of which 33 exhibited sufficient wear to suggest function (Finlayson and Mithen 1997, 119). A sample of 101 microlithic pieces from Bolsay Farm yielded 37 where evidence was sufficient enough to suggest function (Finlayson and Mithen 2000). Finally, from the four sites of East Barns, North Park Farm, Runnymede Bridge and Malham Tarn Site A collectively, 62 out of 238 microliths and microlithic fragments bore evidence of use-wear that could be used to interpret function (Evans 2009, 221). The percentage of each respective sample population to yield results from which function could be determined is presented in Table 1. The highest frequency with which the determination of function through microwear analysis was achieved was around 36% of the sample population, recorded at Bolsay Farm and Runnymede Bridge.

Investigators	Sites	Study Sample	Determinable Function (DF)	DF % of Sample
Dumont (1988)	Star Carr	31	1	3.2
Finlayson & Mithen (1997; 2000)	Gleann Mor	120	33	27.5
	Bolsay Farm	101	37	36.6
Evans (2009)	East Barns	48	17	35.4
	North Park Farm	98	24	24.5
	Runnymede Bridge	25	9	36.0
	Malham Tarn Site A	67	15	22.4

Table 1: Results from three selected microwear analyses of microliths from mesolithic sites in the UK

It is clear from the description of the results from these studies that with some regularity, the analysts are unable to provide functional interpretations for substantial portions of the analysed assemblages. This trend is not restricted to materials or studies based within the UK. Another notable and relatively recent study directed at Mesolithic microliths from the site of Verrebroek in Belgium found similarly high frequencies of pieces bearing no evidence of wear among their sample population (Crombé et al. 2001, 265). It should also be stressed, however, that these results are by no means true for all cases in which microlithic pieces have been examined. Lawrence Keeley’s consideration of backed bladelets, considered in the section dealing with Cantabrian Spain, found a high frequency (82-90%) to bear traces pertaining to projectile use (1988, 22).

2.4 Identification of Functional Traces on Projectile Armatures

So far, discussion has focussed exclusively upon microwear studies, as it is this particular analytical approach that has received the most scrutiny from the lithics researchers. The establishment of microwear approaches has paved the way for the development of other microscopy based analytical techniques. Micro-residue analyses offer an alternative assessment of function. The early development of these techniques was also plagued by methodological troubles, and for a time, contradicting requirements in preparatory procedures meant that microwear and micro-residue analyses seemed incompatible with one another (Cattaneo et al. 1993; Cattaneo et al. 1994). Advancements in the field have delivered promising results however, as evidenced by recent work by Marlize Lombard and others (Lombard and Wadley 2009), considered in greater detail in the Howieson's Poort Section. A notable limitation of residue analyses remains the inability to infer action from these analyses.

As well as complementary techniques, allowing further cross-testing of function through multi-faceted approaches, speciality sub-fields have developed. Most notably, in regard to the identification of projectile armatures, has been the development of micro-fracture analysis, examining particular wears and breakage patterns. Some of these fractures and wears are considered diagnostic and exclusive to projectile use (Fischer et al. 1984; Dockall 1997).

2.5 Biases against the formation of wears from projectile use

Rather than speculating openly regarding the full range of activities in which microliths may have been used without resultant use-wear formation, the next section focuses specifically on theorising their life-history in their commonly assumed role as projectile armatures. Through exploring various factors in this possible use-life, reasons for diminished representation will be clarified. This will be done through considering a number of factors including discussion of the method of delivery, nature of the hafting, nature of penetration, the frequency of use and re-use, the impact of use-related breakage on re-use, the possibility of multifunctional uses obscuring projectile related wears, and factors that may influence representation of pieces used in this manner within the archaeological record. There are two main reasons for considering these issues in greater detail.

Firstly, and perhaps because of the relative lack of functional analyses directed towards microliths, there has been inadequate discussion of biases at work in the formation and representation of certain use related wears, particularly those pertaining to projectile use. The issues considered below highlight limitations within microscopy based studies of function that have been insufficiently discussed in the evaluation of data production.

Secondly, while the supposition that microliths indeed served primarily as projectile armatures in the majority of cases prevails overall (Torrence 2002, 181), a number of functional studies have called these assumptions into question (e.g. Finlayson and Mithen 1997; Finlayson and Mithen 2000; Hardy and Svoboda 2009). It is not the intention of this work to rebut specific cases where hypotheses of projectile weaponry have been rejected, merely to identify reasons as to why additional characterisations of the study material are necessary before forming such conclusions. Indeed such a statement is true of most all archaeological approaches when treated independently. I am inclined to agree with Torrence's assessment (2002) that in many cases microliths may well have served an array of purposes in addition to or instead of their widely assumed default function as projectile armatures. I feel that appropriate consideration of the issues discussed below may offer a more critically reflexive approach to the interpretations we draw from use-wear studies, particularly when based upon sample populations for which considerable portions remain functionally unaccountable.

2.5.1 **Projectile Polishes and Fractures**

Tests have shown that polishes generated from contact with meat form only rarely (Newcomer et al. 1986). The short length of time with which projectile armatures are in contact with meat potentially further lessens the likelihood of creating any diagnostic polishes. It is also often difficult to differentiate between tools used for cutting meat, and those used in weaponry from these polishes alone, resulting in assumptions regarding tool morphology being factored into interpretation (Newcomer et al. 1986, 207). A more reliable indicator of use as projectile weaponry is damaged incurred from impact. Fractures and breakages are induced at the moment of impact or when subjected to stress subsequent to impact. Wears may form from the abrasive contact of chipped stone upon the main armature during and after breakage. The hardness of the struck material and angle of impact are crucial in the determining the nature of these traces. Several diagnostic and even exclusive wears and fracture patterns can be identified from such impacts. Many of these have been documented and loosely categorised by John Dockall (1997).

2.5.2 **Method of Delivery**

The matter of identifying delivery methods utilised in hunting strategies remains problematic for archaeologists, as already discussed. Unfortunately, attempts to differentiate between hand-delivered spears, spear-thrower projectiles and the bow and arrow have not been met with success (Cattelain 1997). It remains difficult in many cases to differentiate between these and fracture patterns associated with thrusting spears (Dockall 1997, 328). Through using several complementary approaches in combination with other circumstantial evidence, some analysts have felt suitably vindicated in their assessments of delivery method (Lombard 2011; see also Mohapi 2008), although concede that their suppositions remain, at this stage, impossible to verify. Consequently, such assertiveness has not escaped without cautionary responses (Villa et al. 2010, 640; Villa and Roebroeks 2014 SOM). Comparison of the rates of wear and trace formation in different delivery mechanisms is problematic due to the wide number of variables that must be accounted for, including the design of the projectile itself.

2.5.3 **Tips, Barbs and Cutting Insets**

In designs of projectile weaponry, microliths most likely served one of three roles: as either the tip of the weapon, as a laterally hafted barb, or as a laterally hafted cutting inset designed to enlarge the wound (Friis-Hansen 1990) (but not necessarily to catch and hold within the flesh). While traces generated by barbs and cutting insets have been investigated, the majority of attention has focussed upon weapon tips, perhaps because this constitutes a far more ubiquitous design feature. Bearing the brunt of immediate impact, it is unsurprising that damage sustained by projectile tips can be quite different to that generated on barbs and cutting insets. Broadly speaking, from a functional perspective, barbs are assumed as intended to catch within the flesh once penetrated, and/or maximise the damage of the initial impact by further tearing the wound both upon entry and subsequent struggle once lodged inside the prey, causing further laceration in the event of any breakages incurred (Crombé et al. 2001). Laterally hafted elements may also serve to shred flesh upon entry rather than to hook the projectile in place. This theory has been deemed as particularly plausible but overlooked in the case of Upper Palaeolithic bladelets (Pétillon 2008, 67), although barbing and shredding need not be seen as mutually exclusive functions.

2.5.4 **Nature of Hafting**

Microliths have the potential to be hafted in a variety of designs. Different configurations may affect the chances and nature of any wears (macro and microscopic). Different weapon designs, and particularly different delivery methods, may be characterised by different approaches with regards to the quantity, positioning (both upon the shaft and the angle at which they are inset) and method of hafting. For example, while some arrows have been characterised as having laterally hafted barbs (see Yaroshevich et al. 2010; Chesnaux 2008; Bergman 1993 among others for examples), larger series of multiple insets are usually only hypothesised for spears. The positioning of the microlith, whether laterally upon the shaft, or as the tip of the projectile, may relate to intended aerodynamics, the desired effect upon prey, as documented recently in experiments by Yaroshevich et al. (2010), as well as stylistic preferences (Blankholm 1990). Hafting position may be influenced by the type of microlith as well as the hafting method used, with particular morphologies intended for specific design configurations (Pétillon et al. 2011, 1279). Figure 3 shows a variety of hafting positions for microliths as weapon tips and barbs as envisioned from the Epipalaeolithic of the Levant (Yaroshevich et al. 2010). The extent to which elements inserted within the shaft and mastic (or other hafting facility) will limit the area upon which any use-related wear or damage may form from impact.

Figure 3: Variety of Epipalaeolithic Levantine type microliths shown in an array of hafting configurations. Original Photograph from Yaroshevich et al. (2010)

As mentioned above, analysts typically expect different wears to be identified on laterally hafted pieces compared to armature tips. Wears are arguably less likely to form on barbs than tips as they do not bear the brunt of impact in the same manner. The types of striations and fractures associated with projectile use are largely dependent upon the angle at which the armature is hafted and therefore intended to impact. As an example of this, the study of microliths at Gleann Mor (Finlayson and Mithen 1997) has been criticised for utilising a very conservative range in variation for the wears that they deem diagnostic of projectile use. Criteria comparable to that used in other studies may have given a very different interpretation (Evans 2009, 37–38).

2.5.5 <u>Penetration</u>

Assuming a constant force behind the propulsion of the projectile, the hardness of the material being penetrated will affect the likelihood and nature of certain wears and breakages. For example, contact with bone upon impact is likely to induce breakage more than softer tissue. The extent of penetration depends upon a number of variables, including the prey hunted, and the method of delivery. Traditionally, many researchers have held great belief in the penetrative power of the bow and arrow (Friis-Hansen 1990; Bergman 1993), with Jean-Georges Rozoy having once claimed (1989, 19) that a microlith tipped arrow drawn by a bow 1.6m long would be able to pass right through a bear at 50m! Early experiments attested to the penetrative power of the bow and arrow (Fischer et al. 1984; Fischer 1990), although the Brommian points used in the studies would not generally be classified as microlithic.

Recent tests have shown that penetration depth can vary greatly depending upon a number of variables (Chesnaux 2008; Grimaldi 2008; Yaroshevich et al. 2010; Pétillon et al. 2011). Specific details regarding the parameters of the tests (draw weight of the bow, distance from target etc) are given in the respective studies (Chesnaux 2008, 141; Grimaldi 2008, 154). Chesnaux gives estimates regarding arrows shot into the rib cage (14 cm) and back bone (9 cm). The limited penetration recorded in each of these experiments led the investigators to consider the possibility of use in conjunction with poisons administered via the projectiles (Chesnaux 2008), or that such weapons were designed specifically for smaller game where damage potential would be maximised (Grimaldi 2008). Penetration depths recorded by Yaroshevich et al. from arrows fired into a goat carcass varied according to the design of the arrow and particularly the configuration of the tip, with the maximum depth of 22-23cm achieved by arrows tipped with oblique, transversal, and “self” points (those lacking stone tips) (2010, 372). In tests where antler pointed spears, both with and without laterally hafted bladelets as cutting insets, were launched using a spear thrower at two young female deer, it was found that on average those with insets penetrated further (c. 28cm) than those without (c. 15cm).

A penetration depth of 14cm (as recorded by Chesnaux) in the area of the rib cage would certainly be sufficient in the targeting of many smaller prey species, assuming also that the ribcage itself was penetrated. Larger prey, with larger skeletal structures may pose a greater obstacle to penetration through the resistance of greater bone mass and larger muscle and sinew attachments, with projectiles potentially either failing to pierce the rib cage or reach the ribs at all. Penetration of the rib cage is necessary to target many (although not all) vital organs for a fatal blow (Friis-Hansen 1990). Experimental research into the extent and nature of projectile penetration utilising microlithic armatures in this manner has generally been lacking, with most of the few studies that have been conducted focussed upon the bow and arrow as a delivery mechanism. The behaviour of projectiles at the moment of impact and once embedded within the target not only affects the likelihood of wear, polish and fracture formation, it also influences the chances of re-use and archaeological visibility. These concerns relate to incidents of breakage and detachment caused from impact and stresses from subsequent embedment within the prey.

2.5.6 **Effect upon Impact**

Projectile design, and particularly the type of tip and hafting of any barbs or shredding implements, may reflect the intentions of the hunter with regards to the nature of the impact. Experimental replication of bow and arrow hunting conducted by Crombè et al. have shown how Mesolithic hunters at the site of Verrebroek (Belgium) illustrate two types of breakage that must be considered (2001). The arrow tips themselves suffer impact damage leaving macro and microscopic traces. Most of the barbs used in these experiments became detached once embedded within the target carcass, most likely due to the manner in which they were hafted using resin mastic, while others came loose upon extraction of the shaft (Ibid 2001). Out of 96 barbs fired, only three exhibited visible damage, and none bore any traces of microscopic linear impact traces or meat polish (Ibid 2001, 260).

It can only be assumed that when subjected to the strains of being embedded in a moving target, the chances of detachment would be even higher. The additional cutting line provided by the penetration of barbs will enlarge the wound, and post-impact breakage, whether of the projectile tip or barb embedded within the target, will certainly maximise damage to the prey (Friis-Hansen 1990; Grimaldi 2008, 158). It is unclear whether these breakages were an intentionally designed strategy on the part of the hunters in question, or whether this occurrence was simply affordable within the economy of manufacturing hunting weaponry. Similar episodes of tip breakage and barb detachment have been documented in other experimental reconstructions of microlith armed bow and arrows (Grimaldi 2008; Chesnaux 2008) and spears (Pétillon et al. 2011) lending credence to suggestions of intentionality, although ethnographic support for such claims remains limited (Ellis 1997).

In Chesnaux's study of Sauveterrian microliths fired into a wild boar carcass, four barbs were hafted laterally, two on each side of the shaft (Figure 4) for forty arrows. Forty arrows were made in total, of which thirty two were fired into the carcass, and the remaining eight fired into the ground. The final location of the 160 (total) barbs is

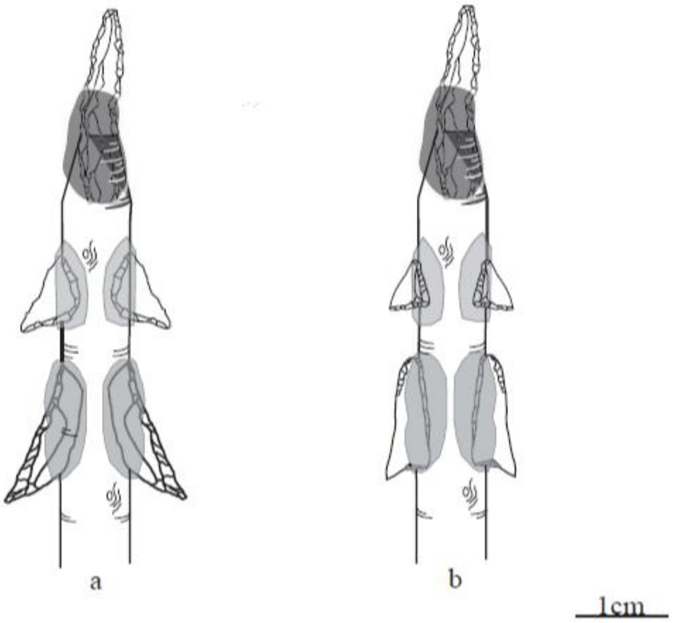


Figure 4: Schematic of Sauvetterian point tipped arrows with laterally hafted crescent segment (a) and triangle segment (b) barbs. From Chesnaux (2008)

detailed in Table 2. The majority of these had become detached, although the final location of these pieces varied; a notable portion had become detached upon impact prior to embedding within the flesh, with similar effects experienced in other experiments featuring laterally hafted insets. As an undesirable result, this effect has been attributed to oversights in design and construction (Pétillon et al. 2011), but the stripping of insets upon impact may have been a legitimate concern even for more professional hunters. Details regarding the final circumstances of the 32 barbs belonging to the 8 arrows fired into the ground were not specified, rendering these results inextricable from those fired into the cadaver. High rates of armature loss were also recorded by Yaroshevich et al. (2010, 384) and Pètillon et al. (2011, 1277–1278).

In the experiments conducted by Crombè et al., arrows were only fired once, with breakage and detachment of armatures occurring during either the impact or process of extraction (2001, 260). Difficulty in extraction was also noted by Chesnaux (2008, 141) and as a cause of armature detachment by Yaroshevich et al. (2010, 379). With such high rates of breakage and detachment, rates of replacement must have been high; only pieces that remained attached to the shaft or, perhaps retrievable from the carcass, and without having sustained irreparable damage would be suitable for re-use. It seems less likely that pieces that ended up on the ground around where the target was shot might be reclaimed unless the hunters were being particularly fastidious. The high rates of damage (particularly in projectile tips) and detachment (particularly in barbs) have several implications for the chances of finding diagnostic wears, polishes and fractures.

Final Location	Triangles	Crescents	Combined	% of total (n=160) barbs
Remained Hafted	26	17	43	27
Found during butchery and consumption	21	25	46	29
Found on the ground	16	13	29	18
Unaccounted for	17	25	42	26

Table 2: Whereabouts of armatures following experimentation. Data from Chesnaux (2008)

2.5.7 Short Use-Life

Microwear polishes are unlikely to form on hunting weaponry such as lithic projectile armatures as the implement is only in contact with the target and in motion for a relatively short period of time. This is the explanation assumed for the lack of wears recorded in experimental studies (Fischer et al. 1984, 28; Fischer 1990, 30). Any chances of these polishes forming, and indeed of any other use-related traces being generated, are greatly decreased by the potentially much shortened use-life of the objects if they require replacing after only a few shots. It is a widespread assumption among many researchers that microliths, in the context of the bow and arrow at least, represent an armature type that is cheap, quick and easy to produce and replace (Rozoy 1989; Zvelebil 1986; Bergman 1993; Yaroshevich et al. 2010; Dusseldorp 2012). Such maintainability is less apparent in other weaponry in which microliths may have been utilised, where greater time and care may have been necessary in the replacement of armatures (Pétillon et al. 2011, 1281). If reparations and replacements were conducted whilst out on the hunt (Zvelebil 1986, 89; Edwards 2007), this further decreases the chances of used materials being deposited at an archaeological site.

If armatures are broken or detached with the expectation of a short use-life, it may be assumed that used pieces are drastically underrepresented in many archaeological assemblages. It has been suggested, again with regards to the bow and arrow, that tips (and presumably other detached components) are lost once shot (Rozoy 1989, 18) unless they remain attached to the shaft and are re-useable. As the majority of projectile weaponry is used outside settlement areas, this further decreases the likelihood of archaeological visibility (Yaroshevich et al. 2010, 372). The high frequency of breakage, detachment and general loss documented in recent experiments involving a number of configurations (Crombé et al. 2001; Grimaldi 2008; Chesnaux 2008; Pétillon et al. 2011) suggests that overall, few pieces sustain damage that can be considered clearly diagnostic of their use *and* become deposited at archaeological sites.

It is generally assumed, relative to other forms of stone tool production, that the manufacture of microliths is relatively cheap and easy, both in terms of material cost and time necessary for production (Rozoy 1989; Zvelebil 1984). This may not always be the case both in terms of the lithic reduction process itself (see Elston and Brantingham 2002 for a detailed example), but also within the greater endeavour of constructing hunting weaponry. For example, while the manufacture of a batch of microliths may, in of itself, require little time, the arrangement of pieces in composite weaponry such as the cutting insets commonly envisioned in Magdalenian hunting equipment may compromise the idea of this being a time-efficient investment (Pétillon et al. 2011, 1281). The ability for microliths themselves to be manufactured in a way that is relatively cheap in terms of labour costs supports the appeal of batch manufacture (Eerkens 1998), particularly for weapon designs in which the armatures are likely to require regular replacement. Such approaches to production may have been further accommodated by the ease and monotony of manufacturing the basic form (Close and Sampson 1998; Close 2002). In cases where these sorts of production methods dominated, it may be likely that a great many microliths and particularly blank forms (without retouch) are manufactured but never used or even finalised for use. These pieces would likely cluster where they were made or become either discarded or stored for potential future use. While their archaeological visibility in such a hypothetical scenario could not be described as over-represented, it could certainly contribute to the obscuration of pieces that were used.

2.5.8 **Multi-functionality**

Finally, the possibility of multiple uses may affect the visibility of wears and damages pertaining to projectile use, particularly considering the biases against formation already established. Despite an influential article by David Clarke (1976) in which it was posited that microliths may have often served as components of various tools other than hunting weaponry, overall prevailing attitudes in many areas maintain this view (Torrence 2002). Perhaps this is true of the majority of cases, but evidence attests to alternative functions in some contexts.

Several studies that have focussed specifically on microwear have contradicted assumptions of use in projectile technology in favour of other activities (e.g. Finlayson and Mithen 1997; Finlayson and Mithen 2000; Hardy and Svoboda 2009). In scenarios where they were utilised for multiple functions however, certain polishes are more likely to form than others, and perhaps masquerade other uses.

A hunting toolkit found in the Levant attests to this sympatric functionality, with lunate/crescent segments commonly associated with projectile weaponry found alongside bladelets hafted in what appears to be a sickle (Edwards 2007). In this case, it seems different microlith designs were used for different purposes, but the premise of multi-functionality remains, and the uniqueness of the find emphasises how difficult it may be in reality to extricate the intended purpose of these artefacts. Beyond scenarios where microliths have been shown to have ranging utility, it remains possible that individual pieces themselves were used for multiple purposes.

Ethnographically recorded multi-functionality in stone spear tips, particularly those hafted in detachable foreshafts, has been documented among a number of peoples, but is much rarer, although not altogether unknown, with arrowheads (Ellis 1997, 54). The small size of microliths might make them less suitable as general cutting implements, and complex composite haftings with lateral barbs might be rendered unwieldy compared to other available implements. In a recent case where arrowheads were documented as serving as cutting implements (Greaves 1997), the pieces were larger lanceolates made of iron. It is assumed that the narrow shafts of arrows are too thin to sustain heavy use (Ellis 1997, 54).

Overall, the multifunctional use of microlithic armatures cannot be ruled out. Analyses of residues on segments from the site of Sibudu have suggested various potential uses within a seemingly homogenous morphological type with, in some cases, varying residues occurring on a single piece (Lombard 2008a). More generally speaking, it is a truism that the potential to haft a small cutting edge in variety of configurations offers a range of possibilities in design, even if projectile weaponry remains the most widespread realisation of this potential.

2.6 Summary

As the above discussion has shown, there are a number of reasons why we should be wary of underrepresentation of projectile weaponry in investigations of function. This may be through no particular fault of the analytical methodologies used, but rather the nature of the evidences being dealt with and the variables of use-life and taphonomy that may affect their archaeological visibility. The behaviour of microlithic armatures both upon and after impact is determined by a number of variables. The types of evidences left from these actions, and the likelihood of their formation also vary accordingly, and do not always conform to what is more broadly considered diagnostic. Furthermore, there is a high chance if used in hunting weaponry, and particularly as armatures for arrows, that many microliths used in this capacity may not be deposited at archaeological sites. Consequently, investigators should be particularly wary of assemblages where large numbers of the sample population appear to have no discernible evidences of use or evidences of an indeterminable nature. While this problem is not limited to microlith assemblages, it does seem particularly prevalent within studies of this morphological type, and the reasons detailed above could sufficiently account for the trend in results.

Unquantifiable interpretive obstacles in the characterisation of microlith use through functional analyses have been insufficiently considered in many previous investigations. Unless these issues can be accounted for, then it is difficult to allay the concerns that may arise with non-critical characterisations of microlith functionality through these methods. While it is desirable that these issues are afforded greater exploration in future assessments, they do not negate the contribution that varying forms of functional analysis offer, but rather stress the need to exercise caution in some areas of interpretation. As these approaches continue to develop, and the importance of experimental and ethnographic data and tighter methodological rigour are better understood, our expectations of the data accordingly, will also be refined. The contribution of such methods, particularly when integrated with other functional and contextual data remains a fruitful area of investigation with the potential to greatly inform our understanding of prehistoric tool use. This contribution is evident both in much of the material that has helped facilitate the above discussion and also in many of the examples included for consideration later in the regional case studies, most notably in the Howieson's Poort of Southern Africa.

3 Final Palaeolithic of Northern Spain (La Riera)

Cantabria in Northern Spain is recognised today as an autonomous community nestled between Asturias, Castile and León and the Basque Country Figure 5. The area seems to have a somewhat more flexible definition archaeologically. "The Cantabrian region", as well as referring to Cantabria *sensu stricto*, may sometimes refer to the broader coastal plain of Northern Spain, which is often subdivided into Asturias to the west, Cantabria (or Santander, the capital of Cantabria) centrally, the two Basque provinces of Vizcaya and Guipuzcoa to the east and sometimes Navarra to the southeast. The area is abutted by the Cantabrian Sea to the north and Cantabrian Mountains to the South. When including the Basque Provinces, the region is sometimes known as Vasco-Cantabria (Straus 2000).

Figure 5: Map showing modern day Cantabria

The high density of late Pleistocene and early Holocene sites in this region has stimulated much research. For example, as of 1985, there were 38 confirmed Solutrean sites (Straus 1992, 97), and over 15 years this number had risen to 52 (Straus 2000, 50). Although the archaeology of the Iberian peninsular extends much further back in antiquity, the unprecedented density of Solutrean sites in Cantabria suggests an explosion of activity at this time, probably a concentration resulting from the area's suitability as a refugium from the worst of the LGM (Jochim 1987; Straus 2000). Today, the area is a part of "Green Spain", a climatic zone defined as temperate and oceanic. The attractiveness of this area probably persisted through time, as archaeological sites from the Mesolithic Asturian are also concentrated here (Straus 2008).

The wealth of sites in Cantabrian Spain continue to attract archaeological attention, and this, combined with the fact that microlithic industries are known to feature throughout this period of prehistory in the region, make the area an ideal focus for my research and a suitable choice as a pilot/first case study. The question of subsistence has proved a major research focus among Cantabrian prehistorians, and this issue has been addressed through narrow focus research and broader regional syntheses of data. While some of these studies have explicitly targeted hunting studies, very few have successfully integrated multiple bodies of evidence, with many studies content to summarise aspects of compartmentalised datasets (Straus 1987; 1993; Arroyo 2009b). The site of La Riera, has proved particularly important in studies of later Cantabrian prehistory. The rich and extensive sequence of the site makes it a suitable referential framework from which to explore the evidence from some other sites, as well as considering the more general regional overviews of Cantabrian prehistory. Following the section on La Riera, other sites in Cantabria with complementary datasets are reviewed. These are: Rascano and El Miron, along with faunal assemblages from La Fragua Cave, and use-wear studies conducted on assemblages from Santa Catalina, Laminak II and Berniollo.

3.1 Introduction to La Riera

Situated at 43º25'31" north latitude, 4º51'25" west of the Madrid Meridian (used prior to the adoption of the Greenwich Meridian) on the narrow coastal plain of eastern Asturias, the prehistoric cave site of La Riera is approximately equidistant between the Cantabrian Sea in the north and Sierra de Cuera coastal mountain range to the south (Straus 1999, 21). Straus and Clark's seminal report (1986a) detailed comprehensive investigation, and integrated their findings with research conducted on contemporary sites, giving La Riera an enduring importance in Cantabrian prehistory.

Figure 6 shows La Riera to the west of the other sites considered. Below are some of the reasons why the site has remained so influential:

- The La Riera stratigraphic sequence spans nearly 14,000 years from the terminal Aurignacian to the early Asturian. Such chronological depth has rarely been paralleled in sites of such antiquity.

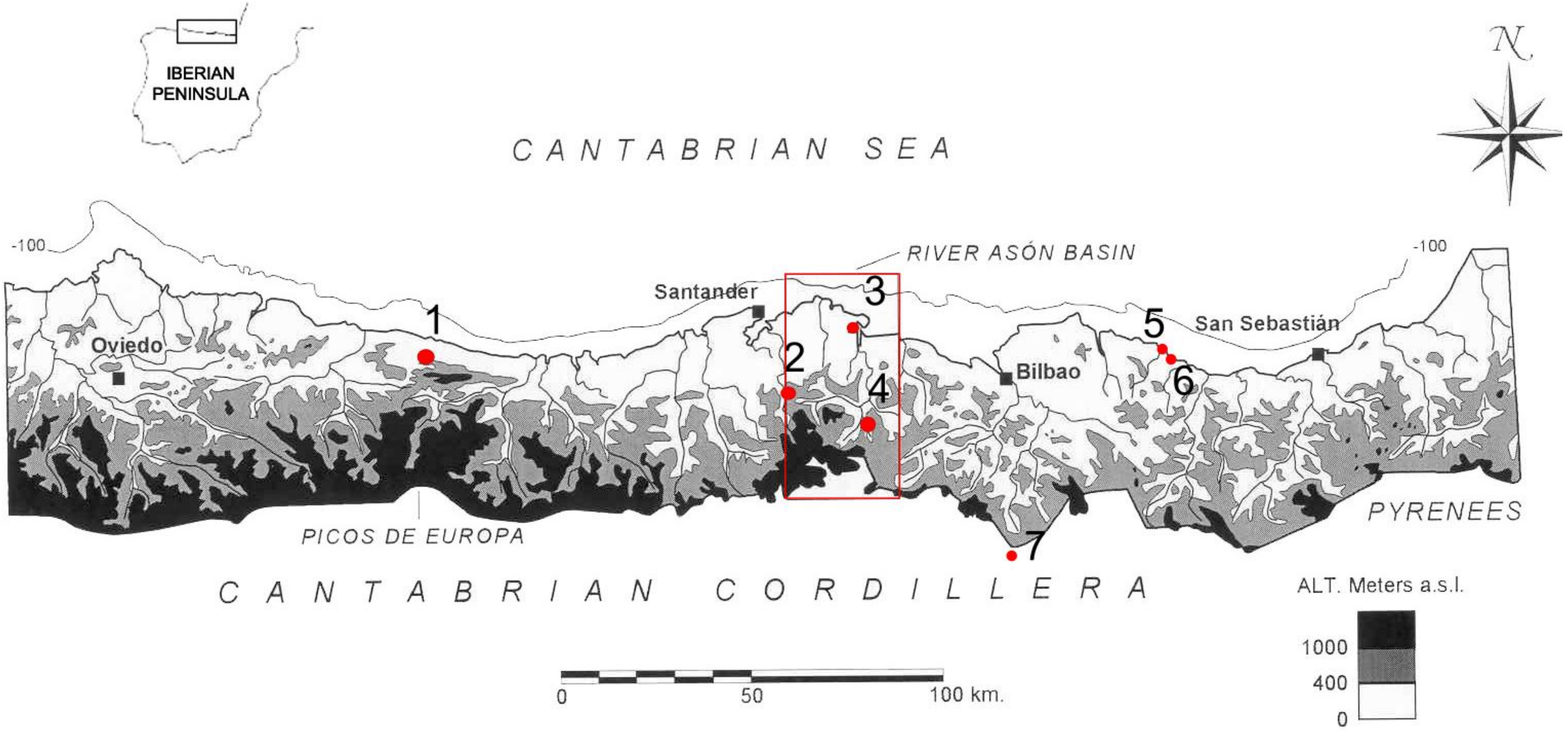


Figure 6: Map showing the 7 sites included for analysis: 1 = La Riera, 2 = Rascano, 3 = La Fragua, 4 = El Miron, 5 = Santa Catalina, 6 = Laminak II, 7 = Berniollo. The rectangle delineates the Ason River Basin

- A substantial quantity and broad variety of remains were recovered during excavation, and these were analysed by a wide team of specialists of mixed professional and national backgrounds. This allowed for comprehensive investigation of a scale and nature previously unprecedented in the region.

- The project was overseen by the two American archaeologists Lawrence Straus and Geoffrey Clark, both of whom were familiar with some of the most contemporary ideas in theory and practice of the time from their respective backgrounds. Of the two, Straus in particular has remained an industrious and prolific presence in this area, frequently referring to La Riera in works of broader geographical focus.

- The cohesion brought by Straus and Clark's integration of La Riera into the broader regional and temporal framework was of a scale previously unprecedented in Cantabrian prehistory. It has served to perpetuate La Riera's position at the heart of many further studies.

- Being published in English made the report accessible to a much wider audience than would have otherwise been attainable.

- Many of the findings established in the La Riera report have been consolidated by the subsequent works of Straus (e.g. Straus 2011) and others, though of course, it must be acknowledged that the site's enduringly powerful presence in Cantabrian prehistory has been likely been a significant influence over this.

There are inevitable issues of ontology when one particular site dominates our understanding of the past, and it is important to be aware of these when informing studies of broader areas. The extent to which this is the case with La Riera is constantly diminishing as work on contemporary sites expands. However, given that to this day, no complete site investigation rivals it in depth or breadth, it is only reasonable that it forms the epicentre of my own work in this region. The extensive variety and detailed nature of the data presented in the La Riera monograph and associated publications present an excellent case to develop as a pilot study.

3.1.1 **Geographical Setting**

Located between the coastal Cantabrian plain and the hills and valleys that back it, La Riera would have provided its occupants with access to different landscapes, resource bases, and ecological niches, which would have developed with time. Situated 30m above present sea level, and 1.5km from the foot of Peña Llabres (max elevation 715m), the site would have also had close access to the Rio Calabres stream valley, the current course of which is around 40m away from the cave (Straus and Clark 1986a, 4). The Sierra de Cuera mountain range is a further 10km to the southeast. At present, La Riera is 1.75 km away from the shore, but may have been as far as 9.7 km around 18,000BP (Ibid 1986b). The cave itself is a small west-facing solution cavity formed out of Lower Carboniferous limestone. Although 7m wide, the entrance to the cave is low, and sunlight penetration would have been restricted, particularly in the summer when the sun is higher in the sky (Ibid 1986b, 9).

3.1.2 **History of Investigation**

La Riera was first investigated by the Conde de la Vega del Sella in the early 20th century, and excavated in collaboration with Hugo Obermaier between 1917 and 1918. Although details of their work can be found in several of their other publications, the first dedicated explicitly to La Riera was published by the Conde in 1930. The standard of their work is widely regarded as laudable for its time, and of pioneering importance in the field (Straus and Clark 1986a, 9; González Morales and Fano Martinez 2005) but nevertheless incomparable to the standard of more recent works. As with many other sites investigated at this time, very little of their collections have survived through Francoist Spain (Straus and Clark 1986a, 9). Since the Conde’s excavations, the site experienced repeated looting and also some action during the Spanish civil war (Ibid 1986b). The next excavations were the preliminary trials conducted by Geoffrey Clark in 1969. Details of this are extensively covered in Straus & Clark’s monograph, with certain elements also having been published separately elsewhere (Clark and Richards 1978; Straus and Clark 1978). These excavations were the primer for initiating the much larger scaled La Riera Palaeoecological Project (Straus et al. 1981), culminating in the final report (Straus and Clark 1986c). My own assessment is based entirely upon work derived from Straus and Clark’s most recent excavations.

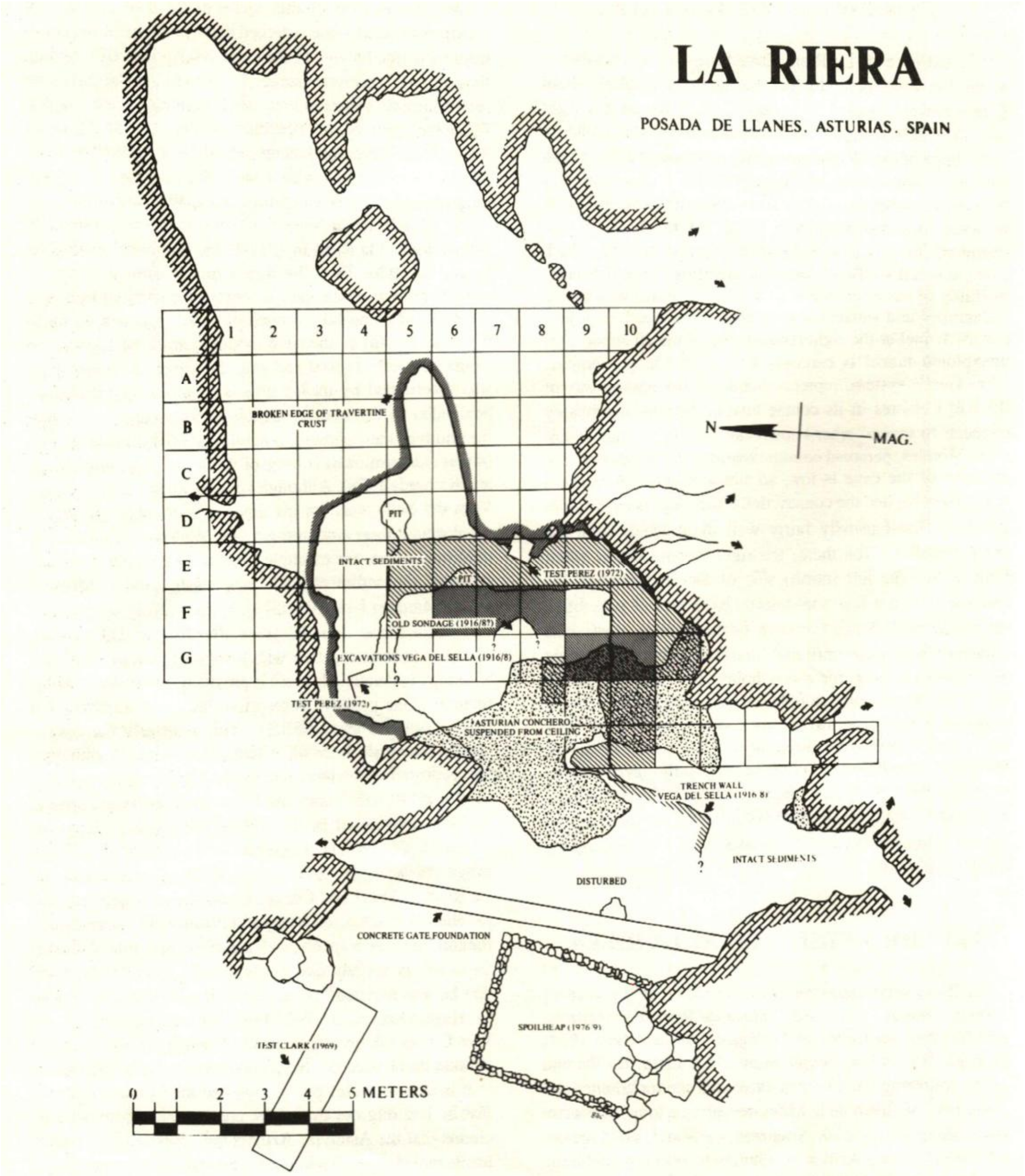


Figure 7: Overhead Plan of excavations at La Riera

Stratigraphy throughout the cave varies both naturally, and also because of the limits to excavation in some quarters. Several section drawings, deemed to be broadly representative of the site stratigraphy are provided in Laville (1986). Details of the units excavated are given in Table 3.

Level	Area Excavated m²	Estimated Average Thickness (cm)
1	5	30
2	3.2	4
3	5.2	16.5
4	5.5	6
5	5.5	7
6	4	4
7	8.5	10
8	9	4.5
9	8	5
10	7	5
11	5.5	3
12	3.3	2.5
13	2.3	4
14	8	11.5
15	8	4
16	8	15
17	7.5	2.5
18	8	7
19	7	8
20	6.5	8
19/20	2.5	16
21-23	9	25
24	6	10
25	1.3	2.5
26	5	2.5
27	8	25
28	3	8.5
29	3	7
30	1.3	10

Table 3: Excavation Unit Details for La Riera

3.1.3 Issues of Stratigraphy

For reassessment of La Riera, it has been necessary to reconfigure some aspects of the report to facilitate the identification of actual trends. While it is important not to neglect the actual measurements recorded during excavation, the quantification of various datasets (e.g. various assemblage components) have been recalculated as proportions. This allows a more meaningful comparison to be made between two stratigraphic units which may vary substantially in size as excavation units: a rise in the number of microliths through time is only meaningful if it is relative to the rest of the assemblage. Further to this, decisions regarding appropriate ordering of the La Riera sequence have also had to be made.

Treatment of the stratigraphic levels at La Riera by different investigators varies throughout the original report depending on the dataset in question. Some matters are uniform, for instance the decision to treat levels 21-23 as a singular and monolithic depositional unit, while others, e.g. the differentiation of level 8 and level 8 (top) by Altuna (1986b, 421) have been tailored to suit specialist analysis and are not uniformly acknowledged by different specialists. In the ensuing discussion, it has been necessary at times to revise some of these systems to facilitate cross-analysis of different suites of evidence.

3.2 The La Riera Diagram Explained

The (Appendix 1) presents the La Riera sequence, starting with level 29 at the top and descending to the oldest of the excavated levels, level 1. The column to the furthest left shows the radiocarbon chronology in years BP (uncal) as cited in Craighead (Craighead 1999, 12) and the original report (Straus 1986b), with n/a representing levels where no dates were collected, and dates dismissed as inconsistent by the original investigators written in red. The youngest date recorded, 6500±200 BP, was taken from the top of level 29. A '*' besides a radiocarbon date denotes a date obtained by Alan Craighead (1999) rather than during the original site investigation. The next column to the right gives the 'type fossil stratigraphy', which assigns portions of the site sequence to different archaeological periods based upon supposedly diagnostic artefacts. Solid lines denote levels where these so called type fossils are found, and dot-dash lines identify levels where assignment was based on their being bracketed between these levels rather than the yielding such artefacts themselves. The 'radiocarbon stratigraphy' assigns levels to these periods according to the dating chronology provided by Straus (Straus 1986b, 21), with n.d. denoting deposits that were not dated at the time. Both the ‘type fossil stratigraphy’ and ‘radiocarbon stratigraphy’ are taken from Straus, 1986 (Table 2.1).

Coloured levels indicate problematic excavation units. Levels 19 and 20 are incomplete due to an uncertain horizon between the two (level 19/20, which is not included in this investigation). Levels 21-23 are collapsed into one excavation unit due to the dearth of material remains recovered and the possibility of a hiatus in deposition (Laville 1986). Level 25 was an ephemeral lens, yielding only 2 retouched pieces. In level 29, materials recovered from the 1969 excavations were conflated with those from 1976/9 excavations to compensate for the small assemblage size of the latter, complicating assessment of this unit. Level 30 is not included due to the fact that it is a stalagmitic crust that was not formally excavated.

Some levels have been excluded from consideration having been deemed as being distortive of overarching trends. Level 19/20 has been removed from consideration as an artificial depositional unit born out of ambiguity; this in turn means levels 19 and 20 must be regarded as ultimately incomplete as interface materials from both were incorporated into the constitution of level 19/20. Levels 21-23 are considered as a single unit, due to the conflation of a large amount of sediment. Level 25 is excluded from reassessment, but included in the diagram on the grounds that it is too small a deposit to be considered representative of any broader trends. Quantification of level 29 conflated some details of the 1969 excavations with those from the 1970’s investigation to compensate for the small scale of the latter (Straus and Clark 1986b, 180); this complicates further assessment in some regards. Level 30 is not included due to the fact that it is a stalagmitic crust that was not formally excavated. The (Appendix 1) synthesises the main data pertaining to hunting activities throughout the La Riera sequence. The levels identified above as problematic for analysis are coloured in the diagram.

The ‘Climatic Indicators’, as adapted from Straus (Straus 1986b, 22–23), comprise four categories of evidence. The first two columns show the climatic reconstructions afforded by sedimentological (Laville, 1986) and palynological (Leroi-Gourhan, 1986) analyses of the site; dashed lines represent hiatuses in deposition. The double line between levels 21 and 22 of the sedimentology column represents a cryoturbation event. Episodes of erosion are not shown on the diagram; these occur between levels 1 and 2, 23 and 24, and 26 and 27 (Straus and Clark 1986b). The third provides reconstruction of the vegetation as according to Leroi-Gourhan (1986), and the fourth are faunal species considered to be indicators of notable climatic variability as recognised by Altuna (1986c), highlighted in the units in which they were found.

The 'dominant fauna' columns show the three most dominant species in the assemblages of each level throughout the sequence by quantity of remains. Levels where the third most dominant species account for less than 5% of the assemblage are not given. This data was taken from Altuna (1986a). The next section of the diagram shows the proportional representation of backed bladelets, with a rounded percentage given within each plot. The actual number of backed bladelets recovered in each instance is given as 'n', adjacent to the plots. The dominant three flint types recorded in each of these levels is also given (coding explained later), along with whether the lithic assemblage is dominated overall by flint or quartzite materials by both count and weight. The dashes in level 25 indicate that data was not included from these levels for this study. Lithics data is derived from Straus & Clark (1986), Straus et al. (1986), and my own reanalysis discussed later in the chapter.

The diagram neatly summarises the main bodies of evidence pertaining to hunting activities recorded at La Riera within the internal chronological framework developed for the site. While this allows for easy visual correlation, some of the more specific details about the information presented here has been excluded. These aspects of the data are discussed elsewhere. Consequently, while this diagram concisely illustrates some key features, it should not be consulted in isolation.

3.3 Radiocarbon Dates

A total of 28 radiocarbon dates were acquired from La Riera, making it one of the most extensively dated Palaeolithic sequences of its time (Laville 1986, 42). There were however a number of difficulties in integrating them with the broader archaeology. As well as some substantial margins of error, it has proved difficult both to correlate various environmental indicators with cultural remains, and to correlate the La Riera sequence with events recorded at other contemporary sites (Straus 1986c, 67; Straus 1986a, 225). As well as this, there are internal inconsistencies within the sequence itself: for example, level 16 was dated to 18,200 BP, which was deemed too old when bracketing determinations from levels 15 and 17 were considered (Straus and Clark 1986b, 132). Finally, there was also some disparity between results from the same levels as recorded by different laboratories, leading some of the La Riera team to use the C^{14} dates as secondary indicators rather than the primary basis of their chronologies (Laville 1986, 42; Straus 1986c, 68).

While the establishment of a radiocarbon sequence has proved invaluable for understanding the La Riera deposits, the problems detailed above mean they also raise many questions regarding the site's chrono-stratigraphy. For example, despite obtaining a date more consistent with the Azilian as recorded at other Vasco-Cantabrian sites, Level 24 yielded two fragments of a single cylindrical section biserial Magdalenian harpoon, and was thus classed as an Upper Magdalenian deposit (Straus 1986a, 225). Radiocarbon dates only provide a useful framework if we can successfully integrate them with existing patterns in the archaeological record. Therefore, it is imperative that some of the issues with the La Riera chrono-stratigraphy are addressed.

3.4 Chrono-Stratigraphy

The thirty levels of La Riera range from the Aurignacian, or at least "pre-Solutrean", through to the Asturian across a time span of approximately 14,000 years. The majority of the sequence comprises Solutrean deposits, and it is the transitional stages between this and between subsequent periods which are most problematic to define. Each major cultural horizon (e.g. Lower Magdalenian) is defined by differences in artefact association, and where these "type-fossils" are absent, our ability to assign levels accordingly is reduced to relying upon identifiable bracketing levels. Only three levels between Level 21 and 29 (24, 28 and 29) contained incontrovertibly recognisable type-fossils, the rest being ascertained to varying degrees of reliability according to bracketing layers and other indicators, such as correlating radiocarbon dates with those from contemporary site stratigraphies. The type fossils confirm that Level 24 is Upper Magdalenian, while Level 28 is Azilian and Level 29 is Asturian.

3.4.1 **Lower Magdalenian Levels**

Prior to Level 24, there are no typologically confirmed Lower Magdalenian levels. Level 18 is the first presumed Lower Magdalenian level, identified only because of the lack of a cultural affiliation with either the Upper Solutrean or Upper Magdalenian. The layer does, however, have quadrangular sectioned bone and antler points which are "supposedly" typical of Cantabrian Lower Magdalenian assemblages (Straus and Clark 1986b, 139). In qualifying the above observation with "supposedly", Straus and Clark clearly exhibit some doubt in this association. This doubt is only strengthened by their own admission that, aside from the lack of archaeological index fossils, the composition of retouched tool components of Level 18 ("Lower Magdalenian") and Level 17 ("Upper Solutrean") are statistically identical (Ibid 1986, 139). Level 17 is considered Upper Solutrean on the basis of a single but characteristic willow leaf point fragment and two flakes with invasive retouch (ibid: 134). Levels 19, 19/20 and 20 are all considered Lower Magdalenian on the grounds that they lack index fossils and are bracketed by Level 18 and Level 24 (24 being confirmed as Upper Magdalenian). None of the levels assigned to the Lower Magdalenian by Straus and Clark are confirmed by traditional typological methods; at best they can be said to fill the gap in the sequence where the Lower Magdalenian should be. In reality, while some levels are more questionable than others, there is little evidence to challenge this classification.

3.4.2 **Upper Magdalenian Levels**

Levels 21-23 are suggested as most likely being Upper Magdalenian based on a single radiocarbon date from Level 23 of 10,300 BP (considerably younger than Level 20) and approximately equal quantities of burin and endscraper percentages. Such a ratio is more common of Upper Magdalenian assemblages, though it should be noted that there is, in general, a dearth of material remains, and retouched pieces are proportionately more common than elsewhere in the site (Straus and Clark 1986b, 155). I would dispute the value of this criterion as a chronological indicator, at least in the case of La Riera, as the same trend can also be found in supposedly Solutrean level 17 and Lower Magdalenian levels 18, 19 and 20. This does not negate the radiocarbon date though. The possibility of a major episode of erosion after the deposition of level 20, and a 5000 year hiatus in stratigraphy would rule out any possibility of a transitional horizon (Ibid 1986, 159).

Levels 25 and 26, the former considered in amalgamation with the latter, lack diagnostic type fossils but are deemed probably Upper Magdalenian according to bracketing layers and internally homogenous lithic assemblages through from L24-L27 (Straus and Clark 1986b, 165–171). Level 27 on the other hand is more problematic, as it lacks diagnostic index finds, but comes just before Azilian level 28. Despite dividing the level into two sub-units (an upper and lower L27), and suggesting with some confidence that L27 must span the Magdalenian/Azilian transition, there is no clear horizon event in the level according to Straus and Clark's synopsis (1986, 171–175).

3.4.3 **Azilian / Asturian Levels**

While levels 28 and 29 contain clear index fossils of the Azilian and Asturian respectively, there is only one occupation level from each of these (Level 30 is an unexcavated stalagmitic ceiling crust), in comparison with eleven Magdalenian layers and up to maybe 16 Solutrean levels. In the case of the Asturian, the sequence unfortunately terminates, and the Azilian is by definition is a short time period.

3.5 The Lithics

The La Riera lithic assemblages, of which there are 55,634 pieces in total, have been the subject of extensive investigation, including raw material studies (Straus et al. 1986), use-wear (Clark et al. 1986, 342–345), and multivariate analysis (Clark 1989). 52,835 (94.7%) of the stone artefacts were placed in 15 categories of debitage and 5 of manuports (Clark et al. 1986, 326). The other 2,799 (5.3%) retouched pieces were classified according to the descriptive tool typology developed by de Sonneville-Bordes & Perrot (1953), despite some expressions of dissatisfaction with the appropriateness of this system (Straus 1996, 40). In their original analysis, the types recovered are displayed in histograms, along with more detailed lithic inventories provided for each level (Straus & Clark, 1986).

Classically accepted forms of hunting weaponry found at the site included the larger Solutrean points (shouldered points, willow points, and foliates), and a variety of microlithic armatures, by far the most profuse of which is the backed bladelet. As Figure 8 shows, the former are found only in the earlier part of the sequence, levels 4-8 particularly, and the backed bladelets are more prominent in the latter part, particularly between levels 17 and 20. There is some degree of intergrading though, with backed bladelets being present in notable quantities in levels 4 and 5, and transitional phases such as levels 15 and 16 which bridge their paucity in earlier levels and their proliferation in level 17. There are some levels where neither Solutrean points nor backed bladelets were recovered in any significant quantities. This potentially indicates periods when the site was not a focus of hunting related activities, when evidence of hunting technology is less readily apparent, or alternatively, when deposits of these tool types lay outside of the excavated area.

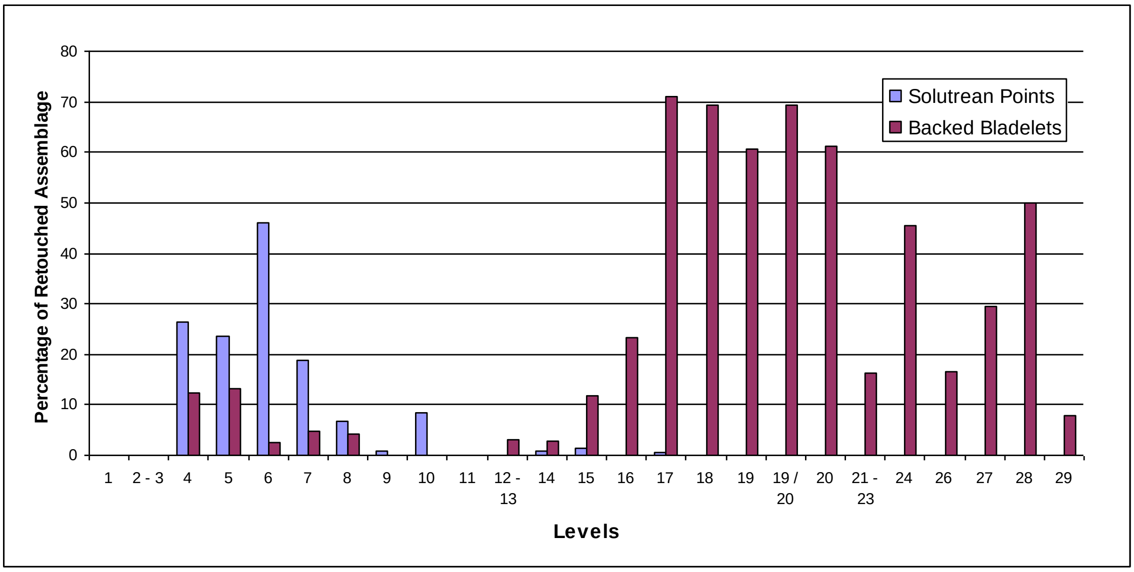


Figure 8: Graph showing Solutrean points and backed bladelets at La Riera

3.5.1 The La Riera Bladelets

Of the ten types of retouched bladelet found at La Riera, by far the most dominant is the backed bladelet. From level 16 onwards, backed bladelets comprise the vast majority of all the retouched bladelets, and also account for over 50% of the total in levels 4 and 5, although in absolute terms they are much less common in these levels (Figure 9). They feature less prominently in levels 1-3 and 6-15, and retouched bladelets as a whole are less abundant in these levels. Figure 9 shows that variation in the quantity of retouched bladelets when backed bladelets are excluded from consideration is much less marked, peaking at 13 pieces in level 10. With the exception of a small peak in levels 4 and 5, backed bladelet use increased substantially in level 17, remained high until level 20, and fluctuated throughout the rest of the sequence, peaking at 50% in level 28 and falling as low as 16% in levels 21-23 (Appendix 1).

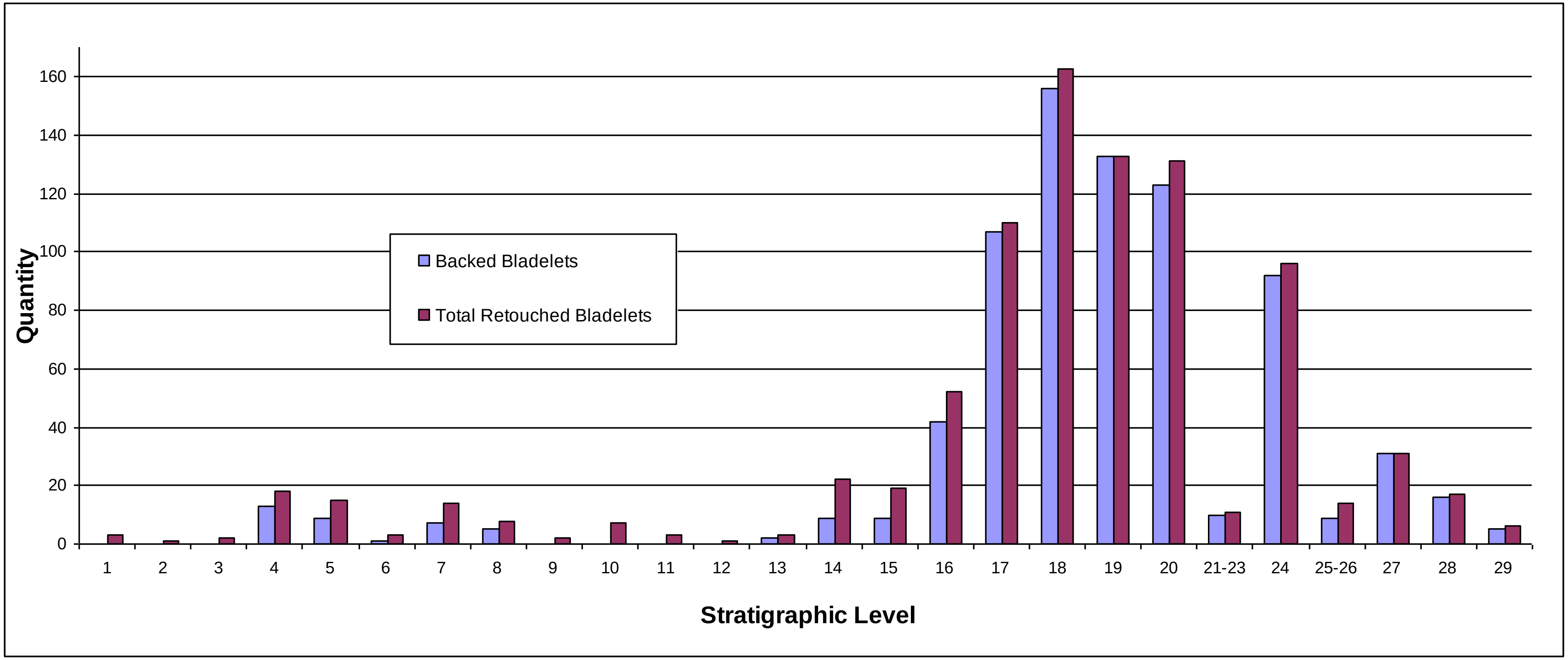


Figure 9: Graph showing backed bladelets (excluding microlithic points) as a proportion of total retouched bladelets at La Riera

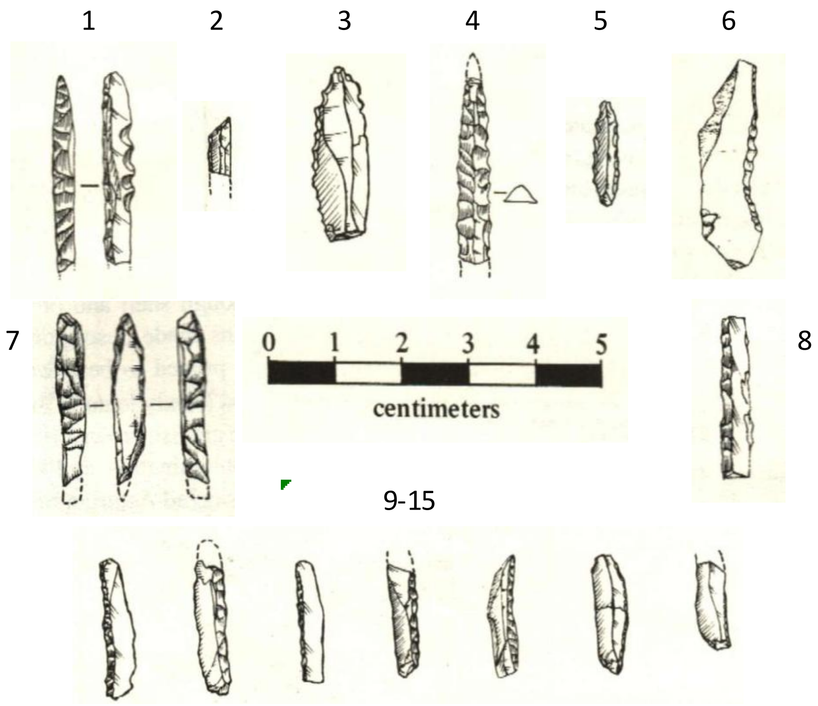


Figure 10: Retouched Bladelet Types at La Riera. 1 backed and denticulated - level 4; 2 backed and truncated – level 19; 3 denticulated – level 7; 4 double backed – level 5; 5 Dufour – level 6; 6 Notched – level 18; 7 backed – level 27; 8 backed – level 4; 9-15 backed – level 17

The other eight types of bladelet are described as: Bracketed, Notched, Dufour, Denticulated, Denticulated and Backed, Truncated, Truncated and Backed, and Double Backed. Divided into their constituent types, only dufour bladelets and denticulated bladelets ever exceed more than two in number in more than one level. It is clear that backed bladelets are easily the most significant type. It is difficult to identify patterns or say anything meaningful of these bladelets in such insignificant quantities; their very recognition may even be the result of overly-zealous adherence to morphological categorisation. Consequently, the overwhelming predominance of backed bladelets is my main focus. Consideration is therefore divided between the early representation of backed bladelets in levels 4-8, and the concentration in later levels from level 17-28. A more detailed breakdown of the backed bladelets can be found in the relevant sections below.

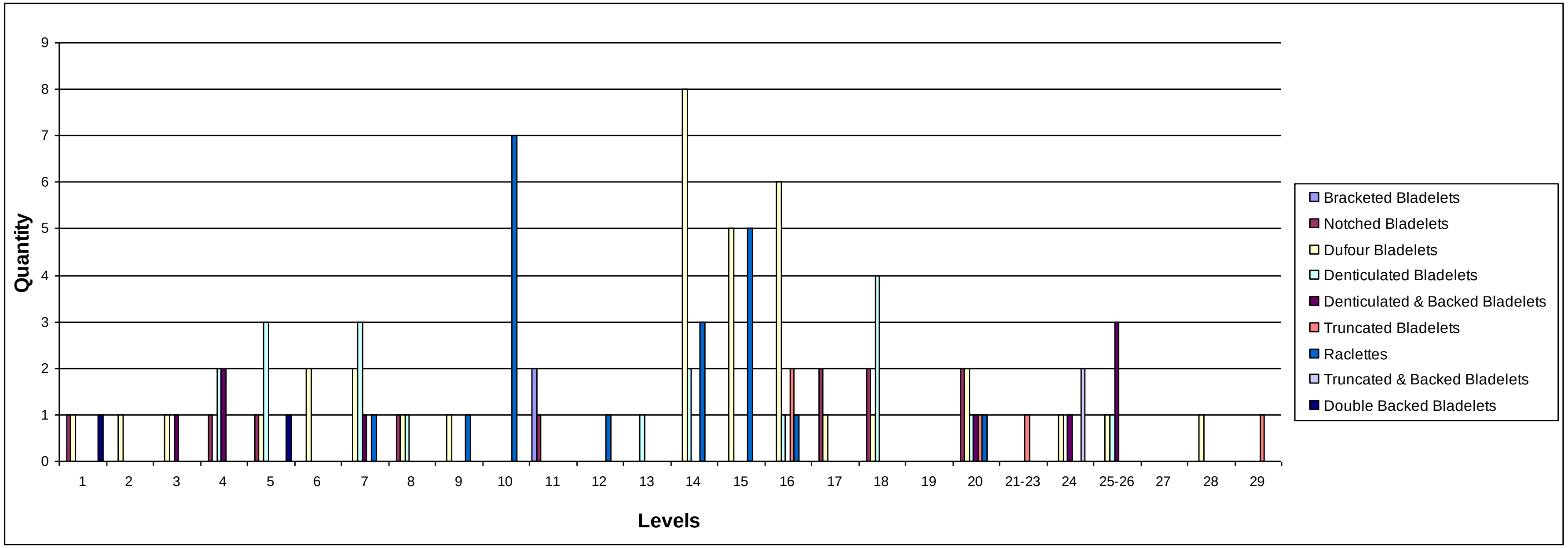


Figure 11: Graph comparing variant retouched bladelet types at La Riera

3.5.2 **Debitage**

Debitage pieces, which comprise the majority of the La Riera lithics, are absent from the diagram despite containing bladelets as a defined type. Debitage bladelets generally exhibited little evidence (< 9%) of use wear analysis (Clark, 1989: 39), compared to backed bladelets where 56% of the sample had evidence of damage, but the fact that some did is intriguing. While the primary emphasis, in accordance with that of the site report, focuses on retouched microlithic elements, it is interesting to note any parallel trends in debitage bladelets. These can be said to loosely match that of retouched bladelets in some levels (Figure 12). The spike in retouched bladelets from levels 4 and 5 is not replicated in debitage bladelets, and the proportion of debitage bladelets recovered from levels 21-23 is curiously high. Interestingly, debitage bladelets only exceed retouched bladelets as proportions of their respective assemblages in levels 1, 2-3 and 29.

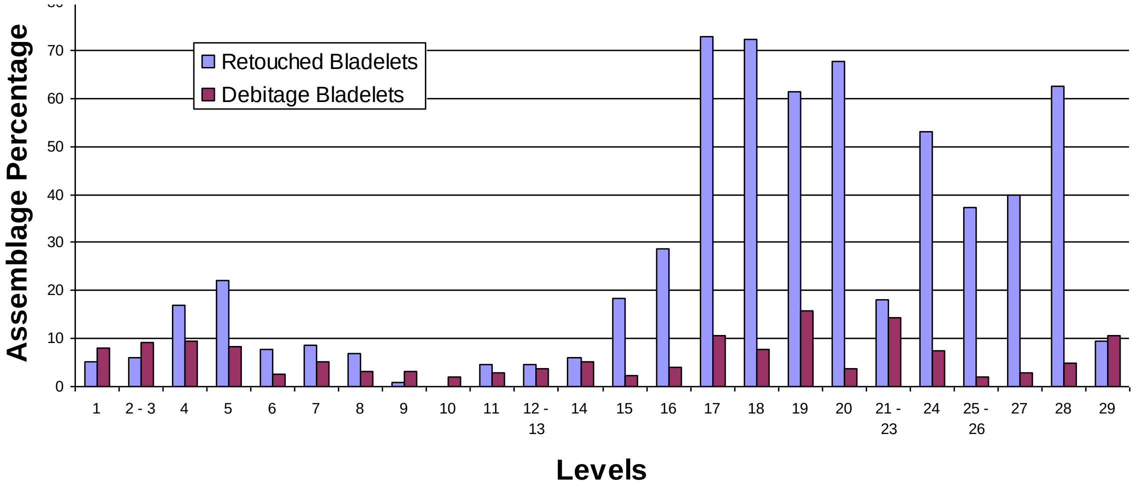


Figure 12: Graph showing retouched and debitage bladelets as proportions of their respective assemblages at La Riera

3.6 Palaeoenvironmental and Climatic Evidence

The La Riera excavations yielded three main sources of climatic evidence, from palynological studies, sedimentological analysis, and the presence of certain indicative species of fauna. This last category is problematic for two reasons. Firstly, as shown in (Appendix 1), very few levels provided this evidence, and the only indicators found will be either cave dwelling fauna or species procured by the occupants (human or otherwise) of the cave. Secondly, there is a degree of contradiction and imprecision in some levels between these climatic indicator species. For instance, in level 24, where both *Rangifer tarandus* and *Capreolus capreolus* are present despite inhabiting starkly contrasting environments (Straus 1986c, 67). While the presence of some species, such as *Microtus oeconamus* (the arctic vole) can prove valuable for palaeoclimatic reconstruction, much of the La Riera faunal deposits are perhaps best focussed towards interpretations of subsistence (Straus and Clark 1986d, 370).

The sedimentological (Laville 1986) and palynological studies (Leroi-Gourhan 1986) provide the best sources for palaeoclimatic reconstruction. As (Appendix 1) shows, the inferences made from these bodies of evidence are, for the most part, in general agreement with one another, with slight differences in timing resulting from the different speeds and resolutions at which processes are felt in these records. These disparities become more numerous and more difficult to reconcile later in the sequence from level 20 onwards; the palynological record has a number of gaps in the Magdalenian levels (Leroi-Gourhan 1986, 59), and the upper deposits of the sequence lack the qualities necessary for definitive interpretation from sedimentological analysis (Laville 1986, 42). Occupation of La Riera was characterised by generally cold conditions throughout much of the Würm upper pleniglacial and the late glacial, punctuated by more temperate oscillations, which were never pronounced or long enough to permit extensive reforestation (Straus 1986c, 72). In the same manner, while some periods may have been severely cold, sufficient refugia (probably within the valleys) were sustained for a continued presence of red deer (Leroi-Gourhan 1986, 59).

Reconstructing vegetation in the vicinity of the site has proved difficult. Few plant macrofossils have been recovered as a result of poor preservation and the sampling strategies employed (Cushman 1986, 65). Other than this, reconstruction is mostly limited to palynological evidence, which is known to be problematic when used for such purposes, along with supplementation from other climatic inferences, the supposed food/habitat preferences of fauna, and inference from the palaeobotanical record from contemporary sites with similar geographical locations.

3.7 **Fauna**

The La Riera deposits yielded a substantial quantity of terrestrial faunal remains. Those identified to species level have been recorded according to NISP, as a proportion of assemblage weight, and as MNI when possible. (Appendix 1) is based upon the proportion of assemblage according to NISP. Faunal remains were found in extremely fragmented condition: of 200,000+ remains, 31,480 were identifiable, 31,336 of which were mammalian, which in turn comprised 31,125 ungulate remains (Altuna 1986c, 237). All terrestrial faunal types, including birds (Eastham 1986), are covered in the La Riera report, but ungulate remains have understandably dominated subsistence oriented research as the most obvious source of meat. While the precedent of marrow extraction has been found in zooarchaeological studies of other Late Glacial Cantabrian sites (Arroyo 2009b), the variety and extent of breakage at La Riera suggests that cave taphonomy is a more probable explanation, though these two processes are obviously not mutually exclusive. The highly fragmentary state of the assemblages reduces interpretive power.

Jesus Altuna, who is responsible for the majority of early prehistoric mammalian zooarchaeological studies in Cantabrian Spain, was the main analyst of the La Riera collection. The extent of his analyses is clear from Appendix B in the site report: As well as recording the quantities and proportional representation in each level of different species, he also recorded the MNI, weight, adult/juvenile ratio, distribution of remains by skeletal elements for all levels and individual measurements recorded for each species (Altuna 1986b). Through calculating the age at death and sex of specimens, it was sometimes possible to shed light on hunting strategies and seasonal exploitation patterns. Although this level of information is not provided in (Appendix 1), Altuna's original report (1986c; 1986a) may be consulted for further details.

In general, red deer (*Cervus elaphus*) dominate throughout most of the assemblage except in levels 2-5. The extent of this dominance varies throughout, but never falls much below 70% of the overall faunal assemblage except in level 24. Ibex remains a consistent secondary prey to red deer in most levels. While much of the site history is characterised by a relatively homogenous breadth of prey, rarely featuring more than 2 species of note, the latter stages of the sequence bear witness to the introduction of newer species with climatic amelioration and reforestation such as *Capreolus*

capreolus and *Sus scrofa*. Some of the larger species, including *Equus* and *Bos* which were largely absent since the beginning of the sequence also make sporadic and lesser returns to prominence in these later levels.

3.7.1 **Problems with Faunal Quantification**

The challenges facing most zooarchaeological analyses are further exacerbated by the highly fragmented nature of the assemblages. For example, in scenarios as at La Riera, MNI will often overvalue the importance of poorly represented species while undervaluing the importance of main species (Altuna 1986c: 249). The weight and number of remains are susceptible to, among other complicating factors, variation in element representation. The collective weight of a species remains may be comparable to that of another, but different in number, and vice versa. For example, in levels 4-6, there is a minor majority of red deer remains over ibex, yet in terms of weight (and, importantly, meat bearing weight) red deer are by far the dominant species represented (Altuna 1986b: B.15)

The problems inherent with these methods of quantification only serve to compound attempts at further extrapolation. Interpretations of the La Riera fauna have been made regarding the sex, age and seasonality of species, yet the confidence with which such inferences can be made varies from level to level. While individual elements may be sexed, these might not provide an accurate reflection of the actual population. For example, while analyses have sexed 14 red deer remains as female to 1 male, a conservative estimation (MNI) suggests 34 individuals (Altuna, 1986b: B.24; B.23). While this does not undermine the fact that to the best of our knowledge red deer exploitation in level 7 was targeted towards females, it does show that this information is far from representative of the whole population.

A final note for consideration should be the stratigraphic differentiation used by Altuna (1986c). All the values regarding fauna here are from his work (1986a; 1986b), and if, as in some instances, such as the faunal remains from level 7 for example, they do not match their originally recorded format, it is the result of averaging to make the data more comparable. Level 7 is divided into three components by his assessment, whereas other levels also divided into subcomponents were already averaged e.g. level 12.

3.8 Reanalysis of Raw Materials at La Riera

The original raw material analysis included in the site report showed that flint and quartzite alternated with one another as the dominant material used for lithic technology. Although general tendencies of preference are described (Straus et al. 1986, 189), there is no specific association between morphological tool types and material choices for each level. The aim of this reappraisal of the data is to reveal trends in raw material selection pertaining to microlith manufacture that were not apparent from the original analysis.

Trends in flint and quartzite were recorded and compared by both weight and number (Figure 13 Figure 14). Microliths may be underrepresented in measurements of assemblage weight due to their small size, unless they are present in relatively large numbers. Fortunately, the backed bladelets, which are the only microlithic element to occur in any great quantity at La Riera, were made almost entirely of flint (Straus, pers comm; 2002: 137). This means that through isolating the flint component of the lithic assemblages, it may be possible to observe trends in material selection that match substantial peaks and troughs in quantities of backed bladelets. Such observations would only be possible when backed bladelets account for the dominant tool type by a substantial margin, and consequently this reassessment only applies to the later levels (17-28) of the La Riera assemblage.

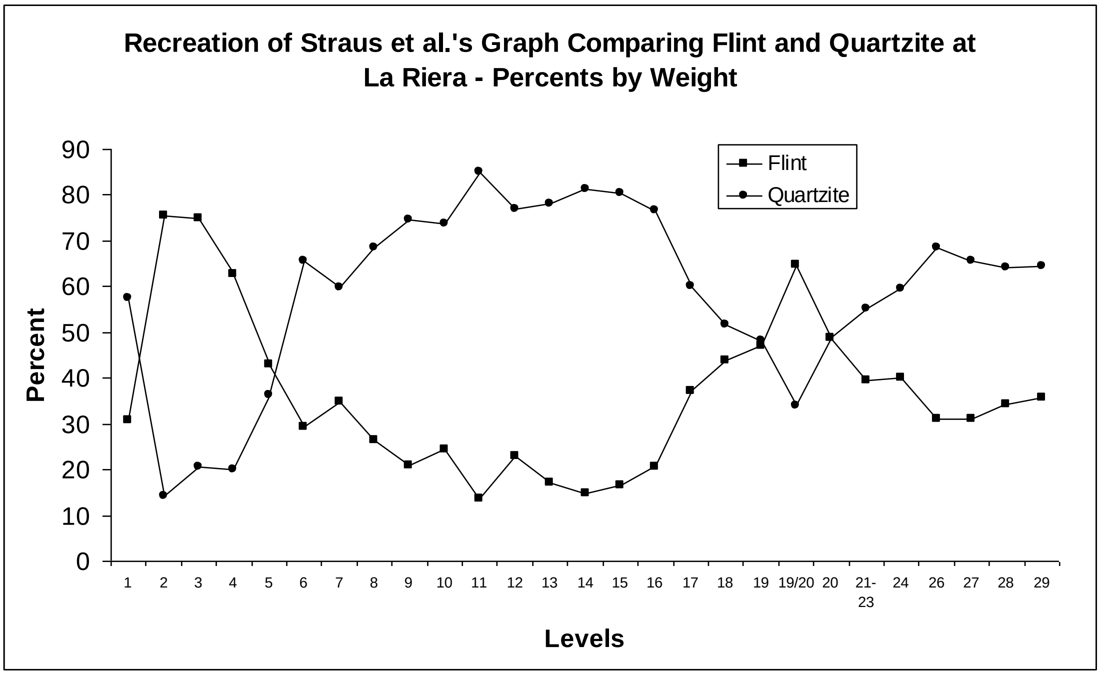


Figure 13: Flint and Quartzite by weight at La Riera

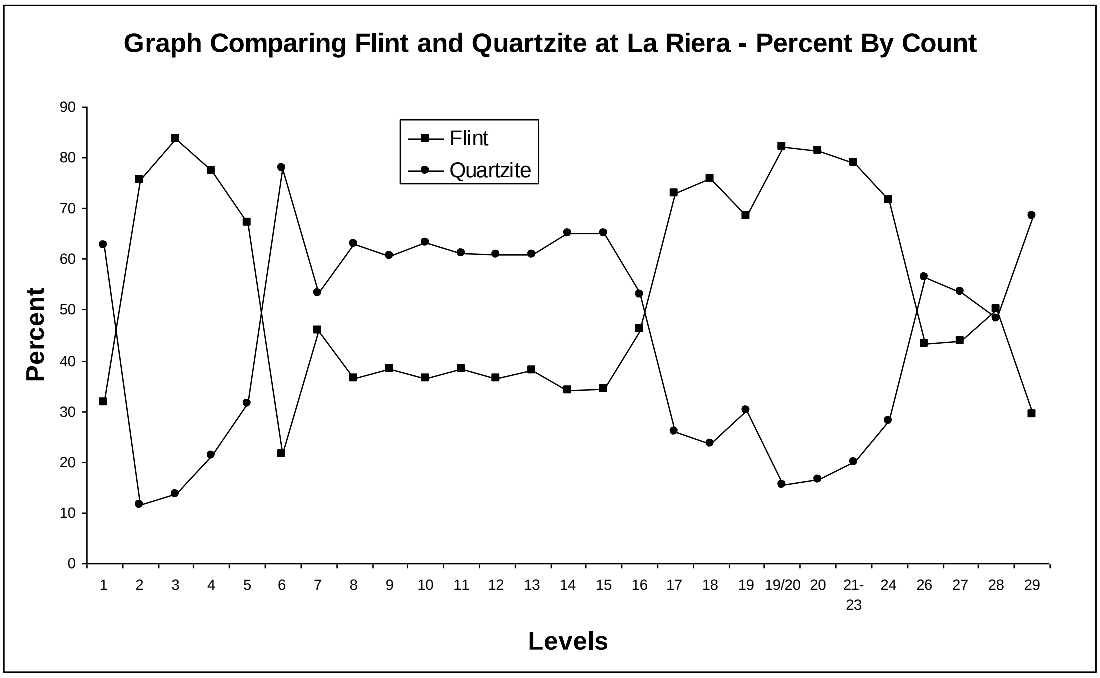


Figure 14: Flint and Quartzite by Count at La Riera

Sixteen different types (Types A, B, C, D, E, F, G, H, O, Q, R, U, W, AA, BB and miscellaneous type 'Ω') of flint were recorded at La Riera. Impressionistic and (some) petrographic descriptions can be found in Straus *et al.* (1986: 191-201). The weight of different types was presented as a proportion of the overall assemblage for each level in histograms. Numerical quantification was not provided. Whereas with the inventories of lithic tool types it is possible to distinguish between retouched and debitage assemblage components, this is not the case for considerations of material types. For trends in flint material selection associated with backed bladelet manufacture to become apparent, backed bladelets must be the prevailing tool type in an assemblage, and we must assume that the debitage component for each level at least approximately represents waste material from the retouched component i.e. the backed bladelets.

3.8.1 **Reanalysis**

Below are descriptions of the raw material breakdown of different portions of the La Riera sequence. The proportional values of flint types given for each level (Straus & Clark, 1986) have been recalculated as percentages of the flint component to remove quartzite artefacts from consideration.

3.8.1.1 Levels 6-16

Levels 6-16 are characterised by a relative dearth of backed bladelets and are dominated by quartzite in both weight and number (Figure 13 Figure 14). The dominant flint types in this section are recorded in Table 4. Type B dominates in every level except 14, but to varying degrees, with the margin as much as 22% in level 13 and as little as 1.5% in level 11.

	L 6	L 7	L 8	L 9	L 10	L 11	L 12	L 13	L 14	L 15	L 16
A	13.00	11.40	11.72	17.03	11.89	17.52	12.38	15.61	22.81	15.55	15.81
B	24.97	25.37	22.68	26.49	25.42	21.90	32.71	37.57	20.80	24.52	18.87
C	17.10	15.39	16.63	8.99	5.74	4.38	6.63	9.83	8.72	7.18	11.22
D	8.21	8.27	16.63	17.03	17.63	10.22	11.05	7.51	12.75	19.14	11.22
Q	16.07	13.97	11.34	12.77	15.17	10.95	9.28	12.14	10.07	16.15	14.79
W	8.89	8.27	10.21	12.30	8.61	20.44	21.22	8.67	15.43	7.18	13.77

Table 4: Dominant Flint types in La Riera levels 6-16

3.8.1.2 Levels 14 & 17

Backed bladelets account for just 2.5% of the retouched assemblage in level 14 and 70.9% in level 17 (Figure 8). The most notable differences between these levels are increased representation of types E and C in level 17. Types Q, W and B are all diminished in representation. Levels 15 and 16, which show some increase in backed bladelets, are much closer to level 14 in their flint materials.

3.8.1.3 Levels 17-20

Levels 17-20 represent the peak representation of backed bladelets in the La Riera sequence. shows the six most represented flint types (A, B, C, D, E and Q) in these levels. Level 17 is dominated by flint types A and C, and to a lesser extent type D with proportional weights of 22.58%, 20.40% and 15.78% respectively. By contrast, type B dominates other flint types in levels 18-20, and by a much more considerable margin (the smallest being by around 8% in level 18). Type B only accounted for 9.52% of level 17's assemblage weight, behind types A, C, D and E.

	L 17	L 18	L 19	L 20
A	22.58	19.47	2.37	12.93
B	9.52	27.71	43.22	30.11
C	20.40	11.22	11.18	11.19
D	15.78	12.82	7.96	11.00
E	10.61	2.75	0.43	1.35
Q	4.62	9.85	13.76	10.23

Table 5: Dominant Flint Types in La Riera Levels 17-20

Curiously, while flint type A is relegated to the second most dominant type in levels 18 and 20 (marginally so in the latter), it drops to just 2.37% in level 19. Type C, which had been prominent in level 17, diminished to around 11% in levels 18-20. Type D and E also diminish in representation, with the latter present only in very minor quantities. Conversely, type Q rises from relative insignificance in level 17 to more notable quantities in levels 18-20. The apparent continuity of backed bladelet use in levels 17-20 belies a shift in material preferences that marks level 17 as quite different from the following levels.

3.8.1.4 Levels 20-28

Excluding level 25, levels 20-28 are all dominated by backed bladelets, though the quantities in levels 21-23 and 26 are probably too insufficient to register a clear majority impact in measurements of assemblage weight. Table 6 shows the five most prevalent flint types in this sequence (A, B, C, D and Q). It is also worth noting that type O, which was not included, rises to 8.45% in level 26 and 6.98% in level 28 from otherwise marginal quantities. Levels with high proportions of backed bladelets (20, 24, 27 & 28) are clearly dominated by one type of flint, more so than levels 21-23 and much more so than level 26. In levels 20 and 24 type B is the dominant material (30.11% and 53.52% respectively), continuing a trend seen in levels 17-20, whereas type A dominates in levels 27 (43.86%) and 28 (46.04%). Levels 21-23 are dominated by flint type B, and level 26 the main flint is type A.

	L 20	L 21-23	L 24	L 26	L 27	L 28
A	12.93	1.35	7.92	30.76	43.86	46.04
B	30.11	35.78	53.52	26.36	26.18	16.74
C	11.19	8.33	5.28	7.77	7.14	15.07
D	11.00	21.83	18.00	15.21	11.22	6.70
Q	10.23	15.08	6.00	5.75	3.74	0.00

Table 6: Dominant Flint Type in La Riera Levels 20-28

Type B is the second most dominant flint in levels 26, 27 and 28, while type D is second in levels 21-23 and 24; the other dominant flints in level 20 are all roughly equal. Interestingly, flint type A drops to 1.35% in levels 21-23. Flint type Q rises from 10.23% of the flint assemblage in level 20 to 15.08% of levels 21-23 before falling to increasingly lesser quantities, one level before the rise in Type O.

3.8.1.5 Levels 28 & 29

It is difficult to compare these levels properly due to the fact that level 29 comprises amalgamated results from Clark's earlier excavations to compensate for the lacking retouched tools recovered in the main excavation. Flint types represented in minor proportions in level 28 (i.e. < 7%) are absent from level 29. Type U, absent from level 28, is present in level 29, but almost the entirety of the level can be divided between flint types A, B and C. Flint type A diminishes by around 12% in level 29, while flint type C increases by 6%. Flint type B more than doubles from 16.74% of level 28, to 37.97% of level 29. While it is tempting to associate the drop in backed bladelets (Figure 8) with the disappearance of minor flint types, it should be noted that the drastic reduction of assemblage size in level 29 further compounds interpretation.

3.8.2 Conclusions

With the exception of level 26, levels 18-28 are characterised by a strong domination by one flint type over all others. This contrasts strongly with levels 6-16, where dominant flint types have a much less significant majority. Level 17 is also notable for not having a single flint type dominant by any substantial margin. Type B is the most dominant flint type in levels 18-24, with a shift to type A in 27-28. Type A is also dominant in levels 17 and 26, but by relatively insubstantial margins. In general, a greater diversity of flint types is represented in levels where backed bladelets dominate, though level 28 is notably anomalous in this respect. It is difficult to identify any further trends that may be associated with increases and decreases in backed bladelets.

3.9 Bladelet Based Hunting at La Riera: Levels 4-8

Early in the La Riera sequence, levels 4-5 stand out as relatively high concentrations of retouched bladelet activity. More notable however is a proliferation of Solutrean points in levels 4-6. The dominant fauna in these levels are ibex with red deer as a secondary species (red deer likely having overtaken ibex in economic significance by level 6). Consequently, these levels have been interpreted as specialised ibex hunting, probably in association with Solutrean projectile points, according to the results of multivariate analysis (Clark et al. 1986: 339). In this section, I seek to shed further light on the potential archaeological significance of backed bladelets in the early levels of La Riera. These levels are reassessed in the context of the broader early sequence to elicit further interpretation. Before this, however, further information about previous interpretation and on the nature of the levels themselves is necessary.

The levels in question represent a relatively discrete portion of the La Riera sequence. This makes the difference in the dimensions of levels 4-6 relative to bracketing deposits more noticeable Figure 8. Level 1 is a thick (1.50m^3 excavated) deposit of pre-Solutrean material. It is followed by levels 2 and 3 which mark the inception of the Solutrean according to type-fossil based chronology. Levels 2 to 3 have been amalgamated by Altuna for the purposes of faunal analyses due to the small assemblage size of the former (1986c). For example, the retouched lithics assemblages, which were not completely conflated, show level 2 to have 7 pieces compared to 44 in level 3. This probably relates to the small deposit size (0.128m^3 excavated). Levels 4-6 represent thin deposits, with level 5 providing the greatest volume (0.385m^3). Some faunal remains from these levels were combined during excavation (Altuna 1986c, 244). This is worth noting, as it highlights the stratigraphic homogeneity of these deposits, and the potential for discrepancies that may have been made in other aspects of recording. Level 7 by contrast was larger (0.85m^3 excavated) and one of the richest strata in the whole sequence. Level 8 is also relatively rich, but a thinner deposit (0.405m^3 excavated).

The thinness, lack of features, and preference for exotic (though the distance has not been verified) lithic materials from levels 4-6 has led Straus and Clark to suggest that these levels represent a relatively short (or series thereof) occupations by people who were mobile around the landscape (Straus & Clark, 1986, 80-86). This apparent mobility, further evidenced by the presence of plains dwelling species in minor quantities, namely horse (levels 4 and 5) and bovines (level 4), along with visitations to the coast evidenced by shellfish deposits, has helped lead to the conclusion that this specialised ibex/red deer hunting aspect of the economy was an “added strategy for subsistence” (Clark & Straus, 1986, 352). Level 6 is somewhat of an intermediary level. The level is thin once more, and red deer and ibex are represented on a more level footing, however raw materials are less exotic (with quartz dominating the lithic industries), and a significant focus on laurel leaf points. Following this level, the occupants of La Riera made the transition to a red deer specialised economy.

While they are still the numerically dominant bladelet type in levels 4-5, the ratio of backed bladelets to other bladelets is much less pronounced than in the later levels of the sequence. However, when bladelets are broken into their individual subcategories, backed bladelets are still the only type recovered in any notable quantity. From being absent in levels 1-3, they account for 12 and 13% of the retouched assemblages in levels 4 and 5 respectively. Their presence continues through levels 6-8, though never reaching more than 5% of their retouched assemblages. From levels 9-12, they are absent once more. Thus when considered separately from the later levels of the La Riera sequence, levels 4 and 5 can be seen as a peak, albeit a minor one, in backed bladelet based activity. While this peak is not reflected in the debitage bladelets, the drop in levels 6-8 is (Figure 12).

3.9.1 **Faunal Representation**

The faunal assemblages of the early La Riera sequence are often typified as a mid-Palaeolithic exploitation of large steppe prey such as Bos/Bison and Horse (*Equus ferus*) in levels 1-3, supplanted by Spanish ibex (*Capra pyrenaica*) specialised hunting in levels 4-5 giving way to red deer (*Cervus elaphus*) hunting in following levels (Clark & Straus 1986, 352-353). There is a danger in this characterisation that more subtle trends might be concealed through simplification (graph 8). The biggest change between levels 2/3 and 4 is the drop in the importance of horse, from 32% and 49.8% of the faunal remains in levels 1 and 2 respectively, to 3.6% in level 4 and 1.5% in level 5. Bos/bison also fall below 5% from level 4, but were already in notable decline during levels 2/3, having dropped from 17.1% of the faunal remains in level 1 to 7.5%. Curiously, red deer also drop in representation from a dominant 44.3% in level 1, to 17.4 % in levels 2/3 before rising again in a consistent manner through levels 4 to 11. Ibex on the other hand rise from 5% of faunal remains in level

1, to 24.9% in level 2/3 before peaking in representation at 63.1% in level 4, before tailing off through layers 5 to 11 (Figure 15). Although levels 4 and 5 represent a significant early break in the faunal assemblages of La Riera, the preceding levels 1-3 were hardly homogenous.

Levels 4 and 5 signify the beginning of an economy based on two principal taxa. In these levels, ibex are the dominant taxa, and red deer are secondary. Their dominance is most pronounced in level 4, and by level 6 onwards, ibex are no longer clearly dominant, becoming secondary to red deer over the ensuing levels (Figure 15). By level 9 ibex fall below 25% of the faunal assemblages and never again exceed this quotient in the sequence, with the exception of in level 24. The focus on two species persists until level 25 when other prey began to be taken in notable quantities (> 5% of the faunal assemblage). Other prey was also taken during these levels, and although never in excess of 5% of the faunal assemblages, the inclusion of certain species and absence of others may still be of note. For example, although it does not occur in significant quantity, the presence of roe deer (*Capreolus capreolus*) in levels 6-11 having been absent in levels 2-5 may be indicative of slight changes in hunting practices relating to the shift away from ibex.

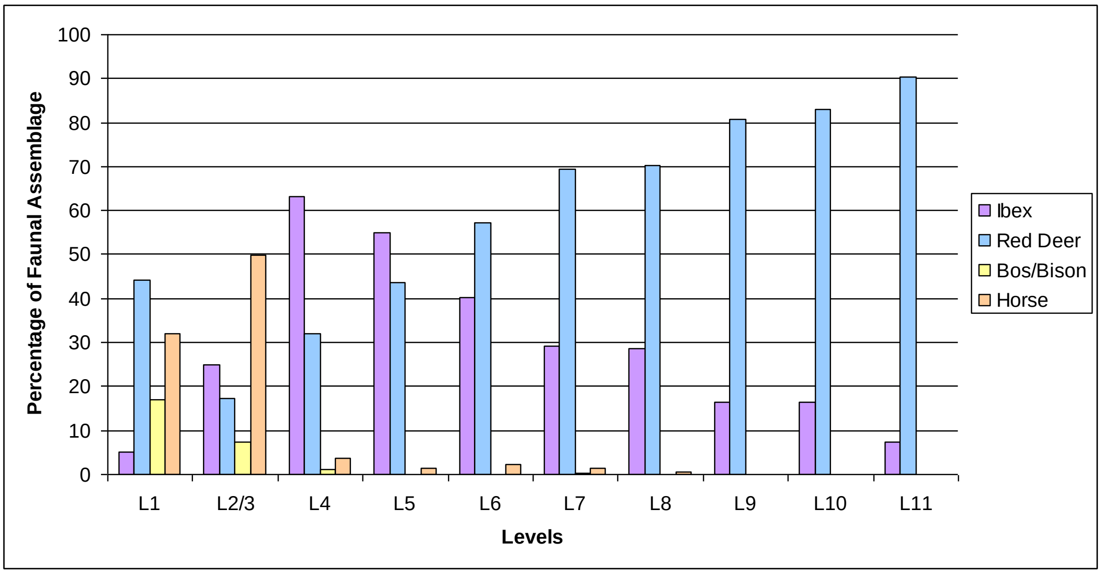


Figure 15: Graph showing faunal diversity (% NISP) in levels 1-11 at La Riera

3.9.2 Seasonality, Sexing, Adult/Juvenile Ratio and Carcass Representation

3.9.2.1 Ibex

It was impossible to determine the precise age of the seven young ibex recovered from levels 4-6 beyond knowing that they were not killed during the birthing months or immediately thereafter (May, June) due to the fact that their milk teeth were all worn (Altuna 1986c, 248). In levels 2-3 and 7-8 no comparable studies were conducted, but in level 1 one young ibex was killed at less than 4 months of age suggesting sometime in the summer (Ibid 1986b, 242). It should be noted that throughout all of these levels adults are more numerous than juveniles (MNI: 21), so the question of season of death remains uncertain for many individuals. In levels 4-8, where it has proved possible, the sexing of remains shows the ratio of females to outnumber that of males in all levels except level 6 (Table 7). Level 7 has an exceptionally high ratio of female to male ibex remains.

Level	Female	Male
4	7	3
5	4	3
6	0	1
7	14	1
8	3	1

Table 7: Sexed Elements of Ibex in levels 4-8 La Riera

While this does indeed suggest that females were more commonly hunted, it should be remembered that these are sexed remains and not individuals. It seems that whole or mostly whole ibex carcasses were being returned to the cave in levels 4-6, with a focus on the meat bearing hind quarters of the animals, and evidence to suggest the possibility of marrow extraction (Altuna 1986c, 248). This behaviour is similar to that exhibited in levels 2/3. Little of significance is noted as different in levels 7/8 for both ibex and red deer, except that the marked prevalence for hind limbs is more pronounced in red deer for those levels.

3.9.2.2 Red Deer

Unfortunately, comparable seasonality and sex data for the red deer remains from levels 4-6 are not available. Seasonality data for levels 7-8 suggest red deer were hunted throughout the year, with the exception of a small gap between September and December in level 8 (Altuna 1986c, 251). Throughout levels 1-8, the ratio of adults to juveniles varies much more than in ibex. The minimum numbers of juvenile and adult red deer are equal in level 7 (17 each). The number of juveniles is greater in levels 2/3 (2 young and 1 adult). In levels 1, 4-6, and 8, adults outnumber juveniles. In levels 4-8, the ratio of juveniles to adults in red deer is either equivalent to or less than that of ibex, whereas in levels 1-3 the reverse is true, with adult ibex more preferred to their young than red deer adults to theirs. Skeletal representation matches the same pattern as ibex in levels 4-6 and in levels 2/3.

3.9.3 **Climate and Palaeoenvironment**

The palynological data retrieved from levels 4 and 5 seem to show evidence of disturbance and do not fit well into the diagram (Leroi-Gourhan 1986, 59). The basal levels can be divided into level 1, which marks the end of a temperate zone featuring pine (*Pinus*), oak (*Quercus*) and hazel (*Corylus*), and levels 2 and 3 which mark a transitional episode with humid conditions, suggested by the presence of ferns (*Polypodium vulgare*) and Gramineae. With the exception of sporadic and small quantities of hazel, juniper and oak, the only tree species to survive well is pine. The first evidence of an Atlantic ericaceous heath also appears at this time. Following a hiatus in the record, level 4 shows the ericaceous heath to have widely colonised at the expense of Gramineae in a cold, dry episode. It has been suggested that these conditions, which do not favour horse and bovines proved the catalyst for a shift towards ibex and red deer hunting in different habitats (Leroi-Gourhan 1986, 63).

Levels 4-8 were seemingly deposited under similar climatic and environmental conditions, about the most severe cold of the Upper Pleniglacial (Straus 1986c, 69). As a whole, this block can be characterised by dry open vegetation, combining aspects of heath and steppe along the coastal plain with very few thermophilic tree taxa. The cold conditions are attested to by the presence of the tundra vole (*Microtus oeconomus*) in level 7.

3.9.4 **Solutrean Points**

The early levels of the La Riera sequence are when Solutrean points Figure 16 are found in their greatest quantities. First appearing in level 2, they occur in every level until level 10, with some laurel leaf and willow leaf points occurring in levels 14, 15 and 17. Differences in trends can be identified when broken into their subcategories. Shouldered points first appear in level 3 (< 4% of the retouched assemblage), and peak in level 4 (18.87%), remaining high in level 5 (13.23%) before diminishing in level 6 (5.13%). Rising again in level 7 (9.4%), they nevertheless disappear altogether after level 8 (< 2%) with the exception of a single point recovered from level 10 (Figure 17).

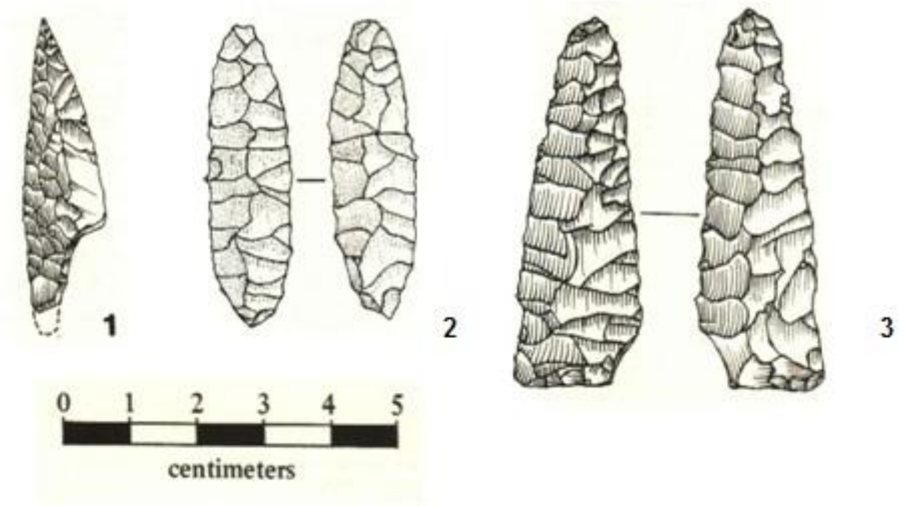


Figure 16: Solutrean Points from La Riera. 1 Shouldered Point – level 4; 2 Willow Leaf Point – level 9; Concave Base Laurel Leaf Point – level 6

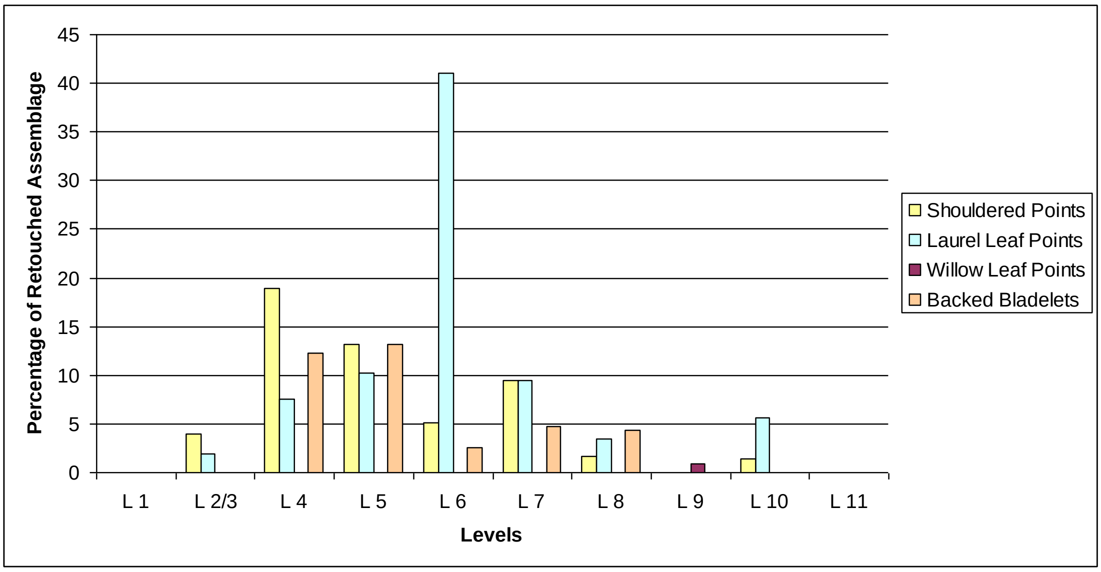


Figure 17: Graph showing Solutrean Point types at La Riera levels 1-10

In contrast, the laurel leaf points, the first of which appears in level 2, are absent from level 3, before rising throughout levels 4 and 5 before a massive peak (41.02%) in level 6. Following this, they fall to a quantity comparable with earlier deposits in level 7, diminishing further in level 8 (< 4%) followed by absence in level 9. However, unlike the shouldered points, the laurel leafs also feature in levels 10, 14 and 15. Only 2 willow leaf points were recovered from the La Riera sequence: one from level 9, and the other from level 17.

3.9.5 **Raw Materials**

Straus et al. divided this section of the sequence into two groups (levels 2-5 and levels 6-16) of raw materials according to whether flint or quartzite dominated as a material (1986,204-205). Quantities of backed bladelets in most of these levels were insufficient for my reanalysis of the raw materials. Levels 2-5 were noted for featuring exotic flint types less common from other levels, though it should be noted that these types are only exotic relative to other materials at the site; they were also probably found locally and their absolute quantities are small (Straus 1992,104). Levels 4-5 were acknowledged as having specialised artefact and fauna assemblages compared to levels 2-3, and level 6 which had similarly specialised assemblages, varied by having a very different raw material composition (1986, 204). Level 4 marks a notable increase in the breadth of flint materials over levels 2 and 3. The number in level 3 doubles from 7 types to 14 in level 4. Overall, flint type B becomes the most dominant flint from level 4 until level 13, having been second in levels 1 – 3. It is dominant over the next type by 11% in level 4 (Type A) and by 7% in level 5 (Type Q). Flint type C is the second most dominant material in levels 6-8.

3.9.6 **Bone Points**

Like the Solutrean points, bone and antler points were not included in (Appendix 1). Only 136 sagaie point fragments were recovered from La Riera, and the small sample size combined with uneven distribution makes interpretation difficult. It has been noted that levels 3-10 are rich in lithic points, and that sagaie/point fragments gain in importance later in the sequence (González Morales 1986, 217). However, I would go further and note that the greatest increase numerically is between the grouping of levels 3-6 (7 point fragments) and levels 7-10 (34 point fragments) (Table 7). From level 7 onwards the importance of Solutrean points begins to diminish. The rise in bone saigaie and points seems to correlate with the reduction of significance in Solutrean points throughout these levels.

3.9.7 **Conclusions**

Such is the wealth of data at La Riera that it is difficult to elucidate much of a coherent pattern from the reviews of individual categories of evidence as presented above. A number of trends are apparent however, seemingly pertaining to the hunting of ibex relative to other species. Below clearly isolates these trends.

	% Ibex Remains	Climate	% Backed Bladelets	% Shouldered Points
Level 1	5		0	0
Level 2	24.9		0	0
Level 3			0	3.9
Level 4	63.1	Cold, dry & very few trees	12	18.9
Level 5	55		13	13.2
Level 6	40.3		3	5.1
Level 7	25		5	9.4
Level 8	28.6		4	1.7
Level 9	16.5		0	0
Level 10	16.4		0	1.4
Level 11	7.5		0	0

Figure 18: Correlation between Ibex, climate, backed bladelets and shouldered points in levels 4-8 at La Riera

Levels 4-5 have already been noted as evidence of specialised ibex hunting, giving way in level 6 to the beginnings of a shift in focus towards red deer. The reassessment of data as surmised in the diagram above allows further comment. Based upon this evidence, ibex were an economically important species throughout the cold and dry conditions of the LGM, the prelude to which is noted in the climatic assessment of level 3. Solutrean shouldered points were probably associated with the pursuit of this prey, and backed bladelets seem to have been used in conjunction with, or at least as a contemporary alternative to this technology. With the end of the cold conditions in level 8, ibex ceased to feature as prominently in Solutrean economy, accounting for less than 25% of faunal assemblages. This also marks the effective end of Solutrean shouldered points and backed bladelets as prominent features of the early La Riera sequence. A further possible correlation is the rise in representation of bone point/sagaie pieces contra to shouldered points and backed bladelets (Table 8).

	% Shouldered Points	No. of Bone Point / Sagaie Pieces
Level 1	0	
Level 2	0	
Level 3	3.9	7
Level 4	18.9	
Level 5	13.2	
Level 6	5.1	
Level 7	9.4	34
Level 8	1.7	
Level 9	0	
Level 10	1.4	
Level 11	0	37
Level 12	0	
Level 13	0	
Level 14	0	
Level 15	0	
Level 16	0	
Level 17	0	

Table 8: Shouldered Points and bone points/sagaies from La Riera levels 1-17 from Gonzalez Morales (1986)

Figure 18 is deliberately selective in order to clearly illustrate certain trends. There are various details of the archaeological record that this presentation overlooks, but these may also be factored in for consideration. The relationship between three of the evidence categories presented above are strengthened when it is considered that the peak representation of backed bladelets and shouldered points coincides with levels 4-5, when ibex are the dominant species represented. Red deer are also synchronised with the trend presented above between levels 3-5, but continue to rise in representation as ibex, backed bladelets and shouldered points wane. While this seems to further support the relationship between ibex and this hunting technology, there is no suggestion that this is an exclusive relationship by any means. It is interesting to note the appearance of roe deer in minor quantities in levels 6-11 considering this species' preference for wooded habitats of more temperate conditions. It is, however, notably absent from levels 4 and 5 when ibex are the dominant fauna. Their appearance might link to the shift in focus towards red deer as hunting trips perhaps shifted to lower elevations away from ibex habitats.

Inferences regarding the seasonality of hunting are difficult, as while we know that ibex were most likely taken during the autumn and winter during levels 4-6, there are no suitable remains in levels 7-8 with which to compare and contrast. In general however, it has been noted that most other ibex yielding levels where there have been suitable remains for seasonality studies have suggested that late spring/early summer was preferred. In this regard levels 4-6 stand out in the context of the broader sequence. The fact that the seven juvenile individuals were dispersed throughout the deposits Table 9 means that the significance of the continuation of this pattern into level 6 remains speculative. Red deer remains from levels 7-8 suggest hunting occurred throughout much of, if not the whole year. This further suggests a change from the mobility pattern witnessed in levels 4-5, to either more permanent or more frequent visitations.

	Min. Number of Juvenile Ibex
Level 4	2
Level 5	2
Level 6	1
Levels 4-6*	2

*Remains from Levels 4-6 were combined during excavation.

Table 9: Dispersal of identified juvenile ibex from levels 4-6 at La Riera

The increased exoticness of flint materials in levels 2-5 is well documented, but the most significant increase is in levels 4-5, which is also characterised by an increase in the breadth of lithic materials with more flint. Flint types revert to more commonly found materials from level 6 onwards, when quartzite is once more the dominant overarching raw material type. This shift may possibly relate to the supplanting of ibex as the dominant fauna by red deer and the reduction in importance of shouldered points and backed bladelets. This is further supported by the idea that a shift in raw material procurement to more abundant local resources being representative of a shift in mobility patterns (Straus & Clark 1986b, 89). There is a proliferation of laurel leaf points in level 6, many with concave bases, and these are preferentially made on quartzite whereas shouldered points are almost exclusively flint (Straus 1992, 104).

It is apparent that the relationship between the correlates is far from simple. However, when the extra considerations discussed above are integrated with the evidence used to illustrate the trend presented in Figure 18, further interpretation is possible. It seems that the behaviour of the occupants of La Riera changed between levels 5 and 7. A shift in raw material procurement strategies is evidenced in level 6, combined with the rise of red deer as the primary species economically. The possibility of a change in seasonal exploitation of prey in the much thicker level 7 further suggests that the broader mobility pattern of La Riera's occupants changed. Level 6 seems a key transitional stage in this possible shift. With this shift, utilisation of the cave probably also changed, and it seems that this marked the beginning of a reduction in focus on ibex with shouldered points and backed bladelets, with red deer taking precedence. Over the course of levels 6-8, quartzite materials became increasingly dominant over flint, possibly matching this shift. The limited evidence for bone points also seems to increase in importance from level 7 onwards.

3.10 Bladelet Based Hunting at La Riera: Levels 17-28

This stage of the La Riera sequence is larger and in many respects more variable than the earlier levels assessed above. Broadly speaking, levels 17-20 (Figure 9) represent a consistent peak in backed bladelet representation, followed by fluctuation throughout the remainder of the sequence. As with levels 4-8, these levels are considered in the context of some of the bracketing deposits to help further elicit interpretation, and also because backed bladelets are present (although in less substantial quantities) in levels 13-16 and 29.

3.10.1 Stratigraphy

The latter half of the La Riera sequence was spatially constricted, providing a smaller excavation area from level 24 onwards (Straus & Clark 1986a, 13). To reiterate complications discussed earlier, levels 19-20 were partially discarded, levels 21-23 are conflated and yielded a paucity of finds, and level 25 likely represents a fleeting occupation incomparable with other deposits. Level 28 also yielded relatively small lithic and faunal assemblages. These issues add to the challenge of inferring patterns from the later deposits of La Riera.

3.10.2 **Backed Bladelets in Levels 17-28**

The second period of the La Riera sequence characterised by a proliferation of backed bladelets spans between levels 17-28. The ratio of backed bladelets to other bladelet types is much greater than in the earlier sequence, suggesting a more concentrated focus on their use in later levels. The peak quantities of backed bladelets recovered from level 17 is unprecedented following the steady but small rise in levels 14-16 (Figure 9). Proportionally, quantities remain comparably high in levels 18-20 before reducing to 16% of the retouched assemblage in levels 21-23. The remainder of the sequence exhibits fluctuation, with peaks in levels 24 and 28, and a trough in level 26. Level 27 represents an intermediary quantity between level 26 and 28. The peaks in levels 24 and 28 are not as substantial as in levels 17-20. The sequence terminates in level 29, where backed bladelets are greatly reduced in representation relative to earlier levels.

3.10.3 **Backed Microlithic Points**

The microlithic points at La Riera can be divided into three main types (Figure 19): Font Yves points, which are Aurignacian in their origins, although regularly microlithic in nature, Microgravettes, which are scaled down models of the larger Gravettian points, and Azilian points, so called because of their originally perceived association with the Azilian phenomena, and characterised by being curved along the backed edge of the point. As well as being straight-backed, microgravettes are generally not very thick, relative to Azilian points which can be (Ibánez Estevez and González Urquijo 1996, 39). These points do not appear in the La Riera sequence until the latter stages of the sequence, with the exception of a single Font Yves point in level 8.

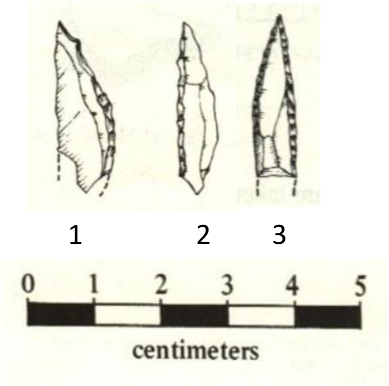


Figure 19: Types of microlithic point from La Riera. 1 Azilian Point – level 24; 2 Microgravette – level 24; 3 Font Yves Point – level 26

Figure 20 shows the quantity of these points relative to backed bladelets as a proportion of retouched assemblages and Figure 21 breaks these points into their constituent types. It is interesting to note the dearth of microlithic points from levels 17-20, when backed bladelets are at by far their most dominant, although they are not entirely absent from levels 19 and 20. After a rise in representation in level 24, microlithic points account for just over 10% of the retouched assemblages in levels 26-28. Microgravettes peak in level 26, sharing dominance with Azilian points, and Font Yves points also appear in this level for the first time since level 16 (Figure 21). Azilian points dominate in levels 27 and 28. Generally, numbers of backed bladelets surpass microlithic points in most levels where both are present. Surprisingly, the retouched assemblage with the greatest proportion of microlithic points is level 26, noted for low numbers of backed bladelets, with the effect of approximately equal quantities of both (Figure 20). Although comparable proportions of microlithic points are found in levels 27 and 28, a greater ratio of backed bladelets is resumed.

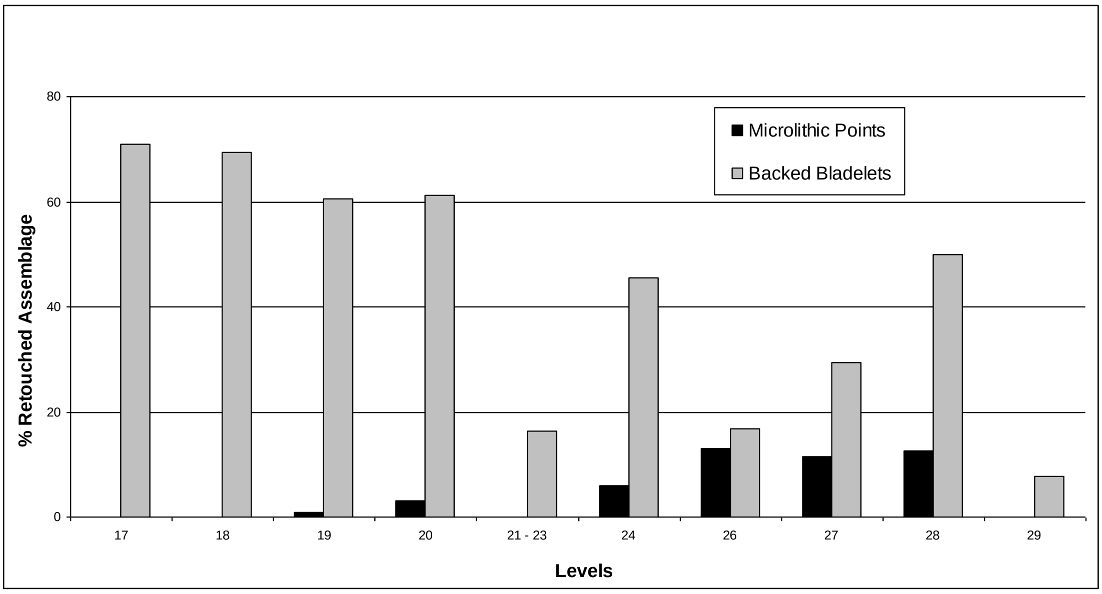


Figure 20: Microlithic Points and Backed Bladelets as a Percentage of Retouched Assemblages in Levels 17-29

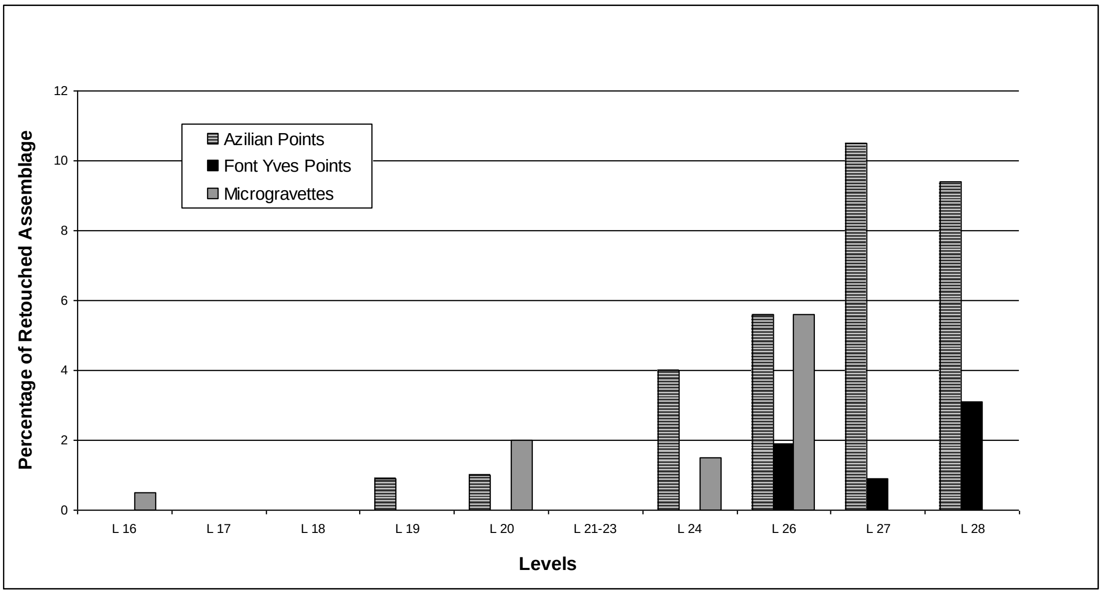


Figure 21: Microlithic points from La Riera levels 16-28

3.10.4 **Bone and Antler Points and Sagaie**

The section profile of bone and antler points and sagaies are often used as fossil indicators for distinguishing between different periods in Cantabrian Spain. Their reliability in this capacity is questionable. For example, level 18 of La Riera is assigned to the lower Magdalenian, and accordingly should yield quadrangular sagaies, yet 9 round or oval points were found to just 3 square/rectangular section pieces (González Morales 1986, 213). Only four point fragments were recovered from level 17, of various cross sections (Straus & Clark 1986b, 136). The rest of levels 19-23 are characterised by a majority of quadrangular points. The presence of one small, circular-sectioned biserial antler harpoon has led to level 24 being assigned to the late Magdalenian, and level 26 is ascribed to the terminal Magdalenian because of a single biserial antler harpoon fragment (Straus & Clark, 1986, 162; 166). Likewise level 28 yielded a singular and nearly complete, flat, uniserial harpoon deemed as characteristic of the Azilian (Ibid, 177). Worked bone in level 27 is negligible.

Overall, sagaies increase in number beginning in level 14 with the first appearance of quadrangular section pieces in level 15 (González Morales 1986, 213). Quantities drop in levels 21-23, along with all other bone artefacts. Level 24 has the largest osseous assemblage, but sagaies form a relatively small portion (30%) of it and in levels 26-28, the bone assemblages as a whole are greatly reduced (ibid: 218). The numerical peak of sagaie point representation is in levels 18-20. Distinction between bone and antler as materials is not always clear throughout the La Riera report.

3.10.5 **Raw Materials**

As Figure 14 shows, levels 17-24 represent a continuum of flint dominated levels. This pattern is also evidenced in Figure 13 where flint is at its closest in weight to quartzite for the latter part of the site sequence. Reanalysis of the raw materials has revealed little about the relationship of shifts in raw material procurement and the shift towards backed bladelet technology. Levels 18-28 are characterised by a narrower focus of dominant materials. With the exception of levels 17 and 26, a single type dominates by a greater majority in these levels than the dominant types in quartzite dominated levels 6-16. Type B dominates in levels 18-24, and type A in levels 27-28. Type A dominates in levels 17 and 26, but by much less substantial margins. In general, backed bladelet dominated levels have a greater diversity of flint types represented. Level 28 has an unusually narrow breadth of materials for a level with a majority of backed bladelets. Ultimately, the observed patterns in these levels cannot be entirely confirmed as relating to backed bladelet manufacture.

3.10.6 **Climate and Palaeoenvironment**

Levels 17-18 mark a cooling period following the climatic optimum experienced in level 15, and levels 19 and 20 continue this trend into a progressively colder and drier period (Laville 1986, 41), probably marking the event of Dryas I (Straus 1986c, 70). In level 16 the replacement of ericaceous heath with composites (Liguliflorae and Tubuliflorae), a family including the daisy and aster, began, as the area turned into a dry steppe environment (Leroi-Gourhan 1986, 62). Arboreal pollen is low in these levels, although oak, elm, willow, alder, hazel and birch were still present. From this point onwards, there are a number of disparities between the results of the sedimentological and palynological investigations. Both methods have associated problems, but palynology is arguably the weaker of the analyses in this case at least. Problems with cave taphonomy including vertical movement across stratigraphic levels as noted by Straus (1986, 19), the colourful history of the site subsequent to its prehistoric occupation, and the possibility of localised microhabitats overshadowing broader landscape environments, are just some potential complications. These problems are further compounded in levels 21-23 due to its conflation into one excavation unit.

Straus' synthesis of palaeoenvironment references Butzer's regional study (1981) among others, to aid contextualisation, though gaps in sequences and other complications prevent consensus on some interpretations. Levels 21-23 most likely represent a consistently humid period tempered by some extremely low temperatures (Straus 1986c, 71). Poor resolution of climatic fluctuation and a paucity of material remains prohibit any strong associations being made with the relative drop of backed bladelets (down to 16% of the retouched assemblage) in these levels. Level 24 is dated to the Alleröd, but probably pertains to Dryas II at the beginning of this phase, characterised by cold temperatures and very humid conditions. Heather and Juniper are absent from this level, and although oak, alder and hazel pollen are present in small/trace amounts, pine pollen is very abundant. Composites continue to outnumber gramineae, and ferns begin a meteoric increase (Ibid 1986). Five reindeer remains recovered from this level also confirm the climate of this time.

Levels 25-26 seem more typical of the Alleröd, with very temperate, humid climatic conditions. Roe deer and wild boar are relatively abundant for the first time, and level 26 shows a dramatic increase in arboreal pollen, with high percentages of birch, pine and hazel (Straus 1986c). Levels 27 and 28 correspond to Dryas III, the last cold snap of the Pleistocene, and would have experienced some severe cold conditions as suggested by the presence of the tundra vole (*Microtus oeconomus*) in level 27. This has led to the suggestion that the temperate portrayal from the pollen sample from level 27 belies the colder nature of the climate, as a result of representing a protected valley microenvironment (Straus & Clark, 1986, 175). Level 28 represents a marked reduction in arboreal pollen, though overall quantities remain high, suggesting this cold period was not enough to incur complete deforestation. Overall, while biotopes changed to a great degree in the later levels of La Riera, climatic oscillations never completely forested or deforested the landscape. Level 29, however, which marks the beginning of the Asturian, and a number of significant changes in the archaeology of the site and broader region, is notable for an enormous percentage of arboreal pollen (ca. 50%). From this point onwards, the Cantabrian lowland coastal plain would have been characterised by dense mixed deciduous forest.

3.10.7 **Fauna**

Red deer are the dominant fauna in every level of the La Riera sequence from level 6 onwards. Between levels 9 to levels 21-23 representation is relatively consistent, never falling below 75% of the faunal remains, and accounting for up to 85% in some levels, with a peak value of 90.4% recorded in level 11. As Figure 22 shows, following a drop to 52.2% in level 24, red deer representation is between 67 and 77% for the remainder of the sequence until level 29, peaking finally at 84.3%. The slight drop in dominance in these levels corresponds with the diversification of fauna being exploited at La Riera at this time.

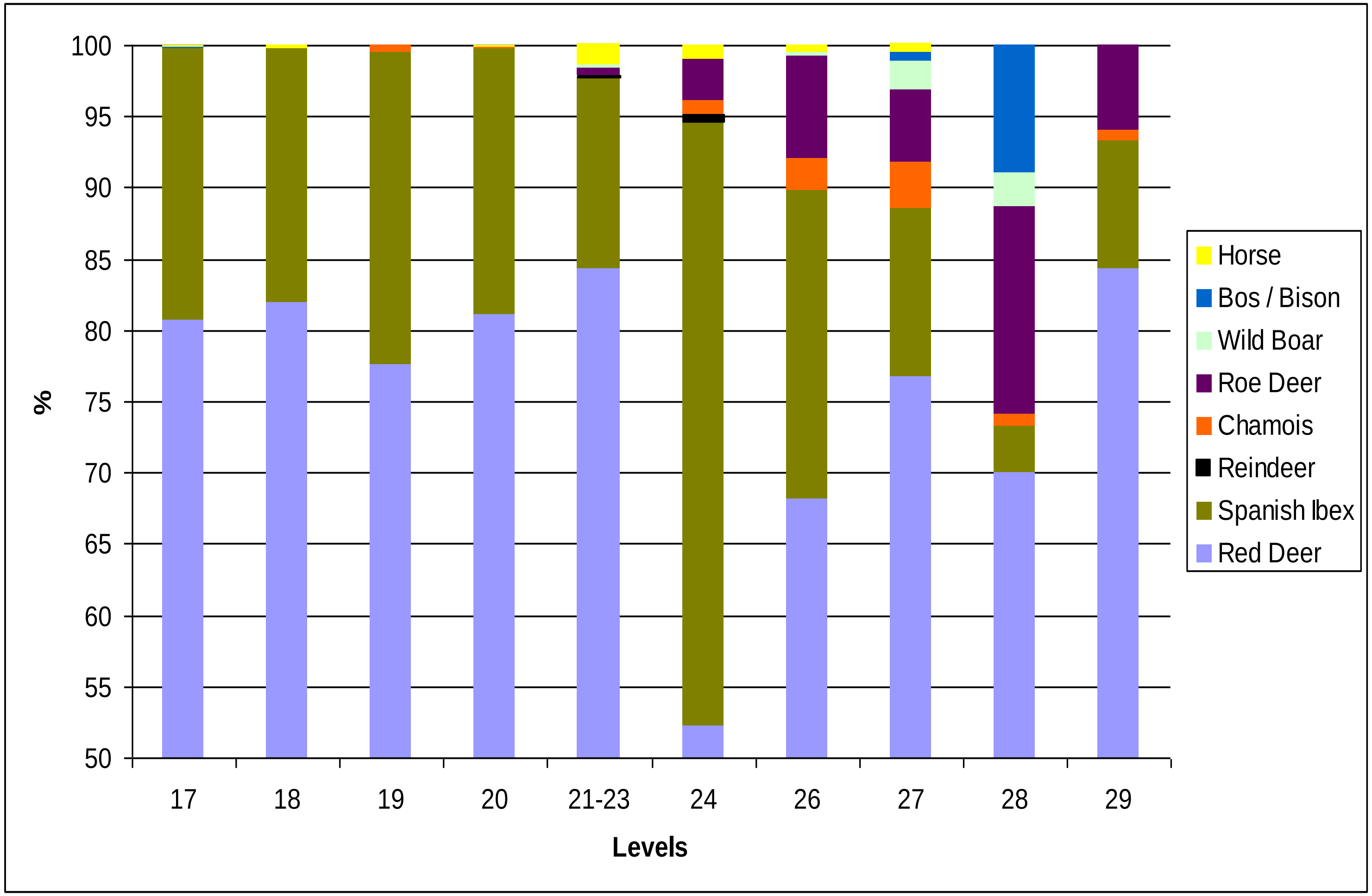


Figure 22: Percentage Breakdown of La Riera Ungulate Fauna levels 17-29

Patterns among the less represented species are complex. The drop in red deer in level 24 is evidence of a much stronger emphasis on ibex (42.4%). Bos/bison also make enough of a return in level 28 (8.9%) to rank as the third most represented species in the latter deposit (Appendix 1). From level 24 onwards, roe deer feature as a notable taxon, particularly in level 28 where representation peaks at 14.6% of the faunal assemblage. Prior to this level, roe deer had been present at times, but never accounting for more than 2.5% of an assemblage. Wild boar (*Sus scrofa*) appear for the first time in levels 21-23, and their presence throughout levels 26-28 is notable as an indicator of changes in environment. Even chamois (*Rupicapra rupicapra*), which is present throughout most of the La Riera sequence but only in minor quantities, reaches peak representation at 3.3% in level 27.

The general increase of roe deer and wild boar towards the end of the sequence is taken to indicate an increase in localised thermophilic forested habitats preferred by these species. Some levels have evidence of ecologically contradictory fauna, such as the presence (barely visible in Figure 22) of reindeer (*Rangifer tarandus*) and wild boar in neighbouring levels (levels 22 and 23). This most likely indicates the complexity of changing biotopes, and suggests that the scales of some changes may not always be clearly visible at the resolution provided by the archaeological record. Beyond these interpretations however, it is difficult to gain a detailed impression of the economic value of these species individually when present in such small quantities. Their collective presence in these later levels reflects changing environments and at least experimentation with alternative prey, even if red deer remain the presiding taxa.

3.10.8 **Seasonality, Sexing, Adult/Juvenile Ratio and Carcass Representation**

3.10.9 **Seasonality**

Information on the season of death of adult animals is lacking (Clark & Straus 1986, 353), and given that there are generally more adults, it must be accepted that seasonality data on the hunting of different species is severely restricted. Seasonality data at La Riera is mostly obtained from individuals of all species under 3 years of age. Figure 23 shows a crude maximal estimation of seasonality based on red deer and ibex remains from levels 9-28 based on the analysis by Altuna (1986c). Levels 13-15 and 25-27 were conflated in his analysis and consequently the chart reflects this.

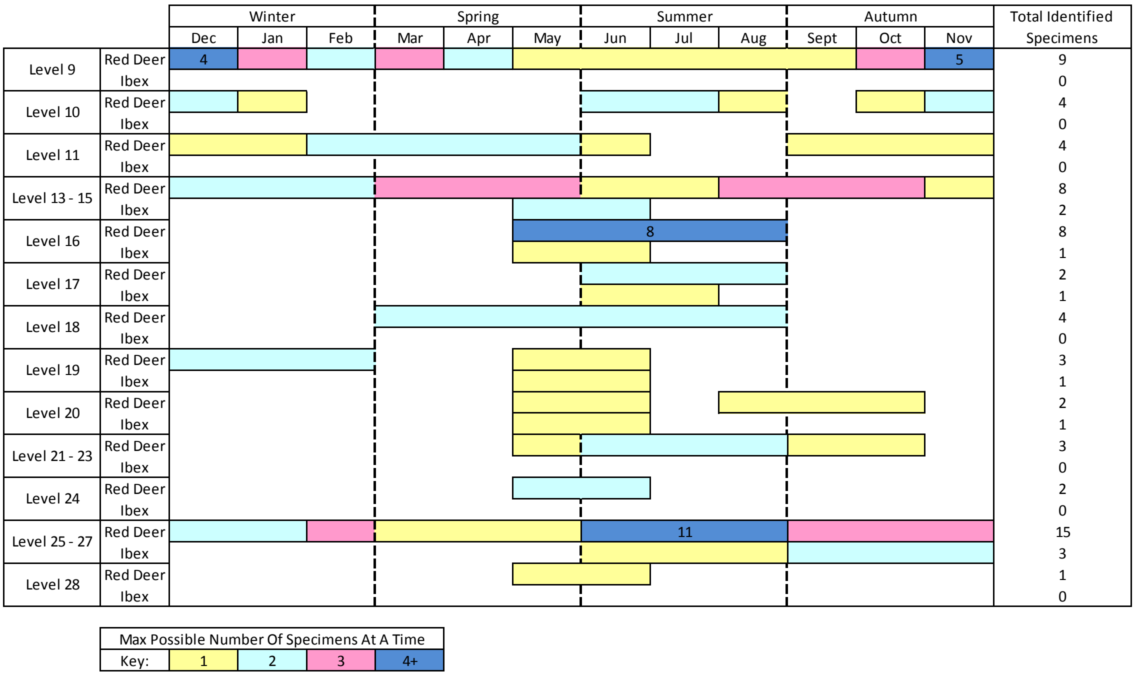


Figure 23: Maximal Estimation of Seasonality Based on Red Deer and Ibex Remains From La Riera Levels 9-28

The season of death recorded from red deer and ibex in levels 16 and 17 suggest the cave was used heavily in the summer. Summer and spring periods are recorded for red deer in level 18, with no results recorded for ibex. Clark and Straus state that spring kills are not clearly apparent from level 18 onwards (1986, 353), even though Altuna clearly states that two red deer juveniles were taken in their second spring (1986c, 258). Level 19 shows a bi-seasonal pattern with summer (1 red deer and one ibex) and winter kills (two red deer) represented.

In level 20, a red deer and an ibex were killed soon after birth (presumably in the summer months), and one red deer died between late summer and autumn (Altuna 1986c, 259-262). The age at death was recorded for three red deer from levels 21-23, with no indication of a specific provenance within this unit. They were killed between summer and autumn, but the significance of these results is greatly reduced when the expanse of time in question is considered. Two young red deer fawns killed soon after birth would also suggest a summer season of death during level 24.

The season of death recorded for animals in levels 25-27 is presented in. Figure 24 This figure was originally labelled as showing only red deer deaths, though I believe this to be a misnomer due to the major disparity with Altuna's written summary of the levels. Unfortunately, if true, this mistake prohibits the identification of the species each plot represents on the seasonality chart. The species that have been labelled in are inferences based upon MNI data for adults and juveniles (Altuna, 1986b: B.85), and the following information provided by Altuna: Among summer deaths, there are eleven red deer, one ibex, three roe deer and two boar, with all but one red deer being killed within their first summer. One red deer and two ibex died in the autumn, two red deer in autumn or winter, one boar in the winter, and one red deer at the end of winter or in spring (1986c: 265).

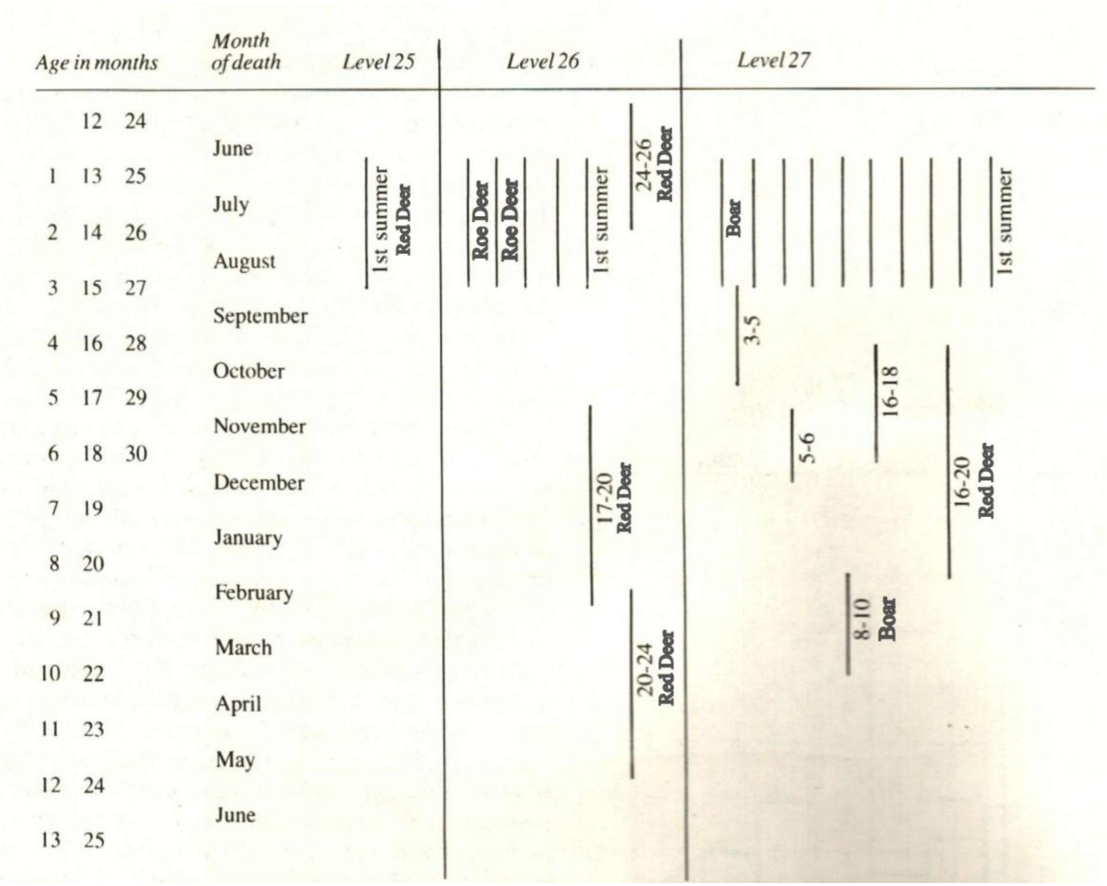


Figure 24: Seasonality Recorded in La Riera Levels 25-27 adapted from Altuna 1986

Based on what little can be reconstructed from Figure 24 it can be safely said that there was a significant focus on taking prey not long after birth within their first summers. This was the only season of death recorded for roe deer. Other than this, red deer seem to have been taken during the autumn and winter and possibly (in level 26) the spring. Boar were being taken in the winter (level 27), and ibex in the autumn (level 27).

The season of death was ascertained for only one specimen from level 28: a red deer fawn killed soon after birth at the end of spring or early summer (Altuna 1986c, 267). Of the two red deer juveniles recorded in level 29, one was killed soon after birth (likely summer?) and the other between 17 and 21 months of age, some time between November and March (Ibid 1986a, 268).

3.10.10**Adult/Juvenile Ratio**

The minor quantities of most species recovered renders it difficult to infer anything meaningful from the adult/juvenile ratios recorded. Occasionally, sufficient remains allow for some inference. For example, the four wild boar individuals identified in level 27 are all juvenile, whereas there were three juvenile and three adult roe deer recovered from level 26. Long term trends in the hunting of these taxa are generally difficult to reconstruct though. Red deer remains are numerous enough to permit further investigation.

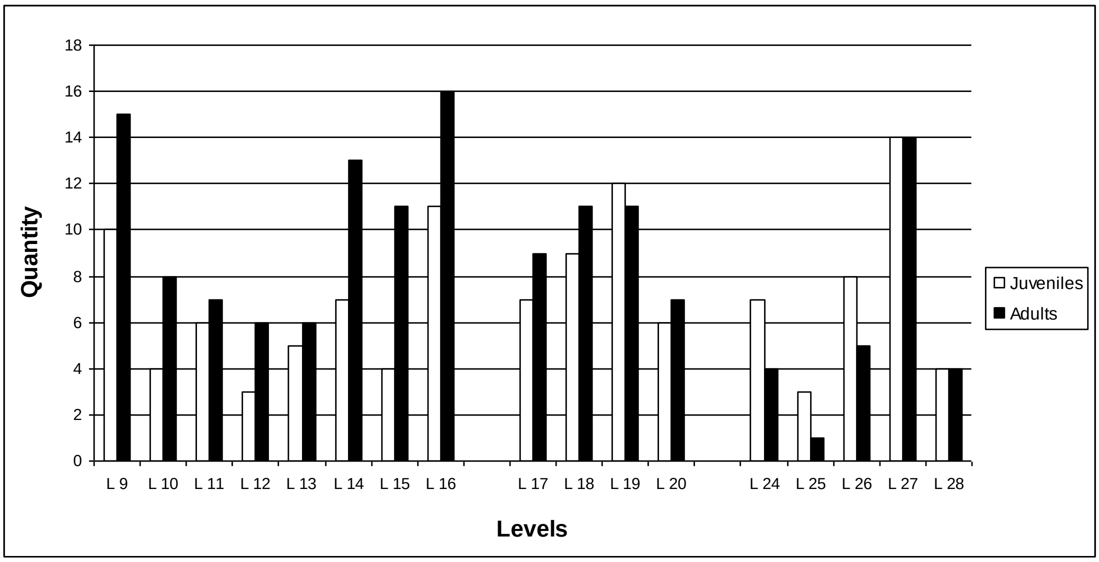


Figure 25: Minimum number of adult and juvenile Red deer from La Riera levels 9-28

Figure 25 reveals that in levels 17-20, there is a generally greater representation of juvenile red deer than in levels 9-16, though it should be noted that levels 11-13 have similar ratios. Figure 25 also shows that from levels 24-28, juvenile red deer are either equal to, or greater in number than adult red deer. Limitations of the MNI data render it impossible to certify the extent to which these patterns are actually true, but there is little reason to suggest they are not broadly representative. Levels 21-23 have been excluded for lacking a suitable quota of data for comparable assessment.

3.10.11 **Carcass Representation**

Overall, skeletal element representation remains relatively consistent throughout levels 16-29, with Altuna repeatedly citing previous levels as being comparable in their structure (1986c). The general trend shows that whole bodies were often being returned to the cave, with a general preference for hind limbs. There are nuanced variations along this theme. For example, level 29 is notable as the first level where forelimbs exceed hindquarters, and ibex limb bones reach their highest proportional representation in levels 21-23 (Ibid 1986a, 268; 262). Studies have, again, largely been restricted to red deer and ibex as the two taxa with sufficiently consistent quantities of remains.

3.10.12 **Sexing**

It was possible in most levels to sex at least some remains. However, reconciling sexed remains with MNI is highly problematic. In levels 16 and 17, there are similar numbers of male and female red deer and ibex skeletal remains (Altuna 1986c, 258). However, the presence of 57 small red deer antler fragments greatly bolsters the number of male remains, even though we have no idea how many individuals these fragments pertain to. For example, in level 18, fourteen remains of red deer were sexed as female to twenty-nine male, except for the fact that 28 of the male remains comprise fragmented antler pieces (Altuna 1986b, B.62). When it is considered that there are only 28 antler fragments from an assemblage of 1,648 red deer remains, this statistic could actually be portrayed as indicative of a preference towards females. In level 19, by contrast, 36 small red deer antler fragments were found in contrast to one single female metacarpal. The absence of non-antler material for sexing in this level creates the quite probably false impression of a male dominance.

As has been demonstrated by reviewing the sexed remains of levels 16-19, sexing hunted populations is highly problematic, particularly as the non-skeletal remains sexed from many of these levels are extremely few. This renders reviewing each level in detail relatively redundant. The only deposits where notable numbers of skeletal remains were sexed were levels 26-27. The trend identified in these levels was of a dominance of female remains in all red deer and ibex, as well as wild boar in level 26 (Altuna 1986b, B.86). While individually each species does not have many female remains, these are greater emphasised by the complete absence of male remains except for 9 red deer antler fragments in level 27. The fact that this representation of female remains occurs across more than one species has led the site investigators to suggest that a female targeting hunting pattern went in hand with the strategy of targeting young of all species within the first Summer months after birth (Altuna 1986c, 265-267), a strategy that is also apparent in these levels.

3.10.13 **Conclusions**

It is difficult to discern any clear trends that match the fluctuation of backed bladelets throughout the later levels of the La Riera sequence. Although by no means exclusive, backed bladelets seem to be most prolific in levels characterised by cold or cooling conditions rather than more temperate environments. This pattern is similar to that exhibited in levels 4-8. In terms of vegetation coverage, it can be said that there is a general association with more open landscapes. The peak quantities of backed bladelets recovered from levels 17-20 coincide with an increase in composites and steppe vegetation at the expense of ericaceous heath, and a drop in arboreal pollen from preceding levels. Level 24 suggests a similarly open environment, although pine pollen is abundant and ferns begin to rise in number significantly (Straus 1986c, 71), and level 28 represents a sharp dip in arboreal pollen, though wooded areas comprising thermophilic species remained during this cold period.

While backed bladelets are at their most numerous in these levels, they still account for substantial portions of the retouched assemblages in levels 21-23, 26 and 27 when compared with other tool types. While they are at their most numerous in cooler/cold levels characterised by open landscapes, this is by no means a strict association.

While it seems fair to note the concurrent shift in local landscape vegetation with the peak of backed bladelets in levels 17-20, correlations in later levels are less clear.

From levels 21-23 onwards, the diversity of species represented in faunal assemblages increases. The prominent rise of ibex in level 24 recalls the earlier period of ibex hunting with backed bladelets (levels 4-8). Although their dominance is slightly diminished from levels 24-28, red deer remain the dominant prey throughout the sequence. The broadening diversification of prey probably reflects the overall trend of ameliorating climate, with each cold period being less severe than the last (Arroyo, 2009b). This perhaps explains how roe deer and wild boar are at their highest representation proportionally in level 28 despite being a period characterised by cold conditions.

Closer analysis of the faunal assemblages reveals an interesting trend in the ratio of red deer young and adults (Figure 25). Juveniles increase in importance in levels with high quantities of backed bladelets, and remain approximately equal to or greater than adults throughout the later sequence. Beyond an apparent trend for targeting females and young of red deer, ibex and wild boar in levels 26 and 27, little can be reliably inferred from sexed remains. Also in these levels, it has been noted that although red deer were probably being hunted throughout much of the year, there was a clear emphasis on taking juveniles in the summer months not long after birth. The popular period for this, ranging from late spring to summer, is roughly equivalent for ibex as well. Whereas levels 9-15 are characterised by more generalised patterns of seasonal exploitation, from level 16 onwards, a shift in focus to late spring / summer is apparent. This coincides with an appreciable rise in backed bladelet quantities, presaging the substantial majorities of levels 17-20, and also the inception of a progressively cooling trend in the wake of the climatic optimum reached in level 15.

The raw material structure of assemblages with backed bladelet majorities are also characterised by subtle differences in comparison with earlier levels. Levels 18-28, with the exception of level 26, have a greater emphasis on a singular dominant flint type and variation in the quantities of flint types is much higher in these levels. Type B is clearly dominant in levels 18-24, and Type A in levels 27-28. Type A also dominates in levels 17 and 26, but by much less substantial margins. The pattern of raw material use in level 28 differs most notably from other backed bladelet dominated levels, and has fewer total types represented. Level 17 is also unusual in that it is characterised by a more evenly spread focus of materials, unlike the following levels 18-20.

Finally, it is interesting to note that trends in the number of microlithic points are not synchronous with backed bladelets. Most of these points were recovered from levels 24-28, when quantities of backed bladelets fluctuated. In level 26, they nearly equal the total number of backed bladelets. When broken into their constituent types, it can be seen that Azilian points, while present in levels 24 and 26, peak in levels 27 and 28. Microgravettes share their last appearance in level 26 with the first Font Yves points (excluding one recovered from level 8), which peak in level 28. Beyond an absence in levels 17-20, the relation between these points and backed bladelets, if indeed there is one, is not immediately apparent. It is interesting to note that bone and antler points reach their peak representation in levels 18-20 when backed bladelets are at a peak, and are present in reduced quantities in the following levels when microlithic points become more prolific.

3.10.14 **Summary of levels 17-28**

Levels 17-28 encompass too much variation to be neatly summarised in a few tables and diagrams as was the case with levels 4-8. Backed bladelets increase in levels 15 and 16 following the climatic optimum. They become the clearly dominant retouched tool type from level 17-20, which coincides with the replacement of ericaceous heath by composites and dry steppe vegetation. Climatic conditions during this period were increasingly cool and dry. From level 16 onwards, the emergence of a clear (but not exclusive) Spring/Summer targeting of red deer and ibex becomes apparent. Levels 17-20 also represent a break from previous levels in that red deer young are nearly as numerous as adults in faunal assemblages. By virtue of the recovery of a single Solutrean point, level 17 is classified as Solutrean, despite the wealth of backed bladelets seemingly much closer to the first Magdalenian deposits of levels 18-20. Reanalysis of the raw materials in level 17 however revealed the composition of the flint assemblage to be notably different from levels 18-20, with a more widely spread range of materials. These levels, with peak quantities of backed bladelets, also represent the peak period of bone and antler points and sagaies in the sequence.

After level 20, patterns in the La Riera sequence become even more complex. A number of problems make it difficult to interpret levels 21-23. These levels are notable for exhibiting evidence of cold and warm phases, and marking the beginning diversification of fauna, although this accounts for a very small fraction of the overall assemblage. The next deposit, level 24, seems to mark a cold phase. Backed bladelets are the predominant retouched tool type, though not by as great a margin as in levels 17-20. Microlithic points become notable additions to the retouched assemblages from this level onwards. The environment around La Riera during this period was fairly open with few trees. Arguably the most interesting feature of level 24 is the increase of ibex representation at the expense of red deer to a ratio similar to that last experienced in level 6.

Level 26 was deposited during warmer conditions with a greater coverage of vegetation. While levels 27 and 28 signified colder conditions (probably pertaining to Dryas III), vegetation coverage persisted throughout this period. Representation of backed bladelets increases in levels 27 and 28, having been low in level 26. From level 26 onwards, the dominant flint type shifts from type B to type A. Level 28 is further unique by having a much narrower range of flint materials compared to other backed bladelet dominated levels. The trend of faunal diversification in these three levels continues throughout these levels with roe deer supplanting ibex as the second most popular species after red deer in level 28. Microlithic points also peak during these levels, with Azilian points replacing Font Yves points as the dominant type, peaking in levels 27 and 28. Bone and antler points and sagaies are very scarce by this time. Level 29 concludes the sequence with the nature of the site occupation having apparently changed considerably, with hunting apparently no longer a primary associated activity.

4 Final Palaeolithic of Northern Spain (Comparative Sites)

Acting as something of a pilot study for the other regional case-studies, this section briefly outlines the broader framework within which other sites included for assessment may be compared with the extensive La Riera sequence.

The general consensus apparent from much of the literature is that bladelet technology as recognised throughout the Palaeolithic of Cantabrian Spain was primarily used as armature components for hunting weaponry. This supposition has largely been based on popular opinion regarding comparable assemblages from elsewhere in Europe (Straus, 1992: 109), but has been further supported by the findings of a few regionally specific use-wear studies (Clark & Straus, 1986; Keeley, 1988; Ibáñez & González, 1996; 1998). Bladelet technology of various forms is evident throughout much of the Cantabrian Upper Palaeolithic, but it is in the Magdalenian that they are found in profuse quantities.

The chrono-cultural framework for the Upper Palaeolithic of Cantabria was essentially modelled on the same system devised for the south-west of France. With time, it was recognised that the Cantabrian record was incompatible with this system, and so the framework has developed in a more individually specific direction. However, many aspects of the framework's origins remain apparent. For example, the de Sonneville-Bordes / Perrot lithic classificatory scheme continues to be used despite dissatisfaction expressed with this typology (Straus, 1996: 40).

The Magdalenian (approximated in this region as generally between 17,000-10,000 kya) is a cultural phase of the Cantabrian Upper Palaeolithic recognised as marking the end of the preceding Solutrean (regionally between 22,000-17,000 kya), a phase commonly characterised by cold-adapted technologies in response to the LGM. The Magdalenian is frequently divided into less easily definable sub-components. At many sites, distinction is made between the Lower Magdalenian and Upper Magdalenian, with a Middle Magdalenian also sometimes identified. The Azilian (11,500/10,000-9,500 kya), although nominally a distinct cultural phase that marks the end of the Palaeolithic in Cantabria, is widely acknowledged to be a permutation of the final Magdalenian, to the extent that it is not even perceptible at some sites according to classically defined material traits. Recent research into the Solutrean / Magdalenian transition, at both site (Straus & González Morales 2010; 2012) and regional level (Aura et al. 2012), has led to a renewed interest in the inception of the Magdalenian, which has prompted calls for the definition of a new sub-phase: the "Initial Magdalenian".

In order to examine the developmental trajectory of bladelet technology, a broad understanding of the cultural-chronological sequence that underpins it is necessary for context. Refining our understanding of these sequences and their timing is a common goal in prehistoric archaeology, as improved temporal resolution may offer insight into contemporary developments. It is particularly important in Cantabrian Spain, as the sequence itself is based largely on distinctions made in assemblages of hunting equipment. Consequently, my own research includes the sites of La Riera, El Rascaño and El Mirón, which lay claim to being the only three sites in Cantabria excavated and recorded to relatively modern standards, and show evidence of this so called Initial Magdalenian in the context of deeper chronology (Straus & González Morales 2010, 34), although the recording of the former two sites predates the wide-spread acknowledgement of the Initial Magdalenian conceptually. El Rascaño lacks Solutrean deposits and is published entirely in Spanish which I have attempted to translate, while the El Miron investigations are ongoing and much remans to be published. Bolstering information from these sites are the faunal analyses of Magdalenian, Azilian and Mesolithic deposits at La Fragua cave (the only aspect of the site reported in English), and use-wear analyses of bladelet assemblages from Santa Catalina and Laminak II to the east of the Cantabrian plain, and Berniollo to the south east. Collectively, while small in size, this sample survey encompasses considerable variation.

4.1 Rascaño

Rascaño (Figure 6) is a small cave site located 30km from the present coast, situated near the small village of Mirones in the Miera river valley (coordinates: 3 41’ 44’’ east, 43 17’ 38’’ north). Approximately 275m above sea level, Rascaño is situated in a montane landscape, and is one of only a few Cantabrian montane sites to be well excavated with assemblages of lithic *and* faunal remains (Arroyo 2009b), something which should be noted, given the frequency with which the site is compared with others not located in comparable environments. Prior to the excavations reported by González Echegaray and Barandiarán Maestu (1981), several excavations had been conducted but of a relatively poor standard and without good recording (Joaquín González Echegaray and Maestu 1981, 8).

Ten levels were identified in the stratigraphy of Rascaño. Table 10 below provides the thickness, radiocarbon dates and chrono-cultural affiliations for each deposit. Level 10 is not included because it was not completely excavated and no date was acquired. Levels 4 and 2 can both be divided into two sublevels: 4 and 4b, and 2 and 2b respectively.

	Thickness	R.C. Date (BP)	Chrono-Cultural Affiliation	Lithic Pieces	Faunal Remains
Level 9	25-30 cm	> 27,000	Aurignacian?	22	7
Level 8	18-25cm			5	21
Level 7	30-35cm	27,240 +950 -810		13	10
Level 6	26-28cm		Sterile	0	2
Level 5	26-30cm	16,433 ± 131	Lower Magdalenian	207	1433
Level 4b	35-40cm	15,988 ± 193		195	1495
Level 4				130	738
Level 3	15-20cm	15,173 ± 160		324	543
Level 2b	45-50cm	12,896 ± 137	Upper Magdalenian	196	640
Level 2		12,282 ± 164		27	
Level 1	25-30cm	10,558 ± 244	Azilian	13	672

Table 10: Basic details from excavations at Rascaño

The site's excavators attributed industries from levels 7-9 to an unspecified Aurignacian older than 27,000 years before present. Industrial and faunal remains in these levels are relatively sparse in contrast to later levels which yielded a greater wealth of archaeological and palaeontological data. The Azilian is also notably poor in terms of the quantity of lithic pieces recovered. The most faunal remains were recovered from levels 5 and 4b. Separating levels 1-5 and 7-9 is level 6, a sterile deposit with exceptionally few remains found. Although only 2 cm thick, level 6 accounts for potentially 10.5 ky, suggesting not only an occupational hiatus, but quite likely a depositional one too, with the sediments indicating temperate and humid conditions (Laville and Hoyos 1981). Given Rascaño's location in a montane environment, it may have been too cold during the LGM to permit a Solutrean occupation. The lack of a Solutrean occupation at the site suggests that the trend of most Solutrean sites (70%) being below 200m was an actual shift in settlement pattern rather than a bias in the geographical concentration of archaeological research (L. G.

Straus and Morales 2009, 120). Regardless of the reasons for its abandonment, it is the archaeologically rich levels 5-1, spanning the Magdalenian and Azilian that are the focus of this reassessment.

4.1.1 **Retouched Bladelets**

Table 11 shows the breakdown of retouched bladelets found in levels 1-5. They account for a far smaller percentage of the assemblages than in the Magdalenian levels at La Riera: Retouched bladelets never exceed more than 15% of the assemblages at Rascaño, whereas in their greatest quantities at La Riera they constitute up to 75% of the assemblage. A number of bone point fragments were also recovered from these levels, but despite detailed description (Barandiarán, 1981), poor preservation restricted meaningful quantification and investigation to typological ordering based upon shaft section (Joaquín González Echegaray and Maestu 1981). The paucity of retouched bladelets from the site, considered to have been excavated to an acceptably modern standards of procedure, has been noted in reference to other Cantabrian sites in regional surveys (Straus 1986a; 1992), but they are nevertheless noted as the third (of nine) most frequently recovered tool type in levels 3 and 4 at Rascaño, being ranked lower in levels 5 (fifth), 2b (sixth) and 4b (eighth) (Maestu and Echegaray 1981, 332). Levels 1 and 2 are excluded from their ranking, presumably because of the dangers of over amplified percentages in smaller assemblage sizes.

	1		2		2b		3		4		4b		5	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Backed Bladelets	2	~	3	11.1	2	1	14	4.3	11	5.6			7	3.4
Dufour Bladelets			2	3.7	2	1	24	7.4	11	5.6	1	0.8	11	5.3
Microgravettes					1	0.5			1	0.5				
Truncated Bladelets							2	0.6	1	0.5				
Notched Bladelets					2	1	2	0.6						
Denticulated Bladelets					1	0.5								
Backed and Denticulated							1	0.3						
Backed and Truncated							1	0.3					1	0.5
Triangles									1	0.5			1	0.5
Total	2		5	14.8	8	4	44	13.5	25	12.7	1	0.8	20	9.7

Table 11: Retouched lithic assemblage at Rascaño

Caution is necessary in extrapolating from numerical quantification however. Conclusions regarding the quantity of a tool type are often made relative to the quantity of other types in the assemblage, and again relative to the quantities recovered at comparable sites. The manner of utilisation is also an important factor to consider: bladelets are commonly assumed to be facets of multicomponent composite tools, meaning that a single "tool" may hold several pieces, whereas other stone tools may only be hafted singularly. Another important factor in shaping our interpretations is the morphological criteria we use to classify lithic pieces. For example, criteria were used in the concluding chapter of the Rascaño report differing to the classificatory method used in the earlier lithic analysis section (Echegaray 1981). Thus from different perspectives, we might find statements seemingly at odds with each other, with Keeley, for example, noting that backed bladelets are common (albeit less common than dufour bladelets) at Rascaño (1988, 20), in contrast with Straus' observation that Rascaño was not very rich in backed bladelets (Straus 1992, 144).

Arguably the most notable feature of the retouched bladelet assemblages at Rascaño is that unlike many other Cantabrian sites, backed bladelets do not overwhelmingly dominate. In most levels they are equal to or less than the quantities of dufour bladelets recovered. They are equal in quantity to backed bladelets in level 4, and double the number in level 3: the two levels with the most retouched bladelets overall. In the lithic analysis it is noted that many of the pieces classified as dufour bladelets are irregular in morphology and do not strictly conform to the typological convention (Echegaray 1981, 69; 76; 84). The doubt cast by these qualifications potentially undermines the conviction with which we can ascertain the numerical significance of backed bladelets relative to other bladelet types. The apparent lack of homogeneity in dufour bladelets may suggest that differences with backed bladelets might have been morphological rather than functional, though this remains speculative. In the levels that yielded greater quantities of backed and dufour bladelets other bladelet types were also recovered.

4.1.1.1 Use-Wear Analysis

Eighteen backed bladelets were included in Keeley's use wear investigation of the site, although curiously only 1 dufour bladelet was examined. Of the backed bladelets, 82-90% were found to bear traces indicative of having served as projectile armatures, with the remainder showing indeterminate traces (Keeley 1988, 22). Keeley believes the findings concur with Moss' supposition that pointed types were more likely projectile tips, while rectangular types were barbs or side blades on composite points (Ibid 1988, 22). Following his analysis, Keeley reconfigured his sample typology to reflect his results rather than morphological form, with (what I suppose to be) the dufour bladelet being included with the backed bladelets. Although not associated with backed bladelets, bone working appears to have been an important activity at the site as opposed to hide working, something which might be expected considering Altuna's conclusion that the trunk the main ungulate prey was rarely returned to the site (1981, 231).

4.1.2 **Faunal Analysis**

Details left unpresented here from Altuna's analysis of the faunal assemblages can be found in Appendix 2-4. In the analysis of faunal remains from Rascaño, the distinction between levels 2 and 2b is dissolved, and only sometimes kept for levels 4 and 4b (with the two being amalgamated for assessments of MNI for example) (J. Altuna 1981). 5773 faunal remains were recovered from Rascaño. The overwhelming predominance (around 90%) of *Capra pyrenaica* remains in the faunal assemblages of levels 1-5 have led to the site being interpreted as primarily focussed around ibex hunting. Other ungulates recovered include red deer, wild horse, cattle (bos/bison), chamois and wild boar, and an array of other fauna were also found in minor quantities. Even though remains in general (cultural and faunal) are markedly reduced in levels 6-9, ibex remains the dominant species in levels 6-8. With the exception of three chamois in level 1, and two horse in level 5, red deer were the only species other than ibex to have an MNI count greater than one

.

Levels	Newborn	< 2 yrs (excluding neonates)	> 2 yrs
5	2	6	26
4	1	9	49
3		5	15
2	1	4	10
1		9	17

Translated from Altuna (1981)

Table 12: Age at death for Ibex at Rascaño

Levels	5	4	3	2	1
< 2 yrs	1	2	2	1	3
> 2 yrs	3	10	2	3	6

Translated from Altuna (1981)

Table 13: Age at death for Red deer at Rascaño

Rough determinations of age were achieved for each identified ibex (Table 12) and red deer (Table 13) individual. In both species, individuals over the age of 2 are more common than juveniles and neonates. This preference is particularly marked in levels 4 and 5 for ibex and level 4 for red deer. Although neonates are not found in all levels, young (of both ibex and red deer) are present in all levels, and in level 1 and they account for the greatest percentage in level 1 (Altuna 1981, 233). Sex determinations were also possible for some *Capra pyrenaica* remains (Altuna 1981), with a clear majority of male remains from levels 4 and 5, and female remains in level 1 , but this data refers to elements and not individuals, limiting potential for interpretation (Table 14).

Levels	1	2	3	4	5
Male	5	14	8	86	51
Female	17	13	4	52	35

Table 14: Sexed ibex elements at Rascaño

Estimations of the season of death for several individuals (ibex and red deer) were also possible (Figure 26). Shaded bars represent red deer kills and black bars represent ibex. With the exception of levels 2 and 3, which are clearly restricted in data in comparison with other levels, there is no evidence of strictly defined seasonal occupations at the site. Summer seems a preferred time for hunting in levels 1 and 5, with ibex kills restricted to early summer (May to June) in level 5. In contrast, the majority of kills in level 4 took place between October and April, with a particular emphasis on November and December. There are, nevertheless, two kills recorded between May and June. Although data for red deer is minimal, it seems that they were not targeted during the late autumn and winter months. There is less potential overlap between red deer and ibex hunting in level 5 than in level 1, though the data for red deer is too minimal to place much conviction in this interpretation.

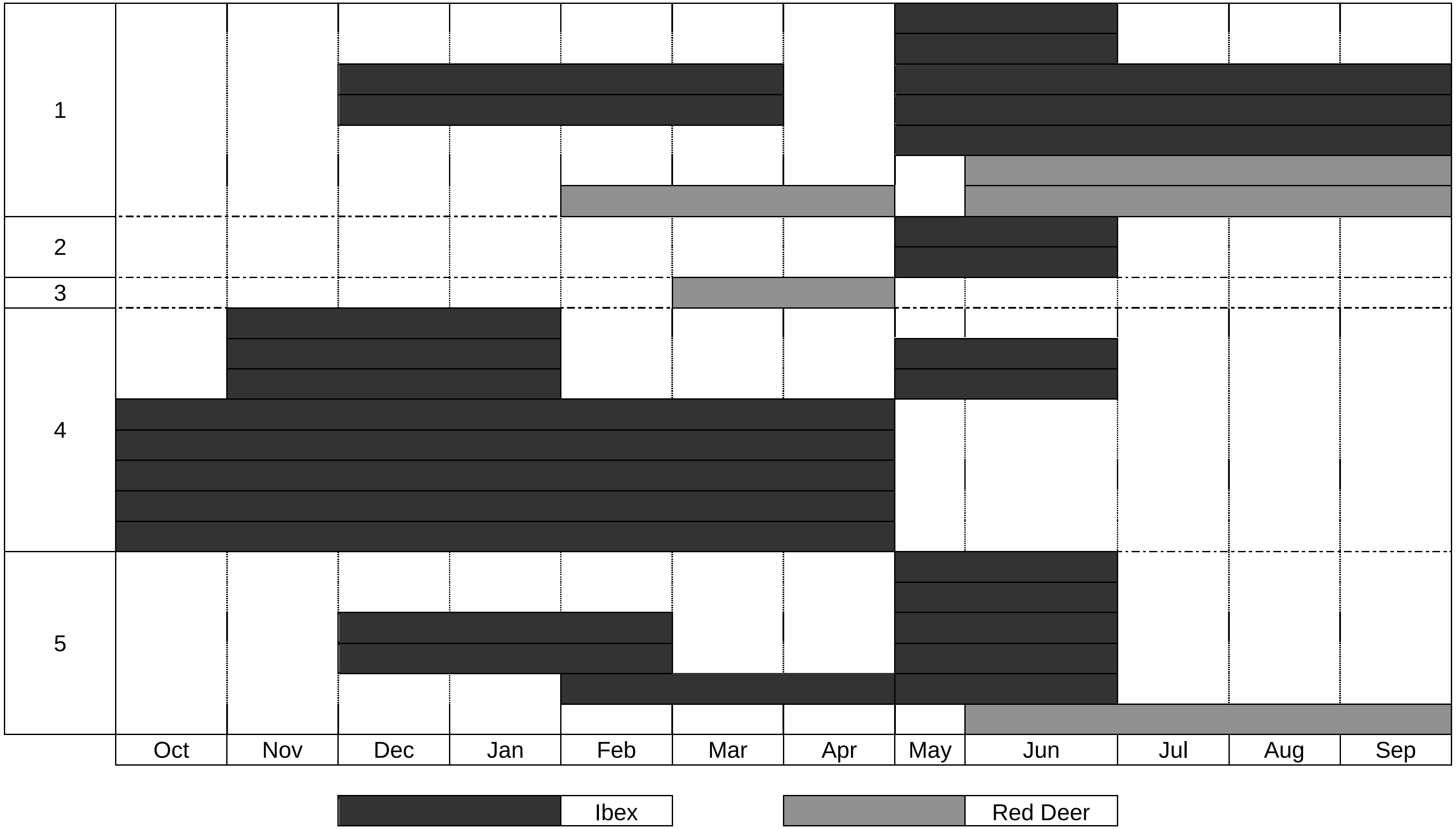


Figure 26: Seasonality chart for Ibex and Red Deer at Rascaño

Studies of element representation were also conducted to assess the nature of carcass transportation. It was suggested that ibex and probably deer were frequently being processed, at least in part, elsewhere, and that the limbs and cranial elements were brought to the site, but not the trunk (Altuna 1981, 231). This pattern is unusual for ibex due to their relatively small size. The presence of atlas and axis vertebrae but not lumber vertebrae supports this interpretation. The scarcity of femurs is attributed to poor preservation conditions for this particular type of bone matrix, and comparisons of the distal ends of humerus and tibia remains show there to be little differentiation between fore and hindlimbs (Ibid 1981, 231). It is also noted that female horn cores and fragments were recovered in greater quantity than those of males, even in levels 4 and 5 where males account for the majority of remains (Ibid 1981, 235). Antlers are a frequently represented element of red deer, comprising up to 40% of red deer remains in level 5, 25% in level 4 and 28.4% in level 2 (Altuna 1981, 238). The high ratio of antlers to skeletal remains must cast doubt upon how reflective quantifications of sex and gender actually are of the broader assemblage In level 3, only 4 pieces were recovered. Fragmentation remains a problem in assessing how many actual antler sets were found.

4.1.3 **Palaeoenvironment**

Level 5 pertains to the end of a humid, temperate phase according to both palynological (Boyer-Klein 1981) and sedimentological studies (Laville and Hoyos 1981). Arboreal pollen is fairly low in this level, as at La Riera in the earliest Magdalenian. Level 4 exhibited evidence of cooler conditions (most likely Dryas I), again from both sedimentological and palynological analyses (Straus 1986c, 70; Boyer-Klein 1981; Laville and Hoyos 1981). Arboreal and fern pollen is virtually absent, with composites and heath both more dominant, leading Boyer-Klein to suggest extreme cold during this period (1981, 219). Level 3, which lacks a clear contemporary at La Riera, exhibits rapid oscillations between temperate, humid conditions and cold, dry periods (Straus 1986c, 70). Level 2, which potentially corresponds with the date of levels 21-23 at La Riera during the end of Dryas II, is characterised by cold but humid conditions, with composites and ferns abundant, but trees and heathers scarce (Ibid 1986b, 71). Level 1 is characterised by temperate, humid conditions with high percentages of hazel pollens, fern spores, and also the appearance of alder and oak pollens in small quantities (Boyer-Klein 1981, 220). The beginnings of Dryas III are possibly witnessed in the sedimentology of the uppermost sequence (Laville and Hoyos 1981) during the Azilian.

4.1.4 **Summary**

Rascaño is an important site for understanding hunting practices in Cantabrian Spain, as it is one of the only montane sites in the region to have provided assemblages of both material and faunal remains that have been subjected to relatively modern excavation, recording and analytical methods. However, in their original site report, Barandiarán Maestu and González Echegaray refrain from commenting in any depth upon the hunting practices that may have been employed at Rascaño (1981, 347). The fact that many of the technologies at the site have been interpreted as having been deposited in their 'final' stages (Ibid 1981, 344), combined with the evidence of use wear on most of the bladelets (Keeley 1988), further adds to Rascaño's potential importance, as a site of post-hunting activity rather than gearing up for the hunt. It is, however, difficult to identify correlations between bladelet use and other patterns of evidence. The relatively small size of the lithic assemblages here enhances the risk of over extrapolating the significance of varying quantities of tools.

In terms of palaeoenvironment, levels 3 and 4, in which retouched bladelets were ranked the most significant numerically, both experienced very cold conditions, however the more temperate and humid level 5 also yielded a comparative quantity of bladelets. In terms of fauna, ibex remain dominant throughout levels 1-5, although absolute quantities increase greatly in level 4b-5, with seemingly little correlation with quantities of retouched bladelets. Level 4b is notable for yielding only a single dufour bladelet, and no others. For whatever reason, perhaps relating to previous excavation or the spatial geography of activities within the cave, retouched bladelets are curiously absent from this particular sublevel, although it is worth noting the minor peak representation of red deer in this deposit. Levels 4 and 5 (and to a much lesser extent level 3) mark a shift in ibex hunting towards targeting older prey (> 2yrs), though this trend is preferential rather than exclusive. Level 4 also marks a clear preference for adult red deer (> 2yrs), though this is not so apparent in level 5. From levels 3-5 there is a notable increase in the ratio of male to female ibex recovered. It is possible that the increase in bladelet technology might be related to this shift in targeting.

Levels 4 and 5 also have the clearest seasonal patterns, with hunting activities focussed in the cooler months during the cold harsh climate of level 4, and in the summer months (particularly May-June) in the more temperate and humid level 5. Shifts in seasonal hunting patterns may well be responses to changing ecology and behaviour resulting from contrasting climates. Level 1, which was also deposited under mostly temperate and humid conditions exhibited evidence of a seasonal exploitation pattern more comparable with that of level 5. Unfortunately, less insight is available for levels 2 and 3 due to restricted seasonality data. One of the most interesting features of the bladelet assemblages from Rascaño is the relative numerical importance of dufour bladelets in levels 3, 4 and 5. Even though many pieces may not conform to the typological definition of dufour bladelets *sensu stricto*, they are at least deemed sufficiently irregular in morphology to be rejected as plain backed bladelets. It is unfortunate that Keeley's study sample did not include more of these pieces. Dufour bladelets are generally curved in profile and exhibit evidence of semi-abrupt retouch, making these points potentially useful both as barbs but also projectile tips. It is possible that the relatively high quantity of these bladelets may indicate a very specific style of microlithic weaponry, or alternatively, a site where tips are extracted from carcasses during processing, perhaps for re-hafting.

4.2 Lithic Analyses at Berniollo, Santa Catalina and Laminak II

Following from Keeley's analysis of bladelets at Rascaño, it was decided to include three other Upper Palaeolithic sites from Northern Spain which, although lacking complete excavation details, have been the subject of microwear investigation. A series of lithic analyses with use-wear studies as the central focus were conducted on assemblages from the late Palaeolithic sites of Berniollo, Santa Catalina cave, and Laminak II in the mid 1990's, of which two reports were published in English (Ibánez Estevez and González Urquijo 1996; 1998). Although not located along the Cantabrian plain itself, Santa Catalina and Laminak II are both situated along the northern Spanish coastal margin further to the east (Figure 6), and Berniollo further south and inland (approx 20km west from the town of Vitoria-Gasteiz in the province of Alava).

4.2.1 **Berniollo**

Berniollo is an open-air site situated in the middle of the Bayas river basin. Excavations at the site in 1984 and 1985 showed the site to have two separate habitation areas, one Neolithic and the other Palaeolithic. The Palaeolithic (likely Azilian) occupation comprises just one deposit, between 10 and 15cm thick and dated to 9940±490 BP (Mariezkurrena 1990). As well as studies on the manufacturing techniques and spatial distribution of the lithic assemblage, 217 pieces were submitted for use wear analysis, of which 22 were backed bladelets (Ibánez Estevez and González Urquijo 1996).

4.2.2 **Santa Catalina**

The cave site of Santa Catalina is located in a limestone cliff near the lighthouse of Lekeitio on the east coast of Vizcaya in northern Spain. Excavations at the site began in 1982, with nine seasons of work completed by the time of Ibáñez Estevez and González Urquijo's analyses. Excavations within a 9m^2 area of the exterior chamber revealed two levels, with one Azilian (10,500 – 9600 BP) and the other late Magdalenian (12,200-11,400 BP) (Ibánez Estevez and González Urquijo 1998). Lithic production during the Azilian was mostly focussed on bladelets, which account for 75% of laminar pieces at the site, but the proportion of blades and bladelets was more similar during the Magdalenian (Ibid 1998, 27). From these levels, functional analysis was conducted on 167 stone tools from the Azilian deposit, including 34 backed bladelets, and 300 from the Magdalenian deposit, including 36 backed bladelets.

4.2.3 **Laminak II**

Laminak II is a cave site situated on a northern slope, 3km from the current coastline and 5km from Santa Catalina. There is a level dated to 11,700 ± 140 BP in the final Magdalenian (Ibánez Estevez and González Urquijo 1998, 24). Analysis of the stone tool assemblage at this site included assessment of manufacturing techniques, and also use wear analysis on 136 tools (Ibid 1998). The majority of flakes at the site appear to have derived from blade and bladelet production; bladelets used for making backed bladelets and backed points comprise 80% of the laminar pieces at the site (Ibid 1998, 24) (Ibáñez and González 1998, 24). Laminak II was not included in Ibáñez Estevez and González Urquijo's use-wear comparison of Berniollo and Santa Catalina (Ibid 1996), but was subsequently included in a later article focussing on production and use at these sites (Ibid 1998). A number of similar conclusions to those reached in the earlier report are referred to in the later article.

4.2.3.1 Unretouched Pieces, Retouched Flakes and Macroblades (Berniollo and Santa Catalina)

Unretouched lithics under 2cm in length were rejected for analysis, as it is commonly assumed that such pieces were not used, due to the awkwardness of their size unless they were hafted (Ibánez Estevez and González Urquijo 1996, 21). While it is true that unretouched pieces are often disregarded for these reasons, this justification is nevertheless teleologically flawed when one considers that the size of microliths commonly predicates the assumption that they are hafted elements. Of the retouched flakes and blades that were analysed from Berniollo (9) and Santa Catalina (Azilian: 10; Magdalenian: 9), results suggested functional heterogeneity, with evidence of a variety of use wear traces in comparison to other morphologically- defined tool types (Ibid 1996, 23). The traces most frequently recorded on macroblades are commonly associated with motions of cutting, whereas flakes tended to exhibit more similar proportions of longitudinal and transverse action (Ibid 1996, 35).

4.2.3.2 Backed Microlithic Points (Berniollo and Santa Catalina)

Of the backed microlithic points, 12 were recovered from Berniollo, 14 from the Azilian deposit of Santa Catalina, and 29 from the Magdalenian level. Most can be classified as Azilian points (16) or microgravettes (20), though there are some that do not correspond to these categories, such as double backed points. Use wear analysis suggested two types of use, with 17% of the points bearing traces suggestive of utilisation in the working of soft animal remains i.e. cutting, scraping, hide boring and butchery, 38% indicative of impact resulting from use as a projectile, and the remaining 45% bearing no distinguishable use-traces (J. J. Ibánez Estevez and González Urquijo 1996, 40). Interestingly, only one point showed evidence of utilisation both as a projectile tip and for other activities (butchery), suggesting duality of function in the same point was not common (Ibid 1996, 40). I believe that this should be of little surprise, as depending on the ergonomics, the utilisation of one point for such different activities may well have required re-hafting in a new format.

	Microgravettes (Quantity and Proportion %)	Azilian Points (Quantity and Proportion %)
Without use traces	8 (40%)	7 (41.1%)
Impact traces	10 (50%)	3 (17.6%)
Butchering or hide working traces	2 (10%)	5 (29.4%)
Butchering and impact traces	0	1 (5.9%)

Table 15: Types of use traces identified on microlithic backed points from Berniollo and Santa Catalina

At Berniollo all damage traces indicated impact as the cause. At Santa Catalina, the proportion of points used for “soft” animal working is higher in the Magdalenian level than in the Azilian (Ibánez Estevez and González Urquijo 1996, 40). Table 15 shows that although no function is associated exclusively either type, microgravettes were preferred as projectile points and Azilian points were preferred as butchery and hide working tools. It seems, therefore, that straight and relatively narrow bladelets retouched to a symmetrical point were preferred for projectile points (Ibid 1996, 45) (Ibid: 45). Although the specific details of the study were unavailable, it is clear that the results from analysis of the Laminak II assemblage were in concord with these observations (Ibid 1998, 30).

It is also interesting to note that two retouched and pointed blades from Berniollo (56 x 21mm and 62 x 28mm) were also used as projectile tips. The dimensions of these points, and particularly the width of the haft diameter has led Ibáñez and González to suggest that these points were used in throwing spears, which would qualify two different types of projectile elements within an individual assemblage (Ibánez Estevez and González Urquijo 1996, 45).

4.2.3.3 Bladelets (Berniollo, Santa Catalina and Laminak II)

Bladelets are common at all three sites, but are particularly abundant at Laminak II and in the Azilian deposit of Santa Catalina. They were mostly manufactured into backed bladelets or backed points; Ibáñez and González believe that they were rarely used without retouch as this was a prerequisite for their hafting (1998, 33). The most notable characteristic of the bladelet assemblages at each of the three sites is the existence of two discrete groupings based upon their length. The existence of two distinct classes of bladelet based on size has also been noted at the Magdalenian site of Ekain (Merino 1984). The separation of the two groups varies at each site, and the authors' original thoughts on this matter are not entirely clear: First noting the smaller gap between the classes at Berniollo (Ibánez Estevez and González Urquijo 1996, 45), and later commenting that duality in the bladelet assemblages was found at Berniollo and Laminak II, but curiously with no mention of Santa Catalina (Ibid 1998). Finally, their estimations of the average size categories vary without clearly detailing any adjustments in calculation (Ibánez Estevez and González Urquijo 1998, 30; 33). However, it remains true that a clear distinction in the size of bladelets can be made at all three sites, even at Berniollo where differentiation is the smallest (Table 16).

The distinction of these groups based on size is corroborated by the results of use-wear analysis. Of 92 backed bladelets subjected to analysis from Berniollo (22) and Santa Catalina (Azilian: 34; Magdalenian: 36), 50% showed use-traces, and of those, 61.2% exhibited traces associated with meat cutting and butchery (Ibánez Estevez and González Urquijo 1996, 45). It is suspected that many of those with more ambiguous traces may have also been used for the cutting of meat, which is an activity known for not always resulting in clearly recognisable use traces (Ibid 1996, 45). The backed bladelets without signs of use-wear are all smaller in size than those that bore evidence of meat cutting. This has led Ibáñez and González to believe that the differentiation in size is a likely indication of a difference in function, supposing the smaller backed bladelets to have been hafted as projectile barbs, reasoning that wear-traces from such use are rarely generated (1996, 47). Although quantities are not given, it is apparent that a similar conclusion was reached in their study of Laminak II, where it was also noted that the smaller backed bladelets appear to have been manufactured from flake cores, whereas longer bladelets were produced from block cores (Ibid 1998, 24).

	Berniollo	Santa Catalina (Azilian)	Santa Catalina (Magdalenian)	Laminak II
Butchering Traces	22.7mm	21mm	40mm	30 - 35mm
Without Traces	19mm	14.8mm	23.6mm	15 - 20mm

Table 16: Average length of bladelets with different wear traces from Berniollo, Santa Catalina and Laminak II

This interpretation is further strengthened by the strong spatial association of smaller backed bladelets and backed points used as projectiles in the cave at Berniollo (Ibánez Estevez and González Urquijo 1996, 47). They are also associated with the bladelet cores and waste debris from their manufacture, suggesting they may have been discarded together during the process of repair or replacement (Ibid 1998, 24). Finally, it is interesting to note that at least three backed bladelets showed characteristic projectile tip wear-traces, suggesting that they had been recycled after fracturing from their original use (Ibánez Estevez and González Urquijo 1996, 47).

4.2.4 **Summary**

The predominance of backed points and backed bladelets in the assemblage from Laminak II, combined with evidence of antler working at the site suggests that the site was used as a specialised hunting camp (Ibánez Estevez and González Urquijo 1998, 32). Red deer are dominant among the faunal assemblage, and were hunted at the end of spring and beginning of summer (Ibid 1998, 32). However, the diversity of resources recorded at the site (including a number of other ungulates), the lack of evidence for butchery or fresh hide scraping (activities commonly associated with hunting camps), and the presence of bone and dry hide working activities associated with the Autumn months have cast doubt upon this interpretation (Ibid 1998, 32). Based upon this interpretation, I believe that Laminak II may well have been a specialised hunting site at least in the spring and summer months when red deer were most targeted, but that it may have had a less narrowly defined role for other times of the year, when the hunting of other game using similar technologies would have continued.

The Azilian level of Santa Catalina does appear to have been primarily a hunting site, as reflected by the dominance of backed points and small backed bladelets, and the relative intensity of butchery and fresh hide working recorded at the site (Ibánez Estevez and González Urquijo 1998, 31). Less intensive wood and bone working activities are explained as relating to the repair of hunting tools (Ibid 1998, 31). In the preceding Magdalenian deposit, the site seems to have been less specialised, with evidence of hunting activities and bone, wood and dry hide working more equally represented (Ibid 1998, 32). In contrast with the other two sites, hunting is (most) scarcely represented at Berniollo, with bone, wood and dry hide working more dominant (1998, 32). Bladelets continue to be an important focus of lithic production, but less so than blades. It is important to note that although Berniollo is not considered primarily a hunting site, the microgravettes from this site were most strongly associated with traces of impact damage, and bladelets in general remain a main feature of the assemblage, and a focus of production. This point should be highlighted as it shows the potential ubiquity of hunting equipment, even at sites where this activity is not emphasised.

Little difference is found across the chronological span of these sites. Although the Azilian of Santa Catalina marks a shift in activities from the Magdalenian, it seems that strategies of use rather than changes in the actual toolkits themselves are more responsible (Ibánez Estevez and González Urquijo 1998, 34). I would argue that at this resolution, the location of the sites is a more significant influence on the activities and toolkits found at each site. The main conclusions regarding Ibáñez and González's analyses of these lithic assemblages are the diversity of uses recorded for backed points, with microgravettes seemingly preferred as projectile tips, and the distinction in size between backed bladelets used for cutting and those hafted as projectile barbs.

4.3 La Fragua Cave

In the 1990's, excavations began at a number of sites in the Asón river valley (Figure 27) under the auspices of a major research project initiated at the beginning of the decade (led by González Morales) to investigate prehistoric salt marshes of the area in an effort to redress imbalances in the geographic resolution of prehistoric knowledge. One of these sites, the small cave of La Fragua (area: $16m^2$) excavated between 1990-1996 (Morales 2000). presents a particularly unique case among prehistoric sites in the area. The site represents a temporary coastal occupation in a landscape where its occupants would have had access to a diverse array of habitats, and boasts a recently analysed faunal assemblage spanning the Pleistocene-Holocene transition. This analysis, which is easily accessible and written in English, forms the basis of this assessment.

The small cave site of La Fragua is located in what was likely a strategic vantage point on the southeastern slope of Monte Buciero (Santoña, eastern Cantabria), overlooking the river Asón and beyond to the continental shelf, some 3-5km wide (Straus et al. 2002; Arroyo and González Morales 2007). Situated at 125m above sea level at the head of the Asón river valley, a variety of habitats would have been accessible to the occupants of La Fragua, including the shore and present day coastal plain, and the montane interior of the valley, which likely served as an important regional topographic funnel, headed off inland by the Los Tornos and La Sía mountain passes (Straus et al. 2002, 1405–1406).

Figure 27: Map of the Ason Basin, eastern Cantabira. 1. La Fragua and El Perro Shelter, 2 El Otero Cave, 3 La Chora Cave, 4 El Valle Cave, 5 El Miron Cave, 6 El Horno

4.3.1 Faunal Analysis

A 6m^2 area of the cave was excavated, uncovering 6 archaeological levels, of which 4 pertained to a period spanning the Upper Magdalenian through to the Mesolithic, the dates of which are presented in Table 17. The faunal assemblage comprises 2,922 bone samples (Table 18) including fragments and teeth weighing 3,550 grams of which only 331 (2,125g) remains could be identified to species level, such was the fragmentary state of the assemblage, which probably relates at least in part to marrow extraction (Arroyo and González Morales 2007, 72). Preferential breakage of bones from certain species has been dismissed although not entirely ruled out due to the size of bone fragments in levels 1, 3 and 4 (Ibid 2007).

As with most Cantabrian sites of contemporary date with faunal assemblages, all the common ungulates (red deer, ibex, bos/bison, wild horse, chamois, roe deer and wild boar) are represented to varying extents, with the Mesolithic level 1 exhibiting an overall greater diversity of representation. Red deer remain dominant by weight in all levels, though they are second to wild boar in both levels 1 and 2. It is interesting to note that in level 2 the representation of red deer is comparable in all respects to other species, unlike other levels. This observation further supports the conclusion of the faunal analysis that the deposit of level 2 is of natural origin (Arroyo and González Morales 2007).

	R.C. Date (BP)	**"Cultural" Attribution**	**Stratigraphy Description**	**Number of Faunal Remains**
Level 1	6.650 ± 120 6.860 ± 60 7.530 ± 70	Mesolithic	Shell midden surface with dirt matrix from above stratum.	547
Level 3	9.600 ± 140	Azilian	Lens of land snails with abundant charcoal and small bone fragments.	608
Level 4	12.960 ± 50	Upper Magdalenian	Dark brown sediments with limestone fragments and lithic remains.	1536

Table 17: La Fragua stratigraphic divisions Magdalenian-Mesolithic

Correspondence analysis has shown there to be a clear dichotomy between the Mesolithic and Magdalenian levels in terms of ibex and wild boar representation (Arroyo and González Morales 2007, 68). The latter is represented in much greater quantities (NISP) in level 1, while the value for ibex is much greater in level 4 (Ibid 2007, 67). It is hypothesised that warmer conditions, favourable for temperate fauna in the Mesolithic, account for the increase in representation of wild boar, and that this climatic and environmental shift towards mixed deciduous woodland probably led to an increase in the altitude of preferred ibex habitats (Ibid 2007, 69). The presence of wild boar in Magdalenian levels shows that although the species was present and exploited in this level, it was not yet prioritised in the subsistence economy of the site, or perhaps comparatively less common. The NISP value for the two dominant species (red deer and ibex) in level 4 is notably greater than the dominant species from other levels (Table 18), perhaps suggesting a greater intensity of frequency of use at this time, and possibly reflective of different subsistence strategies associated with the cervid/capra based dual economy. The relatively high NISP for unidentified fragments in level 4 may suggest that many of these remains also pertain to ibex or red deer.

In level 3, the amount of ungulate fauna drops significantly, with red deer continuing as the main source of meat, but ibex experiencing a reduction in representation. It has been suggested that this might be due to a shift in exploitation to other resources such as land snails (Arroyo and González Morales 2007, 69), however it is also worth noting that carnivores are also absent from the assemblage. This suggests to me that if carnivore remains were deposited in the cave as a result of human activity, as was apparently the case in at least some instances (Ibid 2007, 63), then the site experienced a relatively significant reduction in hunting activities in general if not an overall reduction in occupation intensity at this time.

	Level 1			Level 2			Level 3			Level 4		
	NISP	Weight (gr)	MNI	NISP	Weight (gr)	MNI	NISP	Weight (gr)	MNI	NISP	Weight (gr)	MNI
Bos / Bison	4	91.9	2	1	2.5	1	1	2.7	1	5	39.4	2
Cervus elaphus	18	138.3	2	3	5.3	1	22	253.9	2	79	746	8
Capreolus capreolus	8	8.7	3	2	4	2	6	8	2	13	13.3	3
Capra pyrenaica	6	22	3	2	5.1	1	4	15.2	1	114	518.3	5
Rupicapra rupicapra										1	0.7	1
Sus scrofa	19	220.6	4	5	6.7	1				7	8.9	3
Canids	3	2.3	1									
Vulpes vulpes	1	1.3	1	1	0.9	1				5	7.2	1
Meles meles	1	1.9	1									
Non Identifiable	428	133.9		204	72		441	122.1		900	494.2	
Total	547	718.7	17	231	140	7	608	512	6	1536	2186	23

Table 18: Faunal remains (NISP and MNI) from La Fragua cave (Arroyo and Morales Gonzales, 2007)

4.3.1.1 Seasonality and Carcass Representation

Analysis of dentition shows that in level 4, red deer were hunted during the late summer and autumn, and that ibex were hunted during the autumn in their rutting season, which would have required relatively low human expenditure of time and energy (Arroyo and González Morales 2007, 67). Red deer teeth from level 3 suggest a winter period of occupation during the Azilian (Ibid 2007, 69). Unfortunately there are no details of the sample size for these estimations, and seemingly no results provided for the Mesolithic remains from level 1. Combining these observations with seasonality estimates from other sites within the Asón Valley (El Valle, El Horno and El Mirón) has led to the supposition that La Fragua may have acted as a support base for incursions to the coast in the warm season for plant gathering and red deer hunting (Ibid 2007, 79), although seemingly at the end of this season prior to withdrawing inland up the valley. The speculation that hunting during the warmer months was part of a strategy of seeking greater meat utility for winter reserves (Ibid 2007, 79) requires clarification as a statement, as it makes a number of suppositions about the economic system of the cave's occupants.

Analysis of body element representation indicates differential transportation of red deer and ibex carcasses in both levels 3 and 4. Ibex probably inhabited the landscape immediately local to the cave, and this perhaps explains why more complete carcass representation is apparent, whereas red deer, whose preferred habitat would have been around an hour's walk away, are most represented by extremities with a notably low number of axial remains (Arroyo and González Morales 2007, 71). Analyses of wild boar and red deer in level 1 suggest a limbs and head pattern among the former, and variation according to age among red deer remains, with juveniles more frequently represented in whole and adults present in a pattern more similar to that of levels 3 and 4. Unfortunately, data for adult to juvenile ratios in other levels are not provided (at least in this publication), and so it is not possible to compare these trends any further. That similar observations were not made for levels 4 and 3 suggests that this pattern was not apparent, or at least that data was too insufficient to justify comment. It is interesting that the authors note that whole ibex were returned to the cave regardless of age in level 1 (2007, 71), considering the site would have no longer been located in such close proximity to their habitat range.

4.3.2 **Summary**

The original analysts of the site’s faunal assemblages stress the importance of considering economic activities at La Fragua within the framework of a broader mobility pattern in the Asón Basin (Arroyo and González Morales 2007, 79) comprising El Miron and other less well known sites that are yet to be more thoroughly investigated. The dual economy of red deer and ibex apparent in level 4 (Upper Magdalenian), with red deer as the clearly dominant species gives way to a more generalised range of ungulates in level 1 (Mesolithic), with wild boar and red deer respectively as the most dominant species. From 9,600 BP there is a notable decrease in ibex and the proportion of roe deer increases slightly (Ibid 2007, 78). It is argued that sudden environmental change explains the confusing scenario presented by level 3, which yielded an industry typical of the cervus/capra based economies of many Azilian sites, but with a faunal assemblage more correspondent with the emergent postglacial, showing signs of diversification (Ibid 2007, 77–78). The absence of wild boar from this level, the shift from land snails to marine molluscs between levels 3 and 4, and the interruption of level 2 all suggest that while level 4 also represents a diversification of subsistence, the trend is not one of linear continuity.

The site’s investigators conclude that the site’s occupants appear to have hunted based on their energy needs, difficulty of prey, and technological capacities (Arroyo and González Morales 2007, 77–78). It only follows that considerations of the environment and environmental change at the end of the last glacial must have been an important factor (not necessarily a driving cause) in the developing economic strategies evidenced at La Fragua.

4.4 El Mirón

The large cave mouth (16m wide x 20m high) of El Mirón Cave faces west, overlooking the confluence of the Calera and Gándara tributaries with the Asón river (Figure 27). Located at the eastern end of the Ruesga Valley, within the Asón Valley, the site lies at approximately 100m above the valley floor, and 260m above sea level, surrounded by mountain summits and ridges up to and over 1000m above sea level (Straus and Morales 2009, 123). As well as the mouth mentioned above, the structure of the cave comprises a vestibule (8-10m wide x 12-13m high) and an inner cave (6-8m wide x 100m deep) (Figure 28). First discovered in 1903, the site has been excavated since 1996 following Gonzalez Morales' reappraisal of prehistoric sites in the Asón River Valley (Straus et al. 2002). Sixty five radiocarbon dates from the site show a nearly complete cultural sequence from terminal Mousterian (41,000 BP) to the early Bronze Age, as well as traces of medieval activities (AD 1400) (Straus and Morales 2009, 123). So far, only excavation of the Holocene (Mesolithic and later) deposits has been published as a collective monograph volume (Straus and Gonzáles Morales 2012). With the exception of reports about exceptional finds (González Morales and Straus 2009) the sondage excavation of a small area of Magdalenian deposits in the cave vestibule (Straus et al. 2008), and a few updates on excavation progress, little beyond two preliminary reviews (Straus and Morales 2009; 2012; Straus et al. 2011) has been published on the material culture of the Pleistocene deposits. There is, however, more complete analysis of the faunal remains from Mid-Magdalenian – Mesolithic levels (Arroyo 2009b; Cuenca-Bescós et al. 2009; 2012).

4.4.1 Solutrean

Solutrean materials recovered from El Mirón are scarce compared to the following Magdalenian levels, and this probably relates to one of four causes:

1) The Solutrean of El Mirón Cave may well represent a genuine difference in the nature and intensity of occupation at the site.

2) The area of the cave from which Solutrean materials were excavated was comparatively narrow, a 2m^2 sondage (W-X/10) at the rear of the cave

vestibule (Figure 28). Solutrean deposits were recorded elsewhere, but it is this sondage that comprises the bulk of the preliminary analysis and the focus of this assessment.

3) The levels (120-130) that were excavated from this sondage show a double slope in profile toward the South and West, and into the darker recess of the vestibule, suggesting this may have been a relatively marginal area for human occupation (Straus and Morales 2009, 127; 2003, 55).

4) The crater within which the sondage was placed had clearly been repeatedly dug in recent times, presumably by looters (Straus and Morales 2009, 124). Combined with previous unrecorded excavations, it is possible that these Solutrean deposits (seemingly undisturbed) may have been subjected to previous mixing as has been noted with level 120 (Ibid 2009, 129).

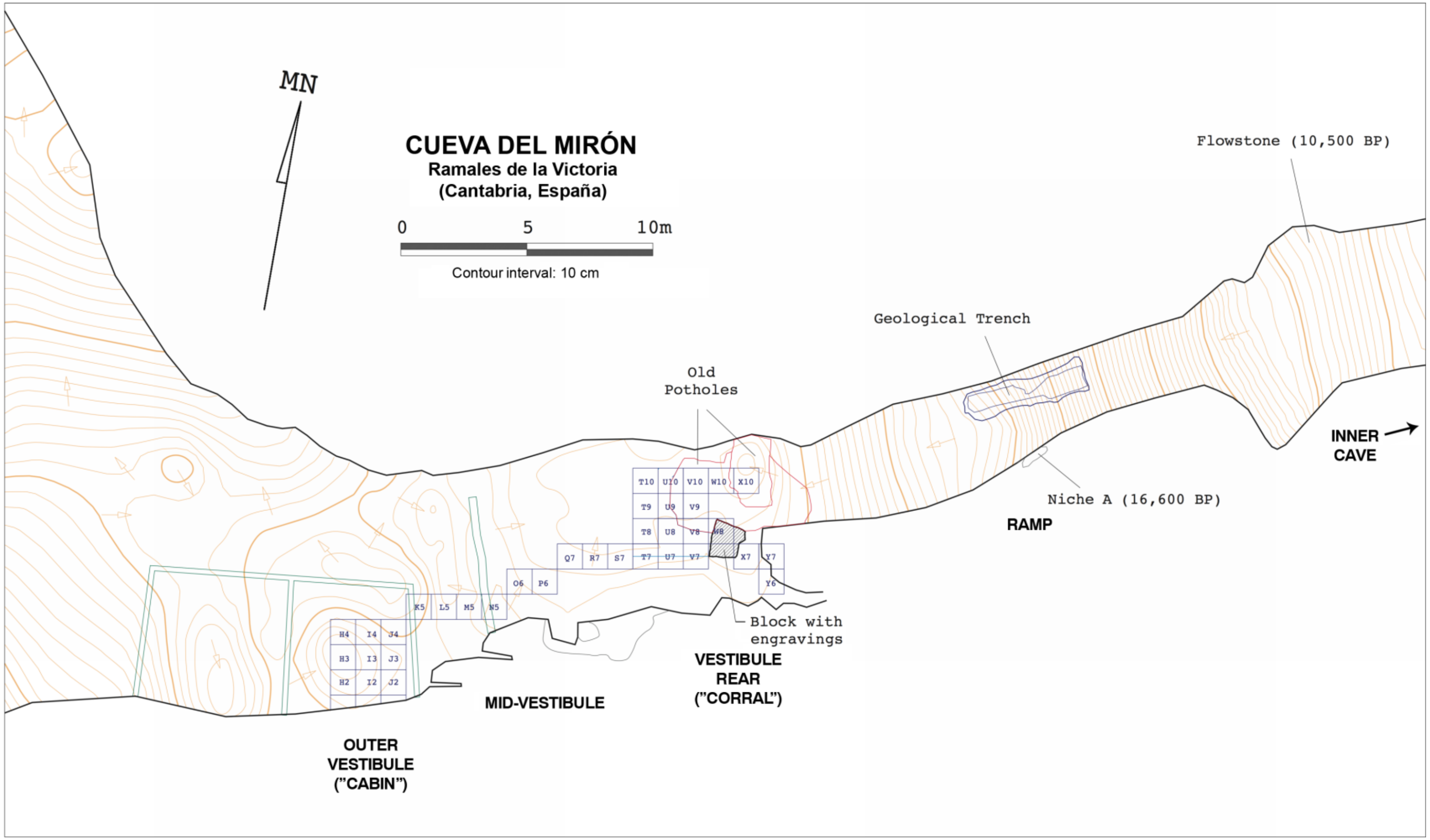


Figure 28: Excavation plan of El Miron Cave (Straus and Morales Gonzales 2012)

These deposits are nevertheless of great archaeological significance as they represent some of the only good quality evidence for a Solutrean presence in the Asón Valley at this time. Three dates from this sondage (recorded below), supplemented with dates obtained from excavations elsewhere in the cave and from the presence of type fossils in the form of Solutrean points have led to the conclusion that levels 120-128 pertain to the Solutrean occupation of the cave (Straus and Morales 2003, 55). Although level 128 is included in their analysis, the date retrieved (27,580 ± 210 BP) is strictly speaking more likely Gravettian or terminal Aurignacian, albeit lacking diagnostic artefacts from this time (Ibid 2009, 129).

Dates from the W-X/10 sondage:

Level 121: 18,390 ± 300 BP
Level 125: 18,980 ± 360 BP
Level 126: 18,950 ± 350 BP
(Straus and Morales 2009, 127)

In terms of palaeoenvironment, the landscape around El Mirón was largely open, dominated by composites, grasses and heaths, with a scarcity of trees (mostly pine and birch) during the Solutrean, with a spike in the representation of *Microtus oeconomus* reflecting the cold rigorous climate of the LGM (Straus and Morales 2009, 129). These findings are consonant with those from La Riera. Analysis of the ungulate fauna from the Solutrean is yet to be published and remains are seemigly scarce (Straus et al. 2011), with most attention so far having focussed on the terminal Palaeolithic deposits (Arroyo 2009b; Cuenca-Bescós et al. 2012). Only small amounts of macro-mammalian remains were recovered, and these were dominated by ibex and red deer, and are heavily fragmented, probably having been broken for marrow extraction (Straus and González Morales 2009, 129). Combined with the presence of salmon and other species fish, the Solutrean faunal assemblage seems fairly similar to later Magdalenian assemblages, even if different in scale and overall diversity of taxa.

Of the 3701 lithics recovered from levels 120-128, only 103 are retouched pieces, with the vast majority of waste materials classifiable as microdebitage (Straus and

González Morales 2009, 129). Table 19 shows quantities of retouched bladelets and Solutrean points recovered from levels 120-123. The small assemblage size restricts the conviction with which they can be interpreted. Of thirteen retouched tools, all but three were found in levels 122 and 123. Ten of the thirteen are backed bladelets. This distribution is interesting given that the majority of retouched tools and indeed the twenty Solutrean points (which include unifacial, laurel leaf, willow leaf and shouldered variants) were recovered from levels 123-128 (Ibid 2009, 131). Proportionally, debitage bladelets account for between 4.5 and 10% of the debitage in Solutrean levels. Although this range is not large, they were most significant in levels 122 and 123. Regarding osseous hunting equipment, bone artefacts are rare in Solutrean levels, with several sagaie/sagaie fragments recovered from the sequence exhibiting variety in cross-section profile (Ibid 2009, 134).

	Levels							
Tool Types	120	122	123	124	125	126	127	128
Unifacial Point				1	2			
Laurel Leaf Point						2		
Willow Leaf Point					1	1	2	
Shouldered Point	1		2	2*	1	4	1	
Backed Bladelet		3	5		1			1
Truncated Backed Bladelet		1						
Notched Bladelet			1					
Nibbled Bladelet						1		

* May actually pertain to level 125

Table 19: Solutrean points and retouched bladelets from El Miron Solutrean deposits

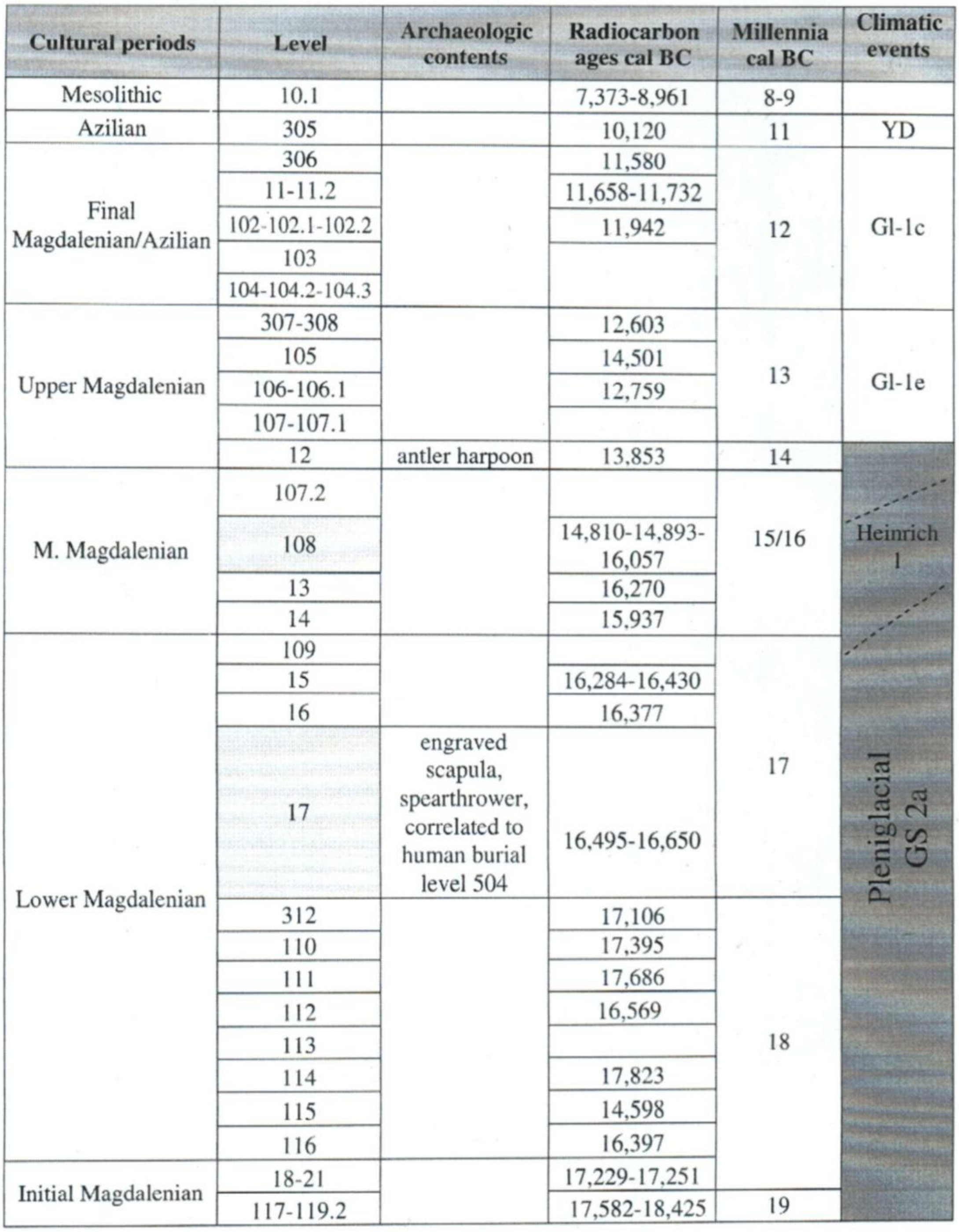
While it is difficult to infer much from the results of a $2m^2$ sondage excavation, the Solutrean occupation of El Mirón has tentatively been interpreted as having comprised repeated, limited, and ephemeral human visits focussed on specific subsistence activities (Straus and González Morales 2009, 136). Occupation of the site changed in nature and intensity in the following Magdalenian as the end of the Last Glacial Maximum brought about a shift in the economic possibilities for a site at this location (Ibid 2009, 136).

4.4.2 **Magdalenian and Azilian**

Full details of the Magdalenian deposits excavated at El Mirón cave are not yet published. It is possible, however, even at this early stage to gain a general impression of the site, even without detailed inventory descriptions. Although El Mirón boasts one of the most complete and thoroughly dated Magdalenian sequences in Cantabria, the initial and middle phases are relatively poorly known, with less precise radiocarbon dates and an absence of diagnostic artefacts (Straus and González Morales 2012). Consequently, some deposits are afforded their cultural assignation on a more arbitrary nominal basis, such as the relatively nondescript Azilian levels at the site (Ibid 2012, 16). Table 20 shows the chronological ordering of the Magdalenian deposits excavated at the site, along with those attributed to the Azilian and earliest Mesolithic after Cuenca-Bescós *et al.* (2012).

Prior to the classic Lower Magdalenian deposits, there are levels, not in clear stratigraphic order, pertaining to what has been termed the “Initial Magdalenian”. Dates from these deposits show them to be approximately contemporary with levels 17-20 at La Riera, though unlike these levels, backed bladelets do not comprise a significant portion of the lithic assemblage (Straus and González Morales 2012, 6). Excavation of a sondage in the mid-vestibule of the cave led to the identification of another level pertaining to the so called “Initial Magdalenian”: level 313, curiously absent from Table 20 (312, the Lower Magdalenian deposit discussed in the same paper, is included in the table). Unlike levels 117-119.2, this deposit yielded notable quantities of backed bladelets (45%) from an admittedly small (38 pieces in total) retouched tool assemblage (Straus et al. 2008, 212).

The Lower Magdalenian deposits boasted abundant lithic assemblages, with the retouched component heavily dominated by backed bladelets. There is also a small number of geometric microliths (triangles and circle segments). As a whole, the assemblage is characterised by high-quality and non-local flints, probably from Upper Cretaceous outcrops along present day coastal cliffs (Straus and González Morales 2012, 114), although it is not clear whether there is differentiation between the materials used for backed bladelets and other tools as noted at sites such as Berniollo. Antler sagaies are also abundant in these levels, and included a wide variety of cross-sections and bases (Ibid 2012, 114). Of particular note is the recovery of a small antler atl-atl spearthrower from level 17, with similar examples having been found in the South West of France (González Morales and Straus 2009, 274–276).



Cultural periods	Level	Archaeologic contents	Radiocarbon ages cal BC	Millennia cal BC	Climatic events
Mesolithic	10.1		7,373-8,961	8-9	
Azilian	305		10,120	11	YD
Final Magdalenian/Azilian	306		11,580	12	Gl-1c
	11-11.2		11,658-11,732		
	102-102.1-102.2		11,942		
	103				
	104-104.2-104.3				
Upper Magdalenian	307-308		12,603	13	Gl-1e
	105		14,501		
	106-106.1		12,759		
	107-107.1				
	12	antler harpoon	13,853	14	
M. Magdalenian	107.2			15/16	Heinrich 1
	108		14,810-14,893-16,057		
	13		16,270		
	14		15,937		
Lower Magdalenian	109			17	Pleniglacial GS 2a
	15		16,284-16,430		
	16		16,377		
	17	engraved scapula, spearthrower, correlated to human burial level 504	16,495-16,650		
	312		17,106	18	
	110		17,395		
	111		17,686		
	112		16,569		
	113				
	114		17,823		
	115		14,598		
	116		16,397		
Initial Magdalenian	18-21		17,229-17,251		
	117-119.2		17,582-18,425	19	

Table 20: Magdalenian, Azilian and Mesolithic deposits and dates from El Miron (taken from Cuenca-Bescos et al. 2012)

The Middle Magdalenian at El Mirón is not well represented, and proved problematic to date, with most suggestions as to the possible nature of these occupations coming from observations based on other sites (Straus and González Morales 2012). Upper Magdalenian deposits at El Mirón coincided with the warming conditions of Greenland Interstadial 1e, with retouched assemblages comprising large quantities of backed bladelets, including backed micropoints (Straus and González Morales, 2012: 13). These levels are poor in osseous artefacts, although level 12 yielded a unilaterally barbed antler harpoon (Ibid 2012, 117). Following these levels are a series of artefact-poor deposits that mark the end of the Pleistocene sequence, recognised nominally as the Azilian (Ibid 2012, 119). The importance of backed bladelets in these levels is not clear from the summary provided by Straus and González Morales (Ibid 2012), but the asserted apparent similarities with the preceding Upper Magdalenian deposits, the presence of backed micropoints, and reference to quantities of backed bladelets recovered from other Azilian sites may at least validate the assumption that they were present in some quantity. What is clear is that the relatively sparse Azilian levels comprise a much more ephemeral use of the cave in contrast to earlier levels from the Lower and Upper Magdalenian.

4.4.2.1 Magdalenian and Azilian Fauna

Faunal remains from the terminal Pleistocene (Mid Magdalenian – Azilian) deposits at El Mirón have been the subject of extensive analyses (Marín Arroyo 2009a; 2009b; Cuenca-Bescós et al. 2012). Of 117,557 faunal remains recovered, only 5320 could be identified taxonomically (Cuenca-Bescós et al. 2012). Of these, 19% exhibited anthropomorphic cut marks, and 30% were broken, with the presumed intent of marrow extraction (Cuenca-Bescós et al. 2012, 132). The NISP values for the ungulate fauna are shown below in Table 21, which measures by stratigraphic level (Middle Magdalenian-Mesolithic), and in Figure 29, which shows change across time (16-10,000 BC). The overwhelming majority of faunal remains come from Mid-Magdalenian level 108.

Cultural periods	Level	Radiocarbon ages cal BC	Millennia cal BC	*Equus caballus*	*Bos/Bison*	*Cervus elaphus*	*Capreolus capreolus*	*Sus scrofa*	*Capra pyrenaica*	*Rupicapra rupicapra*
Mesolithic	10.1	7373–8961	8–9			28	11	3		
Azilian	305	10,120	11		1	14		1	6	2
Final Magdalenian/Azilian	306	11,580	12	1	2	85	16	1	46	11
	11–11.2	11,658–11,732				122	30	1	121	4
	102–102.1–102.2	11,942				147	27	4	68	13
	104–104.2			1		92			88	1
Upper Magdalenian	307		13			31	2	2	13	4
	308	12,603				21			20	7
	106–106.1	12,759		4		277	3	1	266	16
	107–107.1			4		77			109	9
	12	13,853	14	3		24	6		33	
Middle Magdalenian	107.2	–	15/16	4	2	206	13		162	23
	108	14,810–16,057		1	2	1524			1096	62
	13			4		15			21	7
	14	15,937				56	9	3	117	1

Table 21: Ungulate NISP data with associated dates and cultural affiliation for El Miron. Taken from Cuenca-Bescos et al. 2012

Red deer and ibex are the dominant fauna throughout the Magdalenian and Azilian deposits, although an intentional diversification of resource exploitation is apparent in the latter deposits (Arroyo, 2009b: 79). Figure 30 shows how, starting in the Azilian and becoming more apparent in the Mesolithic, mountain species (ibex and chamois) seem to decline in favour of lowland woodland species such as roe deer and wild boar (Cuenca-Bescós et al. 2012). Analysis of carcass transportation in the Magdalenian and Azilian deposits has shown that processing regularly began prior to arrival at the cave, enforcing the interpretation of the site as a residential camp (Arroyo, 2009b: 89). Seasonality data shows that the site was mostly occupied during the warmer months throughout the final Palaeolithic (Ibid: 90). Although this interpretation was derived exclusively from young prey, there is, at least in the later deposits, a clear shift towards the exploitation of juvenile taxa. The pattern of occupation inferred is further corroborated by the presence of bearded vultures (*Gypaetus barbatus*, a predator that would not have cohabited with humans) established in the winter months (Ibid, 2009b). With this pattern in mind, it has been suggested that the cave's occupants were tracking red deer as they migrated inland up the valley to higher pastures at this time of year (Ibid, 2010: 464).

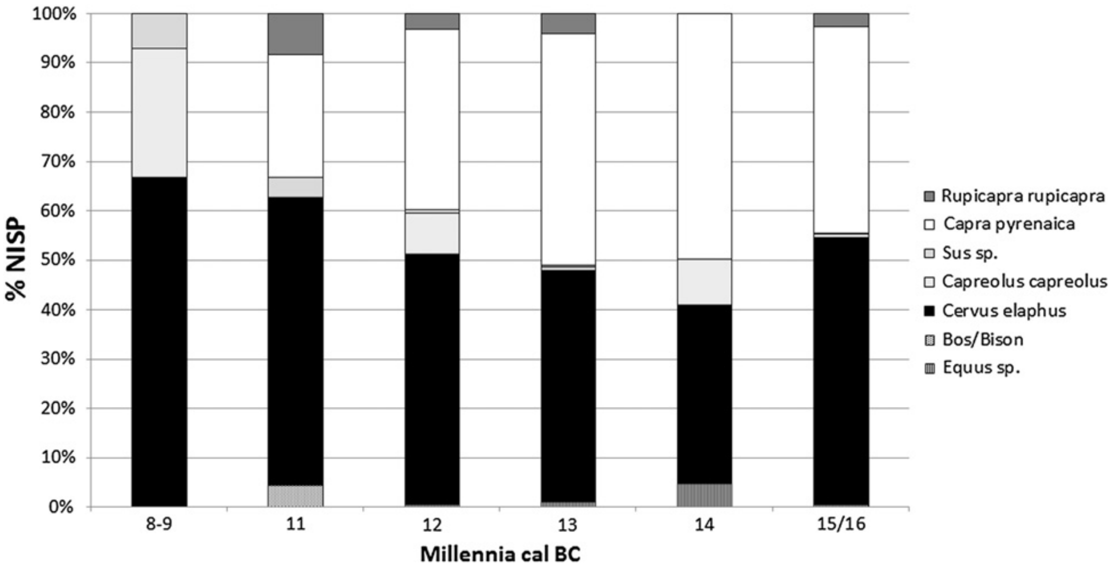


Figure 29: Graph of ungulate NISP at El Miron by millennia. Taken from Cuenca-Bescos et al. 2012

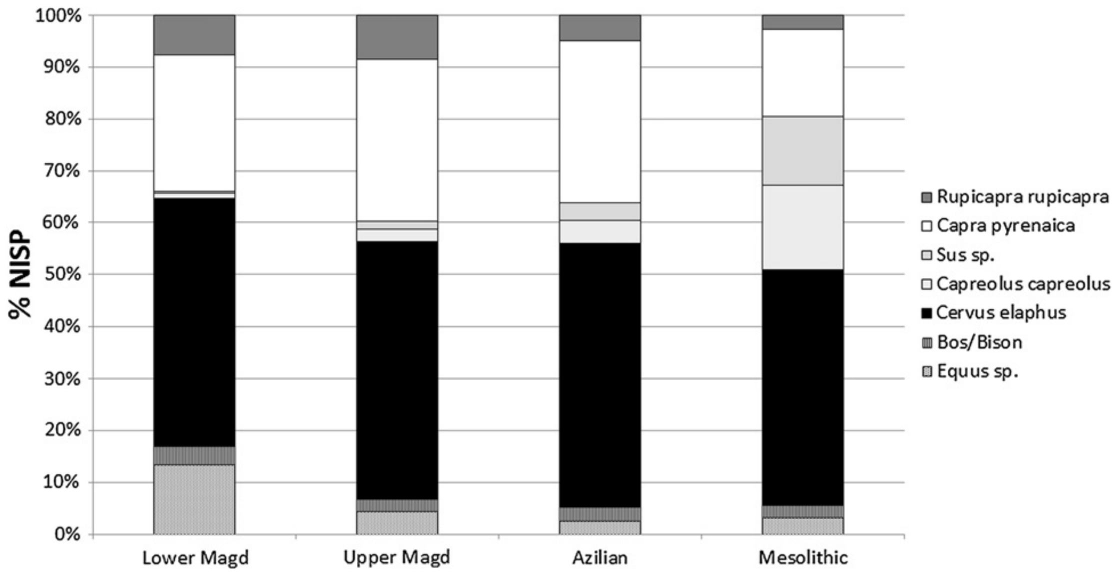


Figure 30: Graph of ungulate NISP at El Miron by cultural affiliation. Taken from Cuenca-Bescos et al. 2012

The Magdalenian of Cantabria is often characterised by red deer hunting at lowland sites on the coastal plain, and ibex hunting in mountainous areas. This dichotomy, based on game exploitation, has led to the recognition of three broad types of site in the area at this time.

1. Sites located in open, coastal areas, and located close to rocky terrain (e.g. La Fragua) specialised in red deer hunting but with appreciable percentages of ibex and other species.

2. Sites located in open terrain away from mountain areas, specialised in red deer hunting.

3. Sites located in areas of steep hillsides, often at greater distance from the coast and with dominant quantities of ibex, and other montane species.

(Arroyo 2009b, 69-70)

El Mirón is notable for not conforming to this categorisation. The site is located on the steep, rocky cliff-side of a mountain, but also overlooks the broad upper valley of the Asòn river, with faunal assemblages consistently dominated by red deer and ibex, a trend continued from the earlier Solutrean and Lower Magdalenian deposits (Straus & González Morales, 2012). Of the Magdalenian levels, red deer are the more dominant of the two except in levels 14 and 107, in which ibex predominate. In the Upper Magdalenian, it is apparent that the young of both species, along with their mothers, are being preferentially targeted (Straus & González Morales 2012, 14). This trend is also evident in the hunting of woodland ungulates (wild boar and roe deer), which increase in number in the Azilian, although red deer and ibex remain the dominant prey (Ibid: 17).

4.4.3 **Summary**

El Mirón is, in many ways, the keystone site for our understanding of Pleistocene archaeology in the Asón river valley. Already, despite research not yet being completed or fully published, the site has had a significant impact upon research into Palaeolithic Cantabria. Details from the Solutrean are limited but show that Solutrean Points and retouched bladelets were used simultaneously, as in the early Solutrean at La Riera. Further work is necessary before more in-depth assessment can be conducted, but from the details made available thus far, it seems that changes in the presence of bladelets in lithic assemblages appears to have very little relation on changes in fauna, which are in turn overshadowed by the prevailing duality of ibex and red deer that dominate throughout until the more diverse Mesolithic assemblage.

So far, excavation of the complex stratigraphy at the cave has revealed a series of variable occupations throughout the Pleistocene. Like La Riera, some twenty five years earlier, a significant emphasis has been the regional context of the site. The scale of research conducted in the Asón river valley is such that archaeologists have been able to begin addressing broader questions through investigating subsistence and settlement mobility movements within the region. El Mirón was most likely utilised as part of a complex mobility system, influenced by seasonal trends in red deer migration, but as the varied seasonality studies at other sites in the Asón valley have shown (Arroyo 2009b, 93), we should be wary of overly simplifying this system.

4.5 Northern Spain: A Summary

Summary of the above chapters may be broken down into four distinct points of discussion: the hunting equipment, the prey, the environment, and changes in site distribution. Archaeologically speaking, analysis of lithic and osseous implements comprise most of the evidence for assessment of hunting equipment, and ungulate anlyses account for much of the information on prey species.

4.5.1 Hunting Equipment

With the exception of rare finds such as triangle pieces, which make a precocious appearance in the Initial Magdalenian (Straus 2012, 114), the microlithic assemblages of the late Upper Palaeolithic of Cantabria almost are almost entirely comprised of bladelet technology. Of the retouched bladelets, plain backed elements are by the far most dominant in the region. It should be remembered that in essence, all retouched bladelets are backed bladelets, and other types that do not conform to the definition of a ‘backed bladelet’ are derivative of this form. Other types of bladelet are rarely found in significant quantities throughout the late Upper Palaeolithic of Cantabria. Combined with the widespread belief that unretouched or “debitage” bladelets are merely manufacturing blanks, this has meant that backed bladelets receive the majority of attention. While bladelets are not uncommon in Solutrean assemblages, they are generally found in much greater quantities in Magdalenian assemblages, so much so that they are sometimes considered indicative of the transition between these two cultural phases. Their prominence continued in the Azilian, but they are less well represented at Asturian sites (Clark 1983b).

These trends are generalised, and while larger quantities of bladelets are typically associated with the post-Solutrean Palaeolithic, they are not abundant in all such deposits, as evident in levels at La Riera, El Mirón, and throughout the sequence at El Rascaño. Particular attention should also be given to the backed micro-points that do not commonly feature in assemblages until the Magdalenian. The two main types are known as “microgravettes” and “azilian points”. As the name suggests, azilian points are common among Azilian assemblages, but are also found in many earlier assemblages also. Usewear investigations have shown that backed bladelets, particularly smaller pieces, and many “micropoints” were used as projectile armatures (Keeley 1988; Juan Jose Ibánez Estevez and González Urquijo 1998). Although it has proven difficult to differentiate, morphologically it would seem that regular backed bladelets would have served best as laterally hafted cutting insets for spearthrown projectiles.

The Solutrean Points, from which the cultural phase takes its name, are far from ubiquitous during the period. Consensus suggests that these points were used as armature tips, and that impact damage accounts for the nature and high frequency of damage noted in many examples (Straus 2000, 42). Most were probably used as spear tips, though the smaller, lighter and abruptly (rather than invasively) retouched shouldered points, more frequently knapped from flint, may also have served as arrow-heads (Straus 1992, 104). The Magdalenian marks the disappearance of these points, although their recovery from early levels is not unheard of, with El Mirón and arguably La Riera being two such examples. This period is instead characterised by antler sagaies, some of which feature grooves potentially used for the hafting of bladelets (Straus, 1992), while some others have barbs carved into them, and still others have neither of these features. It is possible to argue that bladelets and harpoons represent the replacement of Solutrean points with cheaper and lighter weaponry (Straus 1992, 109; 2000, 42) that were also likely more durable (Pokines 1998), though the two are not mutually exclusive in Solutrean deposits.

The Azilian, and main subdivisions of the Magdalenian, are distinguished chiefly by changes in the cross-section of antler harpoons, along with changes in base morphology. While these trends may hold true at a general level, this rule is highly problematic as there are many exceptions, and further still many Magdalenian and Azilian sites where such artefacts are simply not present (Straus 2011, 5). Furthermore, such implements are difficult to quantify when fragmented. Finally, excavations at El Mirón have yielded evidence of the first atlatl from Magdalenian Cantabria (González Morales & Straus, 2008), though it seems unreasonable to rule out the probability that this technology was also in use during earlier periods.

4.5.2 **Prey**

Ungulate fauna were likely hunted for food but also hides and their antlers/horns. The main ungulates characteristic of Cantabrian assemblages are Red Deer (*Cervus elaphus*), Ibex (*Capra pyrenaica*), Chamois (*Rupicapra rupicapra*), Wild Cattle (*Bos/bison* – usually indeterminate), Wild Horse (*Equus Ferus*), Wild Boar (*Sus scrofa*) and Roe Deer (*Capreolus capreolus*). Following Leslie Freeman's seminal paper (1973), which proposed the idea of 'wild-harvesting' of red deer, an idea that remains popular today (Straus 2005, 153), most faunal analyses have until recently been conducted or supervised by Jesus Altuna, ensuring a degree of consistency.

Most faunal assemblages from the Solutrean and earlier stages of the Magdalenian are dominated by red deer and ibex to varying degrees. In the Holocene, faunal assemblages are more diversified, and this shift is presaged at some sites in the Azilian and final stages of the Magdalenian, as noted to varying degrees at La Riera, El Mirón and La Fragua. At these three sites, it seems that the emphasis on the exploitation of ibex and other montane species is decreased in favour of wild boar and roe deer, which are more commonly associated with temperate and forested environments (Altuna 1986c; Cuenca-Bescós 2012; Arroyo 2009b). Despite the beginnings of this trend of diversification, red deer (and to a lesser extent) ibex regularly remain the dominant species at most Cantabrian sites even in the final stages of the Palaeolithic. Concordant with this trend is an increase in the role of marine resources noted at some sites.

Although many faunal assemblages can be described as conforming to the dual economy of red deer and ibex, most sites conform to one of three variations of this pattern: sites with faunal assemblages specialised in red deer but with appreciable quantities of ibex and other species located in open, coastal areas with access to rocky terrain (e.g. La Riera), sites with faunal assemblages specialised in red deer but located in open terrain away from mountainous areas, and sites with a significant presence of montane species located at greater distances from the coast and in areas of steep hillside (e.g. El Rascaño) (Arroyo 2009b, 70). While this model is not necessarily incorrect, zooarchaeological analyses of the Magdalenian assemblages and those from other sites in the Asón valley has shown that inland sites in the uplands of the valleys contributed to a more complex seasonal round, with evidence of residential sites deep inland with red deer as the dominant fauna (El Miron) (Ibid).

As fine mesh-screen recovery systems were implemented, the resolution of micro-fauna has greatly improved (Pokines 2000). Some of these species, even if not of economic significance, still offer valuable insights as indicators of climate and palaeoenvironment, and even patterns of human behaviour (Cuenca-Bescós *et al.* 2007; Marín-Arroyo, 2009c). After analysis from sites such as La Riera revealed this potential, micro-fauna have increasingly gained attention with studies completed at the Magdalenian site of El Juyo (Pokines, 1998) and El Mirón (Cuenca-Bescós *et al.* 2009; 2012). However, much of the faunal analyses conducted on Cantabrian assemblages have proven to be of little use in attempts to correlate climatic shifts due to their monotony over time (Altuna 1995).

4.5.3 **Environment**

The environment in which prey are hunted is determined by a number of factors, including climate, landscape and topography, vegetation and a host of other even less archaeologically visible considerations (weather for example). Reconstruction of the palaeoenvironment of the Cantabrian Palaeolithic has been a major focus of research over the past forty years. Most efforts have revolved around assembling records at individual sites and correlating evidence of localised change with the larger-scale climatic events known to have taken place. As noted above, unlike many other areas of Europe, changes in the palaeoenvironmental record of Cantabria are not as clearly reflected in the composition of many faunal assemblages at many sites (Altuna 1995). Furthermore, the chrono-cultural framework developed for archaeological deposits does not always neatly correlate with changes documented in climate or palaeoenvironment either. Palynological and sedimentological analyses contribute the majority of evidence, and sites such as La Riera and El Mirón, with extensive and (relatively) continuous, well dated sequences, offer the most insight for the construction of regional trends (Straus 1986a; Straus et al. 2001, 629), though difficulties with the interpretation of these records can seemingly indicate contradictory conditions at contemporary deposits, and require critical knowledge of taphonomic processes (Straus 1990).

A chief motivation in efforts to reconstruct palaeoenvironment is the desire to understand the impact it had on the development of peoples inhabiting Cantabria at the time. Two schools of thought have developed over explanations for change in the Palaeolithic of Cantabria, with one citing changes in environment as a catalyst (Bailey 1983; Clark 1983a), and others downplaying the effect of the environment in favour of internalised change (Arroyo 2009c). While advocacy of the former has continued in some circles, the latter is seemingly more popular, and has also been championed (and espoused several times) by Straus (2005). Broadly speaking, following the LGM, the climate ameliorated, but was punctuated by Dryas events of increasingly less severe (but nevertheless notable) cold conditions. Although the region undoubtedly experienced significant shifts in ecosystem, climatic change was seemingly never severe enough to completely eradicate many species of flora and fauna entirely, and likewise conditions did not ameliorate sufficiently to permit extensive reforestation until the very terminal Pleistocene.

4.5.4 **Site Distribution**

Assessments of site distribution in the Cantabrian Upper Palaeolithic are problematic due to preservation biases against open air sites. There may have been times, particularly during cold periods such as the LGM, when cave shelters did indeed account for the majority of sites, but it must be accepted that this preservation bias potentially obscures important locations inhabited within the wider landscape. In general, the Magdalenian represents an increase in site number over the preceding Solutrean, and the Azilian also marks a continuation of this trend. However, this gradual increase in site density does not compare to the relative explosion of sites experienced in the Solutrean, in response to the suitability of Cantabria as a glacial refugium. It is difficult to meaningfully compare site densities between these cultural phases though, as they span different time-depths, and have been subjected to varied taphonomic processes. Although the increase in sites recorded in the Magdalenian over the Solutrean is only slight, the Magdalenian spanned a slightly shorter time period, and is generally believed to have experienced less severe climatic disruption. Furthermore, cave sites appear to have endured throughout this period as popular habitations, with little apparent variation in site distribution over time until the Asturian (Straus, 1992: 130; 206).

5 Howieson's Poort of Southern Africa (Klasies River)

The Howieson's Poort is the focus of the next regional case study. Typically, Howieson's Poort (HP) lithic industries are characterised by various backed and/or truncated pieces (notably crescents and trapezes between 10-60mm in length alongside more conventional MSA flake-blades) (Figure 31) (Thackeray 1992, 390). As an archaeological industry, it has been identified at several sites across the southern African sub-continent with disparate clusters to the east, along the southern peninsular and in the west (Figure 32). The Howieson's Poort provides some of the earliest evidence from a southerly latitude of early microlithic tools from a relatively early age (approx 65-59 kya) (Jacobs and Roberts 2008, 26), some of which were utilised for hunting (Pargeter 2007; Wurz and Lombard 2007; Lombard and Pargeter 2008; Lombard and Haidle 2012). New dates from Pinnacle Point show even earlier microlithic industries predating the HP. Generally, the Howieson's Poort occurs as an intercession within the comparatively homogenous Middle Stone Age (MSA). The MSA itself is broken down variously into sub-stages at most sites, usually based on associated lithic industries and / or depositional sequencing. Chronologically, the Howieson's Poort occurred between MSA II and MSA III.

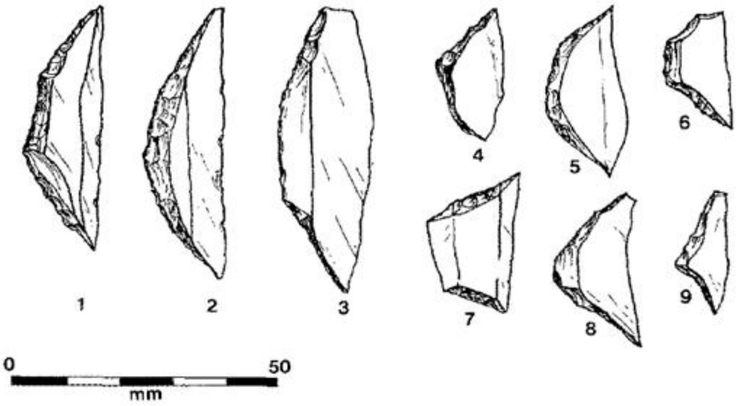


Figure 31: Howieson's Poort Backed crescents (1-5) and trapeze (6-9) segment pieces (Thackeray, 1992).

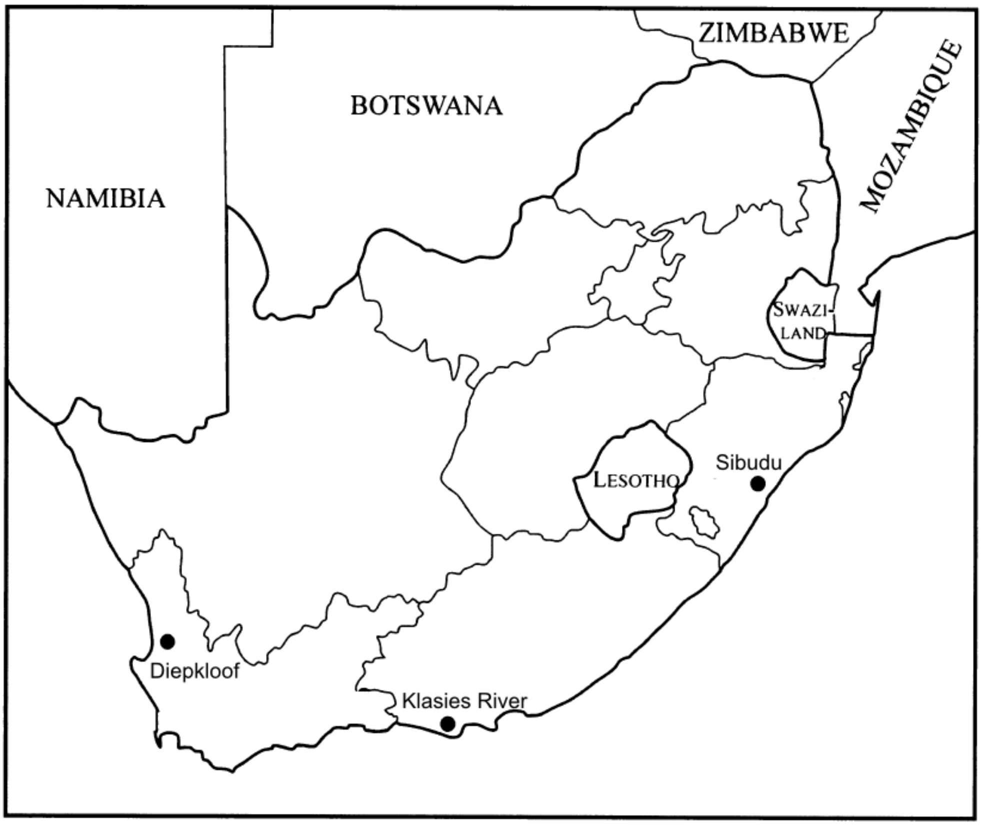


Figure 32: Map of southern Africa showing sites of Klasies River, Sibudu and Diepkloof Rockshelter

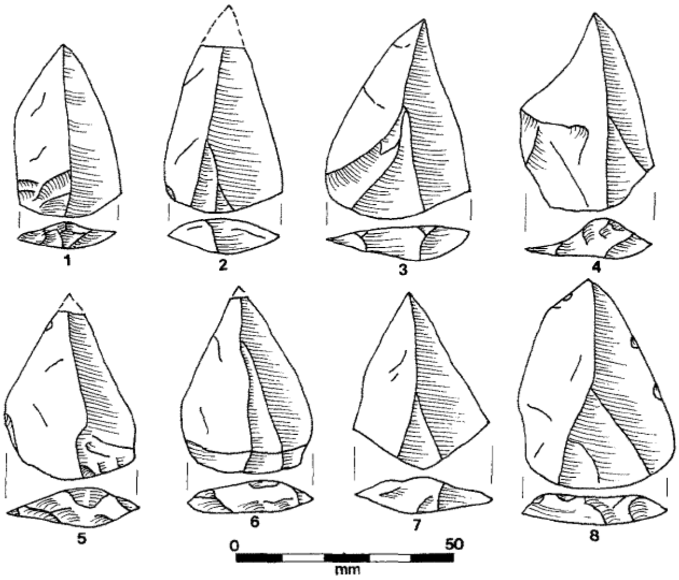


Figure 33: Pointed (convergent) MSA "flake-blades" (Thackeray 1992)

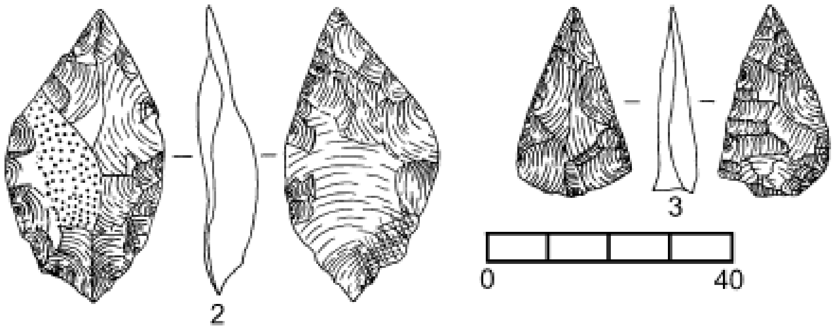


Figure 34: Bifacial Still Bay points (Wadley 2007) N.B. Points can vary in form and size being much larger in some cases.

The most commonly used format to transcend the homogeneity of the MSA is that of Volman's division into four stages (in Thackeray 1992, 398; Wurz 2012, 1001), based roughly on the scheme devised by Singer and Wymer at Klasies River Mouth (1982, 43). Chronologically and stratigraphically, the Howieson's Poort occurred between MSA II and MSA III. Although assemblages vary from site to site, the MSA is typified by flake and blade industries that include prepared points and cores, and usually without any retouch (Figure 33) (Thackeray 1992, 393; Mcbrearty and Brooks 2000, 456; Wurz 2005). The Stillbay industry, typified by elongated bifacial points (Figure 34) (Wadley 2007, 682), is also worth noting as an earlier MSA interlude between 72 and 71 kya (Jacobs and Roberts 2008, 26). Although it has remained more elusive as an archaeological phenomenon than the Howieson's Poort (Henshilwood and Dubreuil 2011, 369), the Stillbay has become a focus of interest in much the same way, being a notable temporary break from otherwise longstanding technological traditions. Curiously, it is absent from most Howison's Poort yielding sites, including Klasies River Mouth (McCall and Thomas 2012, 36).

5.1 Klasies River Mouth

Klasies River Mouth, interchangeably referred to as simply Klasies River from herein (at the behest of Wurz (2000)), and regularly abbreviated to KRM or KR, is the ideal site to serve as the keystone for this case study. It was at Klasies that the currently accepted relationship between the Howieson's Poort and other MSA phases was first established, in what is still one of the deepest stratigraphic sequences (20m) from a site of such antiquity in the area, spanning between approximately 110 – 60 kya

(Wurz 2005, 419–420). The Howieson's Poort portion of the sequence is the most extensively dated of its kind (Lombard 2006c, 36), and has served almost exclusively as the primary source of reference for the industry until relatively recently (Ibid 2009, 4). Finally, and perhaps most importantly, Klasies gained significant attention for providing the archaeological context for what were thought to be the earliest known anatomically modern human remains at the time of their discovery (Thackeray 1992, 385).

Intense interest has continued, largely due to the role in which Klasies and other approximately contemporary sites play in informing us about the development of cognitively modern behaviour. The view that humans of this period were indeed cognitively modern is one that, while not wholly accepted, has increasingly gained consensus in recent years (Deacon 1989; Wurz 1999; Wurz 2008; Mcbrearty and Brooks 2000; Wadley 2001; Wadley, Hodgskiss, and Grant 2009; Minichillo 2006; Marean et al. 2007; d' Errico et al. 2008; Jacobs et al. 2008; Jerardino and Marean 2010; Henshilwood and Dubreuil 2011; Lombard and Haidle 2012). Much of this thinking stems originally from the parallels traditionally drawn between the Howieson's Poort and the microlithic technology associated with Upper Palaeolithic and Mesolithic modern humans e.g. by Mcbrearty and Brooks (2000, 500–501). Klasies retains its position at the fore of discourse, remaining one of the best-known MSA/HP sites to this day. The impact it has had on shaping the archaeology of the period is reflected by the publication of works such as Pyne's "*The Life History of Klasies River Mouth: A Case Study of Archaeology and the History and Philosophy of Science*" (2008).

5.1.1 **Location Of The Site**

Klasies River actually comprises five individual caves Figure 35, all located within 3km to the east of the actual river mouth (34º06' S, 24º24' E) along the Tsitsikamma coast in the Humansdorp district of the Eastern Cape Province, South Africa (Singer and Wymer 1982, 1). The five caves actually constitute three different sites: caves 1 and 2 (the main site), caves 3 and 4 (not considered in Singer and Wymer's investigations), and cave 5. The main site is partly open air and presents a series of well stratified deposits against a quartzite cliff, filling the caves and niches labelled

Cave 1, 1A (or rock-shelter 1A) cave 1B, 1C and cave 2 (Villa et al. 2010, 630). Cave 1C is not visible in Figure 36, which shows a photograph of the main site. Caves 1, 1A and cave 2 can all be related to one another through stratigraphy (Figure 37 and Figure 38).

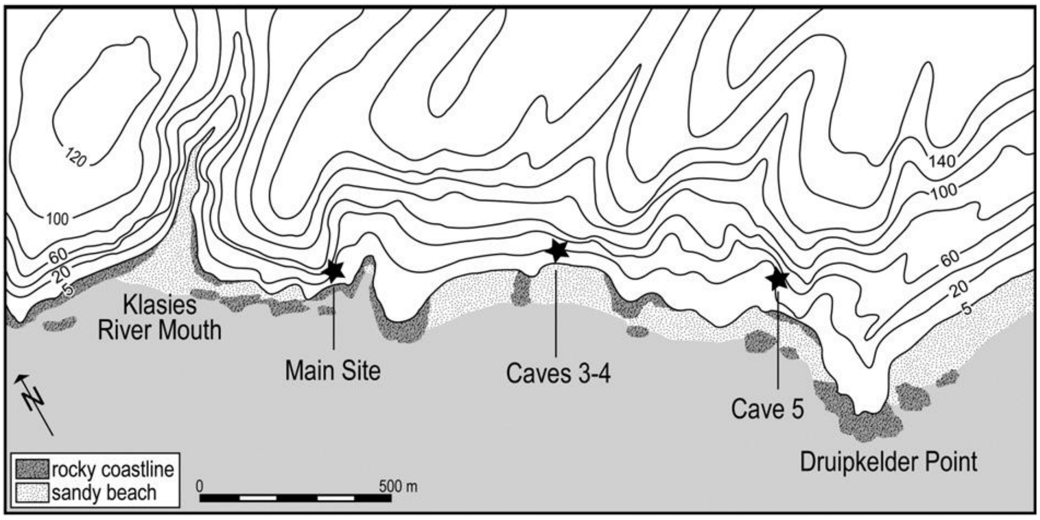


Figure 35: Map showing the three site clusters of Klasies River (Villa et al. 2010)

Figure 36: Photograph of Klasies River Main Site showing relation of caves 1 and 2 and rockshelter 1A (Thackeray 1992).

The base of the site rests 6-8m above sea level, at the foot of cliffs that rise to between 60 and 100m, atop of which is a coastal plain that extends some 10km in width before a mountain range (average elevation of 600m) (Avery 1987, 406). The site is located towards the eastern limit of the fynbos biome, and vegetation comprises a mixture of Dune Fynbos (mid-dense to closed shrubland) and Kaffrarian Thicket (closed shrubland and low forest) (Ibid 1987). Howieson's Poort deposits were located in rock-shelter 1A and cave 2, suggesting an approximately contemporary age for the two. Rockshelter 1A is the focus of this investigation, as the sequence provides Howieson's Poort deposits sandwiched within bracketing MSA phases.

5.1.2 History Of Work At The Site

Although Howieson's Poort industries had been documented since their discovery in the 1920's at their namesake site (Goodwin and Van Riet Lowe, 1929), Klasies was one of the first HP yielding sites to be excavated and recorded to relatively modern quality standards. Few such excavations had been undertaken elsewhere in the Cape Province, with a few exceptions to the North, none of which had been extensively published (Singer and Wymer 1982, 5). The site was excavated between 1967 and 1968 by a team of archaeologists and labourers led by Ronald Singer and John Wymer. Though the slope dynamics involved in site formation processes posed complications, the excavators were at least satisfied that there were no signs of previous human disturbance (1982, 7). Their final site report was notable for including supplementary palaeoenvironmental studies based from the faunal (Klein 1976) and sedimentological (Butzer 1978) analyses of the site, the latter in particular a relatively recent development for the field at the time. The resultant publication was the source of much discussion, perhaps most notably from Lewis Binford who contested several of the excavator's conclusions regarding the stratigraphy of the site and significance of the faunal deposits recovered among other issues (Binford 1984).

With time, many of Binford's objections regarding the site have been disproved (Deacon 1985; Singer and Wymer 1986; Deacon and Geleijnse 1988; Deacon 1989; Milo 1998). Excavation at the site was renewed under the auspices of the late Hilary Deacon in 1984. Deacon's meticulous excavations were intended to improve understanding of the site stratigraphy and formation processes, gain a tighter resolution on the dating and palaeoenvironmental history of the site, and to ensure the future preservation of the site by stabilising the slope and sections (Villa et al. 2010, 630). Although work from this period has been published, there has been no complete synthesis or unified report since Singer and Wymer's, and the high-resolution focus of the investigation has ensured minimal intrusive removal during excavation. Consequently, Singer and Wymer's study remains the main source of documented archaeological material, including the lithics collected from Howieson's Poort deposits (Wurz 2000, 16). The various revisions made to the stratigraphy throughout the history of work at the site make clarification of the order cited for this study necessary.

5.1.3 Stratigraphy

The stratigraphy of the Klasies River Mouth site has been subjected to several major revisions since excavations began in 1967. The most detailed of these is the most recent reconfiguration by Wurz (2000; 2012). Although it is possible to identify corresponding cultural divisions (Figure 38) according to changes in lithic industry, at any higher resolution the new depositional sequence is incompatible with the schema used by Singer and Wymer (1982). The closest (partial) approximation of Wurz's new schema with Singer & Wymer's original sequence is presented by Villa et al. (2010) in (Figure 39). Despite Wurz's revision, it is still common to find Singer and Wymer's sequence referred to, for example in Feathers' luminescence dating project (2002), as material is continually reanalysed, particularly for dating, demanding reference to the cruder original order. The relatively small Howieson's Poort assemblage from Deacon's subsequent excavations (upon which Wurz's revised stratigraphy is based) (Wurz 2000, 16–17), and the lack of a complete report from these investigations at present made it more beneficial to consult the more complete analysis of Singer and Wymer's original investigations, and, accordingly, the stratigraphic sequence they devised.

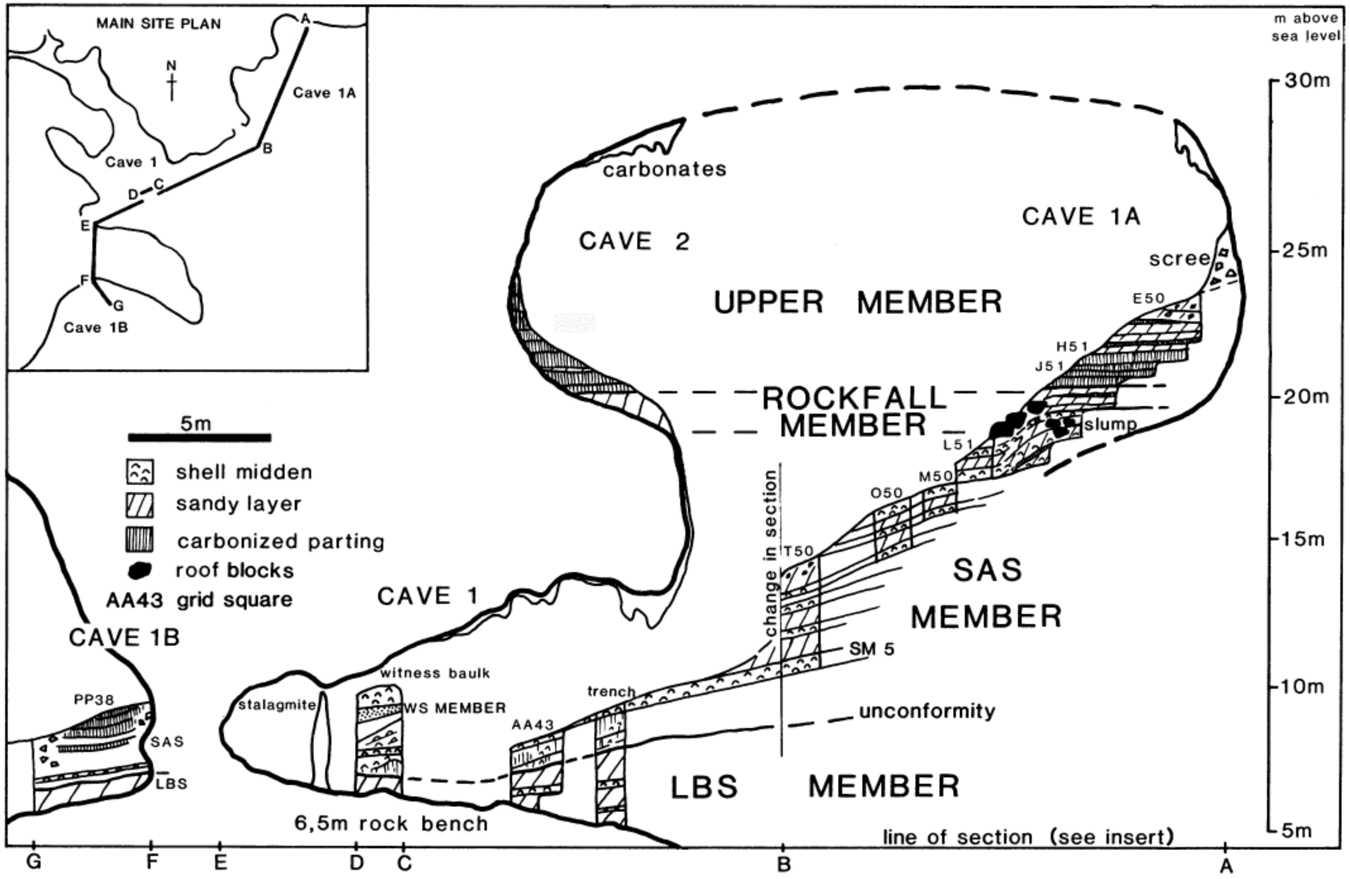


Figure 37: General Stratigraphic relation of Klasies River Main Site 1A, 1B, 1 and 2 (Deacon and Geleijnse 1988)

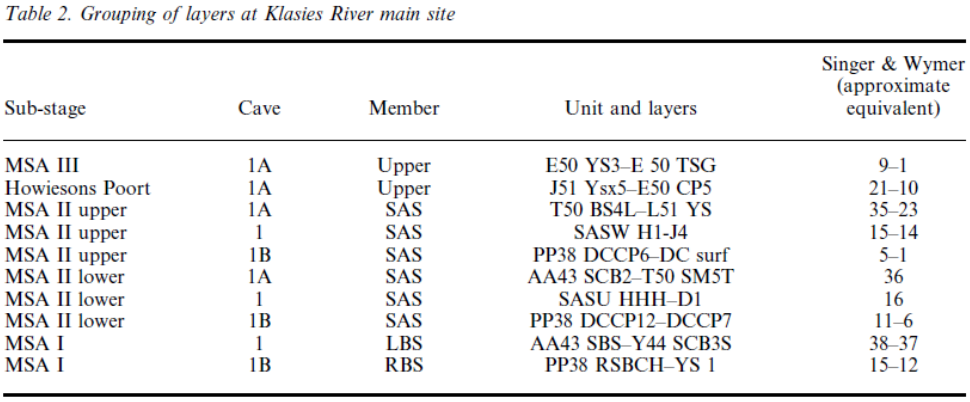


Table 2. Grouping of layers at Klasies River main site

Sub-stage	Cave	Member	Unit and layers	Singer & Wymer (approximate equivalent)
MSA III	1A	Upper	E50 YS3–E 50 TSG	9–1
Howiesons Poort	1A	Upper	J51 Ysx5–E50 CP5	21–10
MSA II upper	1A	SAS	T50 BS4L–L51 YS	35–23
MSA II upper	1	SAS	SASW H1-J4	15–14
MSA II upper	1B	SAS	PP38 DCCP6–DC surf	5–1
MSA II lower	1A	SAS	AA43 SCB2–T50 SM5T	36
MSA II lower	1	SAS	SASU HHH–D1	16
MSA II lower	1B	SAS	PP38 DCCP12–DCCP7	11–6
MSA I	1	LBS	AA43 SBS–Y44 SCB3S	38–37
MSA I	1B	RBS	PP38 RSBCH–YS 1	15–12

Figure 38: Grouping of levels at Klasies River main site. Comparing Deacon and Singer & Wymer's excavations

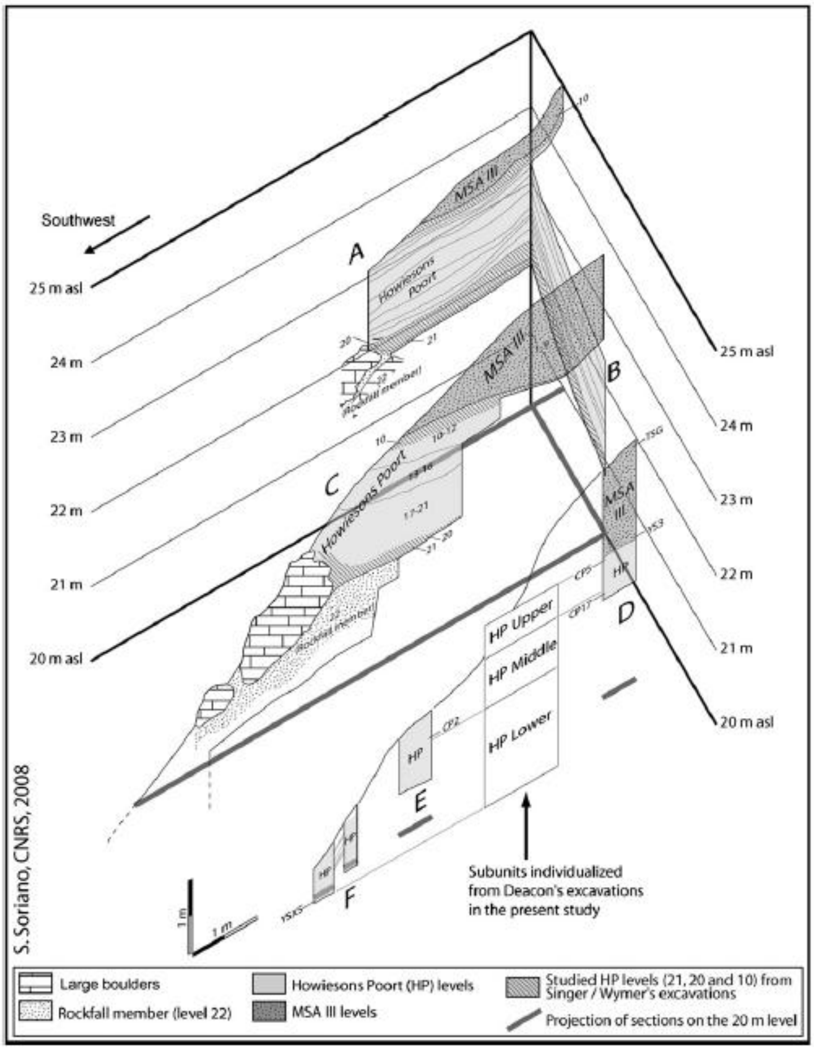


Figure 39: Cross section of Singer and Wymer's stratigraphy compared with Deacon's (Villa et al. 2010)

Although Klasies River Mouth main site comprises 5 separate sites, the relationship of caves 1, 2 and shelter 1A is such that through contiguous excavation profiles, it has proved possible to construct a relatively continuous general section across all three sites (Figure 39). Although the original interpretation of the stratigraphy and internal chronology of the sites has been challenged (Binford 1984; Hendey and Volman 1986), these challenges have been rejected by both the original and subsequent investigators of the site (Singer and Wymer 1986; Deacon and Geleijnse 1988). The Howieson's Poort assemblages, sandwiched between MSA III (above) and MSA II deposits (below) are part of an apparently unbroken sequence from KR 1A. A series of 5 standalone Howieson's Poort levels were also recovered from Cave 2, which the site excavators argue would have offered a habitation space approximately contemporary to the corresponding deposits in KRM 1A (1982, 2). They cannot be confidently interdigitated with the deposits identified in shelter 1A though, and have clearly been subjected to a different series of taphonomic processes, with many of the remains being cemented to the cave wall or in breccia deposits (Ibid 1982, 23–24).

It was decided to focus on material from KRM 1A, as this provided a relatively clear and uncontested depositional sequence with evidence of site use spanning before, during, and after the Howieson's Poort. The levels in this sequence, from top to bottom, span MSA III (levels 1 – 9), Howieson's Poort (10-21), MSA II (22 – 36) and MSA I (37 – 40). For the purposes of this investigation, the extent of the sequence considered terminates at level 33. Excavation of levels 33-36 proved problematic (Singer and Wymer 1982, 22), but when removed (along with antecedent MSA I deposits), a sizeable portion of pre-Howieson's Poort sequence material remains available for reference. Excavation of the site took place over 14 months between 1967 and 1968, with deposits pertaining to either the "Initial Cutting" of the rock shelter in 1967, or the main excavation in 1968, which expanded the investigation area (Figure 40). Figure 41 shows a magnified portion of the plan in Figure 40 focussing upon the study area of KR1A. Sections detailing these excavations (Figure 42, Figure 43 and Figure 44) are given in reference to Figure 41. Between the completion of the 1967 Initial Cutting and the 1968 excavation, a revision was made to the stratigraphic sequence of the site, dividing the three initially identified Howieson's Poort levels further into eleven separate units. This unfortunately rendered it impossible to precisely integrate material from the two excavations from this portion of the sequence, unlike the MSA deposits where the two were amalgamated without such complication.

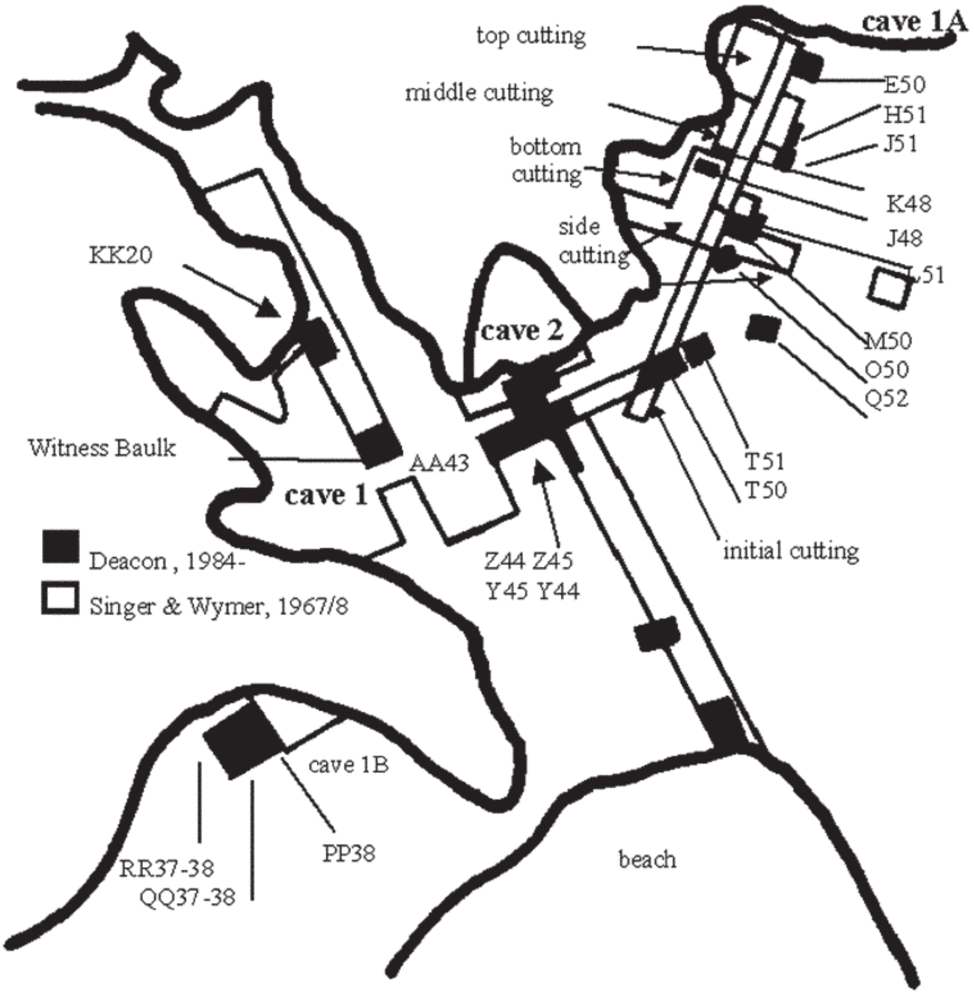


Figure 40: Plan of Klasies River Main Site showing different excavation periods for cross reference of different interrelating sections (Wurz & Lombard 2007)

Hilary Deacon noted that material excavated during Singer and Wymer's investigation was removed in gross stratigraphic units with minimal attention to contextual detail (Deacon 1985, 59). Singer and Wymer make no pretence that their sequence of the Howieson's Poort deposits represents any actual discrete occupation phases, conceding that difficulties in delineating such boundaries forced arbitrary divisions to be made on the basis of particularly visible laminations at 15-20cm intervals (1982, 21). Wurz's reconfiguration of the site stratigraphy suggests that whole sequence of the rock shelter, and not just the Howieson's Poort deposits, probably comprises many more occupation stages than were initially recorded (Wurz 2000). Deposits attributed to the Howieson's Poort were done so on the basis of large numbers of HP characteristic crescents and related forms recovered.

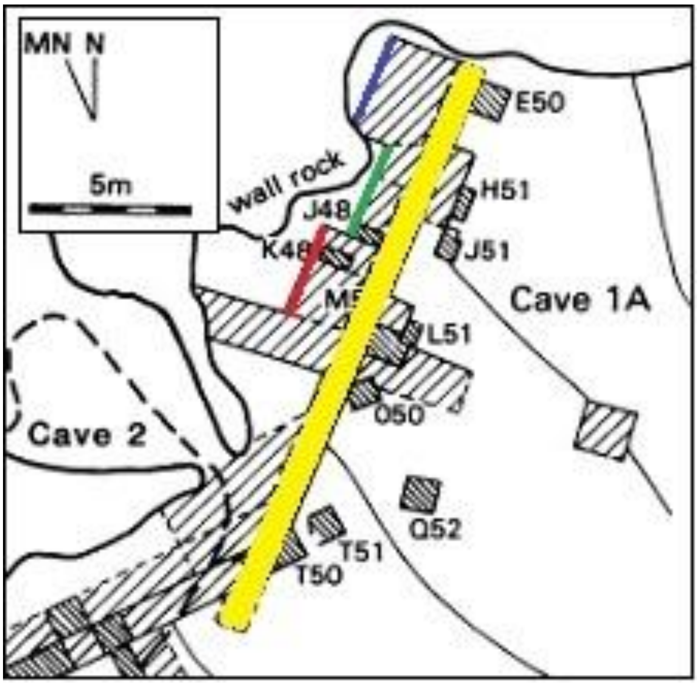


Figure 41: Close up plan of Singer & Wymer's "Initial Cutting" is highlighted in yellow. The locations of sections are also highlighted: figure 13 "top cutting" (blue), figure 14 "middle cutting" (green), and figure 15 "bottom cutting" (red). Original image from

The broader boundaries by which the KRM 1A sequence was originally divided has withstood the various revisions that have been made: the Upper Member referring to levels 1 – 21 (MSA III and Howieson's Poort), Rockfall Member (RF) referring to level 22, a natural deposit that segregates the Howieson's Poort deposits from the earlier MSA II levels, which are included in the upper Shell and Sand (SAS) Member, referring to levels 23 – 40 (Deacon and Geleijnse 1988, 7–11).

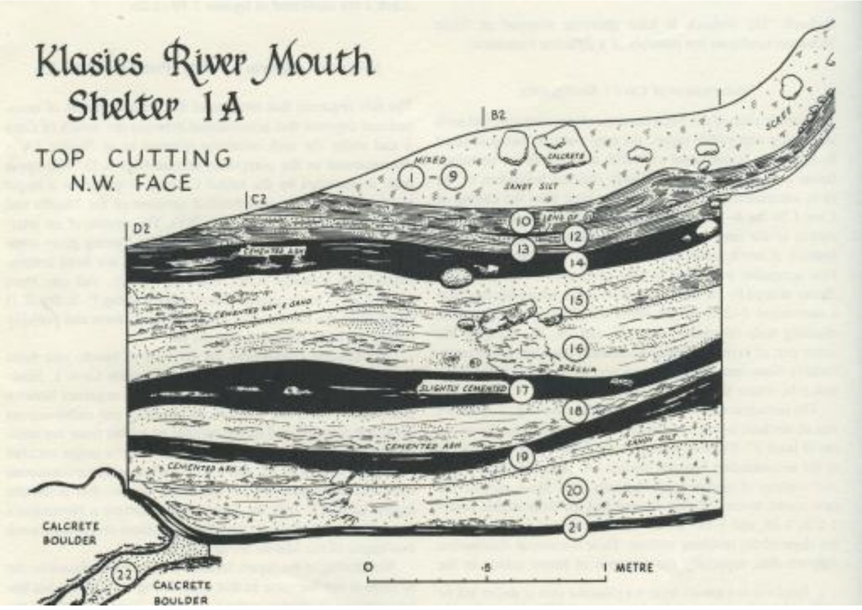


Figure 42: Section facing NW through Top Cutting of KR1A (see figure 12). MSA III deposits 1-9 (mixed), Howieson's Poort deposits 10-21, and MSA II deposit 22 (Singer & Wymer 1982)

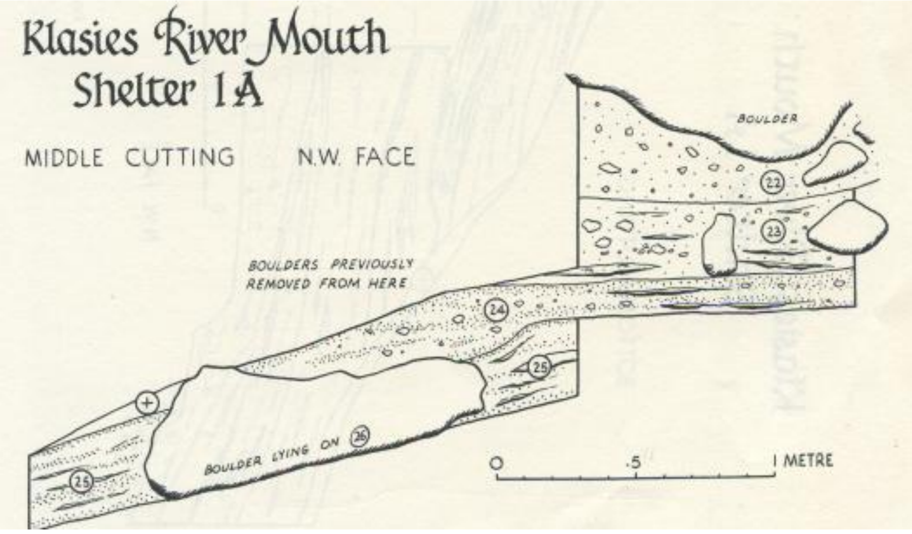


Figure 43: Section facing NW through Middle Cutting (see figure 12). MSA II deposits 22-25 (Singer & Wymer 1982)

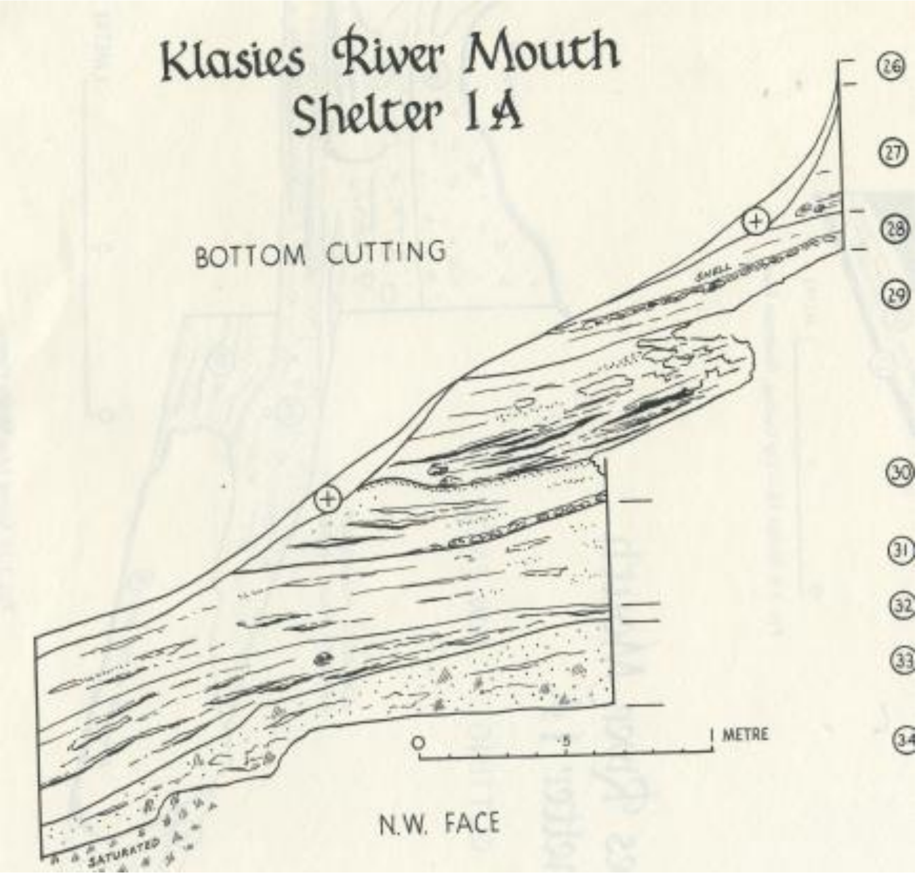


Figure 44: Section facing NW through Bottom Cutting of KR1A (see figure 12). MSA II deposits 26-34 (Singer & Wymer 1982)

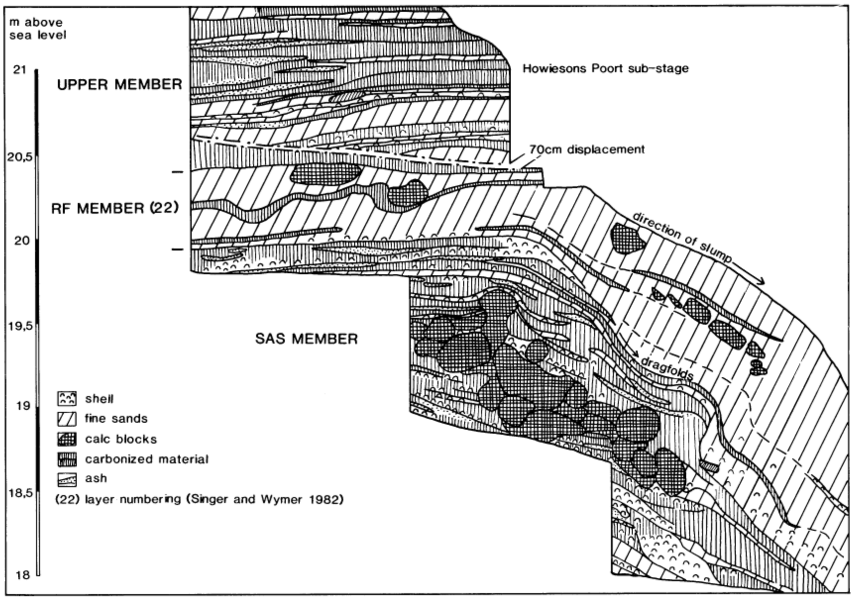


Figure 45: Drag Folding in SAS and RF members of the wall in the Initial Cutting of KR1A (Deacon & Geleijnse 1988).

The MSA II deposits preceding the Howieson's Poort levels are contorted and drag folded as a result of slumping (Deacon and Geleijnse 1988, 9) (Figure 45), while the cutting of the Upper Member of the sequence, containing Howieson's Poort and MSA III levels that cap the MSA II slope, have been affected by the partial collapse of a sediment column (Ibid 1988, 10). The MSA III deposits are about 90 cm thick, the Howieson's Poort levels are 100 cm thick, and the MSA II deposits, including Rockfall Member level 22, are about 330 cm thick (Butzer 1978, 145). Level 22 itself is a natural accumulation around 50 cm thick, and represents either a period of accelerated deposition or particularly low occupation intensity (Deacon and Geleijnse 1988, 9). Other MSA II deposits are sandy, and although Deacon and Geleijnse argue they represent periods of low occupation density (Ibid 1988, 9), they have mostly yielded relatively large lithic assemblages (Singer and Wymer 1982, 21–22). The Howieson's Poort deposits comprise a series of laminations of ash, black carbonaceous soil and silty sand, becoming sandier towards the shelter wall, with a distinct depositional break between level 21 and level 22 (Deacon and Geleijnse 1988, 10). Even with the aid of Singer and Wymer's section drawings (Figure 42, Figure 43 & Figure 44), it is difficult to clearly delineate these units; they are suggested as indicative of intense occupation (Singer and Wymer 1982, 26). The MSA III deposits are mostly sandy with darker laminations throughout and also include admixed sandy scree in some levels, probably the result of the severe erosion these deposits have endured at the top of the sequence (Ibid 1982, 21; 27). The top of the sequence is capped by scree containing micromammalian remains but no evidence of archaeological activity (Deacon and Geleijnse 1988, 10).

5.2 **Recounting the Lithics**

In order that the lithics from each level could be represented proportionally to the rest of their assemblage, it was necessary to calculate the total number for each level, figures for which were not provided in the original site report. While collating the appropriate data for these calculations, several inconsistencies in the recorded lithic counts were encountered. So that cross reference comparisons between deposits and cultural units at the site could be made, as well as further comparisons with other sites, it was necessary to recount the data, identify these inconsistencies and, where possible, how they arose. Some were due to the lack of clarity as to where data recorded during the excavation of the Initial Cutting had been amalgamated with that from the 1968 excavation, while others were likely the result of human error in the counting, recording or writing process. This would likely have been compounded by the fact that there were slight changes to the field team between seasons, which also included a team of general labourers partaking in the excavation, and the fact that it took well over ten years for the final publication of the report (Singer and Wymer 1982, 7). While it has previously been acknowledged that material was excavated in gross stratigraphic units with hasty regard for contextual detail (Deacon 1985, 59), there has been no previous review of the integrity of the original data collection to my knowledge.

The data presented in the Howieson’s Poort chapter (chapter 6 of Singer & Wymer’s report) is noted as excluding material recovered from the Initial Cutting due to a revision in the stratigraphic sequence rendering the data incompatible (Singer & Wymer, 1982: 87). Although it is not made readily explicit, the data presented on the MSA I-IV industries (chapter 5 of Singer and Wymer’s report), does, for the most part, incorporate material from the Initial Cutting (See Singer and Wymer (1982, 111) for confirmation of this). In both chapters, the tools recovered from different levels in the KR main site sequence are detailed according to type, although no cumulative total for each level is given. A separate table included in an overview chapter (Ibid, 111: Table 7.2) details finds from levels excavated in the Initial Cutting, but not in the same level of detail as those from the 1968 excavation. A further table, (Ibid, 110: 7.1) presents the total number of tool types recovered from the different areas of the main site as they pertain to different cultural orders. Throughout these three chapters, there are various instances where the numbers recorded do not tally with one another. To assess the extent of this problem, and to make the numbers workable for my own investigation, the lithics data was recounted and compared to the totals presented in the monograph.

The recounted lithic totals are presented in (Appendices 5-11) so that the corrections asserted below may be corroborated. Without access to the assemblages themselves, the recount is based on the data given in chapters 5 and 6 of the monograph, as these were presented in the most detail. Data for material from the Initial Cutting comes from chapter 7, which provides the most detailed information for these excavations. The main errors identified in the original report are described in brief below. For the purposes of this investigation, only the lithics from KRM 1A have been recounted, with the rest of the site left un-reviewed. For further information regarding the tool-types discussed in this section, reference should be made to the original site report (Singer and Wymer 1982) or, for pieces classifiable as microlithic hunting armatures, the lithics analysis section below.

5.2.1 **MSA III**

- A note for Singer & Wymer's table 7.2 suggests that Initial Cutting assemblage totals were included for their tallies of MSA II pieces in an earlier chapter (chapter 5). In fact, they were also combined for most of the MSA III assemblages, which are also presented in chapter 5 of their report.

- The number of lithics recorded in Singer and Wymer's chapter 5 accords with the combined totals of the 1968 excavation and Initial Cutting excavation as given in their table 7.1, except for cores and core preparation and rejuvenation flakes, which, without explanation, exclude finds from the Initial Cutting. Appendix 5 shows these categories combined, as with other lithics from these assemblages.

- According to Singer and Wymer's overall summary (Singer and Wymer 1982, table 7.1), excavation of the Initial Cutting yielded 391 flake-blades, when there are only 196 accounted for in their detailing of the Initial Cutting assemblages (Singer and Wymer 1982, table 7.2). This in turn affects the number of flake-blades estimated from the 1968 excavation. In Singer & Wymer's table 7.1, 186 flake-blades are recorded. If the 196 recorded in their table 7.2 are subtracted from the total of 577 given in the sum total presented in their chapter 5, then there are in fact 381 flake-blades from the 1968 assemblage (Appendix 5).

- The number of pointed flake-blades from the Initial Cutting recorded in Singer & Wymer's table 7.1 is 13, when there are 16 recorded in their table 7.2.

- The number of worked points from the Initial Cutting is 17 rather than 16 as recorded in Singer & Wymer's table 7.2.

- Although it is known that 8 crescents were recovered during the 1968 excavation, their provenance and distribution throughout the sequence is not clearly stated Appendix 5.

5.2.2 **Howieson's Poort**

- The total number of broken segments recovered from the 1968 excavation is given as 5880 when it is in fact 6080 (Appendix 6).

- The number of cores made from local material is recorded as 363 when it is actually 361 and the number of exotic cores is recorded as 524 when it is in fact 514 (Appendix 6).

- The number of flake-blades made from fine silcrete is reported as 889 when it is in fact 887, this brings the total of exotic flake blades from 1246 down to 1244. In (Appendix 6), this difference of 2 is reflected in the greater category of "Non-local flakes including flake-blades and segments", which conforms to the format for tabulating other MSA assemblages.

- Seven worked points are recorded as recovered from Howieson's Poort layers excavated from the Initial Cutting (Singer & Wymer 1982, table 7.2) whereas none are noted in Singer & Wymer's table 7.1.

- Although the total raw material count for crescents and allied forms in level 17 is the same as the recorded lithics count, an extra ten pieces are have been erroneously added somewhere in the exotic materials. Although purely speculative, it seems most likely that the 78 fine silcrete pieces should in fact number 68, as there is a greater likelihood of mistyping this number than the 22 pieces of indurated shale or 11 pieces of quartz. This value is corrected in (Appendix 7).

- There are 11 completely blunted crescents recorded from level 15 in Singer & Wymer's original tabulation of crescents and allied forms. This value has been reduced to 1 in order to match the totals recorded for the level, sub-type, and the number of pieces recorded in the raw material count (Appendix 7).

- The total of 43 worked flakes recorded from the Initial Cutting (table 7.1) does not include worked points. Although these points are included as a sub-category under worked flakes from the Initial Cutting (Singer and Wymer 1982, table 7.2), they are afforded a separate designation in their discussion of the MSA industries. The six worked points recorded in table 7.1 are included under the worked flakes in earlier discussion (Ibid 1982, 99-105).

5.2.3 **MSA II**

For MSA II deposits, the numbers for levels 22-36 were reviewed and corrected where necessary (Appendix 8) before being recalculated without levels 34-36 (Appendix 9) in accordance to the stratigraphic configuration explained earlier.

- As with the MSA III data, the total number of cores and core preparation and rejuvenation flakes given in chapter 5 excludes those recovered from the Initial Cutting, unlike the totals given for all other lithic types from this phase.

(Appendix 8) shows the two collections combined as with other tool types from MSA II deposits.

- The number of cores recorded in MSA II deposits from the 1968 excavations is 295, with a further 150 coming from the Initial Cutting (Singer & Wymer 1982, table 7.1). The 150 cores do not include those made from exotic materials, with the total rising to 163 if this is taken into consideration (Appendix 10). Furthermore, the 295 recorded from the 1968 excavations are in fact 371, bringing the combined total to 534 (Appendix 8).

- The number of flakes recorded is 25076 (Appendix 8) rather than 25561 as recorded in Singer and Wymer's table 5.10.

- The number of flakes recovered from the Initial Cutting is also recorded incorrectly, given as 12708 when the actual total is 12774 (Appendix 8).

- Of ten MSA II assemblages from the Initial Cutting, six levels (levels 22, 23-24, 25, 27, 28-29 and 34) are totalled incorrectly.

- The total number of cores, worked flakes and crescents from the Initial Cutting as recorded in Singer and Wymer's table 7.1 excludes pieces made from exotic materials, unlike totals recorded for MSA III and Howieson's Poort assemblages.

- 1057 MSA II flake-blades from the Initial Cutting were recorded in Singer and Wymer's table 7.1, when there are in fact 1152 recorded in their table 7.2. and given in Appendix 8.

- The flake-blade data recorded in Singer and Wymer's chapter 5 curiously only includes Initial Cutting material from levels 23-24 and 26, but the numbers given for levels 23-24 is less than the number of flake-blades from the Initial Cutting alone (Singer & Wymer 1982, table 7.2) without the 1968 material added.

- The above is also seemingly true for pointed flake-blades from MSA II, however, no flake-blades were noted in level 26 from Singer & Wymer's chapter 5, but 29 were noted in their table 7.2 from the Initial Cutting.

- Singer & Wymer's table 7.1 in chapter 5 records 68 worked flakes (excluding worked points) from the Initial Cutting when there are in fact 69. It also has only 6 crescents recorded when there are actually 8. Presumably the total given in the table excludes the two quartz examples (Appendix table 10).

A number of the problems detailed above can be rectified through reorganising some of the methods by which the assemblages have been classified to be more consistent with one another. Others come from errors in tabulation or calculation which can be re-tallied. The remainder of the inconsistencies identified have proved otherwise unsolvable.

5.2.4 **Refining the Data**

After taking the errors detailed above into account, it was possible to refine some of the data, which is presented and explained in this section and with accompanying Appendices 5-11. Access to Singer & Wymer's original report facilitates easier cross-reference.

It is impossible to accurately combine Howieson's Poort assemblages excavated from the Initial Cutting with those from the 1968 excavation because of the incompatible stratigraphic sequences used in recording. Conversely, it is difficult to confidently distil the 1968 and Initial Cutting components of some MSA lithics without losing finer detail such as size gradation, information for which is generally unavailable for pieces from the Initial Cutting. The raw data (given per level) in chapters 5 and 6 of Singer and Wymer's report has been checked, re-tallied internally along with material recovered from the Initial Cutting (Appendix 10) with summary tables provided for each cultural unit (Appendices 5, 6 & 8). These summary tables show the fully revised lithics data for the site, and are presented in a standardised fashion to facilitate easier comparison.

For MSA II and III assemblages, the quantity of lithics recovered from the 1968 excavation is deduced from subtracting the revised total of Initial Cutting lithics from the revised combined totals. As well as this data, the figures given in Singer & Wymer's original summary tables (1982, 110–111: Tables 7.1 & 7.2) are also provided for comparison (Appendices 12 and 13). Some numbers in Appendices 5, 6 & 8 are calculated from these tables but not explicitly given in the original presentation. Not all of the numbers given from Singer & Wymer's report are consistent, and this serves to reflect the inconsistencies within the original work. For example, none of the cultural unit totals for the Initial Cutting derived from table 7.2 matches the equivalent values given in table 7.1, and consequently the combined totals of these also do not support those given in table 7.1, as is shown in Appendix 10.

For the summary Appendices 5, 6 & 8 broken blade segments are collapsed into one category, as are worked flakes. Worked points are a category distinct from worked flakes, whereas they were originally amalgamated under worked flakes in Singer and Wymer's Howieson's Poort chapter (1982, 87–106). In Singer and Wymer's tabulation of MSA II flake-blades, they note that only the undifferentiated levels 23-24 and level 26 included Initial Cutting material, although the reason for this is not clear. As there are 25 flake-blades recorded from level 26 of the Initial Cutting, there should be 8 from the 1968 deposit (Appendix 8). For levels 23-24, there were 361 flake-blades from the Initial Cutting (Appendix 8), but only 346 accounted for in total. Flake-blades from the Initial Cutting were added to this data to present a format comparable with totals for other tools from the assemblage, with undifferentiated levels 23-24 left at 346.

As with the flake-blades, pointed flake-blades also required the addition of Initial Cutting material in order that they are made consistent with the tabulation of other tool categories. An ambiguously worded footnote from Singer & Wymer's original tabulation suggested that they were presented similarly to their corresponding flake-blade assemblages (Singer and Wymer 1982, 61), and this was confirmed by the large number of Initial Cutting values that exceeded those originally presented for pointed flake-blades in Singer & Wymer's chapter 5. The inability to accurately separate the Initial Cutting and 1968 excavation material in these levels (23-24 and 26) led to their exclusion from the diagram (Appendix 14). It was also necessary to add Initial Cutting material to the counts of MSA II and III cores and core preparation and rejuvenation flakes, as totals for these were, curiously, also recorded from just the 1968 material (Singer and Wymer 1982, 47–52).

There are several other instances where the number of Initial Cutting tools exceeds the combined count for the Initial Cutting and 1968 excavations, particularly in the MSA III deposits, where it is sufficiently notable to unbalance the cumulative level totals. After reviewing the cases in which such anomalies occur, it seems most likely that some of the material designated to the amalgamated units recorded from the Initial Cutting excavation have been reallocated to individual levels at some point during the post-excavation process, without the records for the Initial Cutting being updated. Instances where this has occurred are highlighted in red in the table, and the number for the combined total has been left as recorded in Singer & Wymer's chapter 5 (1982, 43–86) following their reallocation of some artefacts. This scenario would also explain why some of the Initial Cutting totals as recorded in Singer & Wymer's table 7.1 do not match with those recorded in table 7.2 (1982, 110–111).

Finally, it should be noted that unlike the 1968 excavation HP assemblages, Singer & Wymer deemed it unnecessary to discern exotic material types for flake-blades and segments from MSA deposits. This disparity in the recording of different technological industries is relatively minor as exotic flakes, even when amalgamated with exotic flake-blades comprise such a small portion of MSA assemblages (318 from 1968 excavations of MSA II) compared with those of the Howieson's Poort (27368) (Appendix 11). Although not all flakes can be regarded as waste products (Singer and Wymer 1982, 85; 95), they (both exotic and local quartzite flakes) are excluded from the assemblage totals used for calculating percentage portions of different tool types in the diagram (Appendix 14) as they account for such large portions of the assemblages, and this also provides a format more akin (although not identical) to the presentation of lithics data from La Riera, the central site for the pilot study in Cantabrian Spain. The inability to distinguish exotic flake-blades from exotic flakes as a separate category among MSA assemblages means this very minor discrepancy between the MSA and HP is reflected in the representation of flake-blade data in the diagram (Appendix 14).

Although there is a chance that some errors and inconsistencies have not been identified, or are undetectable, the revisions made here to the dataset for KR 1A provide a more internally consistent account of the assemblages. Appendices 5, 6 and 10 summarise the revised lithic totals per tool-type and per level for the portion of the KR 1A assemblage which was used for this investigation (levels 1-33).

5.3 The Klasies River Mouth Diagram Explained

As with the master-diagram for the La Riera sequence, the aim of this chart is to compile the most pertinent aspects of data for microlithic hunting practices from the site in an approximately chronologically synchronous format. With the appropriated stratigraphy justified along with revised lithic counts, the data was then used to construct an approximate visual chronology of the site. The details specific to the construction and reading of the diagram are discussed in the following section.

5.3.1 The Sequence

The diagram surmises information from levels 1-33 of KR rockshelter 1A. Level 1 represents the top of the sequence with the youngest anthropic deposit, and level 33 is used to represent the base of the sequence, as the excavation of levels 34-36 was markedly hampered by instability and running water through the sequence (Singer and Wymer 1982, 22). The extent of the sequence delineated is sufficient to assess the significance of the Howieson’s Poort microliths within the context of the broader history of the site, although the original excavators asserted that the differences between MSA and HP deposits were so readily apparent that assessment of internal variation would perhaps be a more fruitful endeavour (Ibid 1982, 112).

In some cases, levels were amalgamated and the material therein undifferentiated. In the case of KR 1A, these levels likely reflect the original stratigraphic scheme used in the excavation of the Initial Cutting, although some of this material seems to have been subsequently reassigned to individual levels. Following the revisions I have made to the assemblage counts, it is possible in most cases to distil the 1968 material from that of the Initial Cutting, as was done originally with the Howieson’s Poort assemblages. Unfortunately, it is not possible to adjust finer details of the assemblages, such as the size gradation of the artefacts. In the case of flake-blades and pointed-flake blades, the assemblages presented with gradation of size comprise, for the most part, material exclusively from the 1968 excavation. The two notable exceptions to this are level 26 and the undifferentiated levels 23-24 which include material from the Initial Cutting. Consequently, these two units have been removed from consideration in the diagram.

The other undifferentiated assemblages from MSA II material are levels 28-29 and 32-33, which are also excluded, as out of the tools considered in the diagram (Appendix 14), only middle segments were assigned to these units. Conversely, flake-blades and pointed flake-blades were represented for amalgamated MSA III deposits (1-3; 7-9), and are presented as combined totals of 1968 and Initial Cutting material. Their inclusion is why MSA III levels 1-3 and 7-9 were included in the diagram. The amalgamated levels 7-9 lithics are included as well as individually recognised deposits for levels 7-9 in the sequence. The collapsing of levels 1-3 is different as these levels are not marked as undifferentiated. Although details of the individual assemblages exist for the Initial Cutting, the small size of assemblages from these levels was probably the reason for their overall conflation into one combined unit (Singer and Wymer 1982, chap. 5). In the diagram, the four cores recorded in level 3 (Appendix 5) are also incorporated within this unit.

5.3.2 Chrono-Stratigraphy and Dating

The Chrono-stratigraphic divisions in the diagram reflect the division of lithic industries as recorded by the original excavators (Singer and Wymer 1982). The dates provided come from relatively recent re-assessments of the sequence, and are separated according to the methods used: Uranium Series (Vogel 2001), TL (Tribolo et al. 2005), OSL (Jacobs et al. 2008) and Luminescence (Feathers 2002). The original dates acquired for the site (Singer and Wymer 1982, 187–199) have been abandoned in favour of these revisions. Klasies River boasts the most extensively dated Howieson’s Poort sequence (Lombard 2006c, 36), even when dates acquired for Cave 2 are excluded from consideration; the unprecedented geographic scale of the OSL dating programme led by Jacobs et al. (2008) demonstrates the extent to which the Howieson’s Poort in general has been the focus of attention.

With the exception of MSA III level 9 and MSA II level 22, targeted mostly as bracketing deposits for the Howieson’s Poort, dates from the MSA deposits at Klasies are comparatively lacking. The MSA III deposits are perhaps difficult to reliably date with the amount of disturbance noted among the sediments, but dates for the MSA II sequence of KRM 1A comprise of a handful of Uranium series determinations and a single ESR date (Wurz 2012, 1003). One of the uranium series dates, from carbonate crust from level 14, reliably conforms within the range of dates acquired using other methods to assert the approximate age of the Howieson's Poort deposits (Tribolo et al. 2005, 498), but only one other date was derived from carbonate crust (level 30), with other Uranium series dates being determined from shell and stalagmitic material (Vogel 2001). A third Uranium series date of 28kya from final MSA II level 22 using shell can be rejected as too young (Wurz 2002, 1003). Different dating methods operate at varying levels of precision, and the geochemical conditions and preservation of datable materials is not uniform throughout the site (Wurz 2012, 1002). Recently, doubt has been cast on the ages provided by Feathers' TL dates (Jacobs and Roberts 2008, 25). It should also be noted that a date acquired from amino acid dating has been rejected due to problems with the methodology (Jacobs and Roberts 2008, 14), although a single ESR date of 52 ± 4 kya from near the base of the Howieson's Poort deposits (not included in the diagram) is within the range of TL dates acquired by Tribolo (Tribolo et al. 2005).

5.3.3 **OIS Correlation**

The sequence at KRM 1A was not deposited at a constant rate over a continuous period of time. Consequently, any approximation to the OIS chronology can only be relative to specific periods of time represented at the site. The relationship between the site history and OIS sequence is based on the changing interpretation of how the dates recorded from the sequence, and inferences regarding variation in environmental conditions, match with reference material for the chronology of the Marine Oxygen Isotope Stages. Attempts to consolidate various correlations are usually then made through seeking to identify similar matches made at other approximately contemporaneous sites. The lack of certainty surrounding such a unanimously agreed upon correlation, means that the representation provided in the diagram serves only as a loose estimation following more recent appraisals (Tribolo et al. 2005; Jacobs and Roberts 2008).

5.3.4 **Lithics**

Several analyses have been conducted on the lithic assemblages from KR1A, including both those from the original excavations (Singer and Wymer 1982), and from Deacon’s excavations (Thackeray and Kelly 1988; Wurz 2000; Villa et al. 2010). Of particular note is the recent study by Villa et al. focussing on the Howieson’s Poort and MSA III lithics, and the integration their findings with Singer & Wymer’s research, although it is perhaps curious that there is no mention in this paper of Thackeray and Kelly’s assessment of antecedent assemblages from Deacon’s earlier excavations. The implications of microwear analysis conducted on backed pieces from KR Cave 2 (Wurz and Lombard 2007) are also discussed briefly.

The lithics included in the Klasies Diagram are those that seem the most likely candidates for hunting weaponry. As well as the crescents and other allied forms that characterise Howieson’s Poort industries, the diagram also contains basic information about flake-blades (local quartzite, < 4cm in length), pointed flake-blades and broken middle segments (Figure 33). Worked points may well have also served as armatures, but were excluded from the diagram because of their relatively low frequency throughout the sequence (Appendix 6). The grey blocks represent roughly what percentage of their assemblage (excluding flakes) each tool type comprises for each respective level, with the exact percentage value given within the shaded block. Next to each block is an “n” value, the actual number of tools from which that percentage is derived. Flakes are excluded as they largely comprise of waste material and account for such a large portion of the assemblages that their inclusion may obscure trends in other tool categories. This manner of representation is used for crescents and flake-blades. Mean average percentages are also provided for the crescent and flake-blade counts in accordance with the stratigraphic units used in Klein’s faunal analysis.

The dominant raw materials used per level are given, with the three most dominant types per-level ranked. Each letter representing a different material type, for which reference should be made to the raw materials section of the chapter. The fluctuation in dominance of local quartzite and exotic materials is also shown. Unlike the quantification of the tools themselves, the measures of raw material preference are exclusive to the tool categories in question. For flake-blades, exotic material dominance reflects the entire flake-blade assemblage as limitations in Singer & Wymer’s data render it impossible to link size gradation to material preference.

Pointed flake-blades are relatively small in number, and although gradations of size were included for those from MSA contexts, none was given for those from Howieson's Poort levels, perhaps because of their even smaller quantity. Consequently, they are simply represented by their total number in the diagram (Appendix 14). Middle blade segments are given as a percentage value of broken segments overall, with a mean percentage value in accordance with the stratigraphic units used in Klein's faunal analysis along with a mean average per-cultural unit. It is important when considering the lithics in the diagram to remember that the values for MSA III material represents the combination of 1968 and Initial Cutting material. With the exception of the MSA II broken middle segments, all other values are taken from just the 1968 material.

5.3.5 **Faunal Remains**

The numbers of fauna are taken from Klein's original work on the site (1976). Assemblages from rockshelter 1A were presented as MNI due to the highly fragmentary nature of the assemblages. The diagram ranks the top three species according to this count, leaving a blank where no clear position is held. The number after the name denotes the MNI value recorded for the species in that level. The deposit groupings in the diagram reflect those used by Klein, i.e. the same system as reported for the Initial Cutting 1A (Singer and Wymer 1982, 111). This may be because the revised stratigraphy of the 1968 season was not applied to the cataloguing of faunal remains, or simply that these levels were collapsed and amalgamated into cruder units to consolidate sparse data, as MNI counts for individual levels would have resulted in even more minimally informative data representation. Alternatively, it could be (despite no acknowledgement of such being the case), that Klein's analysis simply did not incorporate the remains from both field seasons.

The data presented here has been used to infer both evidence of subsistence and also palaeoenvironmental conditions along with other sources. It is important to note that in Klein's analysis (Klein 1976), and subsequent reprints (Singer and Wymer 1982; Binford 1984), level 12 from the Howieson's Poort is curiously unaccounted for, and without explanation. It is most likely that this reflects a typo, and that levels 10-11 include data for level 12, in accordance with the divisions used in the Initial Cutting which are followed by the rest of Klein's data presentation. It has been treated as such in this investigation.

5.3.6 **Palaeoenvironment**

Palaeoenvironmental assessment of the site depends upon the implications of Klein's faunal analysis (1976) integrated with inferences drawn from sedimentological analysis of the site (Butzer 1978; Butzer 1982) and from the study of microfaunal remains recovered during Deacon's excavations (Avery 1987). The resolution of these studies is much poorer than was possible in Northern Spain, with much grosser generalisations made rather than the more detailed break down of the sequence given at La Riera. Butzer's sedimentological review was presented within the cultural unit framework devised for the site, and generalisations inferred from Avery's work are also presented in relation to these units even though Avery recognised that this defies the reality of cross-cultural trends: the cultural units delineated in the diagram do not represent major barriers or transition events in this regard. The microfaunal analysis is the only aspect of the diagram that relies upon data collected from Deacon's subsequent (1984-1986) excavation (Avery 1987, 406).

5.4 Trends And Further Investigation

In this section, trends identified through the construction of the KR 1A diagram are identified, along with some others that could not be included in this format, and are expanded upon where possible through further investigation.

5.4.1 **Dating**

A variety of methods have been used to obtain dates from the sequence at Klasies River main site. The portion represented in KR 1A, particularly the Howieson's Poort deposits, are the most extensively dated of their kind. There is general agreement between many of the independent methods that the Howieson's Poort at KR 1A dates to between 55 and 65,000 years ago (Lombard 2006, 36). Unfortunately, dates for the extent of MSA II and III deposits are less numerous. It seems that MSA III cannot be younger than 50,000 years as it is beyond the limit of radiocarbon dating (Wurz 2012, 1002), while the oldest date acquired for the MSA II from rockshelter 1A is 82,000 from level 30 (Vogel 2001). Rockfall level 22 is most likely no younger than 70,000 years old (Feathers 2002, 192; Jacobs et al. 2008, 734), implying a possible hiatus in occupation and deposition between MSA II and Howieson's Poort, supported by the relative decrease in density of anthropic material. For similar reasons, a break between the end of the Howieson's Poort and the beginning of MSA III can be argued, although the length of the gap between the two is less clear.

Although an approximate time span can be inferred from the range of dates acquired from the different programmes, a finer resolution is simply not possible. This is exemplified in Figure 46 which shows the thirteen TL dates acquired by Chantal Tribolo in approximate stratigraphic order (Tribolo et al. 2005). Although they are not evenly distributed throughout the sequence, the lack of any real trend in gradation of these dates illustrates the difficulty of generating a more fine-grained chronology for the site and indeed other deposits of such great antiquity. In the absence of a more detailed chronology, relative stratigraphic superposition must substitute as chronometric reference scheme.

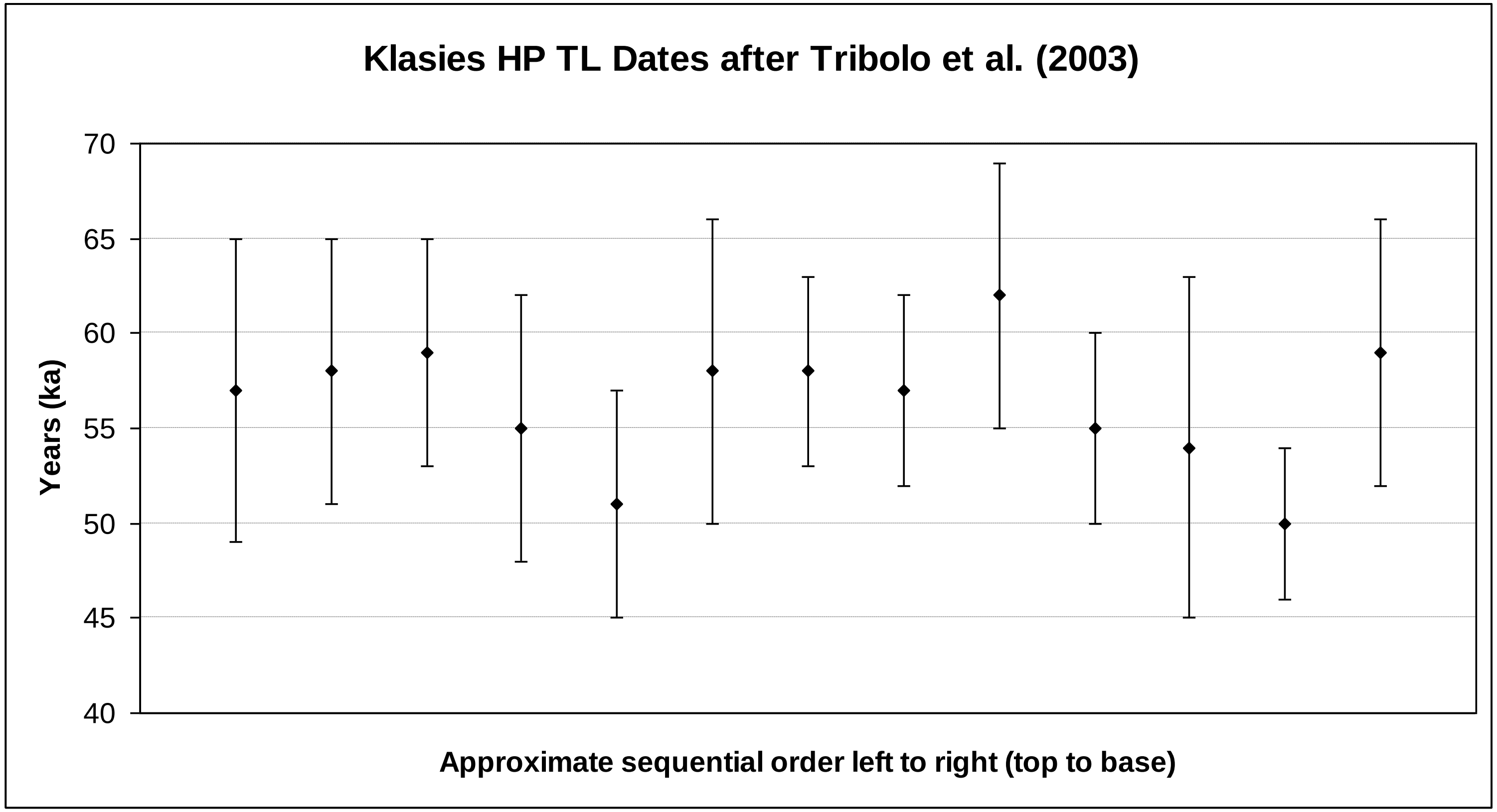


Figure 46: Graph showing thermoluminescence Dates from Klasies River lithics in sequential order (left-right)

5.4.2 **Implications for OIS Stage Correlation**

Along with Border Cave, Klasies River was formative in early attempts at correlating Middle Stone Age industries from South Africa with the Marine Oxygen Isotope sequence. In particular, Shackleton's assessment of $\delta\ ^{18}O$ data from marine molluscs was instrumental in the initial interpretation that the Howieson's Poort industry occurred during a cooler part of OIS 5, although he did not rule out the possibility of deposition within OIS 3 (1982, 196). A main goal of researchers at the time, working both at Klasies and other MSA sites in South Africa, focussed on integrating other aspects of palaeoclimatic and environmental data in consolidation of this estimation (Butzer 1978; 1982; Klein 1975; 1976; 1977; Avery 1987). Revisions in estimates of sea-level relative to site stratigraphy (Hendey and Volman 1986; Van Andel 1989) resulted in challenges to the original estimate, and ultimately the realisation that attempts at interdependent conformity from a range of datasets from regionally disparate locations is highly problematic without tighter absolute chronology (Parkington 1990, 34–35).

Productive dating programmes formulated in the years since Parkington's critique now allow for more credible attempts at correlating site stratigraphy with OIS stages. The weighted average (56 ± 3 kya) of Tribolo's TL dates could suggest an early OIS 3 link for the HP at Klasies (Tribolo et al. 2005, 498). A single date of 64.1 ± 2.6 kya recorded from the large-scale dating project undertaken by Jacobs et al. (2008, 734) puts the site within range of Howieson's Poort dates (64.8 – 59.5 kya) collected under the same programme at other sites, including those from KRM Cave 2 (Jacobs and Roberts 2008, 26). This estimation puts the Howieson's Poort (in general) during the end of OIS 4, when the sea-level would have been around 5m below present day (Ibid 2008, 26). The slight discrepancy between dating methods raises a pertinent issue.

Depending on which dates are consulted, the Howieson's Poort at Klasies River could be argued as pertaining to early OIS 3, late OIS 4, or both. It would be a misreading of the data to infer that the variety of dates acquired from the site represent a concordant chronology. The general consensus, informed by dates acquired from other sites, suggests OIS 4 is a more likely reality, even though the overall weight of dates from Klasies itself (courtesy of Tribolo) would favour OIS 3. The fact that the dates acquired by Jacobs et al. (2008) from Klasies conform to others collected as part of a systematic dating programme conducted on a large geographic scale favours their interpretation of a late OIS 4 correlation. They claim that their dating programme has lifted the chronological haze that has traditionally surrounded the timing of the Howieson's Poort, by using a systematic methodology to acquire dates from a wide array of sites, eradicating the disparity instilled by variation in the materials and methods used previously in more piecemeal approaches (Jacobs and Roberts 2008, 30).

While their efforts are impressive and commendable in realising this aspiration, it does not negate the fact the differing ages offered by alternative methods might be replicated on a larger scale if a similar approach was put into effect. As evidence of this, the TL dates acquired from Klasies are all relatively consistent with one another, along with other dates acquired using similar methods from Rose Cottage (Tribolo et al. 2005, 498). While comparison of the rigour and merit of OSL and TL dating methods is open for discussion, it suffices to note that Jacobs and Roberts are unable to dismiss these results (2008, 17). A possible OIS 3 date for the Howieson's Poort at Klasies cannot be ruled out. We should be wary, at least for the immediate future, of any assertion that a single true date range safe from contradiction may be obtainable. Consequently, although the dating programme conducted by Jacobs et al. (2008) is arguably the most popular singular scheme, researchers continue to be open-minded in the date ranges they cite and reject any notion of a true geographically delineable age range for industries such as the Still bay and Howieson's Poort at this stage (Villa et al. 2010, 632; Henshilwood and Dubreuil 2011, 370).

5.4.3 **Fauna**

With only MNI data available for faunal remains from KR 1A, inferential information remains fairly limited. There is insufficient data to attempt any assessment of seasonality, sex or age as with the La Riera assemblages. Furthermore, it must be remembered that the extent of KR 1A so far excavated is likely just a portion of the preserved deposits and greater site, and is confined to one locale near the abutting rock face (an argument applicable to the representativeness of all remains recovered from the site). As a result of these limitations, despite being the subject of numerous studies, all analysts of the KR 1A faunal assemblages have been fairly restricted in their assessments. Now that the scavenging argument from earlier phases of the site laid out by Binford (Binford 1984) has been fairly well refuted (Milo 1998), the faunal remains are perhaps best used as confirming the successful hunting of certain species at different periods. Changes in the ratios of different species, or changes in their presence and absence may reflect changes in the hunting preferences throughout time, although the reliability of any such indication is limited by the problems detailed above.

In the diagram (Appendix 14), only the top three species ranked according to MNI are shown. As a supplement to the diagram, Figure 47 and Figure 48 are included for more detailed assessment. Figure 47 shows MNI representation of species at the site, while Figure 48 shows MNI values as a percentage of the total assemblage per level. Both the graphs show that the Howieson's Poort levels have a much higher degree of diversity in their assemblages than is present in other levels. The Howieson's Poort levels also have higher overall MNI counts (Appendix 14, Figure 47). The faunal data for the KR 1A sequence is so limited, that it was only in these levels where there was sufficient information to clearly rank three species (Appendix 14).

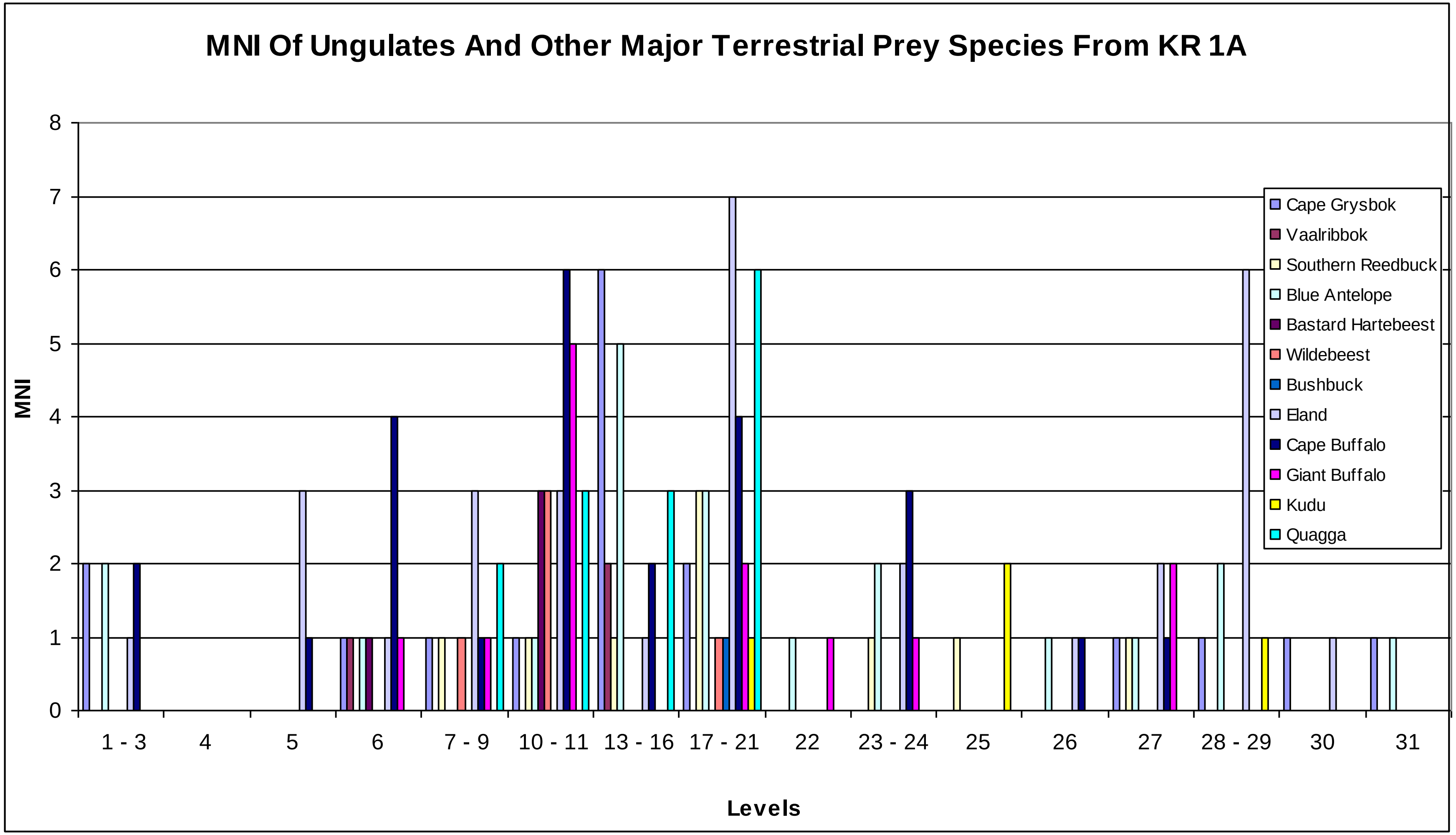


Figure 47: Graph comparing MNI of ungulate fauna at KR1A

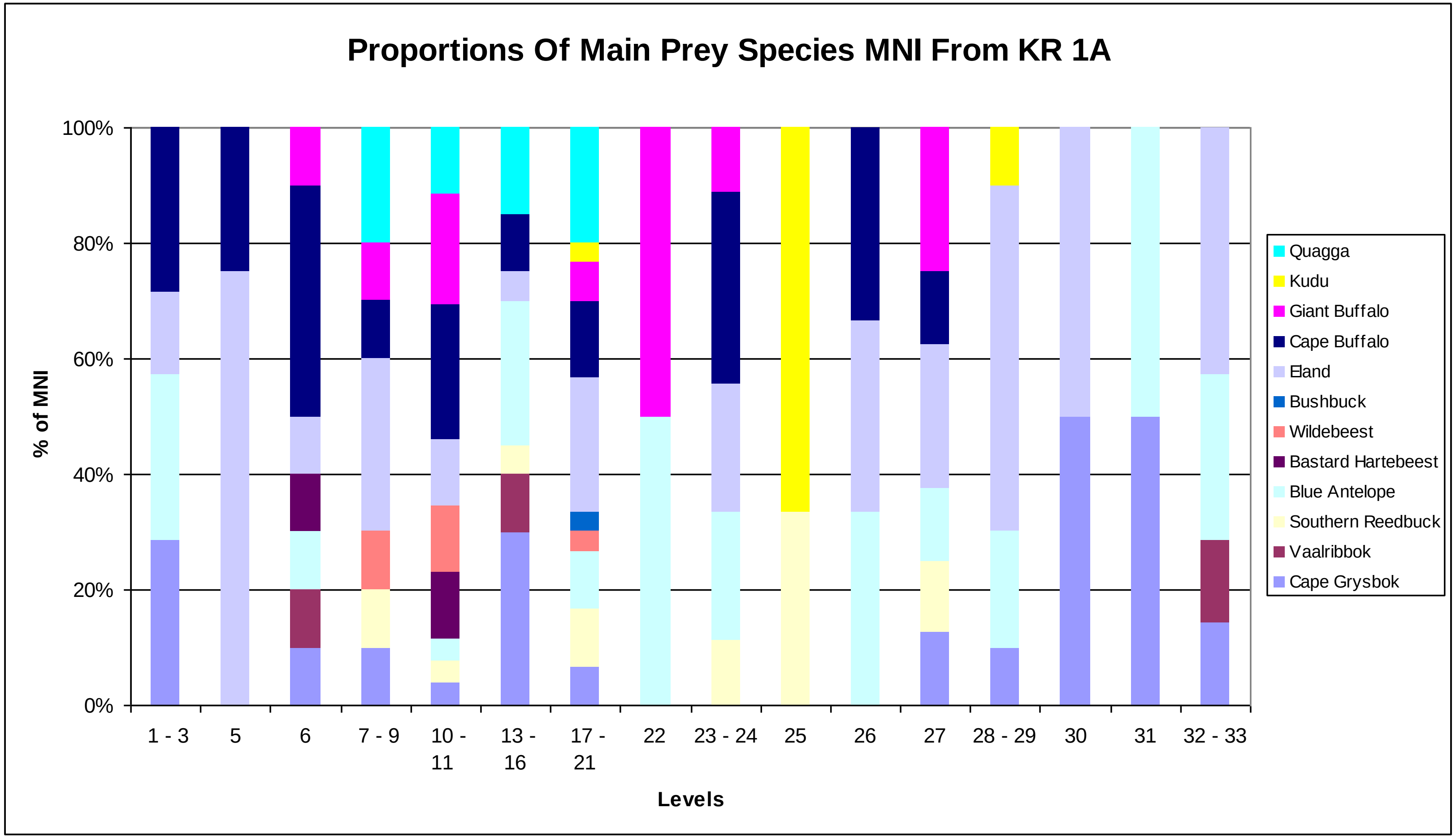


Figure 48: Graph showing KR1A ungulate fauna MNI proportionally

Equus cf quaaga (Quagga) appear in the Howieson's Poort levels for the first time in the KR 1A sequence, and disappear after early MSA III (levels 7-9). *Connochaetes* (Wildebeest) are also present only in these levels (although not in levels 13-16). The preferred habitats of these species informed Klein's broad assessment of the assemblage, which he suggested supported a shift towards more open vegetation in the landscape at this time (Klein 1976, 80). *Tragelaphus scriptus* (Bushbuck) also makes a small but unique appearance in levels 17-21. The internal variation within the Howieson's Poort levels makes it difficult to contrast the cultural phases monolithically with one another.

In general, *Taurotragus oryx* (Eland) is a popular species at several points during the occupation of KR 1A, absent only in levels 25 and 22. *Syncerus caffer* (Cape Buffalo) features in every level apart from levels 25 and 22 after levels 28-29. In this respect, levels 25 and 22 are perhaps the most unique, with only two species noted in both. Level 22 can perhaps be explained by its formation as a rockfall deposit. The higher variety of species in the Howieson's Poort levels could suggest a more generalised spectrum of prey in these levels, with larger animals such as *Pelorovis antiquus* (Giant Buffalo) being taken alongside smaller specimens such as *Raphicerus melanotis* (Cape Grysbok). The presence of these species in the same deposits is not entirely unique to the Howieson's Poort though, as both appear in levels 6-9 and 27 as well. It is also important to remember that the amalgamation of Howieson's Poort levels means that the strict concurrence of different species is more difficult to confirm than during other phases of the rockshelter.

Of twelve species recorded in the KR 1A rockshelter, ten (the most in the sequence) are noted from levels 17-21, with *Pelea capreolus* (Vaalribokk) and *Damaliscus sp.* (Bastard Hartebeest) the only omissions, the former a species found in only three deposits in the sequence, and the latter in only two. Levels 13-16 have seven species, and levels 10-11 have nine. In levels 13-16 there is a higher proportion of cape grysbok and blue antelope as well as vaalribbok. Eland are reduced in number, and giant buffalo and wildebeest are absent in these deposits. In levels 10-11, giant buffalo and cape buffalo are at their greatest representation in the Howieson's Poort levels, and wildebeest and are also present for the first time in this phase. Interestingly, the relatively diverse faunal spectrum of the Howieson's Poort levels is continued to a lesser extent in the immediate MSA III levels, not returning to the more simple dichotomous levels of the earlier MSA II until after level 6. This perhaps reflects the continued openness of the landscape during this time. The amount of depositional disturbance during the formation of the MSA III levels makes it difficult to validate this trend.

5.4.4 **Palaeoenvironmental Reconstruction**

Along with Klein's assessment of the fauna (1976), and the sedimentological analysis by Butzer (1978; 1982), Avery's analysis of microfaunal remains from Deacon's excavations (1987) forms the main body of evidence for the inference of palaeoenvironment at the site. Klein's assessment of the fauna led him to conclude that the surrounding landscape during the Howieson's Poort and MSA III was generally more open than in the preceding MSA II phase (Klein 1976). Avery's data is largely in agreement with this, confirming varying densities of Dune Fynbos in the MSA II, although there is a suggestion of a return to closer vegetation near the top of the sequence as well, with Kaffrarian thicket featuring more prominently alongside the fynbos in this later stage (Avery 1987, 414). The sedimentology data surmised in Appendix 14 is more a vague estimation of the general climate, and Klein's faunal assessment is also sweeping. Although Avery's assessment is also not detailed beyond the reality of limitations with the data, the microfaunal remains in her analysis provide the most specific and finely attuned palaeoenvironmental indicators available for the site. The importance of Avery's research continues with the comparatively sparse distribution of contemporary sites with good environmental evidence known in the area (Chase 2010).

When making her inferences regarding the palaeoenvironment of the site, knowledge of previous work at the site along with the stability of the current fynbos setting was influential in Avery's determination that variations in microfaunal assemblage composition need not invoke major changes in vegetation, and that in turn, such changes are not exclusively the cause of significant climatic change (1987, 414; 406). Further knowledge of the topography of the site and its setting aids the explanation of the occasionally simultaneous occurrence of species with contradictory habitat preferences. Unlike at La Riera, where certain species were used as indicators of extreme climatic fluctuations, the microfauna at Klasies River were studied collectively to reconstruct certain aspects of past conditions, including generalised impressions of vegetation cover and seasonal variations in climatic variables such as rainfall.

These broad inferences, derived by Avery, are presented in the diagram (Appendix 14), and give the misleading impression of neatly coordinated environmental changes synchronised with changes in material culture, an artefact of constraining sample sizes (Avery 1987, 414). While transitional phases between the MSA and Howieson's Poort deposits should not be delineated in such a rigid fashion, there is general agreement between Klein's and Avery's data that the Howieson's Poort at the site is more readily typified by open vegetation. Avery further suggests that these conditions may well have begun before this period, and that the Howieson's Poort may well represent a slightly delayed adaptive response (Avery 1987, 418). Finally it is worth noting that whereas MSA III can be broadly characterised by a more seasonally affected biome, with the early MSA II apparently more monotonous, varying representation of certain species such as *Otomys irroratus* (The Southern African Vlei Rat) (Avery 1987, 415–416) during the Howieson's Poort suggests a period of irregular fluctuations from periods of emphasised seasonal rhythms to less contrasting annual cycles.

5.5 Lithics Analysis

The selected lithics from KR 1A are afforded their own section as they offer by far the most detail and potential for further investigation out of the evidence recovered from the site. In this section, patterns identified within the diagram (Appendix 14) are clarified and elaborated upon, and further observations are also elicited. The terminology used to describe MSA lithic technology has undergone several reformations in time, with the Klasies report itself presenting one of the last major revisions (Singer and Wymer 1982). Most of the terms used in this study (unless noted otherwise), as a matter of necessity, are those used in their report, and can be found fully explained in the appropriate sections, namely chapters 5 and 6 (Singer and Wymer 1982).

The primary emphasis of this assessment is on smaller (microlithic) components assumed as likely candidates for use in hunting equipment. These include the crescent, trapeze, and other “allied” backed forms diagnostic of the Howieson’s Poort, but also flake-blades, pointed flake-blades and middle flake-blade segments. The data presented here are the revised numbers provided from Singer & Wymer’s excavations. Additional information is supplemented from studies of material from Deacon’s excavations (Thackeray and Kelly 1988; Wurz and Lombard 2007; Villa et al. 2010). Unless noted otherwise, considerations of the assemblages are given with the flake count excluded. This brings intra-assemblage analysis more in-line with the system used at La Riera, because the overwhelming assemblage majority that flakes account for obscures more nuanced trends when included. Although flakes cannot be consigned exclusively as waste material and debris, this does undoubtedly form the predominant component. Prior to consideration of individual tool types, familiarisation with the raw materials used at the site and basic trends identified from Appendix 14 is necessary.

5.5.1 Raw Materials

Raw material counts are provided in the diagram (Appendix 14) for crescents and allied forms and flake-blades from Howieson’s Poort. Full data for the raw materials discussed in this section can be found in (Appendices 15-26). Referring back to the retabulation of the lithics, 78 pieces of fine silcrete recorded for crescents and allied forms in level 17 (Singer and Wymer 1982, 99) have been reduced to 68, as it is believed that this figure was most likely recorded inaccurately in deriving a total of 107 (Appendix 7). It should also be noted that the number of flake-blades considered in terms of raw materials is 4439, when the actual number has been recalculated to 4441 based on an error in tabulation of fine silcrete flake-blades (Appendix 6). Although the source of this error is unknown, it is hoped that it is sufficiently marginal to avoid significantly altering the results. Raw materials counts were also provided for flakes, and for fine silcrete flake-blade segments (Singer and Wymer 1982).

In the diagram, the three most dominant materials for each level are recorded, but only when they comprise 5% or greater of the assemblage. The different materials, as detailed by Singer & Wymer, have been coded alphabetically: local quartzite (A), fine silcrete (B), coarse silcrete (C), indurated shale (hornfels) (D), quartz (including crystal quartz) (E), Chalcedony (F) and Chert (G) (Appendix 14). Only types A-E were recorded for flake-blades, with quartz category (E) including crystal quartz and "other rocks" (Singer and Wymer 1982, 90). In their reassessment of the Howieson's Poort, Villa et al. describe the assemblages as comprising quartzite, silcrete, quartz, hornfels (described as indurated shale by Singer & Wymer) and chalcedony (only two pieces of chert were distinguished among 1245 crescents and other backed pieces) in descending order of frequency (2010).

Exotic materials (i.e. not local quartzite) account for such a relatively minor portion of the MSA assemblages (318 pieces from pre-Howieson's Poort levels 22-36, and 246 from post-Howison's Poort MSA III deposits) that the data for specific tool counts was not made available (Singer and Wymer 1982, 75–83). Flake-blade raw material counts do not take size gradation into consideration except for local quartzite and fine silcrete, so it is unfortunately not possible to assess the relationship between size and material selection, although broad covariance of trends can at least be observed if not outright ascertained. Generally, a clear preference for the use of silcrete in the manufacture of small blades, bladelets and other backed pieces has been noted (Minichillo 2006, 360). The inability to discern size variation within divisions of raw material explains the discrepancy between the raw material count, which encompasses the entire flake-blade assemblage, and the flake-blade count which focuses explicitly on pieces less than 4cm in length.

5.5.2 **Trends in Raw Materials From Diagram**

Appendix 15-26 show the raw material selection for crescents, their allied forms and flake-blades from the Howieson's Poort deposits of KR 1A. They are represented as percentages of the total number of their respective tool-types from each level. The diagram (Appendix 14) shows that quartzite is the dominant material used for flake-blades in all levels except level 15, where it is the third most dominant material (16%), behind Hornfels (22%), and with fine silcrete the most dominant (60%) (Figure 49). Fine silcrete is the second most dominant material in levels 11, 14, 16, 17, 18, and 20. Coarse silcrete and hornfels comprise the other dominant flake-blade materials except in levels 13 and 14 where quartz is the third most dominant material.

The diversity of materials featured in the crescent and allied form assemblages appears greater, although it is not clear what “other rocks” are included in the quartz category for flake-blades, and even cumulatively the chalcedony and chert populations never amount to more than 6% of the assemblage. Quartzite dominates in levels 10-14 and 18-21, although it shares this position with fine silcrete in level 20 (Appendix 14). Fine silcrete is the dominant material in levels 15-17. Quartzite is the second most dominant material in levels 15 and 17, but third in level 16, behind hornfels. Quartz features more prominently as a material selected for the manufacture of crescents and allied forms, ranking as the second most dominant material in levels 11-13, and jointly so in level 14 along with coarse silcrete. It is the third most dominant material in level 15. As with the flake-blades, coarse silcrete and hornfels account for the remaining dominant lithic materials.

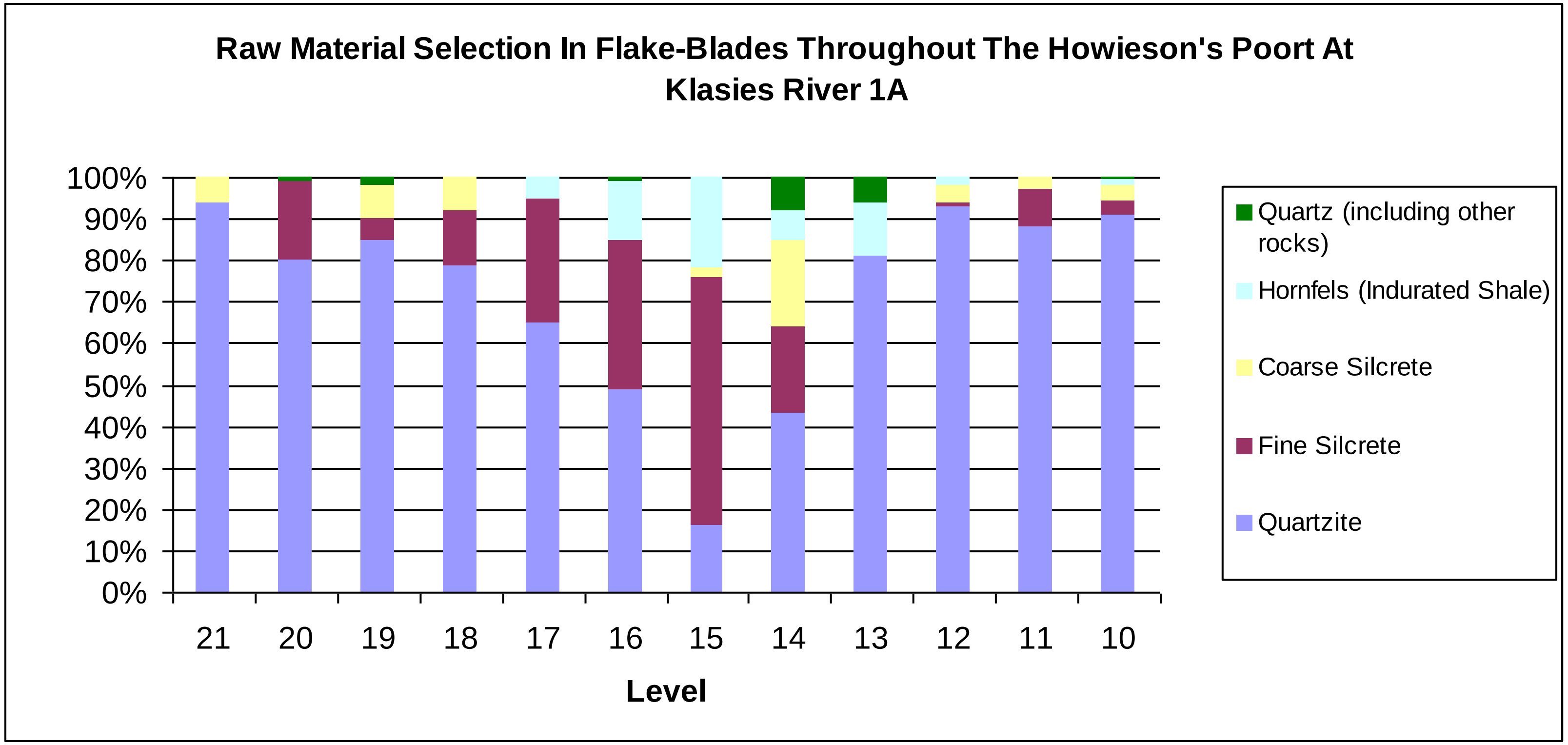


Figure 49: Graph showing proportions of raw materials in HP flake-blades from KR1A

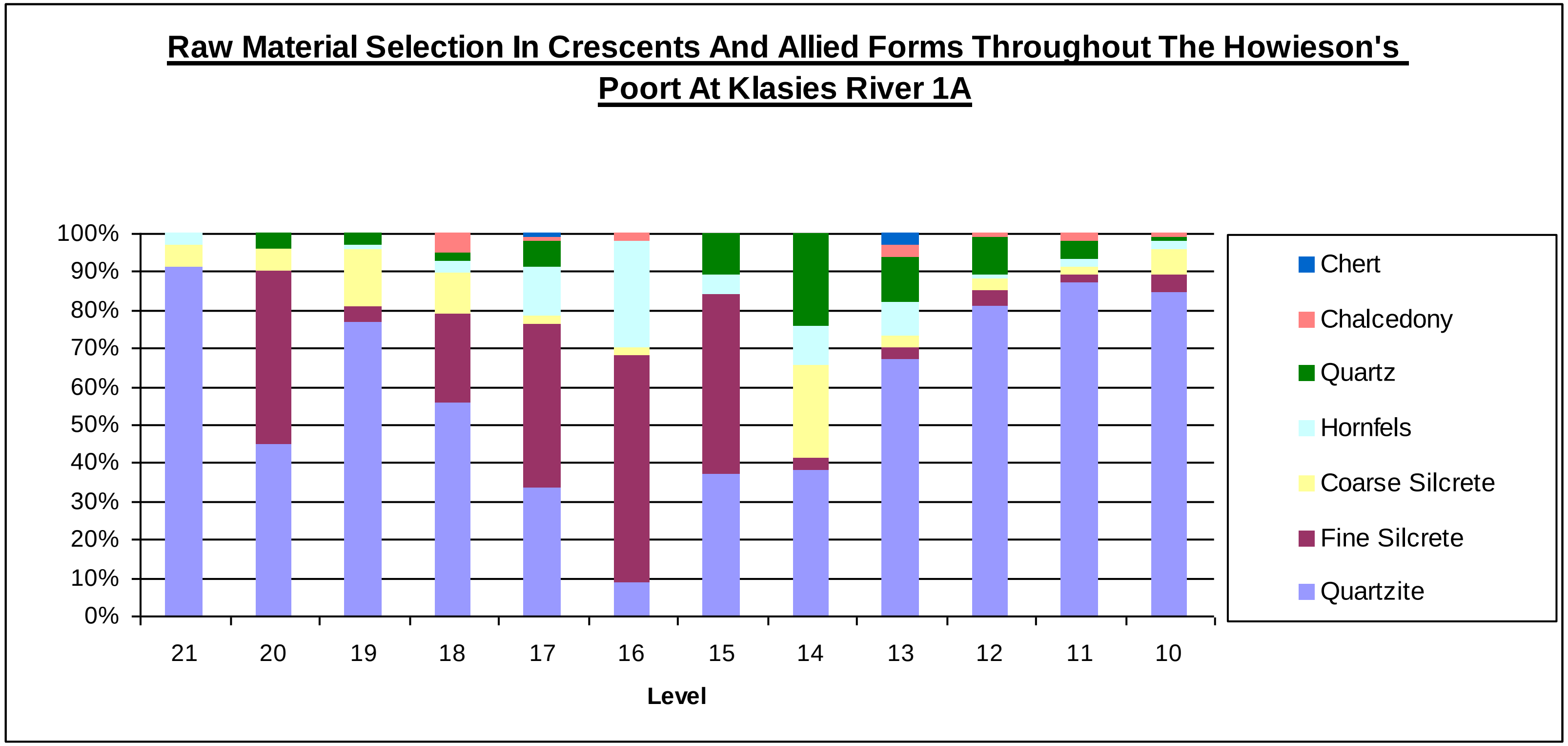


Figure 50: Graph showing proportions of raw materials in HP crescents and allied forms from KR1A.

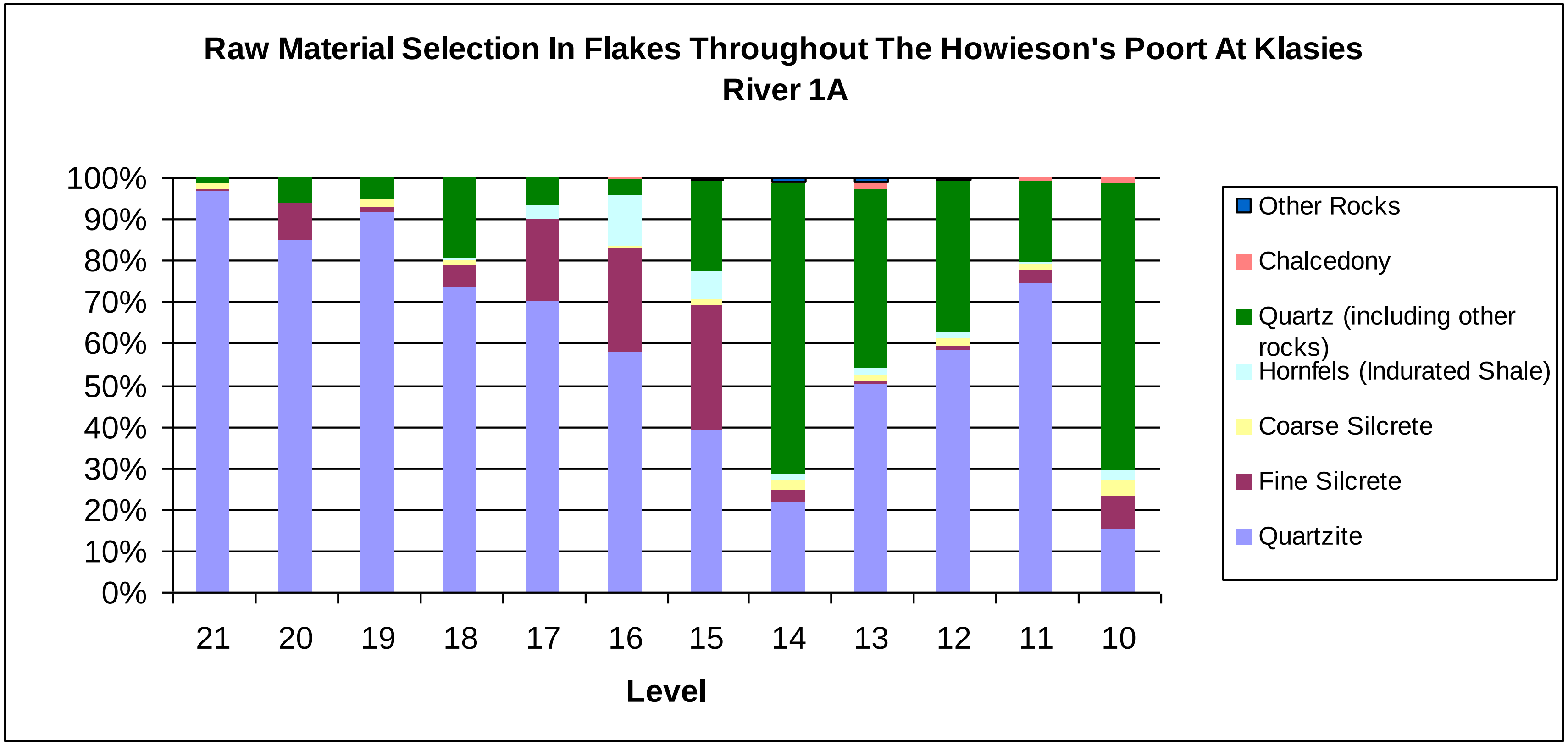


Figure 51: Graph showing proportions of raw materials in HP flakes from KR1A.

It is not uncommon for the Howieson's Poort, and certainly that of Klasies River, to be characterised rather monolithically as a period turned over to a high preference of silcrete, usually associated with the production of the microlithic elements and other small tools characteristic of the industry (Minichillo 2006, 360; McCall 2007). Such statements, whilst not untrue, ignore the more nuanced internal variation within the Howieson's Poort. Fine silcrete is by no means a popular material throughout the HP, being absent in level 21, and increasing throughout levels 19-15 following a spike in level 20 (Figure 49, Figure 50 and Figure 51). Following level 15, fine silcrete becomes a minor component in Howieson's Poort assemblages, never accounting for more than 9% of either crescents or flake-blades, except in level 14, where it still comprises 21% of the assemblage. Hornfels follows a similar pattern to fine silcrete (Figure 49, Figure 50 and Figure 51), although its peaks (max: 28 % of crescents in level 16) are incomparable with those of fine silcrete, and its demise in later levels is not as acute. Villa et al. confirmed the observation originally made by Singer and Wymer that quartz appears to peak in use following the peak of fine silcrete (2010, 636), in what seems almost like a bow wave effect (Figure 50). This pattern is more noticeable in crescents and other backed pieces, as although the prominence of quartz coincides with the demise in preference for fine silcrete for flake-blades too, it barely features in any other levels (Figure 49). Quartzite also increases at when quartz peaks and fine silcrete diminishes (Ibid 2010, 636). Coarse silcrete, while ubiquitous throughout most levels for both tool categories, is never very common (peaking at 24% of the crescents in level 14) (Figure 49 and Figure 50). As quartzite diminishes in popularity, the quantity of other materials included within the assemblage generally increases, although it decreases primarily at the expense of fine silcrete until level 14 (Figure 49, Figure 50 and Figure 51).

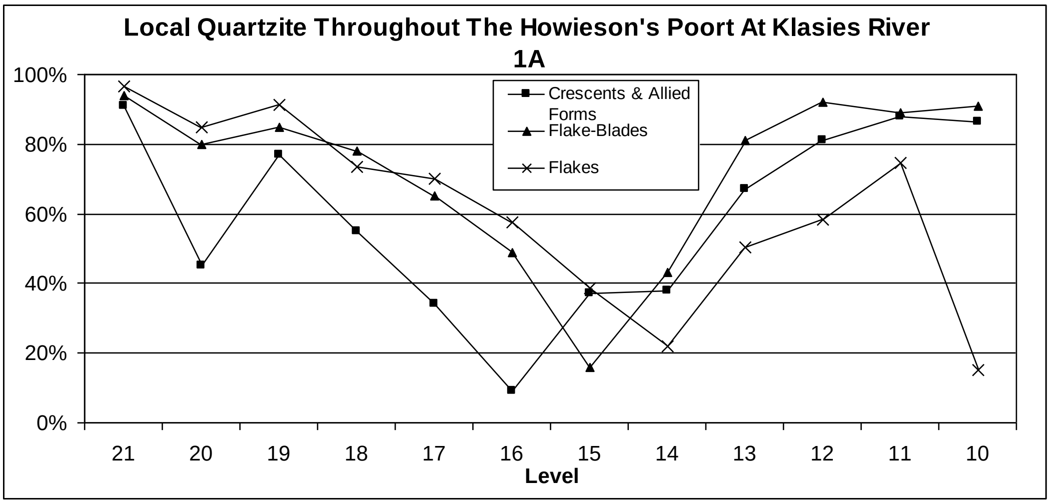


Figure 52: Graph showing Local Quartzite frequency in flake-blades, flakes, and crescents and allied forms throughout the Howieson's Poort of KR1A

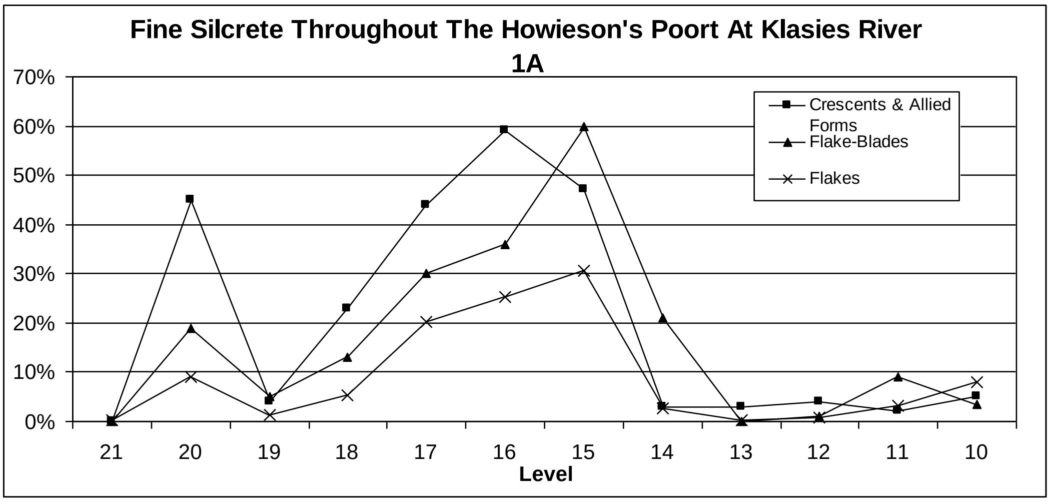


Figure 53: Graph showing fine silcrete frequency in flake-blades, flakes, and crescents and allied forms throughout the Howieson's Poort of KR1A

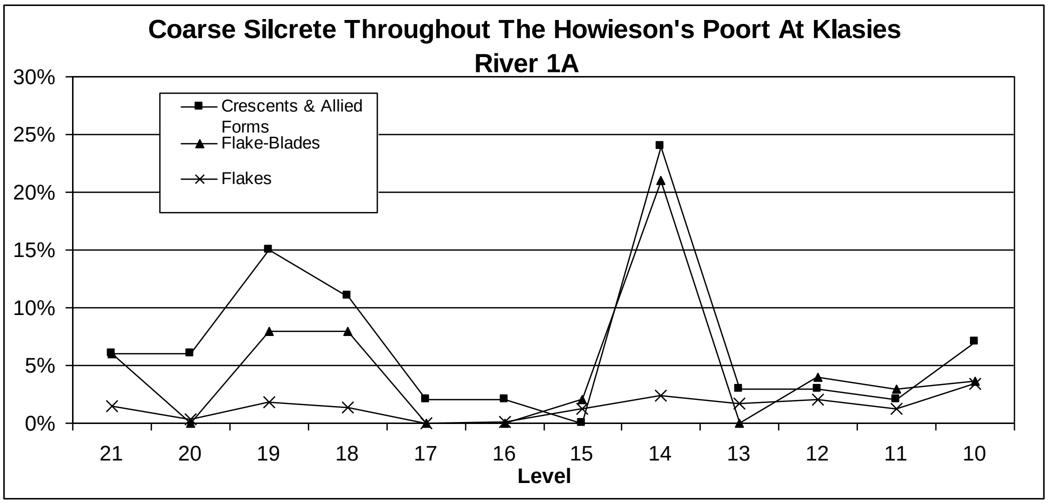


Figure 54: Graph showing coarse silcrete frequency in flake-blades, flakes, and crescents and allied forms throughout the Howieson's Poort of KR1A

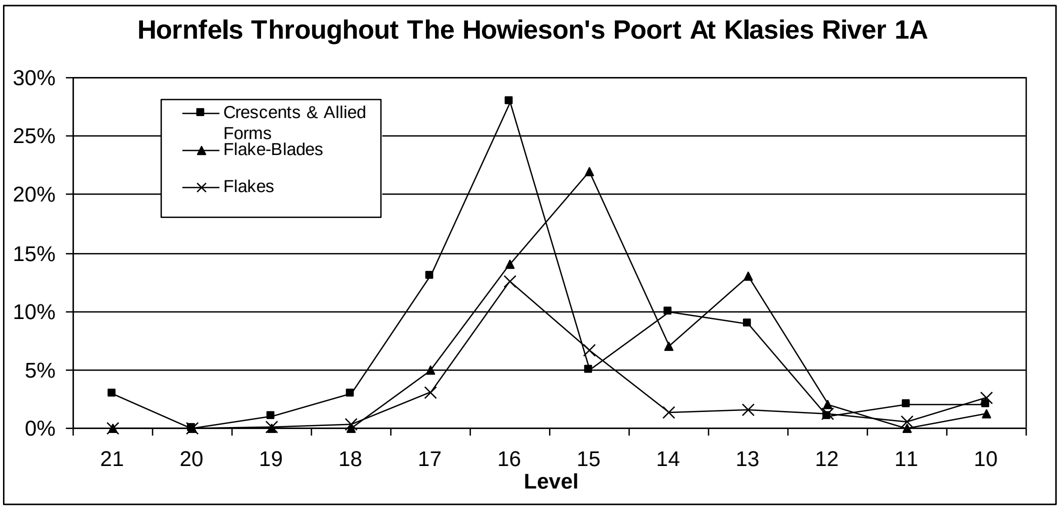


Figure 55: Graph showing hornfels frequency in flake-blades, flakes, and crescents and allied forms throughout the Howieson's Poort of KR1A

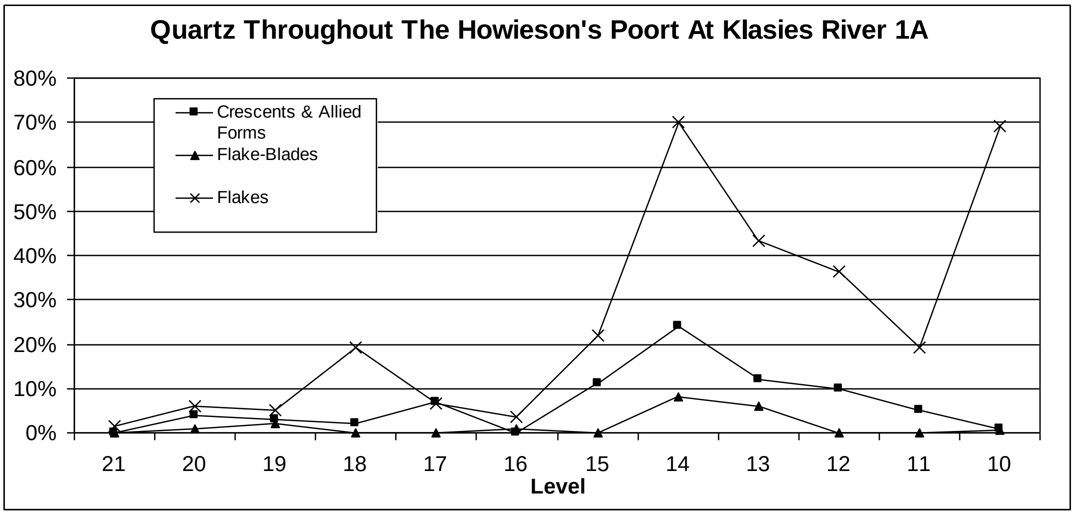


Figure 56: Graph showing quartz frequency in flake-blades, flakes, and crescents and allied forms throughout the Howieson's Poort of KR1A

Figure 52, Figure 53, Figure 54, Figure 55 and Figure 56 plot quantities of different materials throughout the Howieson's Poort levels in crescents and allied forms, flake-blades, and flakes as separate tool categories. Quantities of local quartzite, fine silcrete, coarse silcrete, hornfels and quartz are represented as percentages of the different lithic categories. In (Figure 49, Figure 50 and Figure 51), which show quantities of different materials throughout the Howieson's Poort in these three categories, there is approximate synchronicity in the trends they depict throughout the deposits. In some levels, the increase or decrease of a material type is reflected more in one lithic type than another, and in some cases wiggle matching is necessary to exactly coordinate lag discrepancies in the peaks and troughs of trends (e.g. local quartzite in levels 16-14). The most notable disparity is the much higher continuation of quartz throughout later flake assemblages. However, approximate covariance in these categories shows that materials were not being gathered exclusively for one tool type over the other, reflecting a more generalised preference. This is important as it is sometimes assumed that exotic material selection was particularly for the backed geometric forms.

Approximately concurrent variation in the flake assemblage may show that manufacturing occurred in situ or nearby. Where the trend in flakes does not follow that of the other tool categories so closely, it should be remembered that they include waste material (and more) from the broader assemblage, that the number of debris pieces may have a different spatial distribution across the site, and that variation in manufacture and taphonomy may result in varying representation in this category. Although (Figure 49, Figure 50 and Figure 51) show that material exploitation was seemingly for the most part not exclusively for the purposes of flake-blades or crescents, further potential for differentiation in preference between the sub-categories of crescents and allied forms is explored in the crescents section (Figure 69, Figure 70, Figure 71 and Figure 72).

5.5.3 **Flake-Blades**

After flakes, flake-blades account for the most dominant lithic type throughout the Klasies sequence. Singer & Wymer used the term "flake-blade", as many examples were deemed too irregular to be classed as blades (1982, 50). In her analysis of material from Deacon's excavations, Wurz has argued that blades can be distinguished from flake-blades, as the former were manufactured using soft-hammering techniques, which create a smaller platform and more diffuse bulb of percussion (Wurz 1999, 42). However, she also notes that further testing is necessary to prove this (Ibid 1999, 43), and that the "distinction is too restrictive to be operational" (Ibid 2000, 50). Consequently, she concedes that the simpler option is to classify all elongated products in the MSA as blades (Ibid 2000, 50).

Wurz also suggested at least a contemplation of whether the term bladelet could be effectively used considering the lack of a clear gap in the gradation of flake-blade size (Wurz 1999, 43). Although admittedly somewhat arbitrary, such a suggestion must be rejected simply because our inability to clearly define a cut-off point does not negate the difference in use intended for smaller and larger flake-blades. The difficulties in establishing a set cut-off size for microlithic flake-blades simply reflects the reality of the assemblages: that varying sized pieces were made and used as and when necessary rather than according to strictly defined archaeological criteria. Nevertheless, material from subsequent excavations, as discussed below, has been measured using width as the main index of size.

5.5.3.1 Size

Our inability to segregate clearly discrete tool types based on size does not belie a difference in the design and purpose of pieces of varying sizes. Instead it should encourage greater emphasis on the inference of use from characteristics other than morphometric data, and that if anything, we should perhaps be less blasé about relying upon these criteria. In Villa *et al.*'s recent reappraisal of the Howieson's Poort assemblages from Klasies River (Villa et al. 2010, 632), width, rather than length, is used to measure flake-blade assemblages. This is in accordance with practices used by members of the research team at other MSA/HP sites (Villa et al. 2005), and a response to the unfortunately high frequency of fragmentation which is believed to affect these artefacts. Singer & Wymer included fractured examples in a separate category: "Broken Flake-Blade Segments" or simply "Segments", which were divided into three possible sub-categories based on their fracture properties (Singer and Wymer 1982, 62). It is possible, however, that some fractured examples escaped their attention, and they note that their division between the flake-blades under 2cm in length and small flakes is quite arbitrary (Ibid 1982, 50). Furthermore, broken pieces that were twice as long as they were wide were also included as flake-blades rather than as flake-blade segments (Singer and Wymer 1982, 64).

5.5.3.2 Flake Blades (Exotic Materials)

Smaller flake-blades, those under 4cm in length, are regarded as the most likely bladelet candidates, and most likely microlithic according to most definitions based upon size. Singer & Wymer noted that both the size and overall number of flake-blades (local quartzite) decreased in the Howieson's Poort (1982, 112). The raw material break-down for flake-blade assemblages from the Howieson's Poort levels is presented in Appendices 15-26, and summarised in Figure 49. While the Howieson's Poort levels are notable for including more exotic materials, local quartzite remains the dominant throughout these levels except in level 15, where fine silcrete is the dominant material by a considerable margin. Although fine-silcrete flake-blades are much more prominent in level 15, there is no obvious change in the proportions of different sized pieces within this population, with the proportion of fine-silcrete flake blades 2-4cm in length similar to those in preceding levels (Figure 57). In levels 17-14, a spike in fine silcrete sees the dominance of local quartzite diminished greatly.

Hornfels also becomes a notable component of flake-blade assemblages in these levels (Figure 49). Coarse silcrete peaks, curiously, only in level 14, without precedent or continuation of the trend in the sequence. Quartz only accounts for a little more than 5% of the flake-blades in levels 14 and 13, and so is regarded as relatively insignificant for this tool type.

The spike in fine silcrete and hornfels (levels 17-14) prefaces the re-emergence of local quartzite as the overwhelmingly dominant flake-blade material, as well as a spike in the number of local quartzite flake-blades between 2 and 4cm long during levels 14-11 (Figure 58). It is interesting to note that fine silcrete flake-blades were not recovered from level 13 (also level 21), and that the quantity of small (< 4cm) flake-blades in level 12 is greatly reduced compared to in other levels.

Figure 57: Graph showing size gradation of HP fine silcrete flake-blades as a proportion of the total fine silcrete flake-blade assemblages from KR1A

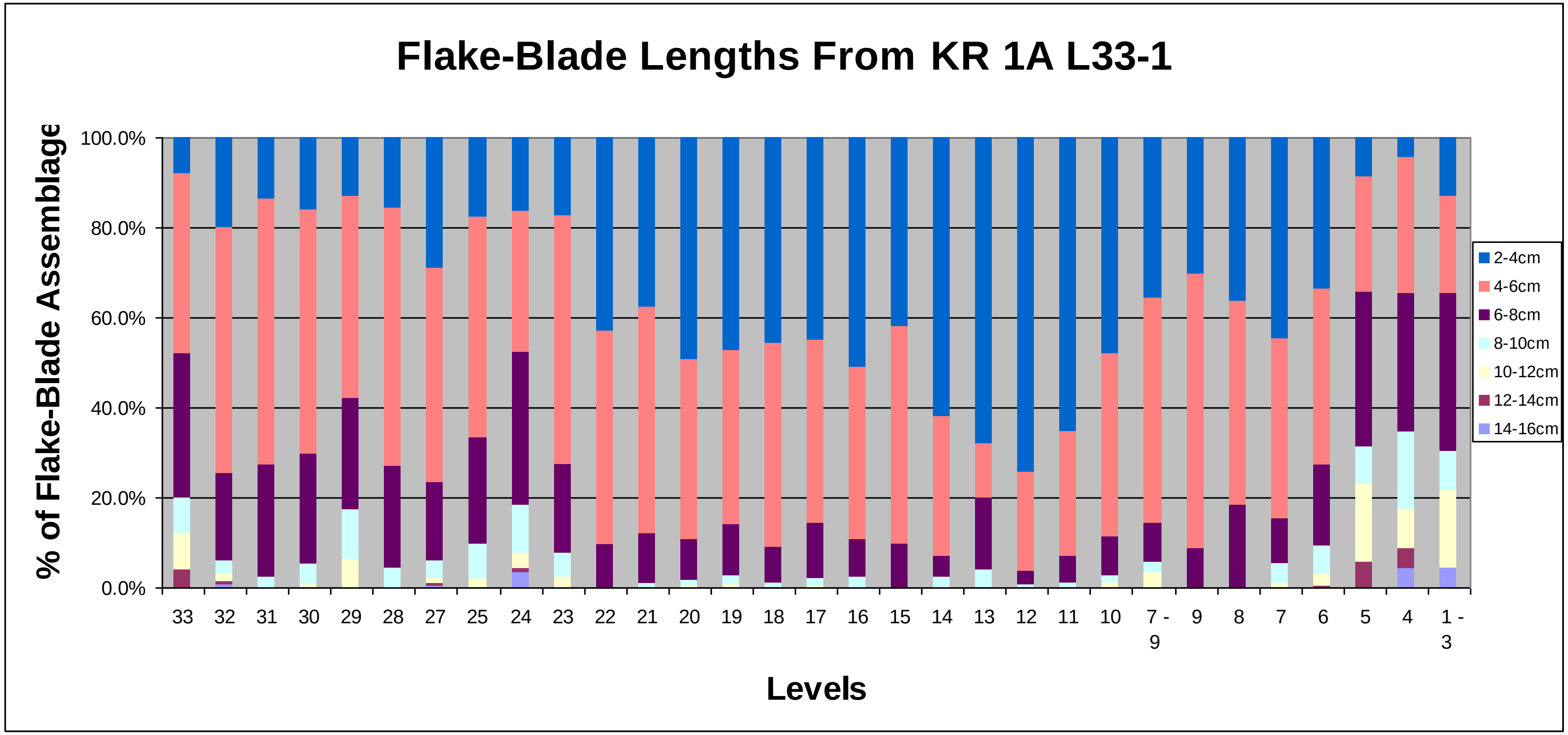
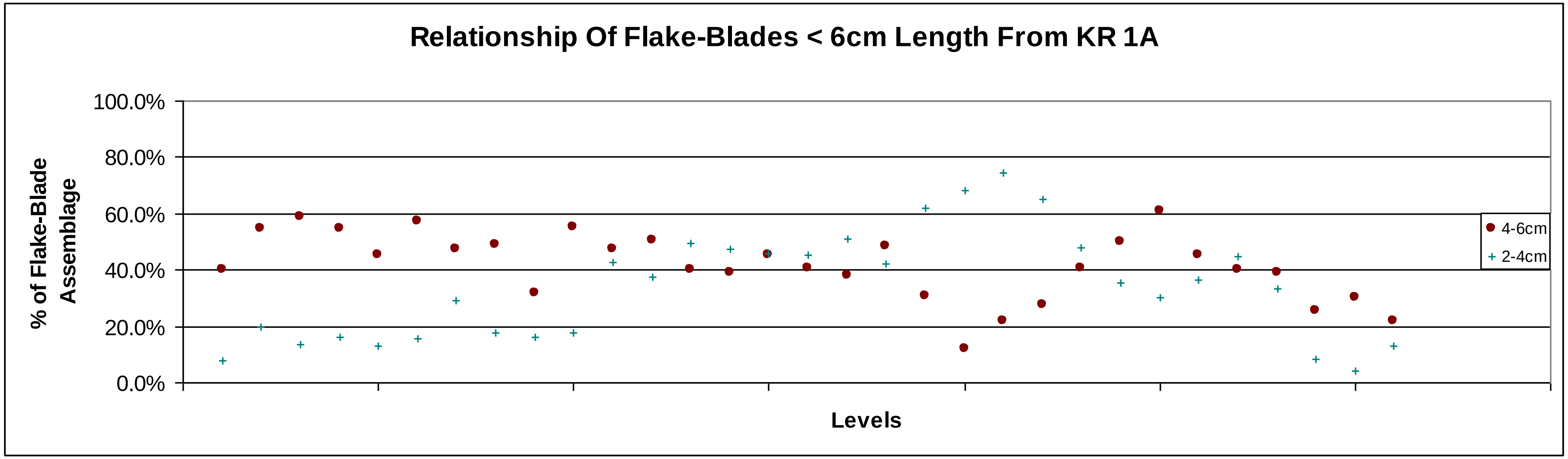


Figure 58: Graph showing size gradation of local quartzite flake-blades from KR1A

5.5.3.3 Local Quartzite Flake-Blades

Figure 58 shows changes in the size of flake-blades of local quartzite throughout levels 33-1 of KR 1A, as percentages of their total local quartzite flake-blade assemblages. This more clearly illustrates the trend depicted in the diagram (Appendix 14). Levels 9-1 (MSA III) exhibit the most fluctuation with larger flake-blades featuring particularly in levels 5-1. Levels 9-6 do not appear to represent a radical departure from the trend apparent in the preceding Howieson's Poort levels when compared to MSA II or other MSA III deposits. The number of flake-blades under 4cm in length is notably higher in levels 22-6. Level 22, the rockfall member regarded as the terminal phase of MSA II occupation, is somewhat anomalous in its composition and probably compressed due to the unique formation processes of this deposit (Singer and Wymer 1982, 21). Regarding the size of the flake-blades in the level, it seems closer to Howieson's Poort levels.

Flake-blades under 4cm in length generally account for somewhere between 15 and 20% of most MSA II assemblages (Figure 58). In levels 22-6, they generally cluster between 35 and 50% of the flake-blade assemblage, except in levels 14-11, where they feature even more prominently, ascending to and descending from a peak representation of 74% in level 12. Flake-blades between 4-6cm long remain fairly constant throughout the MSA II and Howieson's Poort deposits. With the exception of levels 14-11, coinciding with the spike of smaller flake-blades, pieces between 4 and 6cm long generally account for between 38 and 58% of the flake-blade assemblages. Apart from the aforementioned spike in levels 14-11, the increased representation of flake-blades less than 4cm in length seems more at the expense of larger pieces, over 6cm in length.



Level sequence: 30, 32, 31, 30, 29, 28, 27, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 7-9, 9, 8, 7, 6, 5, 4, 1-3

Figure 59: Graph showing relationship of local quartzite flake-blades 4-6cm and 2-4cm long from KR1A.

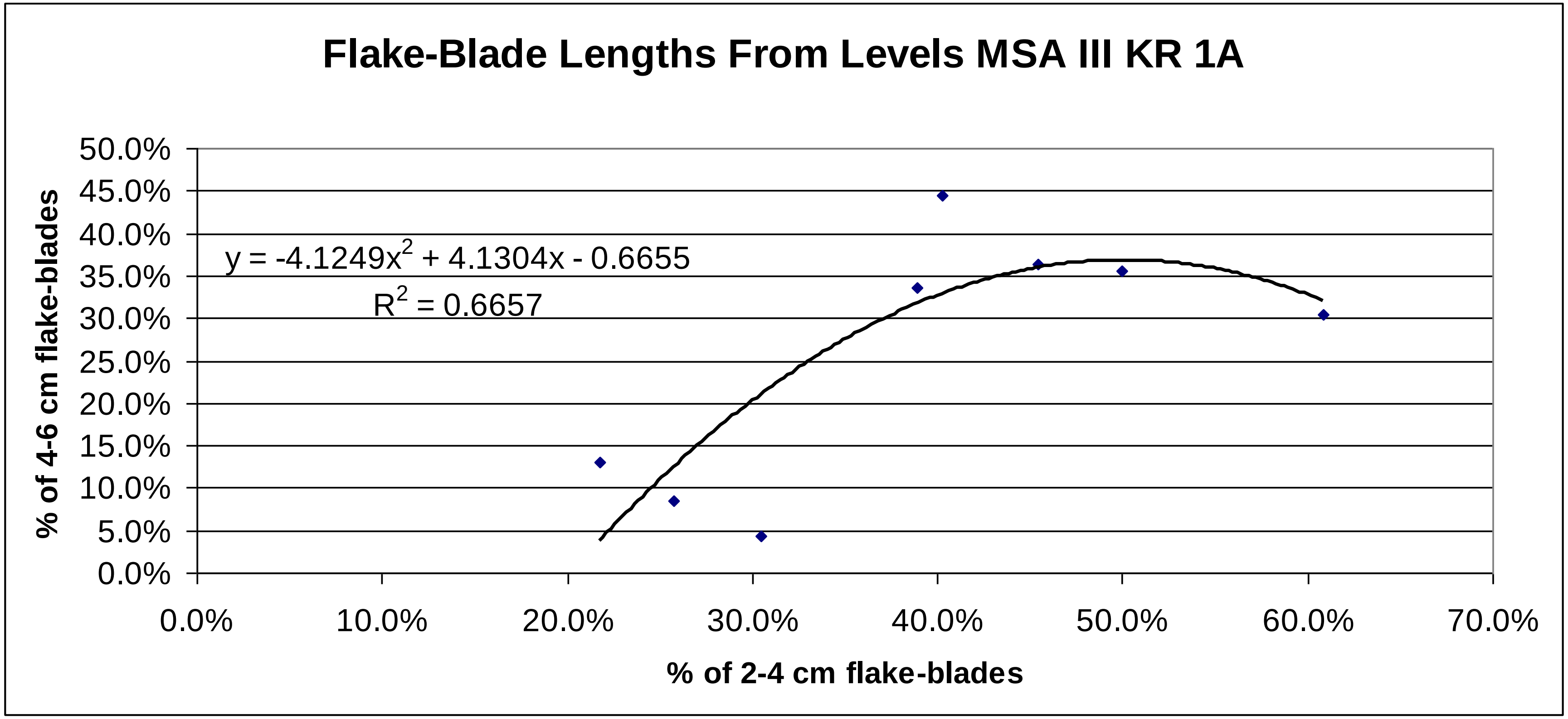


Figure 60: Graph showing relationship (polynomial) of MSA III local quartzite flake-blades 4-6cm and 2-4cm long from KR1A

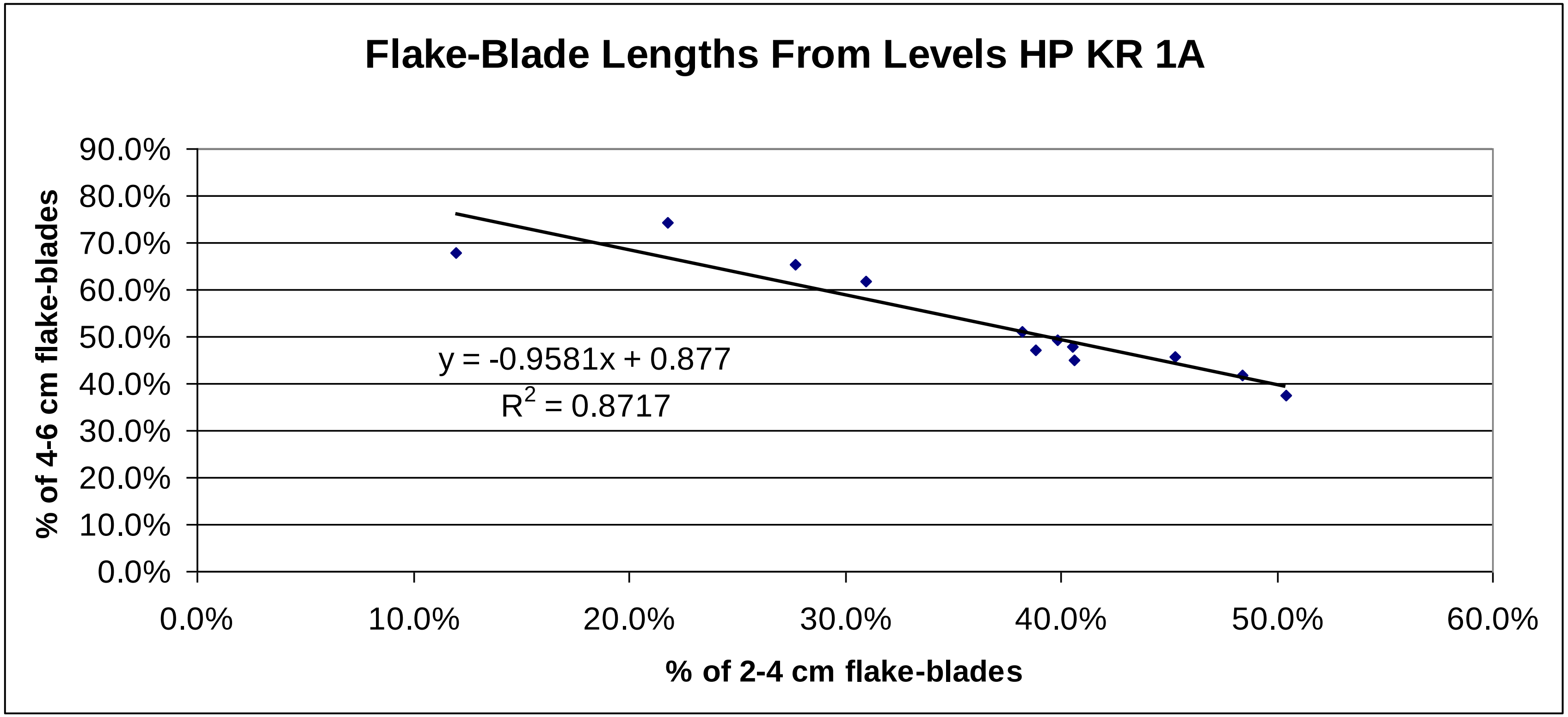


Figure 61: Graph showing relationship (linear) of HP local quartzite flake-blades 4-6cm and 2-4cm long from KR1A

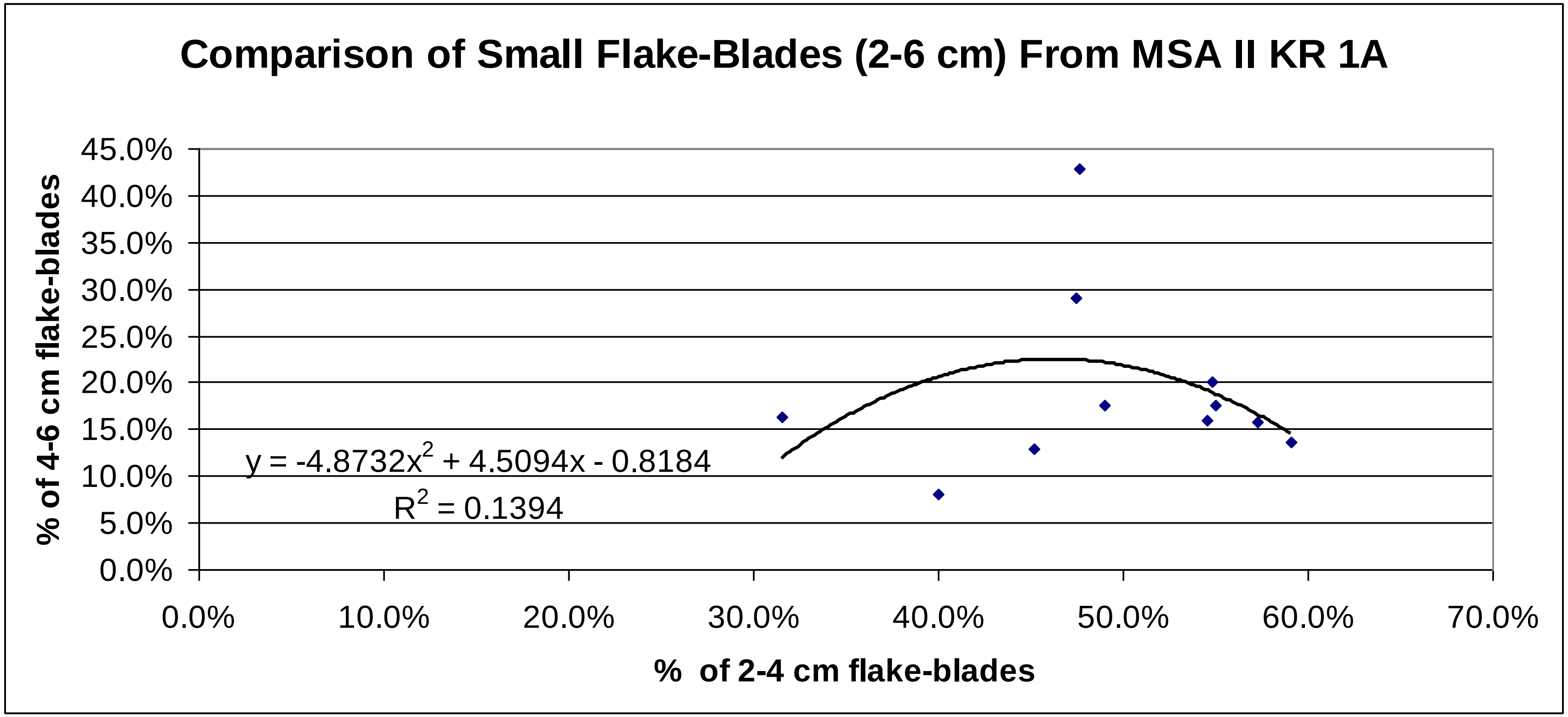


Figure 62: Graph showing relationship (polynomial) of MSA II local quartzite flake-blades 4-6cm and 2-4cm long from KR1A.

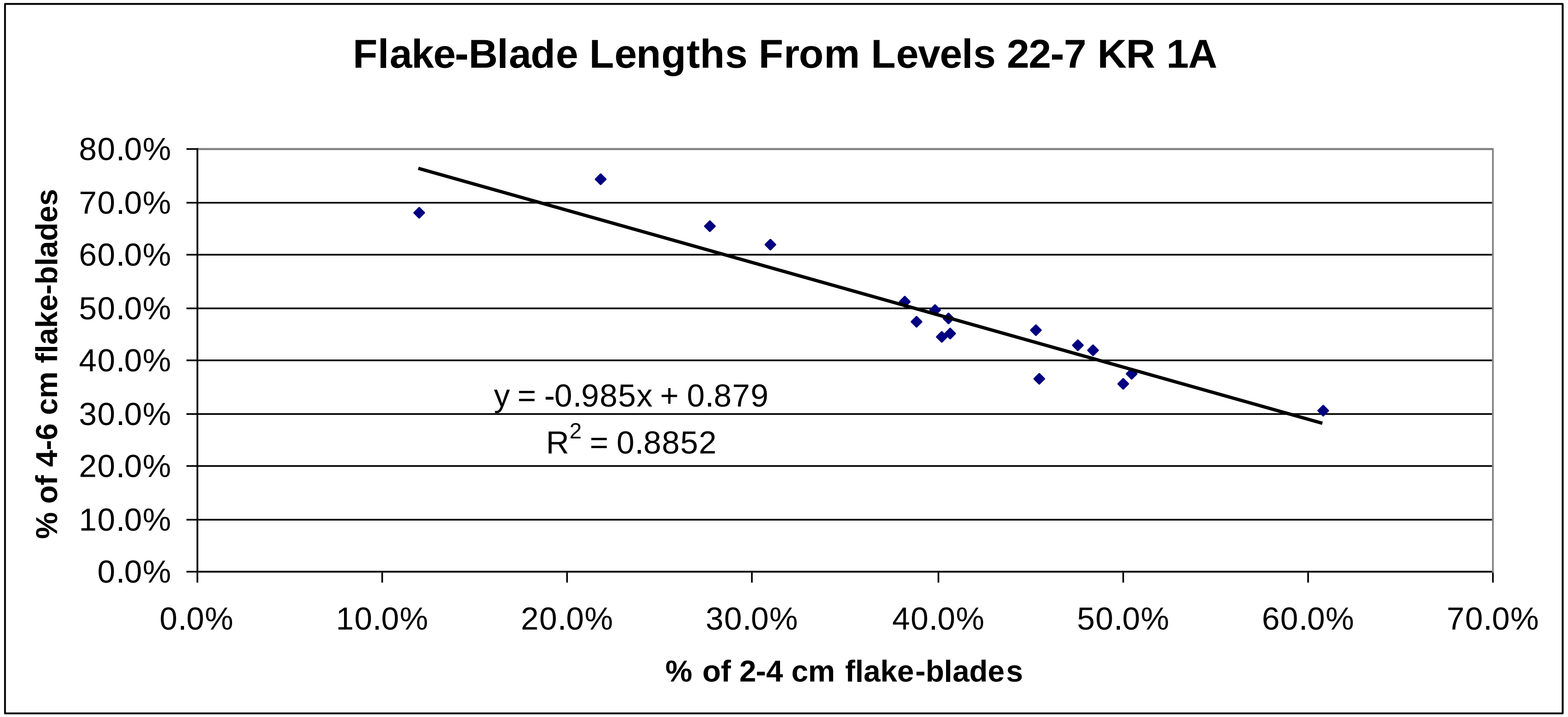


Figure 63: Graph showing relationship (linear) of local quartzite flake-blades 4-6cm and 2-4cm long from levels 22-7 of KR1A.

Flake-blades less than 6cm in length account for the majority of all flake-blades. The relationship between the two smallest categories (2-4cm and 4-6cm) is explored in (Figure 59). From this, it seems there is a correlation between the two categories, at least for certain portions of the sequence where increases and decreases in the two categories seem harmonious. Following this observation, linear regression analysis of the two size categories was conducted on the cultural sub-units of the KR 1A sequence (Figure 60, Figure 61, Figure 62, Figure 63). In cases where the linear value was deemed relatively insignificant, with 60% of the population ($r^2 = < 0.6$) used as an arbitrary benchmark, a polynomial regression was also conducted to assess for a non-linear relationship between the two categories.

There was a striking linear correlation ($r^2 = 0.87$) between the two categories in the Howieson's Poort (Figure 61). Such a correlation was not so clear in the MSA III, although a polynomial curve ($r^2 = 0.66$) shows a trend over time accounting for variation in the relationship between the two categories (Figure 60). For the MSA II portion of the sequence, there is no significant correlation using either a linear or polynomial regression (Figure 62). Using figure 52 to gauge periods of synchronicity in the two categories, patterns transcending designated cultural units were identified. A strong linear correlation ($r^2 = 0.88$) was found to exist across levels 22-7 (Figure 63), showing a continuation in the relationship identified in the Howieson's Poort into the older MSA III deposits.

Although several linear (and at least one non-linear) relationships were found to exist across different expanses of the KR 1A sequence between these different size categories of flake-blade, the trends themselves are not unidirectional over time (Figure 59). This shows that throughout certain periods of time, notably between levels 22 and 7, a clear choice was being made regarding the manufacture of one size category at the expense of the other. This pattern is particularly clear during the spike of flake-blades less than 4cm in length in levels 14-11. These graphs (Figure 59, Figure 60, Figure 61, Figure 62 and Figure 63) show the continuation of trends over time, and do not discern the expression of preference in individual levels.

Recent assessments of flake-blade assemblages have suggested that fragmentation prohibits meaningful inference of length measurements, preferring to refer to width instead (Villa et al. 2010). Breakage is an immitigable problem, and it is difficult to assess the extent to which it has affected the assemblages. As mentioned earlier, many broken flake-blades were classified as such, and are discussed in the section on flake-blade segments. The correlation between flake-blade lengths recorded above suggests that the expression of preferential design underwrites at least a substantial portion of these assemblages.

5.5.3.4 Pointed Flake-Blades

Pointed flake-blades, which retain a central ridge (Figure 33) are found throughout the KR 1A sequence. Although a notable feature of MSA assemblages, they are rarely found in very large quantities (n > 60) and are much less frequent in post MSA II phases, particularly in the Howieson's Poort (Appendix 14). Measurements of the points were excluded for Howieson's Poort examples, negating any further elucidation of trends. In the prior SAS member deposits however, it has been noted that length became shorter relative to width over time, and a higher degree of standardisation is also apparent (Thackeray and Kelly 1988, 20). Singer & Wymer posit that many of these pointed flake-blades were likely but not exclusively used as projectile points (1982, 60). In more recent reanalyses, they are commonly referred to simply as points (Wurz 2000, 49). The uni-directional core preparation utilised in the chaine operatoire of the tool, a detailed description of which is provided by Wurz (2000, 65–66), suggests a relatively expensive manufacturing process, albeit a cost alleviated by the abundance of local quartzite that was available (Singer and Wymer 1982, 62). The comparatively low frequency of pointed flake-blades in the Howieson's Poort and post-Howieson's Poort levels may reflect the rise of alternative projectile armature tips if not a shift in the style of hunting pursued. The manufacture of such alternative forms may have conserved exotic materials better.

5.5.3.5 Segments

The term "segment" is used here in reference to the typology justified by Singer & Wymer (1982, 43). Subsequent revisions to nomenclature mean that the term is now more commonly used as a reference to the general category of crescent and trapeze forms as per various examples of Wurz's work (e.g. 1999; 2000; 2005; 2008). Here, at least in reference to Klasies, the term segment refers to broken flake-blade pieces, as according to Singer & Wymer's report.

Flake-blades frequently break into one of three variants: the distal end (non-bulbous), the proximal end (with the bulb of percussion), or the mid-section. This final category is of most interest, as these mid-section pieces were considered by Singer & Wymer as the most likely intentionally made pieces (Singer and Wymer 1982, 64), although the more or less constant ratio of the three sub-categories, the majority always being bulbous pieces (Figure 64), suggests the creation of many of these segments was by chance rather than design. This ratio remains relatively constant throughout the KR 1A sequence, despite Howieson's Poort levels having a generally much higher quantity of segments. This might simply reflect a higher degree of fragmentation from the seemingly more frequent episodic occupation of the area, or alternatively it might result from an intentionally driven increase in production, perhaps similar to the snapping processes used to create the` basic crescent and trapeze forms that characterise these deposits.

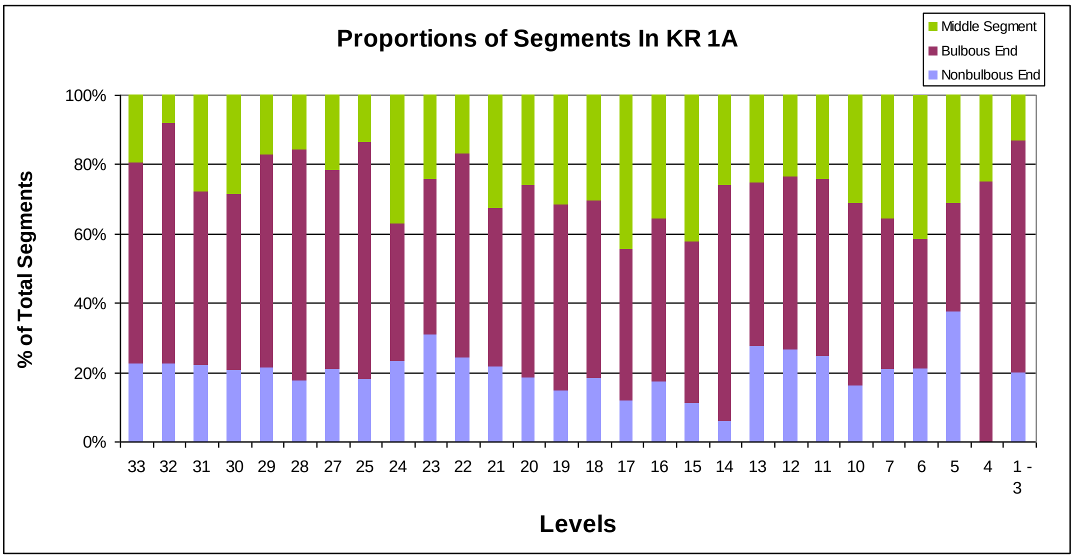
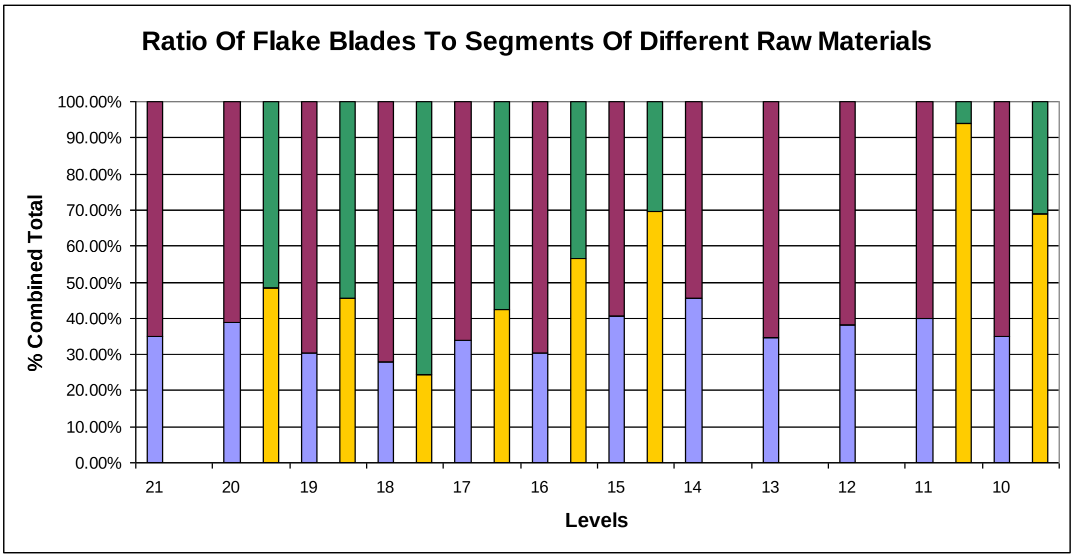


Figure 64: Graph showing ratio of different flake-blade segments throughout KR1A



Quartzite flake-blades: Blue	Quartzite flake-blade segments: Red
Fine silcrete flake-blades: Yellow	Fine silcrete flake-blade segments: Green

Figure 65: Graph showing ratio of HP flake-blades to flake-blade segments throughout KR1A

Figure 65 compares the ratio of flake-blades (blue) and segments (red) made of local quartzite to those made of fine silcrete (yellow and green respectively), as fine silcrete segments are the next most numerous material type used for this tool category. The ratio of quartzite flake-blades to segments is comparatively restricted in range. In nearly every deposit, the ratio of fine-silcrete segments is higher, albeit if only marginally. There is, however, a greater degree of variation in the range of values recorded, particularly if the counts from levels 10 and 11 are included, although the overall quantity of fine silcrete pieces in these two levels is notably smaller than earlier in the sequence (Figure 49, Figure 50 and Figure 51). This comparison allows further speculation: the fracturing properties of silcrete would generally suggest a greater susceptibility (although not always) to breakage than quartzite. While it would be naïve to assume uniform patterns of breakage resulting from manufacturing error or post-depositional effects, one might predict a greater degree of consistency in all material types, with silcrete breakage being on average higher than in quartzite. Although hardly conclusive, the comparative fluctuation in the percentages of silcrete segments could be construed as reflective of varying preference of material type for deliberate manufacture of flake-blade mid-segments. While there is still a high likelihood of accidental breakage either in manufacture or after deposition, Thackeray and Kelly, through measuring pieces from Deacon's excavations, also believed subtle stylistic variation was apparent over time (1988, 18).

In dealing with the MSA assemblages, Singer & Wymer excluded finer grained materials on the grounds that the nature and size of the material would dictate their size (1982, 50). Although they do not divulge further detail, it is at least worth noting that while finer-grained materials are often of a more brittle nature, they are also usually easier to manipulate and control during knapping, allowing for greater controlled variation in the determined size of the end product (Bordaz 1971, 11–12). It is important to note however, that the greatest ratio of fine silcrete segments to flake-blades occurs in level 18, prior to the rise in prominence for fine silcrete flake-blades in the sequence. The creation of longer flake-blades, potentially as blanks for increased design possibilities, may explain the seeming varying preference for fine-silcrete segments across time, but flake-blades made of these materials tend to be smaller overall (Singer and Wymer 1982, 93).

5.5.3.6 Worked flakes (Comparison with La Riera)

At Klasies River, the term “worked flakes” was used to describe a variety of flake or flake-blade types exhibiting modification through secondary working (Singer and Wymer 1982, 73). Although not entirely absent from the MSA, retouched forms are relatively scarce in these deposits compared to in the Howieson’s Poort. Worked flake categories from Klasies River include scrapers, denticulates, and notched flakes among others. These three categories are also noted in the La Riera sequence. Although retouched forms are relatively ubiquitous throughout the later Upper Palaeolithic of Cantabrian Spain, side-scrapers, denticulates and notches are noted in the La Riera report as being prominent in the sequence during periods when backed bladelets are not so prolific at the site (Straus et al. 1986, 189). Although the proliferation of worked pieces associated with the Howieson’s Poort is largely due to the crescents and allied forms, it is nevertheless interesting to note that relative to other MSA deposits at the site, scrapers and denticulates are relatively sparse in these levels. Of 58 scrapers recorded for the Howieson’s Poort, 35 were concentrated in levels 20 and 21; only 4 denticulates were recovered from the entire phase. This apparent similarity between trends in scrapers and denticulates between the two sites merits further investigation.

At La Riera, the scrapers most commonly associated with pre-Magdalenian assemblages are side-scrapers, whereas most scrapers from Klasies (exact figures are not provided) in both MSA and HP deposits are end-scrapers (Singer and Wymer 1982, 75; 98). In both regions these types are manufactured predominantly from local quartzite.

There is some debate as to the function of these tools, with Singer & Wymer remarking that their own experiments suggested poor longevity for their traditionally supposed use in the preparation of skins (1982, 75). Without case-specific use-wear analysis, a single exact function for these tools cannot be ascertained at either site. An assessment of end-scrapers from La Riera (Figure 66) shows that they do not strongly correlate with bladelets in the same manner as side-scrapers, although levels 17-20 when backed bladelets are most numerous is a period when end-scraper representation is consistently low (6-8% of the retouched assemblage). The significance of this trend is not clear other than that they do not negatively correlate as strongly with backed bladelets as much as the side-scrapers, and might have been a functionally distinct tool group from one another. Therefore it may be inappropriate to stress a common trend in this area.

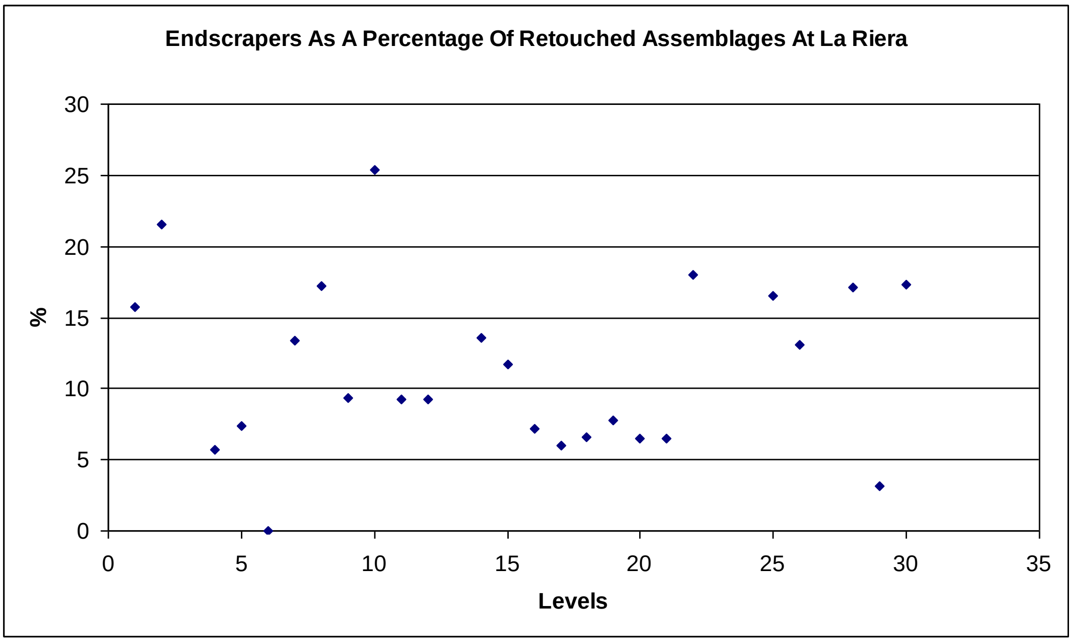


Figure 66: Graph showing percentage of retouched assemblage comprising endscrapers at La Riera, Cantabria

Denticulated flakes go from being the most numerous type of worked flake in MSA phases I-III, to one of the least represented in the Howieson's Poort (Singer and Wymer 1982, 73; 99). It is important to note, however, that in the MSA II levels from KR 1A, stratigraphically antecedent to the Howieson's Poort, their dominance over other worked flake types is less clear. The higher quantities recovered from MSA II levels from Cave 1 provided a greater contrast, and it is from these assemblages that Singer & Wymer slightly misleadingly elicit this particular trend (1982, 108). The difference between these two sets of MSA II deposits may have several explanations. It could result from difference in the spatial patterning of activities at the sites, perhaps relating to the exposed nature of KR 1A compared to more protected areas, or perhaps from differences in site clearance at the time of deposition or in subsequent times. Alternatively, given the expanse of time covered by the MSA II, it could simply be the result of temporal variation in behaviour. Whatever the reason, the difference evident in the Howieson's Poort is nevertheless clear. Beyond their conventionally presumed specialised purpose, the function of these types is also unclear, and their categorisation allows for a high degree of internal morphological variation. At Klasies it was speculated that they may have been used in minor, less strenuous butchery activities or fish processing (Singer and Wymer 1982, 75), while at La Riera it has been suggested that they may have served for tendon cutting (Clark et al. 1986, 341).

The final worked flake type, notched flakes, is noted as relatively uncommon in backed bladelet dominated levels at La Riera. At Klasies, conversely, they are most prevalent in the Howieson's Poort levels and barely present in MSA phases, seemingly at odds with the trend noted at La Riera. This is arguably the result of a disparity between regionally defined lithic terminologies. Although, as discussed earlier, the term flake-blade as used at Klasies is not restricted exclusively to neat and regular blade or bladelet classes, they nevertheless conform to a loose categorisation. The notched pieces referred to by Straus & Clark (1986) are generally larger and more variable in form. Notched bladelets are afforded separate designation (Straus and Clark 1986b); accordingly it may be assumed that notched blades (had there been any recovered) would have also been distinguished. Although their representation throughout the sequence is sparse, there is no clearly discernible chronological restriction on their distribution. This disparity in the terminology means that a comparison between "notched flakes" at Klasies and "notched pieces" at La Riera is inappropriate.

While the trend in denticulates associated with backed bladelets at La Riera and retouched crescents and allied forms at Klasies may be similar, analogous patterns in scrapers and notched pieces are unclear. Further clarification of the specific scraper form weakens the apparent similarity, and a difference in the configuration of the assemblages means there is no suitable equivalent piece at Klasies for the notched pieces described at La Riera. These superficially similar trends in lithic patterns are therefore not actually as strong as they may seem.

5.5.4 **Crescents, Trapezes and Allied Forms**

Singer & Wymer divided these backed elements into several sub-categories: completely blunted crescents, partially blunted crescents, trapezes, triangles, obliquely blunted points forming an angle, obliquely blunted points forming an arc, broken indeterminate forms, unfinished or aberrant forms, notched and snapped rejects (1982, 98). The most common forms, crescents and lunates (confusingly referred to at other sites e.g. Sibudu as segments) and trapezes are shown in Figure 31. The Howieson's Poort crescents and allied forms, whilst microlithic in form in accordance with some other African microlithic industries (Ambrose 2002), have a high upper size limit (some pieces are over 5cm in length). Unfortunately, these tools are not graded in size, so it is impossible to isolate truly microlithic forms.

Although not strictly part of this study population, backed forms from stratigraphically contemporary deposits in KR Cave 2 have been subjected to microwear analysis, and 18 out of a sample of 85 artefacts (21%) were found to have diagnostic impact fractures (Wurz and Lombard 2007, 7). Similar studies have been conducted on Howieson's Poort assemblages that also strongly suggest these pieces served as hunting armatures (Lombard 2005a; 2005b; Pargeter 2007; Lombard and Pargeter 2008; Lombard and Haidle 2012), bearing out Singer and Wymer's original interpretations (Singer and Wymer 1982). It remains unclear as to whether these particular pieces were part of hand-delivered spears or projectile armatures (Wurz and Lombard 2007, 11). In addition to the results discussed above, the examination of 222 backed pieces from Deacon's re-excavation of KR1A identified visible impact scars on 6.3 % (n = 14) (Villa et al. 2010, 638).

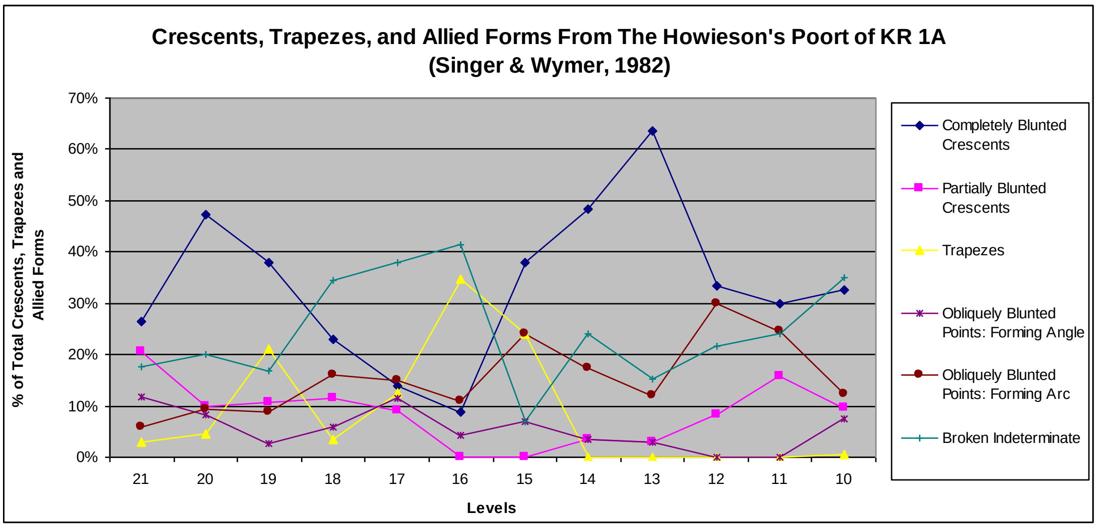


Figure 67: Graph showing ratio of "crescent and allied form" sub-types from the Howieson's Poort of KR1A

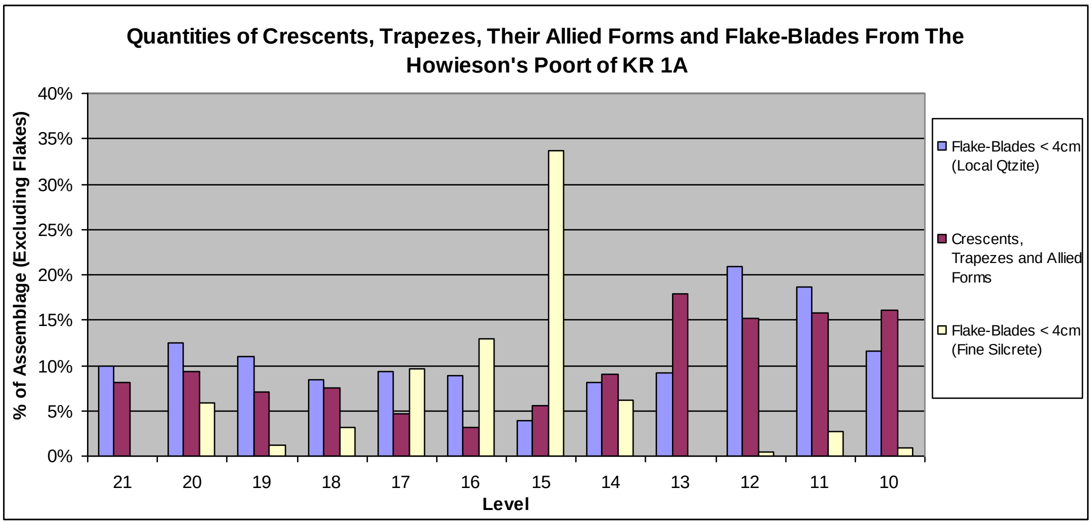


Figure 68: Graph showing flake-blades < 4cm long (local quartzite and fine silcrete) relative to crescents and allied forms throughout the HP at KR1A

Figure 67 shows the different variants according to Singer & Wymer (1982) as percentages of the total tool category throughout the Howieson’s Poort. Three variants are excluded from this graph: triangles, unfinished or aberrant forms and notched and snapped rejects. Although their presence is important, they never account for more than a minor component of the crescent assemblages at the site. Figure 67 shows that completely blunted crescents are the dominant type in levels 21-19, and 15-11, and are dominant by a clear margin (> 10%) in levels 20, 19, 15, 14 and 13. Broken and indeterminate forms replace them as the dominant form in levels 18-16 and again slightly in level 10. The only other form to notably surpass completely blunted crescents is trapezes in level 16. Following a downturn in trapezes in level 15 after this peak, they then comprise an absolutely negligible portion of assemblages for the remainder of the Howieson’s Poort. Other forms fluctuate moderately in low quantities throughout the sequence, with partially blunted crescents curiously absent in levels 16 and 15 when completely blunted crescents transition from relatively low representation back to a dominant portion of the assemblages.

In Figure 68, the number of crescents and allied forms is compared to the number of flake-blades less than 4cm in length of local quartzite and of fine silcrete. The relationship is expressed as a percentage of the total assemblage excluding flakes for each level. Although the value of comparing a tool type with no size restrictions against another with an arbitrary cut-off point might seem questionable, it is nevertheless interesting to note that with the exception of level 13, the disparity between crescents and their allied forms and local quartzite flake-blades less than 4cm in length never exceeds 15%.

5.5.4.1 Raw Material Use For Crescents and Allied Forms

Visual comparison of the raw material division among Crescents and allied forms (Figure 50) with fluctuation in the sub-types of tool within this category (Figure 68) suggest some potential correlations for further exploration. (Figure 69 - Figure 72) isolate some of these relationships. Using spearman’s rank correlation coefficient, it was possible to assess whether these perceived trends in tool sub-types and raw material selection are significant or not. The significance value is always assessed at

10 degrees of freedom, as there are 12 levels (data sample points) being compared, when the degrees of freedom is derived from “n-2” where “n” is the number of samples (Blalock 1972, 400). The relationship between quartz and completely blunted crescents was found to be significant, accepted at over 95% confidence with a value of 0.67. The relationship between fine silcrete and trapezes was even more significant, accepted at over 95% and only just less than 99% confidence with a value of 0.74. Perceived similarities between completely blunted crescents and quartzite, and trapezes and broken indeterminate forms with hornfels were shown to be insignificant. Appendices 27-30 show the input data for generating these values.

If material use within the tool category was exclusive to one single sub-type of tool, then there would be no difference between the two in their percentage of the crescent assemblages. This is clearly not the case. However, the fact that trends in raw materials significantly correlate with the quantity of particular tools shows that some types clearly favoured certain materials over others. Most notably, trapezes heavily utilised fine silcrete, and much of the quartz within the assemblage was used for completely blunted crescents (although this by no means suggests that the completely blunted crescents were made mostly of this material). Perceived relationships between fine silcrete and hornfels with broken and indeterminate forms (Figure 69 and Figure 70) were also tested. The perceived similarity between these types was deemed insignificant.

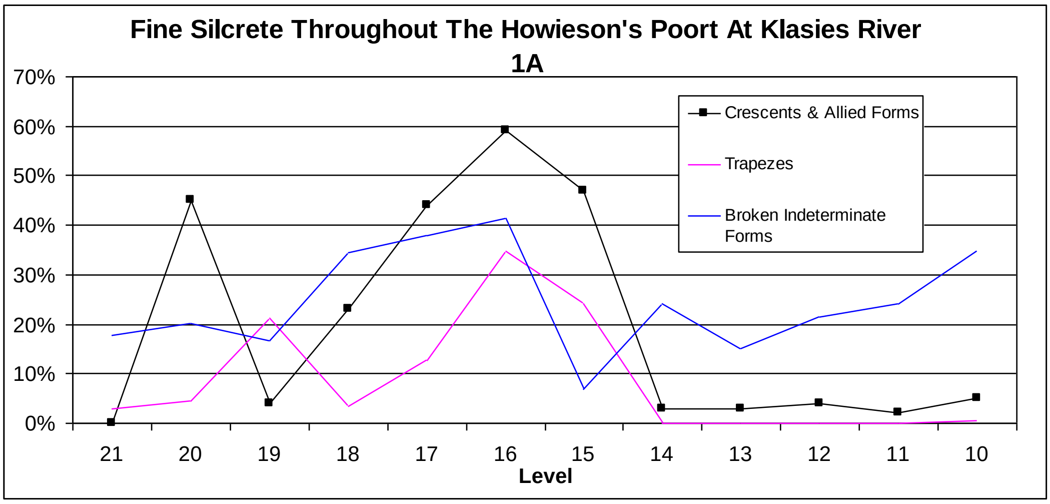


Figure 69: Graph showing crescents and allied forms made of silcrete plotted against trapezes and broken indeterminate forms

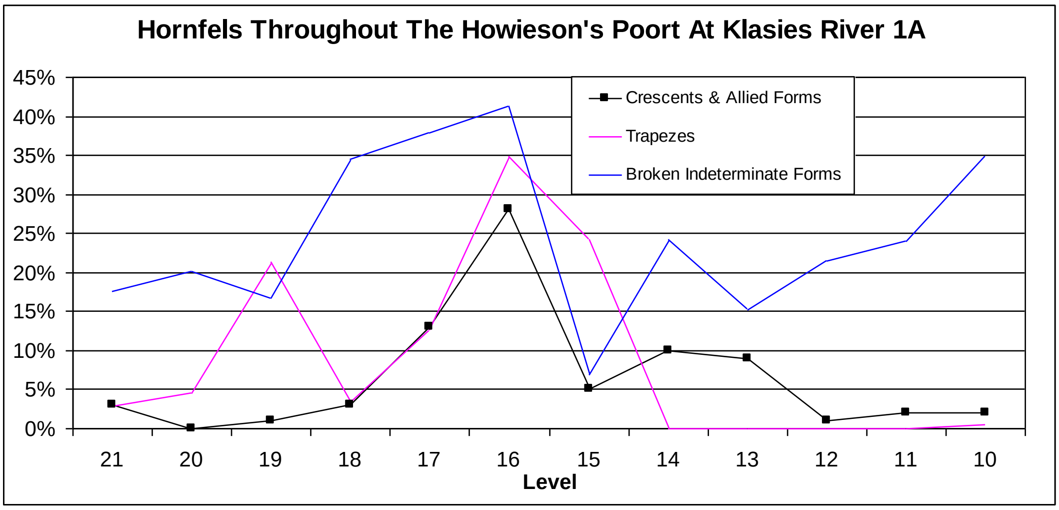


Figure 70: Graph showing crescents and allied forms made of hornfels plotted against trapezes and broken indeterminate forms

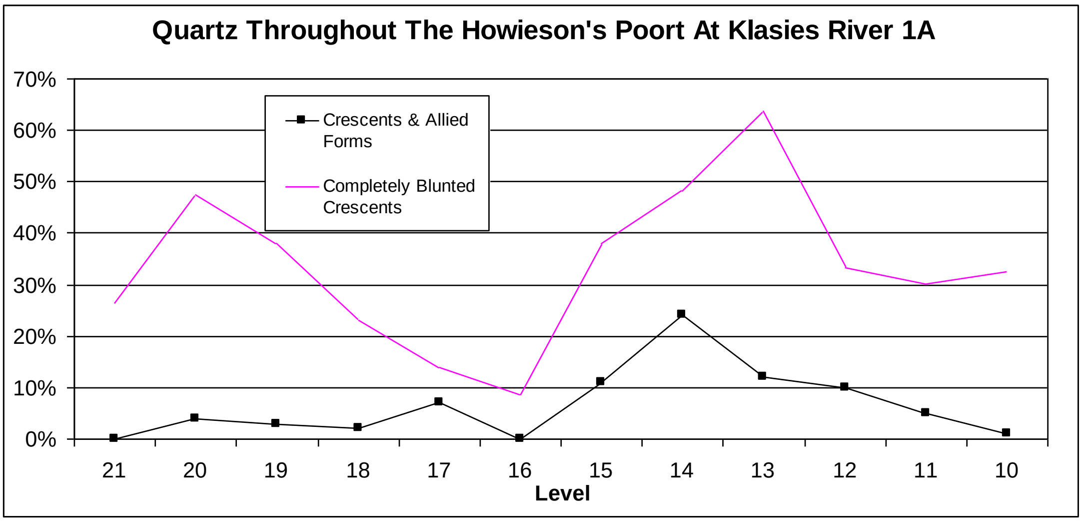


Figure 71: Graph showing crescents and allied forms made of quartz plotted against completely blunted crescents

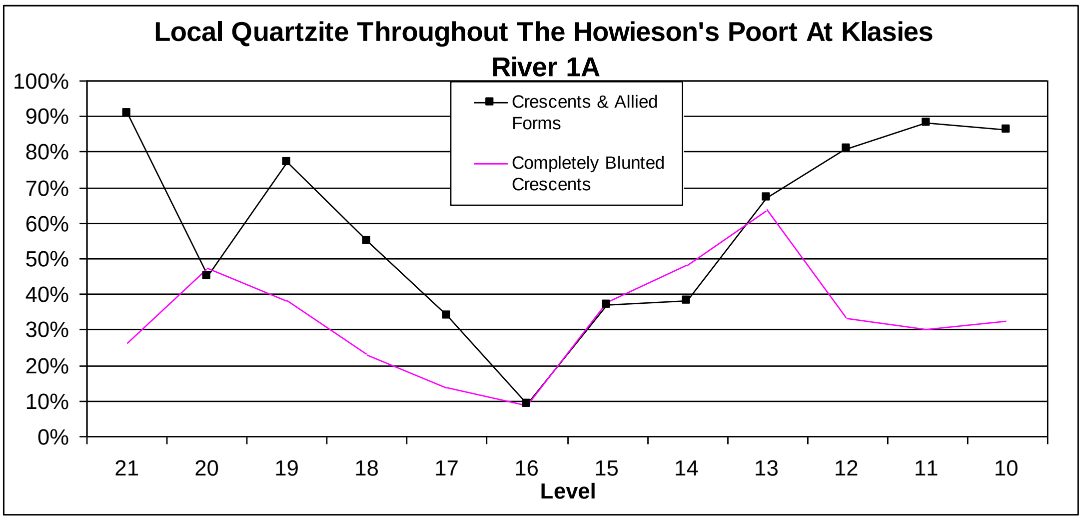


Figure 72: Graph showing crescents and allied forms made of local quartzite plotted against completely blunted crescents

5.5.5 **Worked Bone**

Evidence of worked bone is scant (four possible pieces) throughout the entirety of the sequence. The only piece which is confirmed with confidence as evidence of bone working is a single point tip, 7.7cm long, recovered from level 19 of KRM 1A, which is curious considering the relatively poor preservation of bone in the Howieson's Poort levels (Singer and Wymer 1982, 115–116). Sample sizes are prohibitively small to comment on bone use at any time during the site's occupation, but several other points have subsequently been found from various MSA sub-complexes such as the Howieson's Poort at Sibudu.

5.5.6 Trends In Flake-Blades and Crescents & Allied Forms

Howieson's Poort deposits have a generally lower proportion of flake-blades than other KR1A levels, with level 15 being the notable exception (Singer and Wymer 1982, 108). Small flake-blades (< 4cm long) are a proportionally greater component of the flake-blade assemblages between levels 22 and 10 though. Within the Howieson's Poort, the proportion of small flake-blades is increased between levels 17-11. This is largely the result of an increase in fine-silcrete flake-blades (which are mostly < 4cm) between levels 17-14, which is followed by an increase in small flake-blades of local quartzite between levels 14-11. During this latter stage of the Howieson's Poort sequence, crescents and allied forms reach their greatest level of representation. In the fine-silcrete dominated phase of the HP sequence, crescents and allied forms are found in their lowest frequency. This period is also when trapezes become a more dominant crescent sub-type, correlating strongly with the rise in fine-silcrete. As the peak in trapezes begins to decrease in level 15, a more substantial increase in completely blunted crescents begins, peaking at 64% of the crescent assemblages in level 13. Quartz correlates with this sub-type, and while it is well represented in flake assemblages from level 15-10, it barely features at all in flake-blade assemblages. For the rest of the Howieson's Poort (before and after levels 17-14), local quartzite is generally the dominant material for both flake-blades (> 80%), and crescents and their allied forms (> 70%) in most levels.

5.5.6.1 "Exotic" vs. "Non-Local" Materials

The Howieson's Poort lithic industry at Klasies River Mouth is notable for comprising a high quantity of so-called "exotic" fine-grained stone materials compared to other deposits within the sequence (Singer and Wymer 1982, 90–93; Villa et al. 2010, 634). The frequency of fine-grained materials in the final MSA II and earliest MSA III deposits is also high (Ambrose 2006, 366). This has led to suggestions that as a technological development, the Howieson's Poort was facilitated by changes in exotic material procurement networks (Lombard 2006c, 38).

In Villa et al.'s assessment of the KR1A HP assemblages, hornfels, chalcedony and crystal quartz account for a relatively minor overall portion, with quartzite, silcrete and vein quartz being the dominant materials (2010, 364). Singer and Wymer originally divided the silcrete assemblage into coarse (still finer-grained than most quartzites) and fine grained categories, which have subsequently been further divided for material from Deacon's excavations to distinguish fine and very fine-grained varieties (Villa et al. 2010, 635). The use of "exotic" and "non-local" to describe fine-grained materials from the site are no longer interchangeable, as the latter is now considered to imply a known origin point a certain distance from the site (Minichillo 2006). Accordingly, they are now referred to as "exotic" materials.

5.5.6.2 Material Procurement

Several attempts have been made at modelling the raw material procurement strategies used during the Howieson's Poort. Ambrose maintains (2006) the view, first set out in the 1990's (Ambrose and Lorenz 1990) that the proliferation of fine-grained exotic materials in the Howieson's Poort reflects expanded networks of contact during this period as a response to the deteriorating environments of OIS4. The return to quartzite and abandonment of small backed geometric elements in MSA III is explained by the collapse of these networks, their necessity being relieved in the wake of ameliorating climates (Ambrose 2006, 367). An alternative hypothesis posits that these changes result from intensification in lithic foraging, as a response to the requirements of hunting technology adapted for the maintenance of MSA prey selection in increasingly arid climates (Minichillo 2006). Both hypotheses relate the importance of ecological change as a factor in raw material selection. While much of the quartzite used throughout the MSA was likely sourced locally, perhaps from beach cobbles, a main issue of contention between the models summarised above is the supposed distance travelled in the procurement of "exotic" materials. With our continued ignorance regarding the provenance of many of these materials, this issue remains irresolvable. What is clear, and supported by both the models mentioned above, is that the changes in raw material selection and tool design are intrinsically related, with the tool design seemingly occurring after the shift in selection.

5.6 Review

The transition into the Howieson's Poort is not as smooth as is perhaps sometimes portrayed: Level 22, the rockfall member, represents a serious disruption in the depositional history of the site. Likewise, the amount of scree interspersed among and between delineated MSA III deposits also makes comparative inference with other portions of the KR 1A sequence complicated. These issues have probably also complicated the attainable accuracy of dating programmes e.g. (Feathers 2002). Although the KR 1A sequence is easily mistaken for being largely uninterrupted, the disruption in deposition both before and after the Howieson's Poort gives cause for evaluating this view.

While Deacon's excavations of the site have provided a much clearer record of the site stratigraphy at KR 1A (Thackeray and Kelly 1988; Deacon and Geleijnse 1988; Wurz 2000; Villa et al. 2010), the majority of excavated and recorded material is ordered according to the gross units outlined in Singer & Wymer's original investigation. Villa et al. (2010) provide the most informative alignment of the two matrices, but transferring between schema remains too problematic an endeavour. What is clear from comparing the Howieson's Poort levels to other portions of the KR 1A sequence is that the occupation of the site changed dramatically during this period. It is important to note that this should neither imply homogeneity in the occupation of the site during the Howieson's Poort, nor during the rest of the MSA as has been attested by Wurz (2002; 2005), and that similarity between levels in other portions of the sequence may belie less superficial differences. The laminar series of dark carbonaceous deposits that comprise the Howieson's Poort does, however, support a departure in the occupational history of the site, with most interpretations agreeing on more frequent episodic use of the cave. Concurrent climatic and environmental changes may also be a factor in the formation of these unique deposits. The number of individual occupation episodes masked by Singer & Wymer's scheme (Wurz 2000) means that the data collated through their excavations can only be used to infer general changes through time, assuming that the repeated occupation of the site during this time did not significantly disturb the superposition of material and deposits, something which may well have been the case.

Unfortunately, the degree of conflation in deposits of such antiquity limits the extent to which internal variation within the chrono-cultural units can be detailed. In this respect, Appendix 14 is inherently less insightful than its La Riera counterpart, with both diagrams designed within the restrictions of the stratigraphic frameworks of the sites. Nevertheless, it is possible to distil some trends, particularly with further investigation of the lithics which have the most qualitative data recorded. These remains have offered the only real avenue for assessing the internal variation within the Howieson's Poort that Singer & Wymer called for (Singer and Wymer 1982).

5.6.1 **Summary**

As noted by Singer and Wymer in their original report (1982, 107–104), the contrast between the Howieson's Poort and MSA deposits of Klasies River is stark, particularly in the lithic industries. Although subsequent research has revealed far more nuanced variation in the other MSA sub-phases of the sequence (Wurz 2000; 2005), the Howieson's Poort industry remains by far the most visibly distinct juncture in the history of the site. Although there is no dramatic shift in the prey represented at the site, the change in the lithics is matched by some broadly synchronous changes in the fauna, with a much more diverse range of species being hunted, and with cape buffalo and zebra coming to the fore, the latter being unprecedented at the site until this time. These changes are underpinned by changing trends in the local palaeoenvironment, with the Howieson's Poort itself characterised as a cool and open period from evidence at the site. With dating estimates having regularly been refined or revised over the last three decades, a major research focus has been matching the period to a suitable climatic stage. Different methods have resulted in differing estimations, with those that put the deposits during late OIS4 conforming with dates obtained from other Howieson's Poort yielding sites.

Trends in lithic use at the site are most apparent. While previous researchers have elaborated on the continuation and innovation of particular aspects of behaviour throughout the Howieson's Poort (Singer and Wymer 1982; Thackeray and Kelly 1988; Wurz 2000; Wurz 2002; Villa et al. 2010), this study has shed some further insight. The trend of "microlithisation", associated so strongly with the Howieson's Poort, is restricted neither to the classic geometric forms characteristic of the industry, or to pieces made from exotic materials. In fact, local quartzite continues to play a dominant role throughout most of the Howieson's Poort, albeit much less so than in bracketing MSA phases. Interesting nuances over this period of time in the selection of different materials for certain tool-types and size categories have been identified, addressing Singer and Wymer's request for greater detail regarding internal variation within the period. It has also been shown, in some of the lithic analyses but also the palaeoenvironmental and faunal studies, that what might be considered "typically" Howieson's Poort trends actually extend moderately beyond the stratigraphically delineated boundaries for the period. The key findings of the work presented here is summarised in the discussion section, where the implications for understanding hunting behaviour are also considered.

6 Howieson's Poort of Southern Africa (Comparative Sites)

6.1 Sibudu

Sibudu cave, which is technically a rock-shelter on account of its size (55m long x 18m across), is located 40km north of Durban and 15km inland from the Indian ocean in the KwaZulu-Natal province of western South Africa (Figure 73) (Wadley and Jacobs 2006). Excavations have revealed an extensive sequence spanning from the Iron Age through to the MSA including Howieson's Poort and Still Bay phases. The shelter is around 100m a.m.s.l but the site's southern entrance is around 12m lower than the excavation area, giving an abrupt north-south slope to the floor surface (Wadley and Jacobs 2004, 145). The shelter is situated in cliffs of shale and sandstone, and was probably formed after the lowering of the channel for the Tongati river during a marine regression (Wadley and Jacobs 2004, 145), which today flows some distance below the shelter. The location of the site is partially hidden by forest where woodcutters and sugarcane farmers have not yet reached (Wadley and Jacobs 2006, 2).

6.1.1 History of Work

The first archaeological excavation at Sibudu was in 1983 by Aron Mazel in the form of a small trial trench located where grid squares C3 and D3 (Figure 74) (Wadley and Jacobs 2006, 4). Although recording of this excavation remains unpublished, radiocarbon dates acquired from the excavation inspired the renewal of more extensive investigation under a team headed by Lyn Wadley in 1998 (Wadley and Jacobs 2004). With work at the site having been conducted more or less continuously since then, there is no single site report to contain the various analyses that have been pursued. However, the site is notable for the range in scope of research that it and the material it has yielded have been subjected to. As well as the intermittent publication of research elsewhere, two notable collations of work have been so far published. The first is a collection of papers presented in the March/April 2004 edition of the South African Journal of Science volume 100, where the discovery of Howieson's Poort deposits were first discussed (Wadley and Jacobs 2004), and the second is the November 2006 instalment of Southern African Humanities, volume 18(1), devoted in its entirety to discussion of work conducted at the site featuring, among other projects, research into the recently uncovered Howieson's Poort occupation. An in depth analysis of specifically the Howieson's Poort lithic assemblages was published in 2008 (Wadley 2008). Pre-Howieson's Poort deposits identified as pertaining to the Still Bay were announced in 2007 (Wadley 2007).

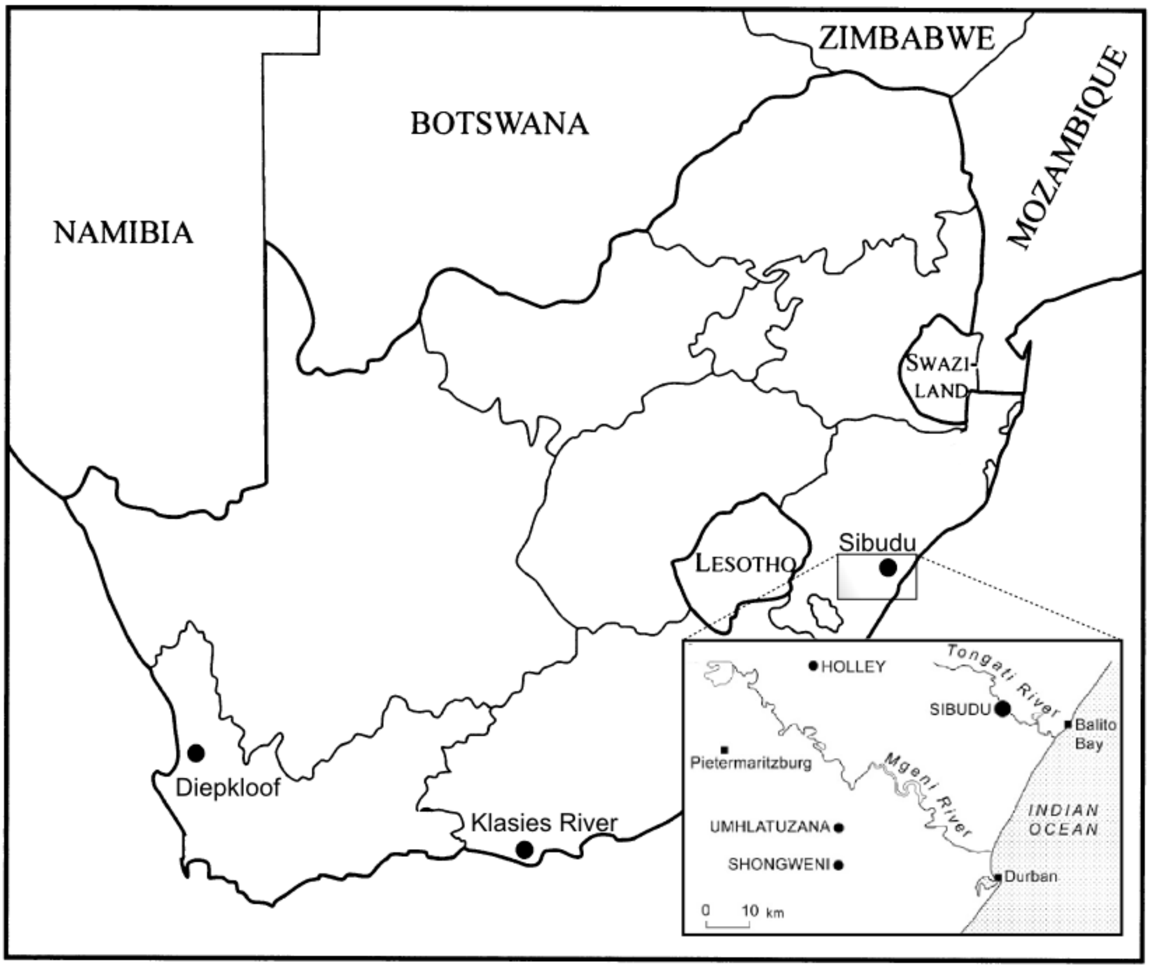


Figure 73: Map of South Africa showing Sibudu

The most recent detailed documentation of the excavations conducted at Sibudu is that provided by Wadley and Jacobs (2006). At this time, excavations had been conducted in an area of $21m^2$ with a $2m^2$ trial trench begun in 1998 representing the deepest extent of the sequence (Figure 75). A rock base (rock fall) was found after a depth of around 3m was reached in 2005 (Pickering 2006) and initially, it was only in these squares that sufficient depth had been reached to reveal Howieson's Poort and pre-HP deposits (Wadley 2007), although by the time of Lyn Wadley's assessment of the Howieson's Poort lithics was published, excavation had been extended to included material recovered from neighbouring squares C5 and C6 (Wadley 2008).

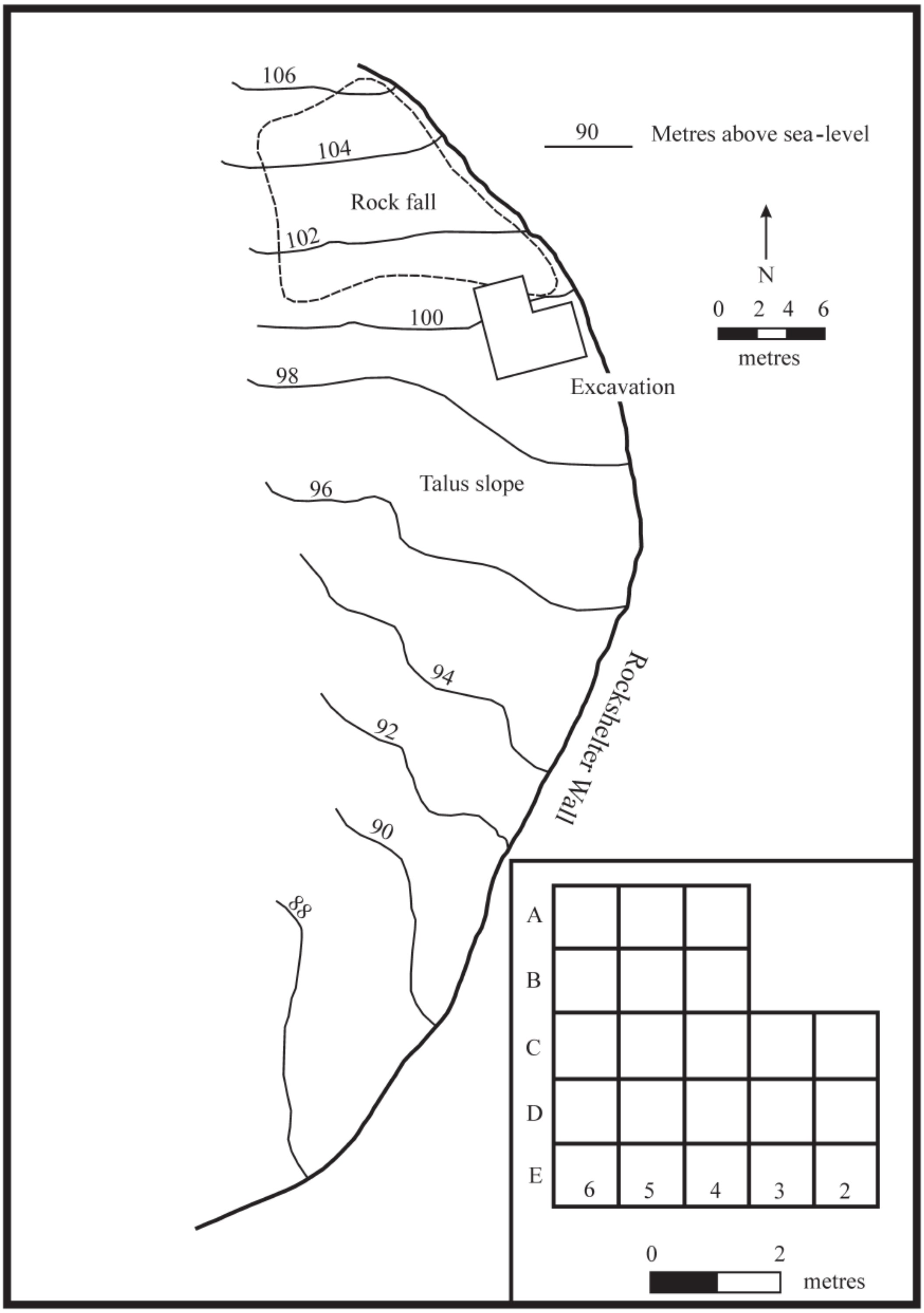


Figure 74: Sibudu site plan

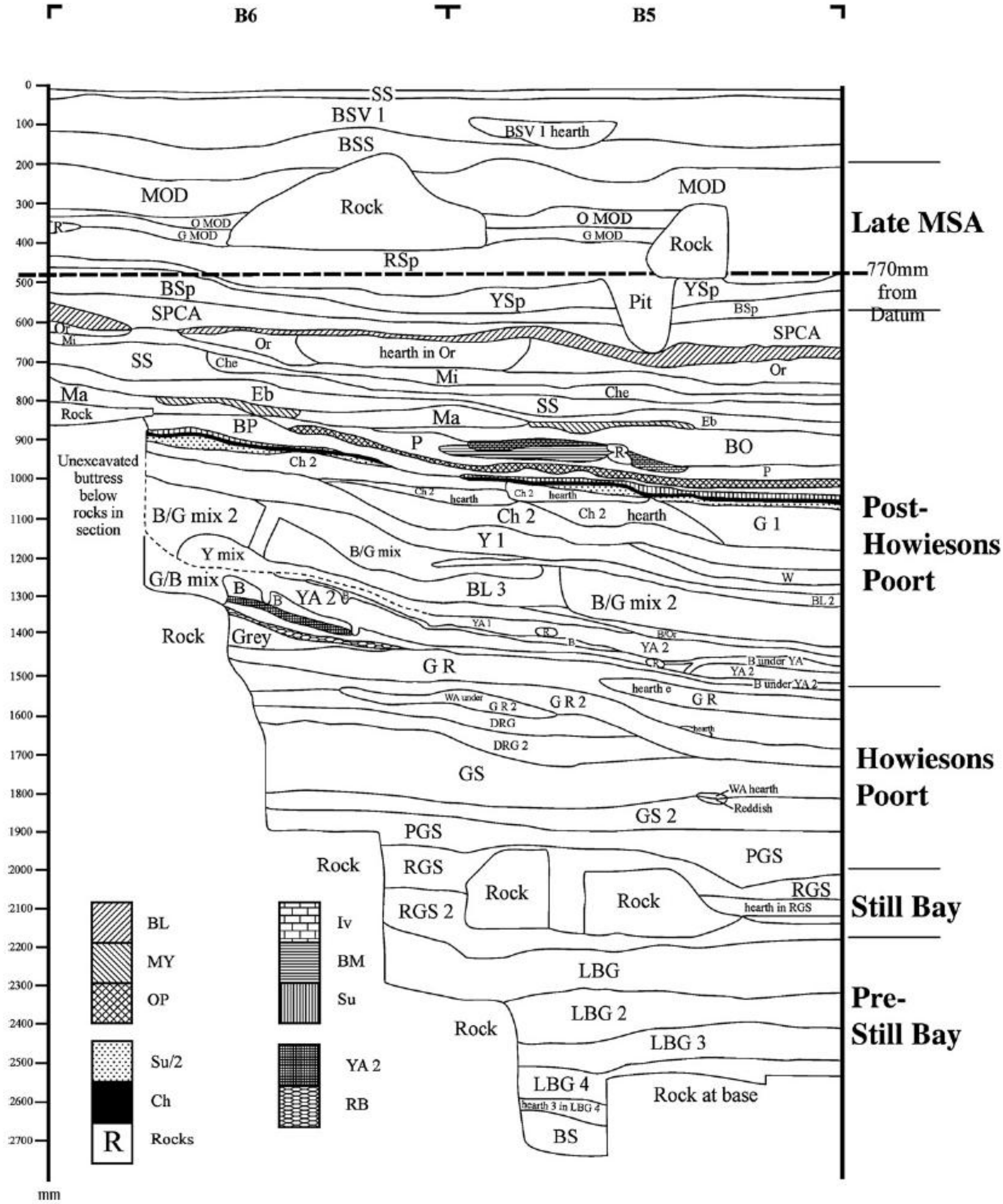


Figure 75: Sibudu Stratigraphic Section B6/B5

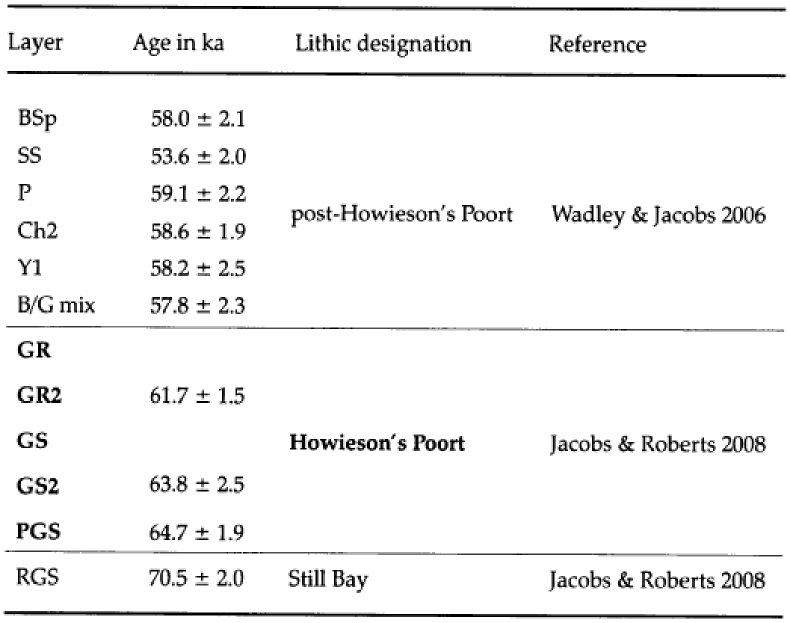
Lithics from these deposits have been extensively analysed (Cochrane 2006; Cochrane 2008; Delagnes et al. 2006; Lombard 2006a; 2006b; 2008a; Lombard and Phillipson 2010; Lombard 2011; Wadley 2005; Wadley 2007b; Wadley 2008; Wadley and Mohapi 2008; Williamson 2005) and despite the limited area of excavation in the rock-shelter, provide a strong database. The faunal assemblages have also been well documented (Plug 2004; Clark and Plug 2008) including microfauna (Glenny 2006) and bird remains (Plug and Clark 2008) among others. A range of investigations have also targeted environmental reconstruction at different points throughout the extensive occupational history of the shelter, although not all of these have focussed on the Howieson's Poort deposits (Allott 2005; Allott 2006; Glenny 2006; Reynolds 2006; Sievers 2006; Wadley 2004; Wells 2006). A reflective synopsis of the significance of these and other projects for interpretations of life at the site has also been published by Lyn Wadley (2006).

6.1.2 **Stratigraphy**

The stratigraphic sequence at Sibudu spans from pre-Still Bay through to final MSA. It is one of only a few sites where Still Bay and Howieson's Poort deposits are stratified with one another at the same site. Although by 2008 excavations had extended to include material from squares C5 and C6 (Wadley 2008), the main stratigraphic reference sequence remains that of B5 and B6 detailed by Wadley and Jacobs and located in the northern sector of the excavation grid (2006). Figure 75 shows broad chrono-cultural phases as delineated archaeologically in the stratigraphic sequence by Jacobs et al. (2008). Individual level names serve as abbreviations for their basic descriptions, detailed in Wadley and Jacobs (2006). The Howieson's Poort pertains to levels GR (Grey Rocky), GR2 (an artificial split to GR), GS (Grey Sand), GS2 (an artificial split to GS) and PGS (Pinkish Grey Sand). These levels directly overlay RGS (Reddish Grey Sand) and RGS2 (an artificial split to RGS) identified as Still Bay deposits (Figure 75). Levels identified as artificial splits serve to divide the material of the site at this antiquity into more manageable units. As well as several hearth deposits, levels WA, DRG (Dark Reddish Grey) and DRG2 are also sandwiched within the Howieson's Poort chronology. Although DRG is noted as being an undated small lens of loose silt with small rock spalls, DRG2 and WA are not described (Wadley and Jacobs 2006, 10). Following the convention established at the site, it might be assumed that DRG2 refers to an artificial division of DRG on the grounds that the deposit is over 10cm deep (despite also being noted as a small lens), and WA most likely refers to a deposit of White Ash, as described elsewhere higher in the sequence (Wadley and Jacobs 2004; 2006) and in accordance with a tiny level labelled as "WA hearth" between GS and GS2 in grid square B5 (Figure 75).

6.1.3 Dating

Both radiocarbon and OSL dating methods have been employed at Sibudu, with the former proving the more accurate and reliable of the two methods, as experienced with attempts at providing chronologies for other sites of MSA antiquity (Wadley and Jacobs 2004, 146). Much of the archaeological sequence is beyond the effective limit of the radiocarbon curve. Consequently, only OSL estimations have been provided for the Howieson's Poort at Sibudu. Dates for this phase were not announced until 2008 (Jacobs et al. 2008; Jacobs and Roberts 2008; Wadley 2008), although dates acquired from deposits in the overlying sequence strongly suggested a conventional approximation of older than 60kya (Wadley and Jacobs 2006). Likewise, prior to obtaining actual dates directly from the Still Bay levels, it was possible to provide a rough *terminus post quem* for their deposition at around 70kya (Wadley 2007b). Both of these estimates have been confirmed by the extension of dating efforts at the site presented below in Figure 76.



Layer	Age in ka	Lithic designation	Reference
BSp	58.0 ± 2.1	post-Howieson's Poort	Wadley & Jacobs 2006
SS	53.6 ± 2.0		
P	59.1 ± 2.2		
Ch2	58.6 ± 1.9		
Y1	58.2 ± 2.5		
B/G mix	57.8 ± 2.3		
GR		**Howieson's Poort**	Jacobs & Roberts 2008
GR2	61.7 ± 1.5		
GS			
GS2	63.8 ± 2.5		
PGS	64.7 ± 1.9		
RGS	70.5 ± 2.0	Still Bay	Jacobs & Roberts 2008

Figure 76: Sibudu OSL Dates (Wadley 2008)

Prior to obtaining dates for these phases, it was already possible to assess the generalised overall occupational history of the site from those acquired from the overlying sequence. The site has been characterised by relatively short and punctuated occupations separated by long hiatuses (Wadley and Jacobs 2006). This interpretation is supported by the clustering of dates at around 60, 50 and 37kya. These suspected hiatuses are not geologically delineable events, but this has been suggested as perhaps due to wind preventing the accumulation of sediment during periods of non-occupation (Wadley and Jacobs 2006, 14).

6.2 Lithics

Several lithic analyses have been conducted on stone tools from Sibudu focussing on particular aspects of the assemblages. Basic quantification of the Howieson's Poort lithic assemblages recovered from B5 and B6, excluding debitage from level PGS, which was not ready for analysis at the time, was published by Delagnes et al. (2006). This study does not provide a comprehensive breakdown of the assemblages however, and much of their analysis focuses in particular on the quartz pieces from level GS which, at the time, had provided the most backed quartz pieces (Delagnes et al. 2006, 43). Advancement in post-excavation has allowed later studies to incorporate material from squares C5 and C6 into their analyses, with level PGS now recognised as having thus far yielded the largest quantity of backed quartz pieces (Wadley and Mohapi 2008; Wadley 2008). The report by Delagnes et al. (2006) remains the most detailed published account of the assemblages overall though, with other projects focussing almost exclusively on backed crescent segments. Lithics from the as yet undated (Wadley 2008) lens levels DRG and DRG2, if indeed there are any, are yet to be described. The section below summarises the main findings of the work published thus far on the Howieson's Poort assemblages from Sibudu, themed according to the main avenues of inquiry that have been pursued: the pertinent findings of the initial report (Delagnes et al. 2006), the key findings of research into the morphometric attributes of the backed pieces (Wadley and Mohapi 2008), and the key findings of the various use-wear investigations that have been conducted (most notably Lombard and Pargeter 2008; Lombard 2006b; 2008a; 2011). Another section, focussing on further extrapolation from the basic raw material data information provided in the initial report (Delagnes et al. 2006) is also included.

6.2.1 **Preliminary Assessment**

The initial account of the Howieson's Poort lithic assemblages from Sibudu was provided by Delagnes et al. (2006). Although this study focussed primarily on backed quartz pieces from level GS, it also serves as the most generalised overview of the basic material quantification from this phase of the site. Among the more notable findings of their report for my own investigation are those summarised below.

Debitage

Layer	Crystal Quartz	Milky Quartz	Hornfels	Dolerite	Indeterminate	Total
GR	8	45	153	426	22	654
GR2	17	44	176	422	13	672
GS	44	53	177	274	18	566
GS2	0	2	37	42	1	82

Formal Tools

Layer	Crystal Quartz	Milky Quartz	Hornfels	Dolerite	Indeterminate	Total
GR	0	1	11	7	0	19
GR2	0	2	20	15	3	40
GS	8	1	19	3	3	34
GS2	0	2	15	4	1	22
PGS	5	1	28	9	0	43

Backed Pieces

Layer	Crystal Quartz	Milky Quartz	Hornfels	Dolerite	Indeterminate	Total
GR	0	0	8	5	0	13
GR2	0	1	13	10	0	24
GS	8	1	11	3	2	25
GS2	0	2	14	3	0	19
PGS	5	1	21	6	0	33

🟨 = Different to originally recorded value (Delagnes et al. 2006)

Table 22: Sibudu Raw Materials: Debitage, Formal Tools & Backed Pieces

The Howieson's Poort at Sibudu is blade-rich with a high quantity of segments and other backed tools (Wadley 2008, 123). Table 22 shows quantities of debitage, formal tools and backed pieces (a subcategory of formal tools) as recorded by Delagnes et al. (2006) from squares B5 and B6. The debitage totals coloured yellow differ with those initially recorded by Delagnes et al., seemingly due to miscalculation on the part of the original analysts. Backed pieces are manufactured on blades, while other formal tools comprise almost exclusively of non-normalised retouched flakes (Delagnes et al. 2006, 45). This perhaps explains the lack of further classification attempted for the assemblages.

6.2.2 **Blades or Bladelets?**

Delagnes et al. 2006 describe blades from GS according to their length, with mean estimates for dolerite, hornfels and quartz provided below (Table 23).

Raw Materials	Mean Blade Length (mm)
Dolerite	30.8 ± 9.9
Hornfels	29.1 ± 8.9
Quartz	16.8 ± 4.5

Table 23: Mean Blade Length

It is clear that quartz was used for the production of smaller blades, and this relates to restrictions inherent in the dimensions of the original material (Delagnes et al. 2006, 46). The relatively large standard deviations, at least for pieces made of dolerite and hornfels, creates a unimodal distribution in size, i.e. there is no clear cut off point for two distinct populations. This, combined with the fact that they all appear to have been produced by the same manufacturing process, leads Delagnes et al. to refrain from classifying bladelets as a separate category (2006, 46), as was also the case made at Klasies River (Wurz 1999, 42). In line with the argument I made regarding Klasies River, our inability to separate two populations based upon size does not preclude the presence of what, under most classificatory criteria, would be recognised as bladelets. Furthermore, although width measurements are not provided, with a maximum length of around 40mm, I would suggest that the vast majority of what Delagnes et al. refer to as blades could be reclassified as bladelets according to the parameters of this investigation.

6.2.3 **Segments**

When used more generally, or not specifically in relation to Klasies River where the term was given a separate meaning by Singer and Wymer, segment is often used to refer to the classic HP geometric backed pieces. Regarding the segments, it is noted that crescents, trapezes and various intermediary forms are made from each of the raw materials. Not all the pieces classed as segments are backed, and the mean length of quartz segments (13.3 ± 3.6mm) is notably smaller than that of hornfels and dolerite (a single value of 35 ± 12.2mm) provided (Delagnes et al. 2006, 48). The proportion of quartz segments at Sibudu is higher than that recorded at Klasies in levels PGS, GS2 and GS but not GR2 and GR (2006, 47). As with the "blades" discussed above, quartz segments are notably smaller in size (Figure 77). Those pieces that are backed (not exclusively segments) are presented as a percentage of the formal tool population (Table 24).

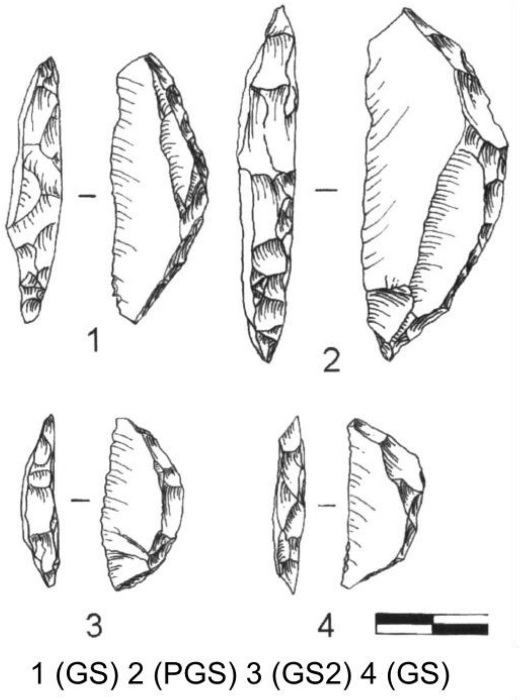


Figure 77: HP Backed Crescent Pieces from Sibudu

Phase	% Formal Tools
GR	68
GR2	60
GS	74
GS2	86
PGS	77

Table 24: Sibudu HP backed pieces as a % of formal tools

6.2.4 **Raw Materials**

In their basic quantification of the Howieson's Poort assemblages, Delagnes et al. (2006) provide some information regarding raw material use across the categories of debitage, formal tools and, within the category of formal tools, backed pieces. Comparison of trends within these categories allows us to make further inferences regarding raw material use at the site throughout this period.

The main lithic materials used during the Howieson's Poort at Sibudu, as already mentioned, are the coarse-grained igneous rock Dolerite and the finer-grained Hornfels and Quartz. Dolerite occurs in the immediate vicinity of the site and outcrops for both Hornfels and Quartz have been noted within approximately 20km of the site with the possibility of closer sources concealed by dune formation (Delagnes et al. 2006, 44). Examples of all three types from level GS show that river cobbles were a source of lithic raw materials as well as geological outcrops (Ibid 2006). Following this assessment, the three materials used during the Howieson's Poort can all be regarded as locally occurring (Wadley 2008, 124). Quartz has garnered the most interest of all the materials (Delagnes et al. 2006; Wadley and Mohapi 2008; Lombard 2011).

The quartz tools recovered at the site can be divided in to one of two descriptive categories: milky quartz and crystal quartz. Crystal quartz lacks the conchoidal fracturing properties associated with most other hard rocks, rendering its breakage unpredictable but producing smoother and sharper edges than most other hard rocks (Delagnes et al. 2006, 44). Curiously, milky quartz is not distinguished in Wadley's analysis; only crystal quartz is discussed (Wadley 2008, 123). Both types are found from the same sources as evidenced by adjoining pieces of milky and crystal quartz. It is unclear how much the fracturing properties of milky quartz differs though the specific reference to crystal quartz by Wadley perhaps suggests that milky quartz is more conducive to conventional breakage patterns. In her discussion of the properties of quartz, Wadley notes that the edges neither become blunt nor require sharpening (Wadley 2008, 123), surely an important trait for the consideration of any prospective knapper. It has been noted that the smoothness and sharpness of crystal quartz is greater than that of milky quartz (Delagnes et al. 2006, 54). By contrast, knapping experiments conducted on locally occurring dolerite and hornfels has shown the former to require a high degree of impact force, limiting the amount of control that can be effectively exercised, while hornfels is more brittle and allows greater control (Cochrane 2006, 74).

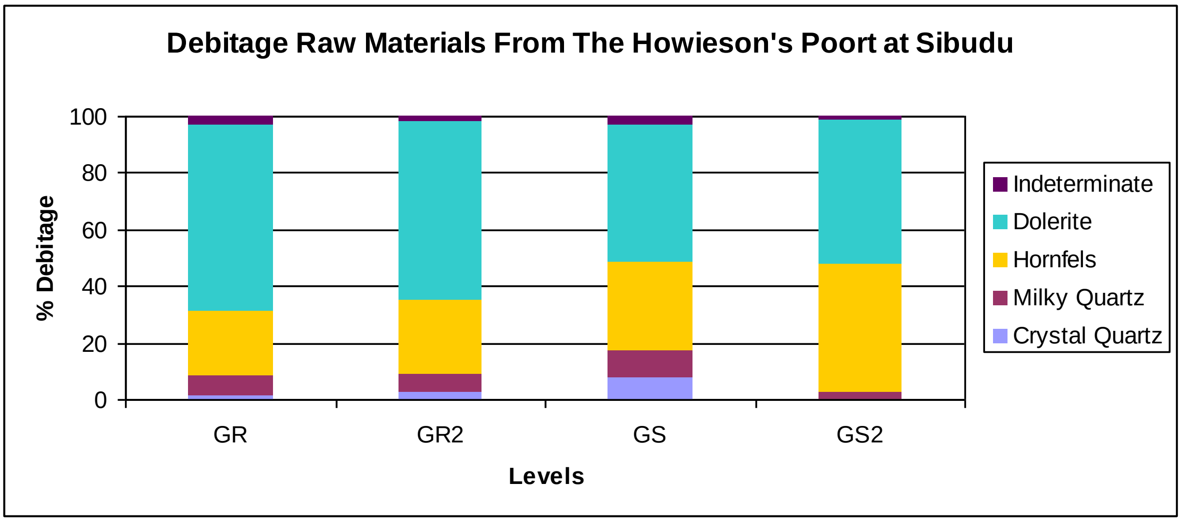


Figure 78: Graph showing debitage raw materials throughout the HP at Sibudu

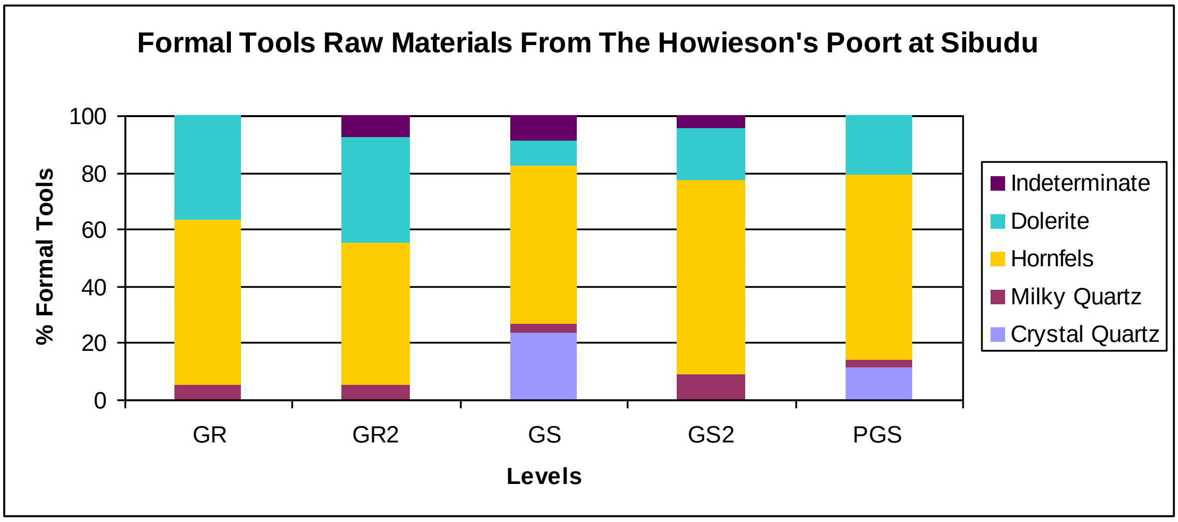


Figure 79: Graph showing formal tool raw materials throughout the HP at Sibudu

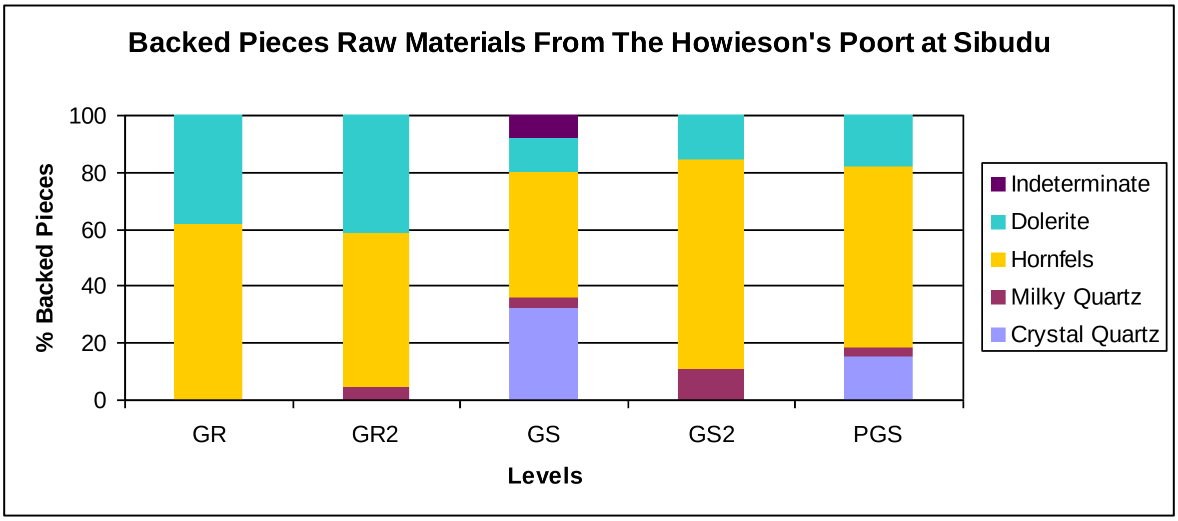


Figure 80: Graph showing backed pieces raw material use throughout the HP at Sibudu

Figure 78, Figure 79 and Figure 80 are derived from values (Table 22) calculated from data provided by Delagnes et al. (2006) and show raw material representation in debitage, formal tools and backed pieces as a sub-category of formal tools. The total number of debitage pieces from levels GR2 and GS given by Delagnes et al. (2006, 45) have both been corrected from 671 and 565 to 672 and 566 respectively (Table 22) based on the assumption that the values for each level were recorded correctly. Dolerite accounts for the majority of debitage in each Howieson's Poort level (never less than 48%), followed by Hornfels (never more than 46%), and with the two quartzes never accounting for more than 18% (Figure 78). For formal tools however, hornfels is by far the dominant material, never accounting for less than 50%. Dolerite is the second most dominant material in all levels apart from GS, where it is surpassed by Crystal Quartz and is represented in equivalent amounts to rocks of indeterminate nature. The percentage of dolerite in levels GR and GR2 (36-38%) is much higher than in levels GS, GS2 and PGS (8-21%). Although there is a higher quantity of dolerite debitage in levels GR and GR2, the contrast is not nearly so great (Figure 79). The notably higher (>20%) proportional quantity of crystal quartz in GS is also reflected more moderately in the debitage assemblage (Figure 78), but amplified in the ratio of backed pieces (Figure 80). Broadly speaking, the trends in backed pieces (Figure 80) reflect those shown in the formal tool category (Figure 79). This is because they always account for a dominant portion of formal tools in each level (never less than 60%) (Table 24).

Several broad trends across time can be identified. Overall, hornfels remains the clearly dominant material in formal tools and backed pieces, and comfortably the second most dominant material in the debitage assemblages. Dolerite, dominates debitage assemblages throughout the Howieson's Poort, and is the second most dominant material for formal tools and backed pieces in every level except GS where it is third. Dolerite increases in importance in GR2 and GR. Although this trend is only slight in the debitage assemblages, the contrast is greater in formal tools and backed pieces. Milky quartz remains consistently low throughout all assemblages, and is completely absent from backed pieces in GR. Crystal Quartz, on the other hand, is a notable component of formal tools and backed pieces in PGS and more so in GS, but absent from these assemblage groups in other levels. Representation of crystal quartz also increases in the debitage assemblage of GS, perhaps reflecting the higher instances with which it was recorded in formal tools and backed pieces from this level. It remains relatively small in quantity however and both Dolerite and Hornfels seem even less reflective of trends in material use apparent in the manufacture of formal tools at this time (Figure 79).

6.2.5 **Tip Cross Section Area (TCSA) and Metric Analyses**

Seeking to expand upon the findings suggested by the preliminary report by Delagnes et al. (2006), and compliment the contemporary and ongoing work of Marlize Lombard (2006b; 2008a; 2011), Wadley and Mohapi provided a more detailed record of the metric attributes of backed crescent segments (Wadley and Mohapi 2008). In their analysis, they use TCSA (tip cross-sectional area) measurements to compare the Sibudu pieces to North American projectile armatures, as recorded by Shott (1997). They found there to be three discrete populations within the crescent segment type based upon size, and seemingly influenced by raw material selection (Wadley and Mohapi 2008). They also noted a trend over time in the material and size of the pieces which is discussed below in the raw material section. Finally, they observed similar TCSA values between quartz segments and arrowheads from their North American analogue population, believing their apparently standardised shape, in conjunction with residue analyses (Lombard 2006b), to indicate transverse hafting in the majority of cases. The standardised shape of the quartz segments is taken to infer a lack of recycling or re-sharpening (Wadley and Mohapi 2008, 2600), a proposition supported by the fracturing properties recorded for the material (Wadley 2008, 124). Segments of Hornfels and Dolerite are suggested as having been hafted differently and with a closer affinity in size (respectively) to dart tips and spear heads (Wadley and Mohapi 2008, 2603).

6.2.6 **Residue and Use-Wear Analyses**

Marlize Lombard has, among others, subjected a range of artefacts from the Sibudu sequence to micro-residue analysis (Lombard 2004; 2005a; 2005b; 2006a; 2006b; Williamson 2005). Similar analyses have been conducted on tools from other sites including Klasies River (Wurz and Lombard 2007), Rose Cottage (Gibson, Wadley, and Williamson 2004), Umhlatuzana (Lombard 2007) and most recently, Diepkloof (Charrié-Duhaut et al. 2013). They have proved particularly effective at Sibudu because of the excellent organic preservation conditions associated with much of the site's sequence. These assemblages remain the most extensively studied using this methodology (Lombard and Wadley 2009), with 53 backed segments examined for residue traces (Lombard 2008a). A further 16 quartz segments from Sibudu have been subjected to combined residue and use-wear analysis (Lombard 2011).

6.2.6.1 Residue Analyses

Of the 53 backed crescent segments subjected to micro-residue analysis, 11 were from GR and GR2, 20 from GS and GS2, and 20 from PGS. The other two segments are not from Howieson's Poort deposits, with one from immediately overlying level YA2 and the other from preceding Still Bay deposit RGS (Lombard 2008a, 31). Not all the data recorded in Lombard's results table (Lombard 2008a, 32 Table 2) enumerate correctly (Table 25), but the trends show that animal processing, while not exclusive, is by far the best represented activity, particularly in GS, GS2 and PGS. Traces of ochre and resin, likely used as adhesive mastic, were shown to be concentrated on the backed portions of most segments (Lombard 2006b, 64). The distribution of the identified residues on individual segments helped inform estimations of hafting position. Although distinguishing the full variety of suggested hafting possibilities is problematic, the results suggested change in preference over time, with transverse or longitudinal variants preferred in PGS, diagonal formats in GS and GS2, and an equal difference between the two preferences in GR and GR2 (Table 25) (Lombard 2008a, 33). Finally, Lombard was able to infer a chronological trend in the hafting materials, which appear to be predominantly bone in PGS, and wood in GR and GR2 with a mix of both hafting materials in intermediary levels GS and GS2 (Table 25) (Lombard 2008a, 32). It should be noted however, that some of the segments bear no traces of hafting, and that in many other cases the hafting material was indiscernible, potentially weakening the trend described for PGS and in GS and GS2.

Deposit	OSL Dates (kya) (Jacobs & Roberts 2006)	Hafting Material %				Hafting Angle %			Insets Used In Composite Hunting Tools (%)
		Wood	Bone	Uncertain	Unhafted	Longitudinal or Transverse	Diagonal	Uncertain	
GR		54.5	0	27	9	45.5	45.5	0	63.5
GR2	61.7 ± 1.5								
GS		15	10	60	20	25	50	20	85
GS2	63.8 ± 2.5								
PGS	64.7 ± 1.9	0	50	40	10	50	30	10	75

Table 25: Results of Analysis (Lombard 2008a) for tests on segment hafting materials and angle from Sibudu

6.2.6.2 Use-Wear Analyses

Complementary to the studies of micro-residue traces, use-wear analyses have also been conducted that further support the notion of Howieson's Poort segments having been hafted as inserts in hunting weaponry (Lombard and Pargeter 2008; Lombard and Phillipson 2010a; Lombard 2011). From a sample of 132 pieces, 22% exhibited what are recognised as diagnostic impact fractures, a value similar to that observed at Klasies and Umhlatuzana (Lombard and Pargeter 2008, 2528). The frequency of diagnostic impact fractures recorded in these Howieson's Poort assemblages is around half of that (40%) recorded in Pargeter's experimental assemblage (n = 30). This possibly results from the fact that each of Pargeter's experimental sample was shot into carcasses multiple times (x ≤ 10) into the ribcage, thus increasing the likelihood with which stress fractures may have occurred.

Figure 81: Sibudu Notched Segment

Lombard and Pargeter acknowledge that use as weapon tips is just one possibility for the use of these segments, albeit generally the favoured theory (Lombard and Pargeter 2008, 2527). The difference in the representation of diagnostic impact fractures may be indicative that HP segments had a more catholic use, that they may not have been used as intensively (repeatedly), or that the parameters of the delivery mechanism used by Pargeter differ notably with those used by Howieson's Poort hunters. Results from Lombard and Pargeter's initial investigation formed the basis for their interpretation of notching, which occurs along the cutting edge of segments from various Howieson's Poort assemblages (Figure 81), and is suggested as resulting from impact damage in cases where it has not been deliberately retouched (Lombard and Pargeter 2008, 2528). Following on from these earlier analyses (Lombard 2006a; Lombard 2008; Lombard and Pargeter 2008), and the suggestions derived from studies of metrical attributes (Delagnes et al. 2006; Wadley and Mohapi 2008; Wadley 2008), subsequent investigations have focussed specifically on smaller quartz segments hypothesised as having potentially served as arrowheads (Lombard and Phillipson 2010a; Lombard 2011).

Most recently, Lombard has published the results of a sample of 16 freshly excavated quartz segments, subjected to both residue and use-wear analyses. In particular, she sought to investigate evidence of impact damage and traces indicative of having been transversely hafted in accordance with the hypothesis that these particular segments functioned as arrow tips (Lombard 2011). Nine of the backed quartz tools appear to have been hafted in this manner. Eight of these nine specimens show evidence of scars and striations associated with impact damage from this method of hafting as documented in hunting experiments (Lombard & Pargeter 2008). Eight also bore traces of animal residue, but not the exact same eight that exhibit impact scars. The sample size is too small to derive any informative diachronic trends from the study, although the results of Lombard's analysis further supports a trend from earlier investigations regarding a possible shift in the preferred hafting material from bone to plant between levels PGS and GS (2008a, 32; 2011, 1927).

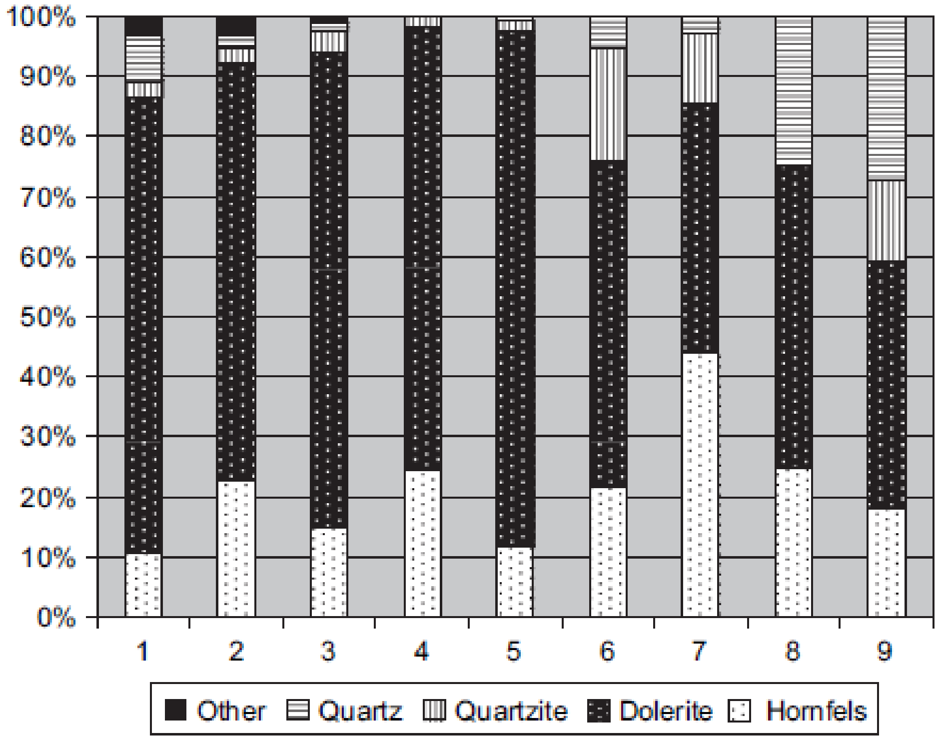
It is clear from these most recent investigations (Lombard and Phillipson 2010; Lombard 2011) and subsequent works (Lombard and Haidle 2012) that the notion of the bow and arrow as a delivery mechanism during the Howieson's Poort has gained favour in recent years. The results of these integrated analytical methods seem compelling, but a method for unequivocal distinction between propulsion mechanisms remains unknown (Lombard and Phillipson 2010b, 638; Cattelain 1997), and other Howieson's Poort researchers remain sceptical of the hypothesis (Villa and Roebroeks 2014; Villa et al. 2010, 640; Rots and Plisson 2014, 10; Igreja and Porraz 2013). It should be remembered that the study sample examined is small. The results interpreted as indicative of propulsion via bow and arrow delivery mechanisms only account for 56% of Lombard's most comprehensive investigation (2011). Although this may be a consequence of limitations with the analytical techniques used, it must be acknowledged that at this early stage in research, only a handful of pieces conform to the hypothesis, which itself only refers to a specific subset of Howieson's Poort segments as viable candidates, and belong to a single MSA site. Aside from the fact that the bow as a delivery method need not be the only means by which the results observed were generated, much data is necessary to strengthen this hypothesis.

6.2.7 Still Bay Lithics

Preceding the Howieson's Poort at Sibudu is a Still Bay deposit divided into two sub-units labelled RGS 1 and 2 (Reddish Grey Sand) and dated to 70.5kya (Jacobs et al. 2008). The date and stratigraphical relation of these deposits along with a lithic assemblage characterised by (mostly broken) bifacial points (n = 32) and very few (n = 4) backed pieces (one of which is a segment) confirms their designation as pertaining to the Still Bay (Wadley 2007b). A total of 11,552 pieces were recovered from these deposits, of which 75 are exhibit retouch. Table 26 below shows the frequencies of different tool types in these assemblages. Bifacially worked tools account for 47% of retouched tools, the majority of which are broken points (only 2 complete examples). Of the broken point fragments, distal elements are best represented, but proximal elements and other fragments are also well represented (Table 26).

	Number of Retouched Pieces	% Retouched Assemblage
Unifacial Point	2	2.7
Bifacial Point	2	2.7
Partly Bifacial Point	1	1.3
Broken Bifacial Point, proximal end	10	13.3
Broken Bifacial Point, distal end	14	18.7
Broken Bifacial Point, other piece	5	6.7
Bifacial Tool	2	2.7
Broken Bifacial Tool	1	1.3
Scraper	5	6.7
Notch	1	1.3
Scaled Piece	8	10.7
Broken Retouch	20	26.7
Backed Tool	3	4.0
Broken Backed Tool	1	1.3
Total	75	100.0

Table 26: Retouched Still Bay tools from Sibudu



Rock types used at Sibudu for: 1 = chunks, 2 = flakes, 3 = broken flakes, 4 = blades and bladelets, 5 = broken blades, 6 = points and point fragments, 7 = scrapers, 8 = backed tools, 9 = cores.

Figure 82: Graph to show raw material use according to lithic type from the Still Bay at Sibudu

Although the possibility of a Still Bay at Klasies River has been mooted, there remains insufficient evidence to certify anything archaeologically recognisable as such in the levels preceding the Howieson's Poort (Wurz 2000, 91). Following the recent dating efforts by Jacobs et al. (2008), the Still Bay is widely considered the last archaeologically visible period prior to the Howieson's Poort, and it is the diagnostic bifacial points that are generally considered to have functioned as components of hunting tools or alternatively perhaps as knives (McCall and Thomas 2012, 15) that are predominantly cited as type-fossils for the industry. Assessment of the points from Sibudu, largely informed from the results of preliminary residue analysis (Lombard 2006a) favour an interpretation of hunting (Wadley 2007b). The basal form of these points is either rounded or pointed, although in the case of the latter, this is not interpreted as evidence of having both been utilised (Wadley 2007b). It is believed that they may have been re-sharpened within their hafts (Lombard 2006a). Based on TCSA measurements, Wadley has likened their form (and from this their function), to that of thrusting spears (2007b, 686). The assemblage debitage is characterised as being flake oriented rather than blade based contra the Howieson's Poort assemblages.

Dolerite, quartzite, hornfels and quartz were all used during the Still Bay, with other rock types amalgamated. A diversity of these materials is represented, if at times minimally, across many of the different tool types (Figure 82). The assemblage size of the Still Bay deposits is relatively small, rendering it difficult to infer meaningful trends in raw material use. It is clear however, that dolerite dominates as the main material type for nearly every tool type (scrapers being the exception where hornfels is slightly better represented). In particular, it accounts for 70% or more of chunks, flakes, broken flakes, blades and bladelets, and broken blades, but between approximately 40 and 55% for points and point fragments, scrapers, backed tools and cores. Hornfels is the second most dominant material (except in scrapers as already mentioned) and generally accounts for between 10 and 25% of each tool type. Quartzite is represented in every tool type except backed pieces, and accounts for more than 10% of points, point fragments, scrapers and cores. Quartz features notably (25% +) in backed tools (although this tool type is small in number) and cores (total n = 22).

6.2.8 **Post-Howieson's Poort Lithics**

The 35 levels immediately overlying the Howieson's Poort are referred to as the "post-Howieson's Poort". Dates from layers deposited after the Howieson's Poort have a weighted mean age of 57,500 ± 1400 kya (Jacobs et al. 2008), but the seven levels immediately overlying the Howieson's Poort have not yielded dates. The youngest age of the HP is 61.7 ± 1.5 kya from GR2 (Wadley 2008), which grounds the theory that the seven undated levels (approximately 20cm thick in total) that represent the stratigraphically immediate post-Howieson's Poort likely do not represent a significant temporal lag (Cochrane 2008, 162). The first level following the Howieson's Poort to be dated is "B/G mix", with an age estimate of 58.2 ± 2.4 kya (Jacobs et al. 2008). Levels BuYA2 to G1 (Figure 83) comprise a phase of the sequence (approx 40cm thick) referred to as "post-HP MSA 2" (Cochrane 2008, 162; Clark and Plug 2008) which is considered to constitute the immediate post-Howieson's Poort. Two of these deposits, GuYA and BLBY1, are not clear in any stratigraphic matrix I have been able to find published, and are apparently not discussed in Wadley and Jacob's more comprehensive discussion of the site stratigraphy (2006). A "post-HP MSA 1" is also noted overlying the post-HP MSA 2 phase, comprising levels P1 (a discontinuous lens not shown in section) through to level BSp (Cochrane 2008, 162). The lithics from these and other later MSA deposits are among the best documented assemblages from the site (Cochrane 2006), and although investigators have refrained from labelling it as such, these levels appear to be at least approximately contemporaneous in age and stratigraphic location with the MSA III deposits as recorded at Klasies River (Feathers 2002; Jacobs et al. 2008).

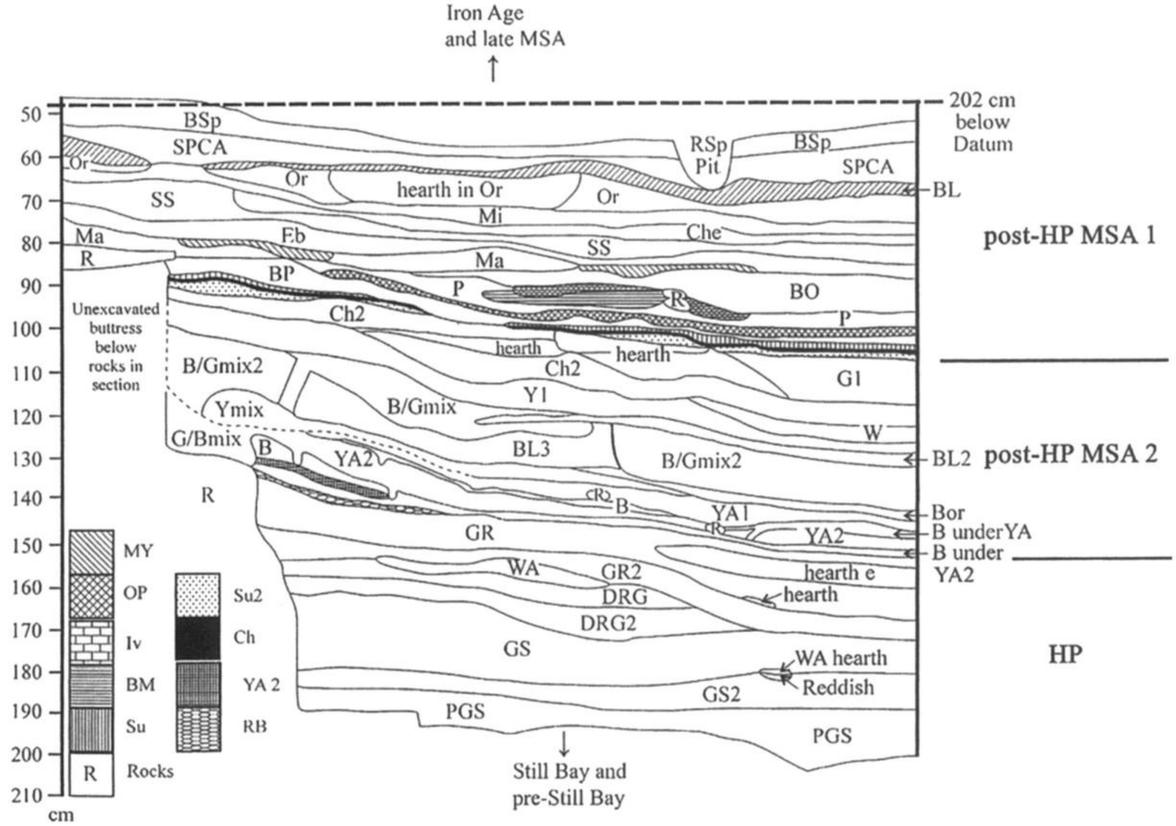
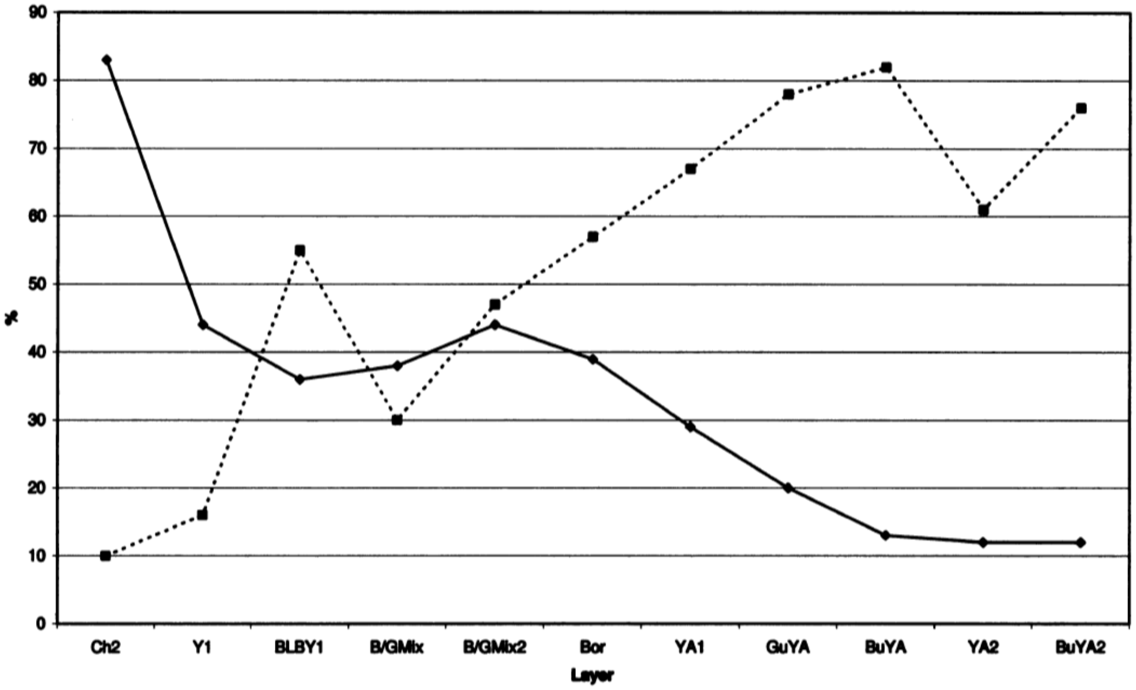


Figure 83: Stratigraphic section of Sibudu showing horizon between post-HP MSA 2 and 1

Lithics from the post-Howieson's Poort have been presented in aggregate because of the clustering of dates (Cochrane 2006) but perhaps also to negate small assemblage sizes from some of the smaller deposits within the sequence. Raw material frequencies for the assemblages (excluding pieces classified as chips) represent the only lithic data detailed at the resolution of individual deposits (Cochrane 2006).

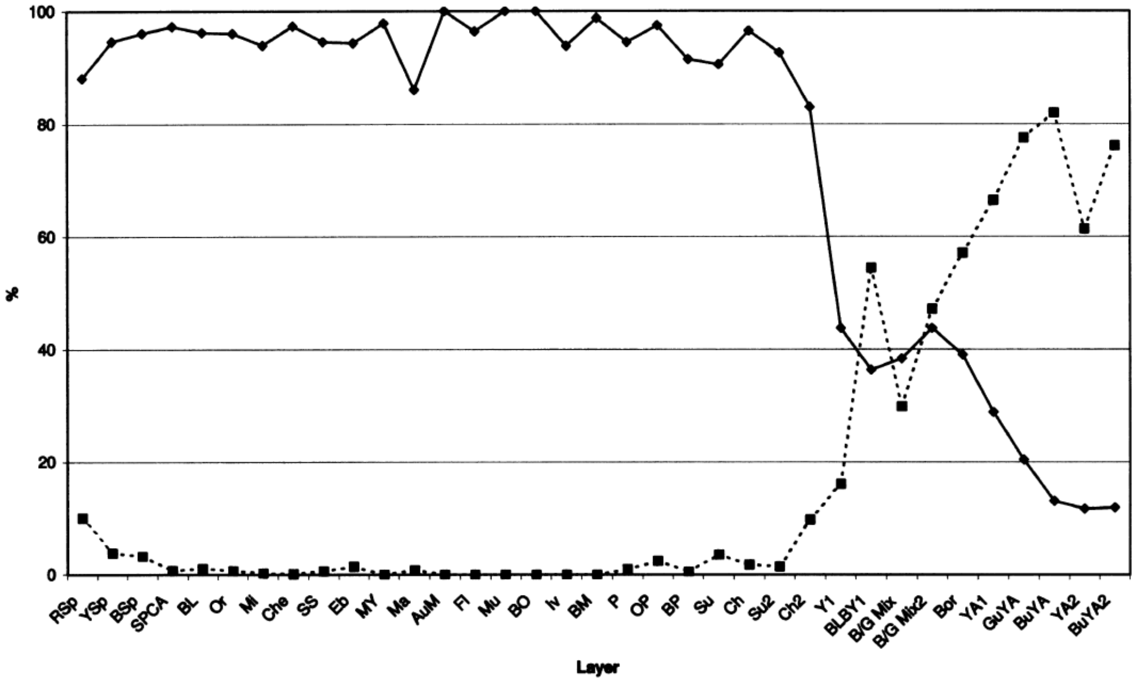
Otherwise, the only further partitions of this period are the sub-phases described above. While the assemblage structure of the Howieson's Poort is given per-stratigraphic level (5 delineated in total) it remains poorly detailed, whereas the assemblage structure of the post-Howieson's Poort is well detailed overall but presented in aggregate (35 levels delineated in total). Furthermore, the terminology used to describe the two phases varies, with the Howieson's Poort divided into debitage and formal tools, and the post-Howieson's Poort afforded a more fine-grained description according to retouch and form. This renders attempts to contrast the phases problematic leaving it best to refer directly to the descriptions provided by the site research team themselves (Wadley 2006; Cochrane 2006; Cochrane 2008).



Raw Materials as a percentage of artefacts (excluding chips) from Sibudu post-HP MSA2. Unbroken line = dolerite and hornfels. Dashed line = quartz and quartzite

Figure 84: Graph showing dolerite and hornfels in contrast to quartz and quartzite in the Post-HP MSA 2 of Sibudu (Cochrane 2008)

Within the post-HP MSA 2 phase, 3163 artefacts were excavated, of which only 12 (0.4%) were retouched. The only backed piece came from the deepest layer, although two backed pieces were also recovered from the retouched tool assemblage of overlying post-HP MSA 1 (Cochrane 2006). Blade and bladelet production continued but became a comparatively minor technological mode with flake production replacing it as the main manufacturing emphasis. Interestingly, dolerite and hornfels combined do not account for more than 15% of raw materials in the first three layers above the Howieson's Poort but increase after these levels, with quartz and quartzite corresponding in an approximately inverse trend (Figure 84). Despite being a potentially important component of Howieson's Poort (Lombard 2011), quartz does not account a large portion of these assemblages (Figure 85). In general, the trends established by the end of post-HP MSA 2 are consolidated in the ensuing post-HP MSA 1 (Cochrane 2008, 163). Retouched tools account for a negligible portion of the overall assemblage (1.33%) excluding chips, which is certainly less than the percentage of "formal tools" counted among Howieson's Poort assemblages. There is little standardisation in form, and they consist primarily of scrapers and unifacial points (Cochrane 2006), different to the bifacial forms that predominate in the pre-HP Still Bay assemblage.



Raw Materials as a percentage of artefacts at Sibudu from Post-HP MSA 1 and 2.
Unbroken line = hornfels and dolerite. Dashed line = quartz and quartzite.

Figure 85: Graph showing dolerite and hornfels in contrast to quartz and quartzite throughout Post-HP MSA 2 and 1 at Sibudu (Cochrane 2008)

6.2.9 <u>Overview of Lithics</u>

Although comprehensive data for the Sibudu lithics remains unpublished, research into the material and particularly the Howieson's Poort assemblages has been characterised by relatively newly developed investigative methods that had not previously been pursued to any great degree on other assemblages. In this sense alone, Sibudu can be regarded as a milestone in the development of our understanding of the Howieson's Poort phenomena (Barham and Mitchell 2008, 277–278). The integrated methods of Lombard's exploration of tool function has, in particular, forged the idea that certain elements of the Howieson's Poort (small quartz segments) served as arrow tips (Lombard 2011). Such conclusions support the earlier speculations of Singer and Wymer (1982, 209), and furthers research agendas concerning the cognitive capacity of the people behind the Howieson's Poort (Lombard and Haidle 2012). There is, as yet, no consensus on the use of the bow during this period however, and various hurdles remain before such an idea may become more universally accepted. Use of bow and arrow technology remains un-certifiable with current evidence.

While research into the Howieson's Poort material has allowed insight into the possibility of internal variation in the manufacture and use of classic backed Howieson's Poort segment pieces, analysis of assemblages from deposits prior to and overlying this phase reinforce typical contrasts made regarding the industry's precociousness in the grand trajectory of the MSA. There are few HP style backed pieces in the Still Bay, and even fewer in the post-Howieson's Poort. Data from all phases represented in the sequence are described as limited in nature having been sourced initially at least from the same two square metres. Faunal data from the Still Bay at Sibudu is not available, limiting the extent to which hunting behaviours from this period can be compared with the subsequent Howieson's Poort. Faunal and climatic data from the Howieson's Poort and post-Howieson's Poort facilitate further comparison however.

6.3 Worked Bone

Evidence of worked bone, although known from Still Bay deposits at sites elsewhere, has not been found from Still Bay contexts at Sibudu, nor has any been recovered from the post Howieson's Poort ~57 000 BP layers (Wadley 2007b; Cochrane 2008). While this leaves nothing of substance to comment upon, their absence archaeologically does not preclude the possibility of their use in these periods. Three worked bone artefacts have been recovered from Howieson's Poort deposits however, one of which is a (refitted) bone point tip that may have been used for hunting (Wadley 2008, 127). Only the point tip itself (about 5cm long) has been recovered so it is difficult to learn more about the artefact. It is described as comparable to bushman arrows (Ibid 2008, 127), although morphometric analyses show it to bear some similarities to the thinnest of Still Bay bone points found at Blombos, and a specimen from Peers Cave (Backwell et al. 2008, 1575). The uniqueness of these results may simply reflect the small database available for comparison, at least from deposits of an approximately contemporary age. It is believed that the tip most likely belonged to a bow and arrow system of weaponry (Wadley 2008; Backwell et al. 2008) in accordance with the Marlize Lombard's research, which purports the use of bone in the hafting of Howieson's Poort segments, albeit seemingly in only a small percentage of cases (Lombard 2008a, 31).

6.4 Faunal Data

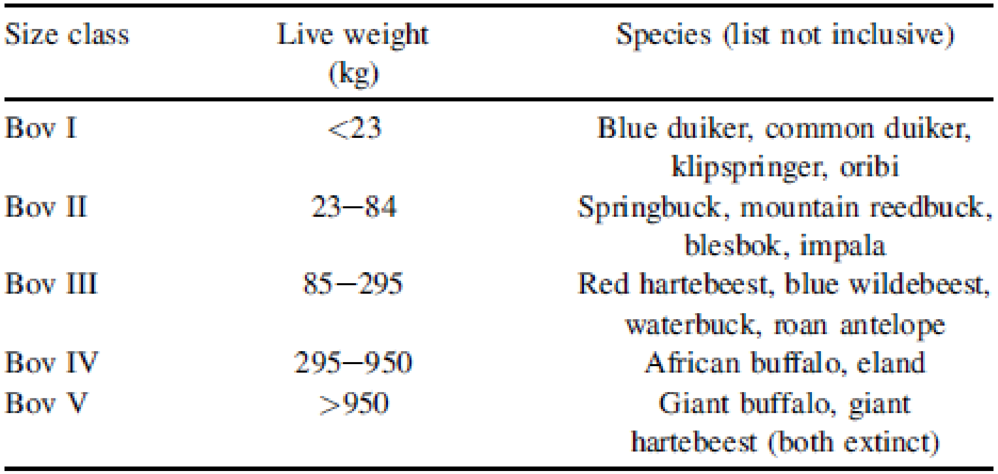
6.4.1 MSA Fauna

As established with assessments of other sites, microfaunal analyses can provide indications of climate and environment in addition to the information larger species offer regarding direct evidence of subsistence systems. Analysis of the microfauna at Sibudu was conducted by Glenny (2006) and is reviewed below. As well as this, studies have also been conducted focussing on avian fauna (Plug and Clark 2008) and aquatic prey along with other marine resources (Plug 2006). Excellent organic preservation makes Sibudu one of the most important sites for understanding MSA subsistence strategies since Klein's work (1976) at Klasies River. Clark and Plug's consideration of the post-HP fauna in conjunction with the HP fauna (2008) is referred to for the purposes of this study. Their study presents the most comprehensive and assessment of the fauna to date.

Faunal remains from the site are considered as an aggregate of depositional units corresponding to chronological phases of the site. The Howieson's Poort is treated as a single unit, and the post-Howieson's Poort is divided into two sub-phases, "post-HP MSA2" and post-"HP MSA1" as detailed earlier in the discussion of the lithics and advocated by Cochrane (Clark and Plug 2008; Cochrane 2008). This division of time precludes assessment of temporal variation within the Howieson's Poort, but facilitates a broader resolution of changes between the Howieson's Poort and within the post-Howieson's Poort. Although bone preservation is good in the Still Bay, no analysis from these levels has been published. A brief description suggests a prey spectrum very similar to that documented in the Howieson's Poort with blue duiker, bushpig and vervet monkey dominating along with other small creatures (Wadley 2007a, 682). The fact that the majority of remains come from a discrete area of 2m^2 renders means spatial patterning of activities cannot be precluded as a factor in the differential representation of some species across time (Clark and Plug 2008, 892).

Phase	NISP	NISP as % of Total Fragments	Unidentified Bone < 2cm	Unidentified Bone >2cm	Total Unidentified Bone	NISP as % of Remains (Identified and Unidentified) > 2cm	Total Fragments
HP	2408	2.25	99533	5055	104588	32.26	106996
Post HP MSA 2	322	0.58	51886	3610	55496	8.19	55818
Post HP MSA 1	542	0.83	57932	7176	65108	7.03	65650

Table 27: Faunal assemblage fragmentation at Sibudu



Size class	Live weight (kg)	Species (list not inclusive)
Bov I	<23	Blue duiker, common duiker, klipspringer, oribi
Bov II	23–84	Springbuck, mountain reedbuck, blesbok, impala
Bov III	85–295	Red hartebeest, blue wildebeest, waterbuck, roan antelope
Bov IV	295–950	African buffalo, eland
Bov V	>950	Giant buffalo, giant hartebeest (both extinct)

Table 28: Bovid size categories after Brain (1974)

Phase	NISP Total	Prey NISP	Prey (% of total NISP)	Bovid NISP (Total)	Bovids (% of total NISP)	Bovids (% of prey NISP)
HP	2408	2134	88.6	1893	78.6	88.7
Post HP MSA 2	322	312	96.9	261	81.1	83.7
Post HP MSA 1	542	526	97.0	458	84.5	87.1

Table 29: NISP Data for Sibudu faunal assemblage differentiating prey (ungulates) and bovids from other taxa

% Bovid NISP	Bov I	Bov II	Bov III	Bov IV / V
Post-HP MSA 1	5	22.5	56.3	16.2
Post-HP MSA 2	19.2	46.7	24.5	9.6
HP	60.5	25.1	12.3	2.1

Table 30: Size categories of bovids (% bovid NISP) at Sibudu

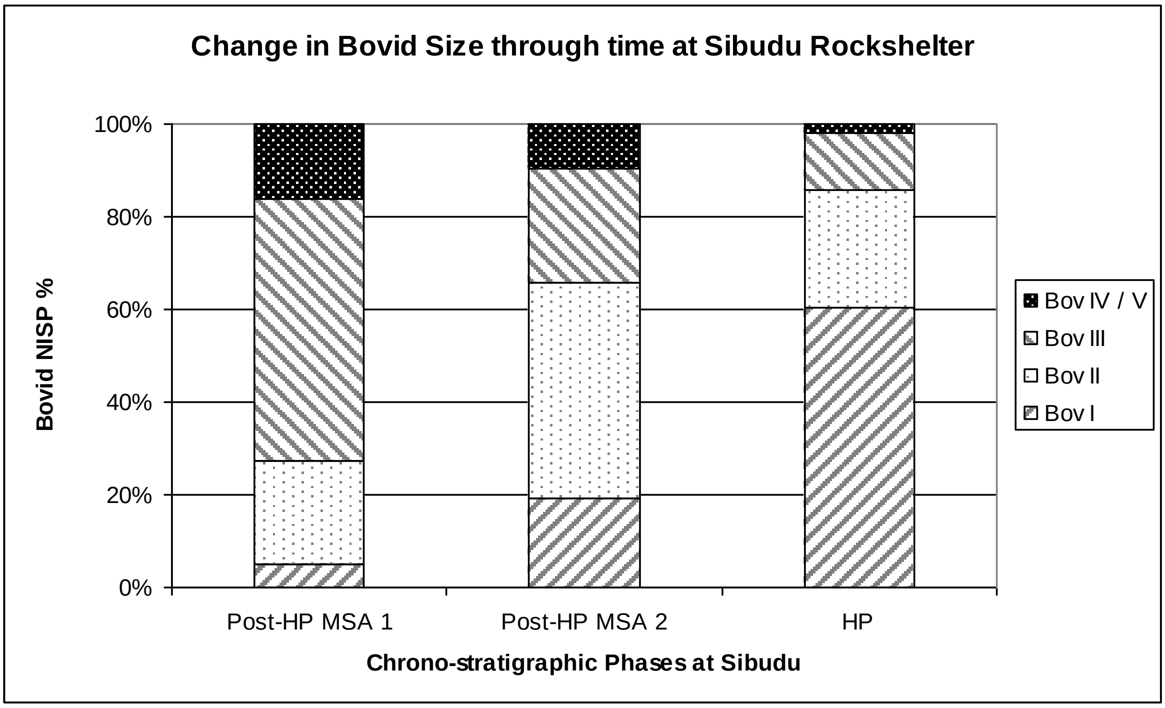


Figure 86: Graph showing change in bovid size over time at Sibudu

Humans are considered the main contributors responsible for the faunal remains recovered (Clark and Plug 2008, 892) but the assemblages are unfortunately highly fragmented (Clark and Plug 2008, 889). Table 27 shows the percentage of fragments that could be identified (NISP %) revealing the full extent of comminution at the site and showing that the post-HP material is more damaged than the HP assemblage. These conditions are favourable for the preservation of the diagnostic elements of smaller species such as the blue duiker (Clark and Plug 2008). The higher quantity of these and other smaller bovids in the Howieson’s Poort may be in some small part partially due to this difference (Table 27). As well as the high degree of fragmentation recorded, evidence of burning is recorded at high frequencies throughout the assemblages, particularly in the earliest post-HP MSA 2 (Clark and Plug 2008, 892).

A complete list of species recovered is provided by Clark and Plug (2008, 890–891), although only ungulate remains recovered from the site, regarded (numerically) as the main source of prey, are the main focus (Appendix 31). The high level of fragmentation further distorts the representativeness of MNI, and so NISP is used both here and by Clark and Plug in their analysis. The number of different species identified is too large to effectively present graphically. The vast majority of species account for less than 5% of the total NISP for each phase. Some specimens were designated cf. if taxonomic resemblance was apparent but could not be verified. Bovids account for the majority of ungulate remains at the site. Those that could not be assigned to individual species were categorised according to size following a modified version of Brain's method of classification (1974) summarised in Table 28. Some remains straddle these categories and are excluded from further analysis to avoid complication. Table 29 shows NISP values for total fauna, species designated as prey, and bovids. Figure 86 and Table 30 hows %NISP for different bovid size classes through time at Sibudu. Smaller bovids (class I) were the focus of hunting during the Howieson's Poort, with size class II becoming dominant in post-HP MSA 2 and bovid class III dominating in post-HP MSA 1. Size classes IV and V are amalgamated because of low representation. With the exception of amalgamated class IV/V, bovid remains that could not be assigned to a singular category were excluded from consideration as per Clark and Plug (2008, 893).

No other individual species is represented nearly as well as the blue duiker is in the Howieson's Poort where it is the best represented taxonomic designation within the entire sequence. The only other singular species accounting for more than 5% NISP is bushpig, also in the Howieson's Poort. Blue duiker accounts for the substantially higher proportion of bovid size I remains in the Howieson's Poort. When removed, the proportion of unidentified bovid remains of this size is relatively comparable with post-HP MSA 2. Given the high state of fragmentation in both these phases, it would seem that blue duiker were simply not such a main focus for hunting in post-HP MSA 2. Although the representation of bovid classes II and III are higher in the post-HP MSA 2 than the HP, it is specifically the blue duiker that comprises the majority by which smaller bovids feature in the Howieson's Poort. It must be remembered when comparing the HP with the post-HP MSA 2 that substantially fewer remains were identifiable to the species level, and that the overall NISP count for post-HP phases is significantly less than that recorded for the Howieson's Poort (Table 29).

Overall, across all phases, bovids overwhelmingly dominate, never accounting for less than 78% of the assemblages. Species considered to have been main sources of prey (all ungulates) account for only 88.6% of the overall HP assemblage, due to a higher frequency of monkeys (Vervet and Sykes), the Gambian giant rat, and rock hyrax. The higher frequency of these species in the Howieson’s Poort further supports interpretations of the local palaeoenvironment of the site being relatively closed and forested, and hunting practices as being targeted towards smaller fauna (Wadley 2006; Wadley 2008; Clark and Plug 2008; Glenny 2006). The low number of upper limb elements among class I bovids in the Howieson’s Poort has been interpreted as possible evidence of intense processing for marrow (Clark and Plug 2008, 895). The high proportion of lower limbs or feet throughout the sequence for bovids of all sizes throughout the sequence, cumulatively never less than 40% of skeletal elements (Clark and Plug 2008, 895), may suggest that much of the carcasses was generally returned to site. The lack of skull and horn elements from class IV/V bovids in the HP and post-HP MSA 2 have been suggested as potentially indicative of a larger ranging distance involved in their transportation back to site (Clark and Plug 2008, 895), but they are not substantially more scarce than those from bovids of other size classes. If the high frequencies of lower limb elements and feet are indicative of wholesale carcass transportation, then an alternative interpretation may pose that hunting ranges actually may not have covered an insurmountably long distance. Small sample sizes for certain anatomical units (most notably axial elements) and taxa, perhaps because of the high level of fragmentation among other reasons, inhibits more detailed quantitative analysis of skeletal representation (Clark and Plug 2008).

The presence of larger game in the assemblages suggests that hunters had, at times during the Howieson’s Poort, access to either open woodland or savanna environments where African buffalo, blue wildebeest and roan antelope were more likely available. In the post-HP MSA 2, the majority of species identified suggest a localised riverine forest habitat around the site, with access to more open landscapes again maintained, as evidenced by the rare presence of warthog and eland (Clark and Plug 2008, 893). The presence of species such as blue wildebeest, red wildebeest, giraffe and zebra suggests that post-HP MSA 1 was quite dry. This conflicts somewhat with the interpretation of the charcoal data from this phase (Allott 2006), with Clark and Plug suggesting that while a forest environment persisted around the vicinity of the site, prey sourcing may have reached further afield to more open areas (Clark and Plug 2008, 893). It is difficult to infer the surrounding palaeoenvironment from this data and know whether the faunal remains reflect changes in local habitats or logistical forays and movements. It seems unlikely that landscapes would have preserved unaltered through the stretch of time under consideration, but it has been suggested that the site was ideally situated near the convergence of several different ecological zones, much as it is today (Wadley and Jacobs 2004).

Throughout the Sibudu sequence, remains identified as juvenile account for less than 10% of the respective assemblages, suggesting that a focus towards prime-age adults prevailed throughout the sequence (Clark and Plug 2008, 896). Although the emphasis in Howieson's Poort hunting seems to have been directed towards smaller game, they were still able to take relatively dangerous species such as the nocturnal and aggressive bushpig, or the African Buffalo rather than the eland (Clark and Plug 2008). The significance of smaller bovids in the Howieson's Poort for subsistence strategies may also relate to the recovery of many smaller mammals from the same deposits, absent from later phases. The possible contribution of raptors and other small carnivores for these smaller animals cannot be ruled out from contention although they are relatively poorly represented (Plug and Clark 2008, 138–140; Glenny 2006; Clark and Plug 2008). Although in the post-HP MSA 2 larger bovids feature more prominently, the majority of bovids are from this phase are still smaller than size class III, with post-HP MSA 1 showing a majority of bovids from size class III or larger. Comparison between the HP and post-HP MSA 1 affords the greatest contrast in procurement strategies. Clark and Plug interpret the changes in fauna over time as reflecting change in prevailing environmental conditions surrounding the site, and indeed indicator species generally (but by no means perfectly) correspond with changes recorded in charcoal data (2008, 897; Wadley 2006). A gradual transition is represented, seemingly at odds with the sharp departure from Howieson's Poort technology recorded by Cochrane with the inception of the post-HP MSA 2 (2008), from a predominantly closed evergreen forest to more open savanna like landscapes with but retaining some more densely vegetated woodland zones (Clark and Plug 2008, 897).

6.4.2 **Microfauna**

Microfaunal analysis at Sibudu (Glenny 2006) was conducted to derive information about prevailing environmental conditions during different occupation phases at the site that could be integrated with other data indicative of environmental conditions, such as seeds (Wadley 2004; Sievers 2006), charcoal (Allott 2004; 2005) and macrofaunal remains (Plug 2004; Reynolds 2006; Clark and Plug 2008). In the analysis, two MNI counts were conducted using different skeletal elements: one at the genus level (using post-cranial elements), and the other at species level (using cranial elements) (Glenny 2006). The species count proved the most informative regarding conditions of habitat preference, although comparison of the two counts shows the species count to be much less representative of abundance (Glenny 2006, 285). The MNI of different species was determined through the assessment of 259 cranial elements from the 29 levels delineated at the site, with thirteen different species identified (Glenny 2006, 282). An MNI total of 8 specimens were recorded from Howieson's Poort levels GR, GS, and GS2. The eight specimens comprised four different species. Information of their habitat preferences, along with those of the barn owl *Tyto alba*, also indirectly evidenced at the site, are provided below as documented by Glenny (2006).

<u>Gambian Giant Rat (*Cricetomys gambianus*)</u>: Prefers forests and forest scrub areas that receive >800mm rainfall per annum.

<u>Laminate Vlei Rat</u> (*Otomys laminatus*): Prefers grasslands, inhabiting sub-montane and coastal areas.

<u>Vlei Rat (*Otomys irroratus*):</u> Prefers grasslands in close proximity to streams and marshes.

<u>Geoffroy's Horseshoe Bat (*Rhinolophus clivosus*)</u>: Prefers woodlands but has a wide habitat tolerance. Roosts in caves and hollow trees.

<u>Barn Owl (*Tyto alba*)</u>: The majority of micromammalian remains at Sibudu were accumulated and deposited by birds of prey, most notably barn owls. While the barn owl is noted by Glenny as preferring to hunt in open habitats such as savanna adjacent to grasslands and low scrub, it is also acknowledged that they are a highly mobile species with relatively catholic tolerances. Although the barn owl is suggested as the most likely species responsible for the accumulation of micromammalian remains at

the site, two other raptors: the grass owl (*Tyto capensis*) and marsh owl (*Asio capensis*), cannot be ruled out as perpetrators.

With the exception of a few deposits (dating to around 37 and 50ka), Glenny refrained from attempting to derive interpretations of the environmental history of the site, deeming microfaunal remains too sparse throughout much of the sequence to allow reconstruction, even when considered in conjunction with other indicators (2006: 286). Furthermore, the presence of micromammalian remains is not continuous throughout the sequence. Periods of absence separate the aforementioned HP levels from other micromammalian yielding deposits, complicating any inference regarding temporal variation immediately prior to and after the Howieson's Poort. Prior to the HP, levels LBG2 and LBG are the only deposits to have yielded micromammalian remains. Levels MY and Or are the first to contain micromammalian remains following the HP. One Vlei Rat was found in LBG, a single Gambian Giant Rat in LBG2; one Laminate Vlei Rat along with 2 Natal Multimammate mice (*Mastomys natalensis*) were recovered from MY, and one Striped Mouse (*Rhabdomys pumilio*) and one Vlei Rat from Or.

The minimal and disparate nature of the database renders interpretation of the environmental history before and after the Howieson's Poort untenable. On one hand, the presence of Natal Multimammate Mouse in level MY, which was not recovered from Howieson's Poort or pre-HP levels, suggests that conditions were no longer arid (Glenny 2006, 283) as is sometimes associated with the Howieson's Poort. However, conversely, the Gambian Giant Rat, which is found exclusively in HP and pre-HP deposits, is a firm indicator of evergreen forest and woodland conditions, which along with Geoffroy's Horseshoe Bat, has allowed a broad impression of humid and moist conditions in layers older than 60kya (Wadley 2006, 328).

6.5 Other Palaeoenvironmental Indicators

6.5.1 Charcoal Analysis

The high degree of organic preservation at the site has meant that Sibudu is one of the first MSA sites in southern Africa where detailed charcoal analysis has been made possible (Allott 2004; Allott 2005). Although exact explanations for how charcoal comes to be a part of an archaeological deposit are rarely determinable, its presence is in this case predominantly a result of human activities (Allott 2006). Through comparison with modern plants, and assuming little change in habitat association and requirement over time, it is possible to infer climatic variability from changes in the taxa represented over time. Changes in abundance of charcoal can, however, relate to variation in deposition and preservation over time, as well as rates of fragmentation, and the frequency of taxa represented may be biased by selections for uses such as fuel, perhaps having been sought from further afield than the immediate vicinity of the site (Allott 2006). Due to the episodic nature of the occupation history at Sibudu, with clusters of dates within the sequence, environmental indications inferred from microscopic charcoal analysis pertain to four stages including the >60kya Howieson's Poort (levels GS, GR2 and GR) and ~60kya post-HP MSA 1 (Eb SPCA BSp). Data from the intermediary post-HP MSA 2 and preceding Still Bay was either insufficient for analysis or is yet to be presented. The Howieson's Poort levels are amalgamated, perhaps to conflate otherwise insufficiently small sample sizes.

The combination of taxa recorded from the Howieson's Poort is not known in South Africa today, but mostly suggests an evergreen forest prevailed at the time (Wadley 2006). In particular, the presence of *Podocarpus* (a genus of conifer) predicates a high level of moisture, as it is most commonly found today in environments with >900mm of rainfall per annum, though moisture may not come exclusively through precipitation (Allott 2006, 185). *Buxus* or boxwood may have been a common constituent of understorey vegetation (Ibid 2006, 185). Identified taxa do not solely indicate evergreen forest, however, with the occurrence of *Kirkia*, a subfamily of Sapindales, indicative of savanna woodland (Ibid 2006, 186) which may have been a nearby ecozone at the time. In general, the charcoal recovered from Howieson's Poort deposits indicates a warm and humid climate with the site located within a predominatly evergreen forest setting, largely supported by accompanying faunal and microfaunal indicators (Wadley 2006; Clark and Plug 2008; Glenny 2006). The presence of *Kirkia* suggests a warmer and drier climate than that of Sibudu today (Allott 2006, 186), but perhaps pertains to wood imported from further afar or from a temporal fluctuation in local climate. Even if conditions were generally warm and humid, conditions may have been cooler within a tall forest (Ibid 2006).

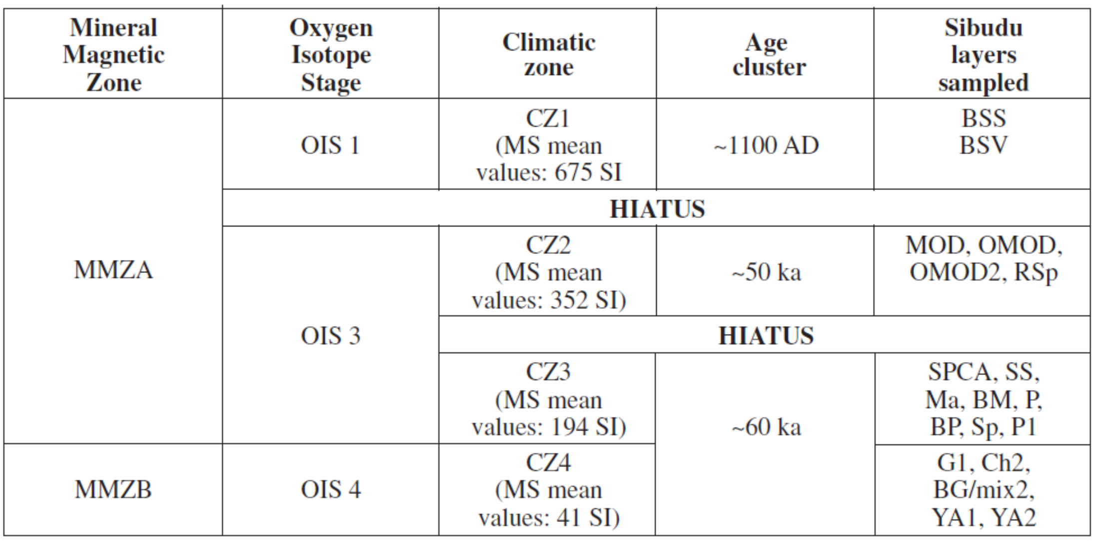
There is no data currently available from levels immediately preceding or overlying the Howieson's Poort, with faunal data offering the best source of inference, from which it has been suggested that the majority of identified species most likely inhabited riverine forest (Clark and Plug 2008, 893). Deposit Eb is the next level in the site sequence to have yielded charcoal data, with identified specimens suggestive of conflicting conditions (Allott 2006, 187–188). Whether this reflects conflated ecological fluctuation recorded within the deposition event, that the site was situated opportunely in an ecotone, or simply that the environmental habitat of the site was a complex and varied one lacking an immediately clear modern parallel, is unclear. In levels SPCA and BSp, identified taxa suggest the local environment was predominantly evergreen forest, although cooler than conditions today, with some types that indicate the presence of a nearby source of running water (2006, 188). Curiously, the preferred habitat of several of the species of fauna recorded from post-HP MSA 1 does not accord with this interpretation, being more suggestive of a dry and open landscape (Clark and Plug 2008, 893). More so than SPCA, BSp has a mixture of evergreen and deciduous components, which is interpreted as evidence of an extended range of sourcing (Allott 2006). This explanation accords with the interpretation of faunal procurement at the time offered by Clark and Plug (2008).

6.5.2 **Seed Analysis**

As well as the charcoal analysis conducted by Allott, a pioneering series of studies have reported on the seeds and fruiting structures recovered from the sequence (Wadley 2004; Sievers 2006). To compensate for the poor frequency with which remains were recovered, deposits were amalgamated according to the supposed cultural and dated clusters identified at the site, and although their frequency was particularly low from Howieson's Poort and older deposits, both the Howieson's

Poort and Still Bay yielded small samples along with the post-HP MSA 2 as well as the post-HP MSA 1. It is the carbonised seeds that are the main focus of interest, as uncarbonised or mineralised seeds are mostly attributed to contamination from modern or Iron Age times (Sievers 2006, 209). As with the identification of charcoal, it remains rare in many cases that analysis can identify fragments beyond the level of genus (Wadley 2004). Many of the species identified were considered catholic in their habitat and vegetation type preference and so should not be used to infer local conditions of temperature and moisture (Sievers 2006). Nevertheless, several observations may be made.

Sedges account for the overwhelmingly dominant seed type in the Still Bay and Howieson's Poort. These remains indicate a high moisture level (Sievers 2006), but this is not surprising given the proximity of the Tongati river, and the fact that riverine taxa is likely to have survived at varying densities throughout the site's history. Their presence fluctuates more in the levels from 60kya and younger. Their absence in some phases such as levels SU-Mi in the early post-HP MSA 1 (including level Eb from which charcoal remains were identified), may indicate warm drier climatic oscillations (Ibid 2006, 215). Overall, through cross referencing the results of the study with those of the charcoal analysis, Sievers identified a broad transition between levels clustering around ~60kya, with evergreen taxa predominant, and ~50kya when deciduous species had become more dominant (Ibid 2006, 220). More nuanced variation within the sequence is also apparent, but should not be reliably referred to for interpretation of palaeoenvironmental conditions at present (Ibid 2006).



Mineral Magnetic Zone	Oxygen Isotope Stage	Climatic zone	Age cluster	Sibudu layers sampled
MMZA	OIS 1	CZ1 (MS mean values: 675 SI	~1100 AD	BSS BSV
	HIATUS			
	OIS 3	CZ2 (MS mean values: 352 SI)	~50 ka	MOD, OMOD, OMOD2, RSp
		HIATUS		
		CZ3 (MS mean values: 194 SI)	~60 ka	SPCA, SS, Ma, BM, P, BP, Sp, P1
MMZB	OIS 4	CZ4 (MS mean values: 41 SI)		G1, Ch2, BG/mix2, YA1, YA2

Figure 87: Chart showing the correlation of climatic zones with post-HP MSA deposits

6.5.3 Archaeomagnetic Data

Throughout the archaeological sequence of Sibudu, measurements of magnetic susceptibility were taken and assessed for fluctuation. Periods of stability or peaks and troughs in the values recorded over time may reflect climatic variation. With dates obtained for the sequence it is possible to cross refer these changes with the known approximate transition between OIS 4 / 3 from glacial to interglacial conditions (Herries 2006). Although measurements have not been obtained for the sequence prior to the ~60kya layers (i.e. the Howieson's Poort), records do extend back to the post-HP MSA 2. In his analysis, Herries was able to delineate four climatic zones, numbered from most recent to oldest. Climatic zone 4 (Figure 87) pertains to the post-HP MSA 2 and is believed to represent the cold final stages of the OIS 4 glacial (Wadley 2006, 334). The date of these levels, and nature of the contrast with overlying levels is consistent with that documented through the Vostok ice core (Herries 2006, 144). The transition occurs between deposits G1 and P1, the latter of which is not marked on the stratigraphic section but lies between Su2 and Ch2 serving as a useful distinguishing barrier between the post-HP MSA 1 and post-HP MSA 2 (Cochrane 2008). Conditions became warmer and moister during this transition into the interstadial (Herries 2006, 144). There does not appear to have been a hiatus in site occupation associated with the transition (Wadley and Jacobs 2006).

6.5.4 **Summary of palaeo-environmental trends**

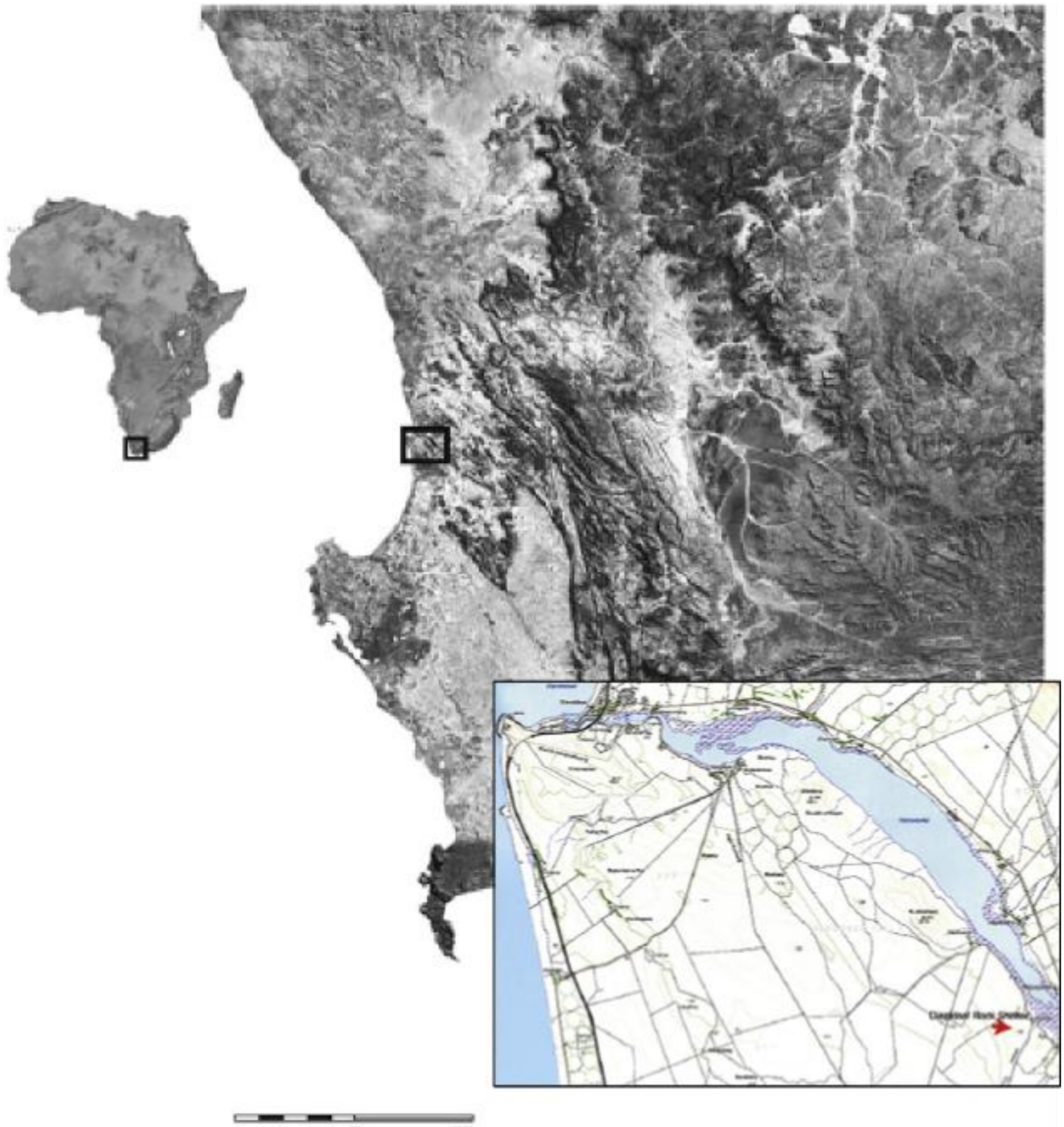
Tying the strands of multiple perspectives on the trajectory of environmental change throughout the MSA occupations of Sibudu is not possible without encountering some contradiction. A general overview of these analyses has been best surmised by Lyn Wadley (Wadley 2006; 2008). It is more difficult, however, to elucidate internal changes within the Howieson's Poort due to small and conflated samples. Broadly speaking, during the Howieson's Poort, Sibudu was located in an area of evergreen forest with warm and humid conditions and riverine vegetation nearby, but, according to faunal evidence, with deciduous forest and savanna style ecozones located not too far away. The post-HP at the site seems to have been colder and dryer, at least by post-HP MSA 1. Data for post-HP MSA 2 is not so plentiful, but seems to have experienced conditions not too dissimilar to the HP. A chronological gap between the Still Bay and Howieson's Poort prevents assessment of the transition between the pre-HP MSA and the HP. Although they have not been published in any great detail, early indications suggest that faunal assemblages from the Still Bay levels at the site are not vastly different in composition to the Howieson's Poort.

6.6 Diepkloof Rockshelter

Diepkloof rockshelter is situated approximately 180km north of Cape Town in the Western Cape Province in South Africa, 120m above the southern bank of the Verlorenvlei River, which flows into the Atlantic Ocean 14km to the northwest (Figure 88) (Parkington et al. 2013). As a generic name, Diepkloof refers to a complex of sites akin to Klasies River, comprising Diepkloof rockshelter (the main focus of research) and Diepkloof kraal (Figure 89). The site complex is part of a quartzitic sandstone outcrop, and the local geology consists of sandstones, siltstones, shales, and conglomerates from the nearby Table Mountain Group (Miller et al. 2013). A large boulder along with other large fallen rocks along the edges of Diepkloof rockshelter has protected much of the site interior from erosive processes (Miller et al. 2013; Parkington et al. 2013)

Unless otherwise specified, the name Diepkloof (or DRS) is used here as shorthand to refer to Diepkloof Rockshelter. The rockshelter was originally investigated as part of research into the Holocene deposits identified at the cave in the 1970's and 80's (Parkington and Poggenpoel 1987), but interest was reignited following investigations conducted at Klasies River and other sites with MSA deposits (Parkington et al. 2013). As part of the renewed investigations into the site, excavations have been conducted more or less continuously since 1998 (Rigaud et al. 2006). The floor surface of the shelter is 25m across and 17-22m from the back of the cave to the drip-line, giving a protected space of around 200m^2 (Figure 90).

The two main ambitions of the renewed investigation have been to explore the nature and chronological extent of the archaeological sequence and to evaluate the integrity of these deposits by reviewing the sedimentary processes at work in their formation. The site is one of the best known occurrences of the Howieson's Poort in the Western Cape, and has attracted attention for, among other reasons, the discovery of engraved ostrich eggshells from the HP deposits associated with symbolic expression (Texier et al. 2013), and the fact that Diepkloof is one of only a few sites to have yielded both Howieson's Poort and Still Bay deposits within the same sequence (Henshilwood 2012). Following on from earlier preliminary publications (Rigaud et al. 2006; Porraz et al. 2008), work at Diepkloof has been more extensively detailed in a recent special edition of the Journal of Archaeological Science (Parkington et al. 2013).



©Landsat

Figure 88: Map West Cape showing Diepkloof Rockshelter

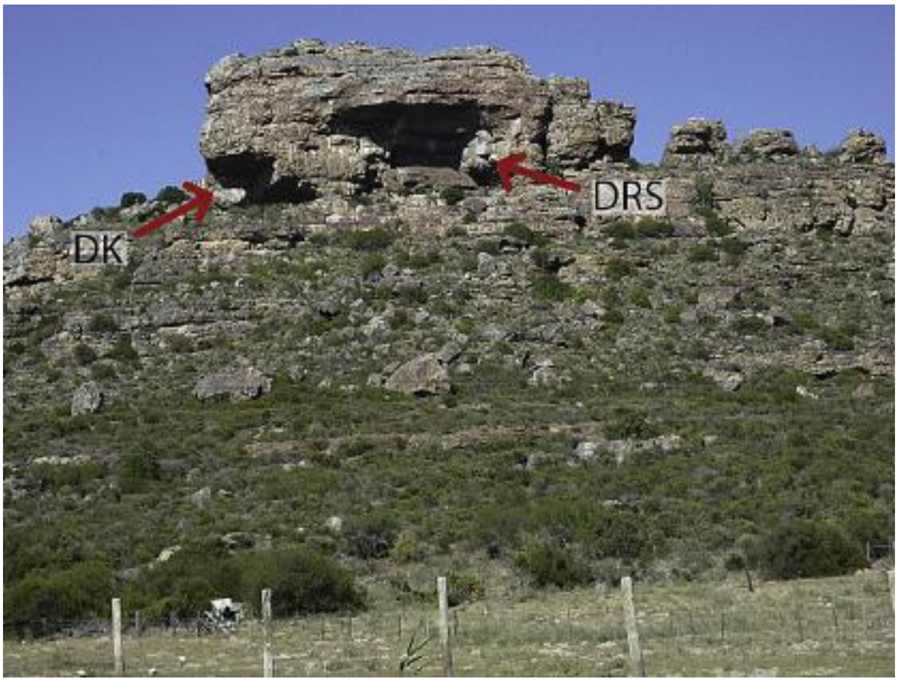


Figure 89: Diepkloof Rock Shelter (DRS) and Diepkloof (DK)

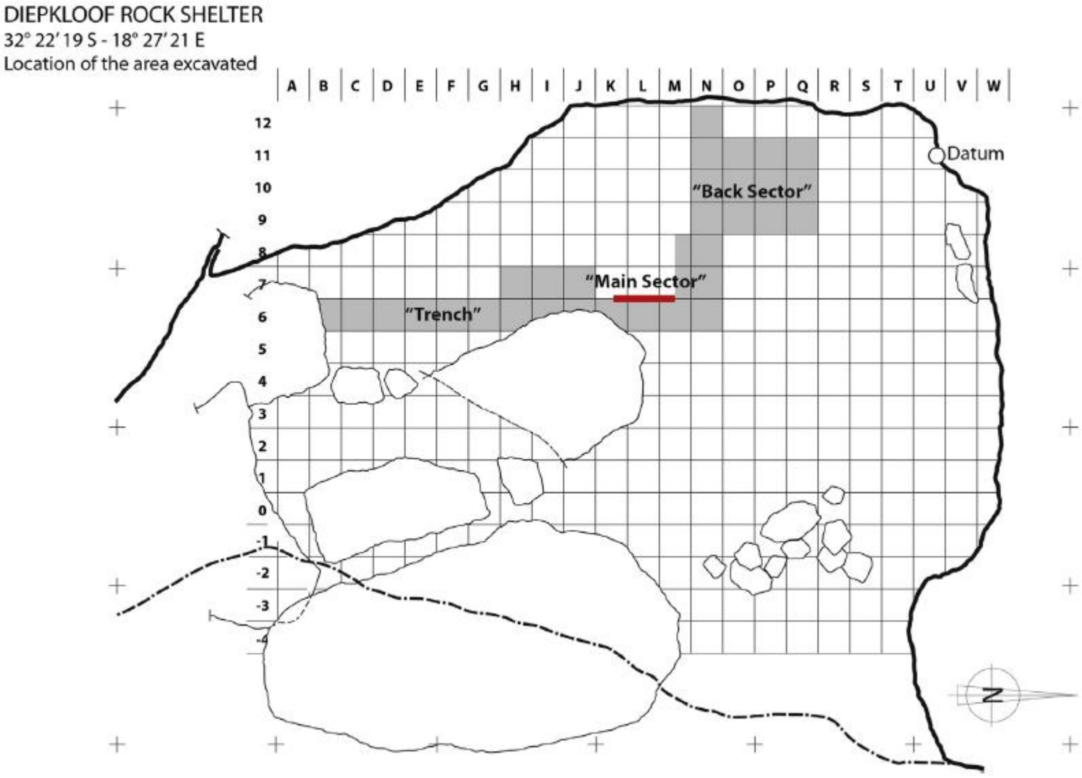


Figure 90: Excavation Plan of Diepkloof Rockshelter

6.6.1 **Stratigraphy**

Most recently, excavation has sought to connect the areas investigated in the 1970's and 1980's (Figure 91) in an effort to explain the notable differences in lithic assemblages reported from these different areas. It is in this newly excavated area, in squares L to N6 ($3m^2$ total), that the deepest extent of the site around 3.1m has been excavated reaching to pre-Still Bay deposits (Parkington et al. 2013). These squares are referred to as part of the "Main Sector" of the site (Figure 91), along with the "Trench" (excavated 1986) and "Back Sector" (excavated 1973) areas. While Howieson's Poort material has been recovered from all these areas of the site, the majority of the recently published work has focussed on endeavours in the "Main Sector" as the deepest extent of the site sequence. The "Trench" holds great potential for investigation into the HP / post-HP transition, while it is hoped that the Back Sector will enable exploration into the spatial distribution of late Howieson's Poort activities at the site (Parkington et al. 2013, 371).

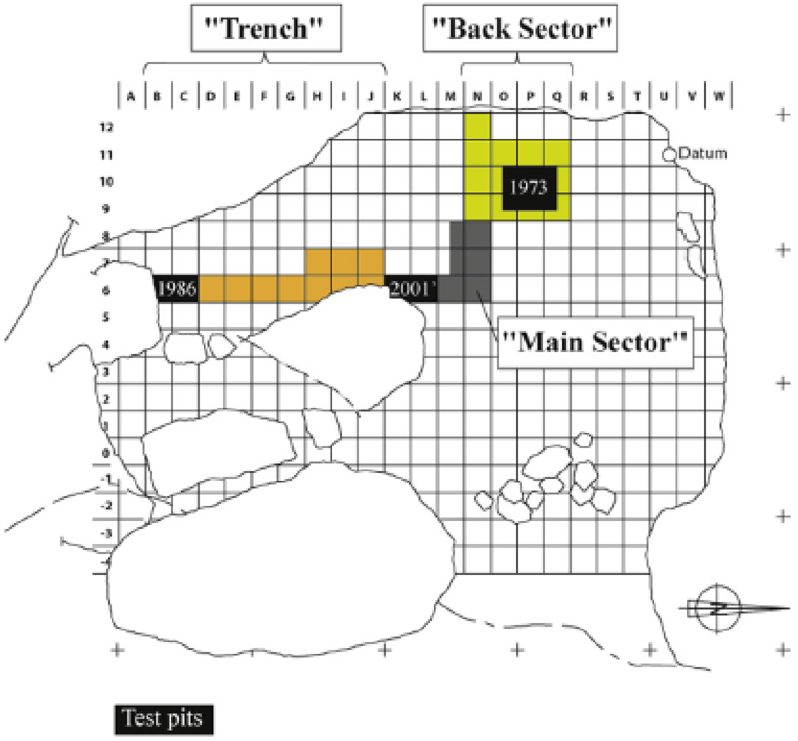


Figure 91: Diepkloof Rockshelter excavation plan showing phases of fieldwork

In the Main Sector of the site, 53 stratigraphic units (SUs) have been identified, delineating distinct complexes of often discontinuous beds and lenses that constitute main sedimentary episodes documented across larger areas of the site (Parkington et al. 2013; Miller et al. 2013, 3433). These have been assigned names in alphabetic order from top to bottom (Figure 92) (Figure 93). Smaller individual depositional events i.e. discontinuous beds, lenses and laminations labelled as microfacies units (MF units), are too numerous to count, and are not detailed individually but instead are grouped according to type as different microfacies types (MF types) (Miller et al. 2013, 3433). The SUs themselves are grouped into four lithostratigraphic units which represent larger scale diachronic variations within the sequence, but also according to technocultural units according to assemblage variability.

Diepkloof makes a perfect addition to the study sample because it has an extensive archaeological sequence exposed by the Main Sector excavations, and contrasts geographically with Sibudu in the east and Klasies on the south coast. Furthermore, somewhat uniquely among MSA sites with comparable sequence depth, there appear to have been no major hiatuses in deposition with the exception of the MSA / LSA transition (Miller et al. 2013, 3451), giving DRS a marked contrast with Sibudu and KR. Figure 92 shows the stratigraphy of the east-facing section as recorded from squares K6/7 to M6/7 with SUs delineated. K6 was only partially excavated due to obstruction from a nearby boulder, and only part of M6 is recorded in section due to an expansion of the excavated area to the western interior of the shelter (Figure 90). A separate stratigraphic south-facing sequence from N/O6 is also included (Figure 93).

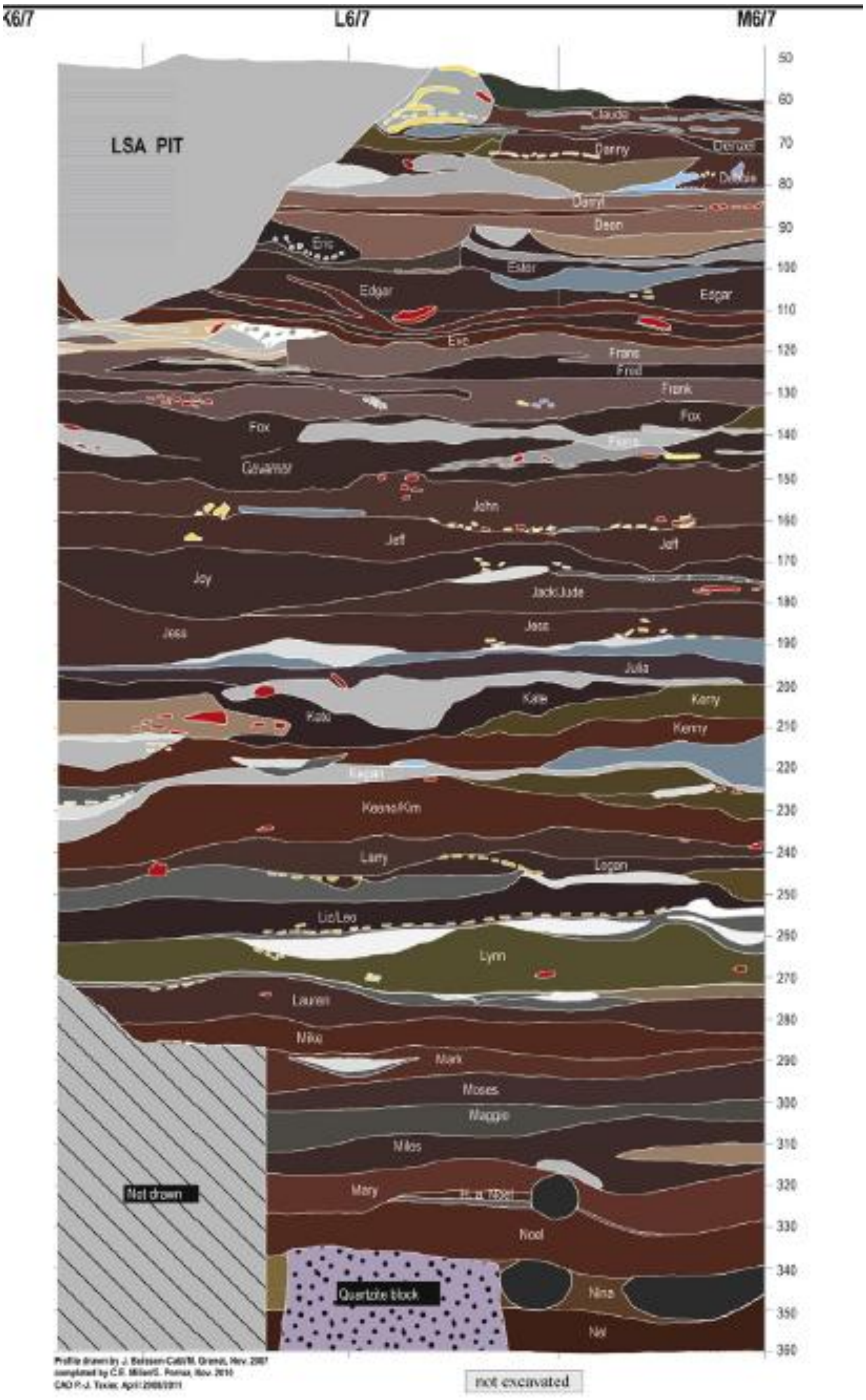


Figure 92: DKR Stratigraphy K6/M6 East Facing Section

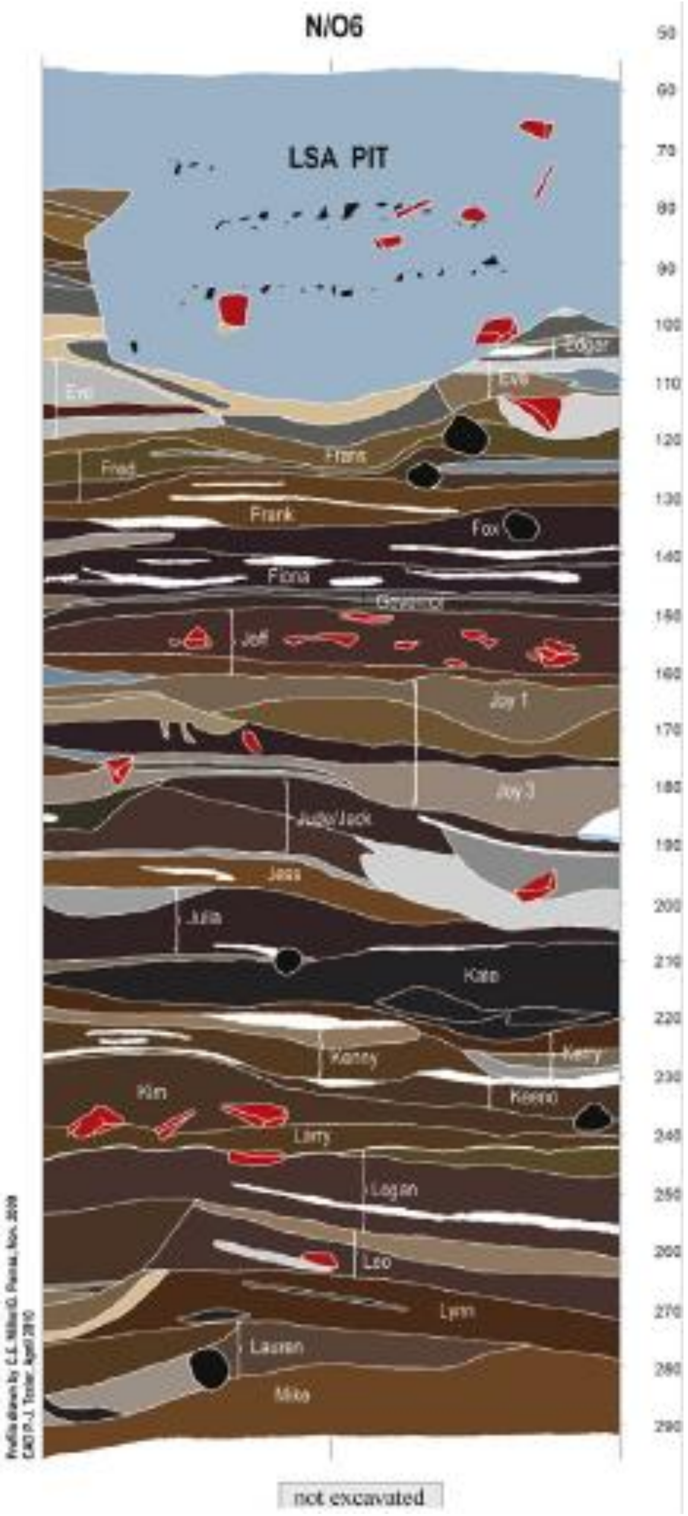


Figure 93: DKR Stratigraphy O6/N6 South Facing

Somewhat similar to the manner in which data from La Riera and Klasies in this study have been synthesised, the investigations from the main sector of DRS have been presented in a summarised diagram form by the investigation team by Porraz et al. (2013), shown here in (Figure 94). Table 31 should be referred to for a more detailed breakdown of which techno-complexes the individual stratigraphic units concerned for this investigation pertain to. These divisions were made based upon observed differences in patterns of raw material selection, blank production and tool manufacture (Parkington et al. 2013, 3378). For the purposes of this study, 37 stratigraphic units are included, and these span from the pre-Still Bay MSA through to the post-Howieson’s Poort. The Howieson’s Poort accounts for 24 of these stratigraphic units, and is broken into three constituent stages, with an intermediary MSA stage (MSA type ‘Jack’) separating the early and intermediate HP portions of the sequence.

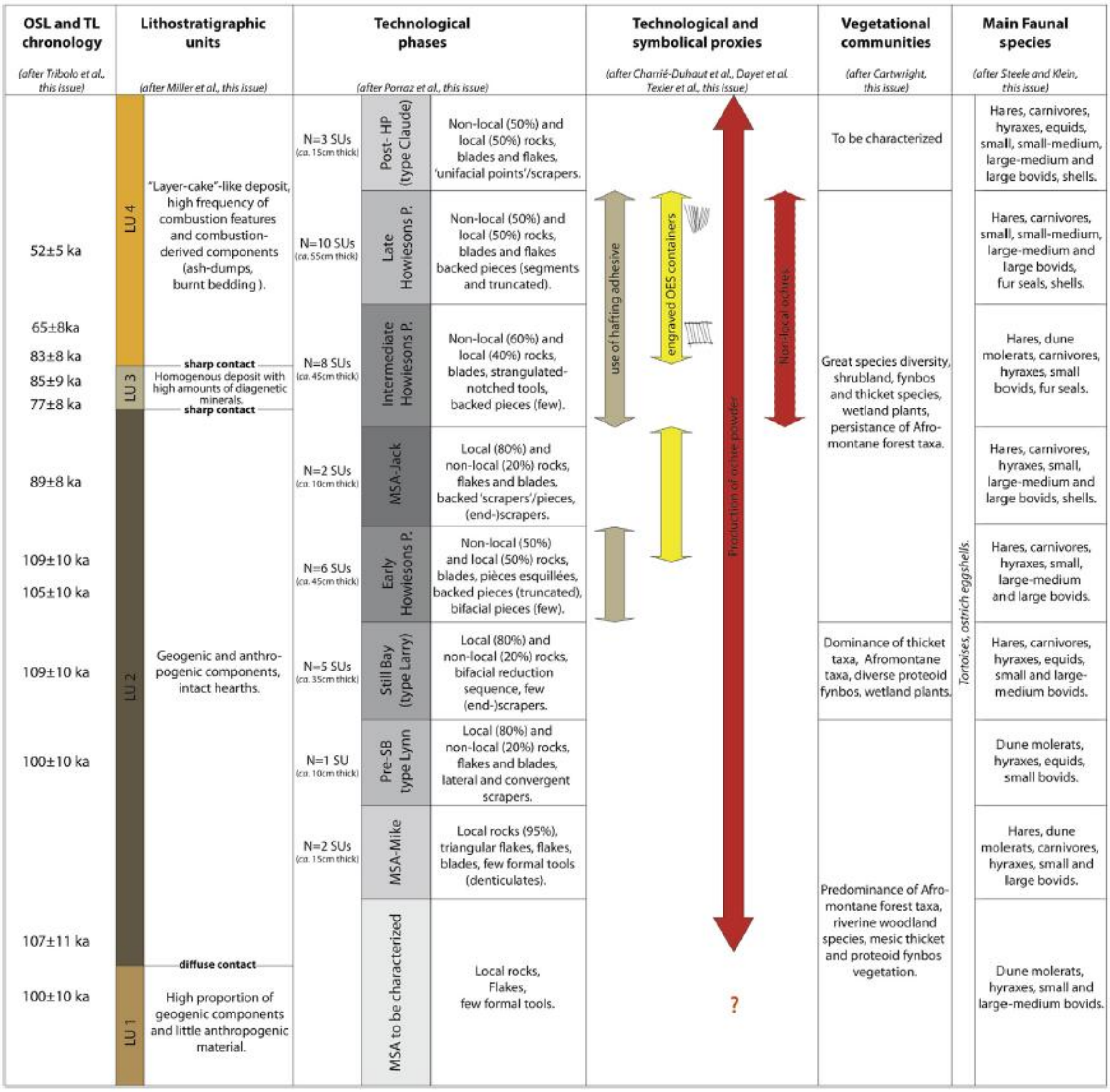


Figure 94: Diagram showing change over time at DKR (Porraz et al. 2013)

6.6.2 **Dating**

Besides Sibudu, DRS is one of the only thoroughly investigated sites to have yielded both Still Bay and Howieson's Poort deposits. Consequently, the dating of the site has been of particular interest. Originally, Diepkloof Rockshelter was dated under the extensive single-grain OSL programme overseen by Jacobs et al. (2008). The dates obtained seemed to conform to the chronologically discrete windows of time generally inferred for both the Still Bay and Howieson's Poort. Subsequent revisions of cultural designation within the sequence of deposits has led the site's investigators to reject these estimations in favour of new dates obtained by a team led by Chantal Tribolo (Porraz et al. 2013, 3545). These dates were acquired using a combination of the lithic based thermoluminescence methods used previously at sites such as Klasies River and Rose Cottage (Tribolo 2005), and the sediment based OSL methods (Tribolo et al. 2009; Tribolo et al. 2013). The new dates suggest an unusually early start for both the Still Bay and Howieson's Poort industries, with the latter being pushed back in its earliest permutation to around 105 kya. Dates from the late Howieson's Poort were obtained from samples taken from elsewhere on the site. An age of 52 ± 5 kya from the back section suggests a long extent for the Howieson's Poort phase of the site, hence the fragmentation of the period into three stages (Porraz et al. 2013).

The re-dating of the DRS sequence has had several implications for how we understand our broader conceptualisation of the Howieson's Poort.

1. If the early estimations for the HP are indeed true, then it would appear that the techno-complex as a wider phenomenon was a lot less coherent and unified in its emergence (Parkington 1990), or that we are missing the early HP at most of the sites where the industry has been identified (Tribolo et al. 2013, 3409).

2. The reassignment of stratigraphic units to different techno-complexes contra the designations asserted in earlier works (Jacobs et al. 2008; Tribolo et al. 2009) means that there is no intermediary between the Still Bay and Howieson's Poort at the site as had previously been thought (Porraz et al. 2008).

Techno-Complex	**Techno-Complex sub-phases**	**Stratigraphic Units**	**TL Mean Age Estimates**
Post HP	Post HP ('Claude')	Claude	
		Denzel	
		Danny	
Late HP	Late HP ('Eric')	Debbie	
		Dean	
		Darryl	
		Deon	
		Eric	
		Ester	
		Edgar	
	Late HP ('Frans')	Eve	
		Eben-HB Eve	
		Frans	
Intermediate HP	Interm. HP ('Fiona')	Fred	83 ± 8
		Frank	
		Fox-fannie	85 ± 9
		Fiona	
		Governor	
	Interm. HP ('Jeff')	John	77 ± 8
		Jeff	
		Joy	89 ± 9
MSA	MSA Type 'Jack'	Jack	
		Jude	
Early HP	Early HP ('Kate')	Jess	109 ± 10
		Julia	
		Kate	105 ± 10
	Early HP ('Kerry')	Kerry	
		Kenny	
		Kegan	
Still Bay	Still Bay Type 'Larry'	Keeno	
		Kim	109 ± 10
		Larry	
		Logan	
		Leo	100 ± 10
Pre-SB	Pre-SB Type 'Lynn'	Lynn	
MSA	MSA Type 'Mike'	Lauren	
		Mike	

Table 31: DKR Stratigraphy Phasing

The contrast in time-span for the Howieson's Poort is even further emphasised when compared with dates acquired at other sites using Tribolo's TL method (Tribolo et al. 2005), where age ranges at Klasies and River Cottage were slightly younger those proposed by the census undertaken by Jacobs et al. (2008). In deference to the authority of the site's primary investigators, Tribolo's dates are cited here as the most recent and reliable determinations for DRS. Details of the full dating schema can be found in Tribolo et al. (Tribolo et al. 2013). Table 32 shows the nine mean ages derived from the portion of the main section that is the focus of this study with their corresponding stratigraphic units and associated technocomplexes.

6.6.3 **Lithics**

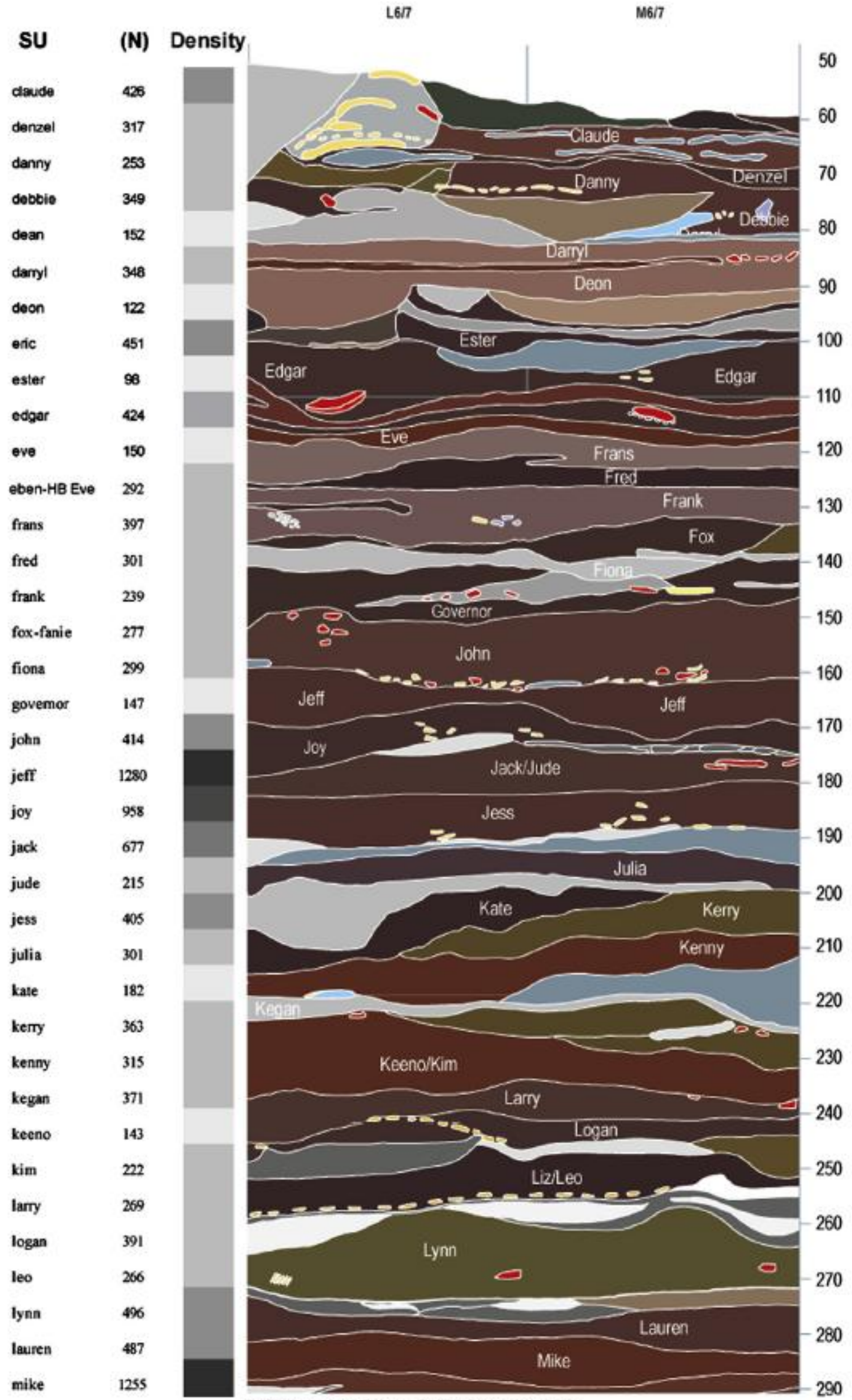
Porraz et al. have provided the main lithics analysis, focussing on material from squares M-N6 (2013). Material from square L6 was studied as part of an unpublished PhD thesis. The analysis of material from M-N6 terminates at level Noël, as levels Nina downwards were considered to have yielded an insufficient frequency of artefacts for informative investigation (Porraz et al. 2013, 3377). Figure 95 refers to the extent of the sequence from which assemblages have been analysed, with SU Mike referring to the lowest extent of MSA deposits (Miller et al. 2013). Table 31 shows the techno-complexes and sub-phases assigned to these stratigraphic units. Lithic assemblages are classified by the technological phases they represent (referring to modes of production), variations noted in raw material usage and in a more conventionally recognised typological format (Porraz et al. 2013). They are considered at the resolution of techno-complex sub-phases, with data for individual stratigraphic units provided in supplementary material (Porraz et al. 2013). Pieces less than 20mm in length were quantified separately, and invariably classified as flakes, shaping flakes or fragments.

Techno-Complex	Stratigraphic Unit	Mean Age (ka)
Intermediate HP	Fred	83 ± 8
	Fox	85 ± 9
	John	77 ± 8
MSA Jack	Jude / Joy	89 ± 9
Early HP	Jess	109 ± 10
	Kerry-Kate	105 ± 10
Still Bay	Kim-Larry	109 ± 10
	Larry	
Pre-SB	Lynn-Leo	100 ± 10
Lower MSA	Mark	107 ± 11

Table 32: DKR TL Dates

Various difficulties in reconciling certain aspects of this data become apparent when attempting to further cross-reference different facets. For example, in the classification of the assemblages according to technological phases, fragments and manuports are seemingly excluded from quantification (Appendix 32). In (Appendix 33), manuports and fragments (> 20mm) are included resulting in different subtotals. Not all the differences in quantification can be explained by this though (Appendix 32). It is suspected that these discrepancies reflect errors in assemblage quantification. In other cases, it is simply unclear how some values have been derived. When "formal tools" are given as a percentage (Porraz et al. 2013, 3383), it is not clear which sample total the value pertains to. Whether considered per techno-complex sub-phase or per individual stratigraphic unit, the percentage of formal tools (Figure 96) does not seem to correspond to any of the totals or subtotals presented elsewhere in the analysis. For the purposes of this analysis, lithics data is regarded at the sub-phase level, as this is the resolution at which the site's analysts primarily focussed.

The classification of assemblages according to technological phasing is not ideally suited for cross-reference with the Klasies material, but comparison is nevertheless possible typologically. The typological classification for DRS material describes "truncated pieces", referring to elements with straight or concave truncation oblique to the axis of the tool edge, otherwise known as trapezes, and "backed pieces" which include lunate / crescent segment forms with curved backed edges (Porraz et al. 2013, SOM). In the technological classification, blades (regular and irregular) and bladelets are considered as a subtype of flakes (Porraz et al. 2013, SOM 13). Such a description recalls that which Singer and Wymer used at Klasies River, termed flake-blades (1982). Bladelets are qualified as blades whose width is less than 11mm (Porraz et al. 2013, SOM 13). It appears that different production methods as documented at Klasies River by Wurz (1999, 42) are noted in the study of *chaîne opèratoire*, but not otherwise delineated in their technological classification.



Profile drawn by J. Buisson-Catil/M. Grenet, Nov. 2007
completed by C.E. Miller/G. Porraz, Nov. 2010
CAD P.-J. Texier, April 2008/2011

Figure 95: DKR Section showing the extent of the sequence from which lithics data was assessed

6.6.3.1 Raw material procurement at DRS

The raw material survey conducted by the Diepkloof team provides the first systematic documentation of lithic raw material availability on the West Coast of South Africa (Porraz et al. 2013). Three zones of procurement have been identified, <5km, 5-20km, and >20km, and it is believed that locally available raw materials would have been coarse grained and fairly poor quality, with finer grained silcrete only available from >20km away from the site (Porraz et al. 2013, 3380). Appendix 34 shows the seven different material types petrographically identified at the site based on the geological survey of the surrounding area.

Figure 97 is from the analysis by Porraz et al. (2013), and shows the representation of raw materials at the site characterised both petrographically by individual stratigraphic units and according to distance from the site. Hornfels does not appear to be represented in the graph, but is acknowledged as present throughout the sequence although never as a dominant material (Porraz et al. 2013, 3381). I believe that the quartzite categories have been amalgamated. Both coarse and fine grained varieties fall within the category of (sub)local, and generally fine grained quartz is only minimally represented (never more than 2.2%) in any particular stratigraphic unit.

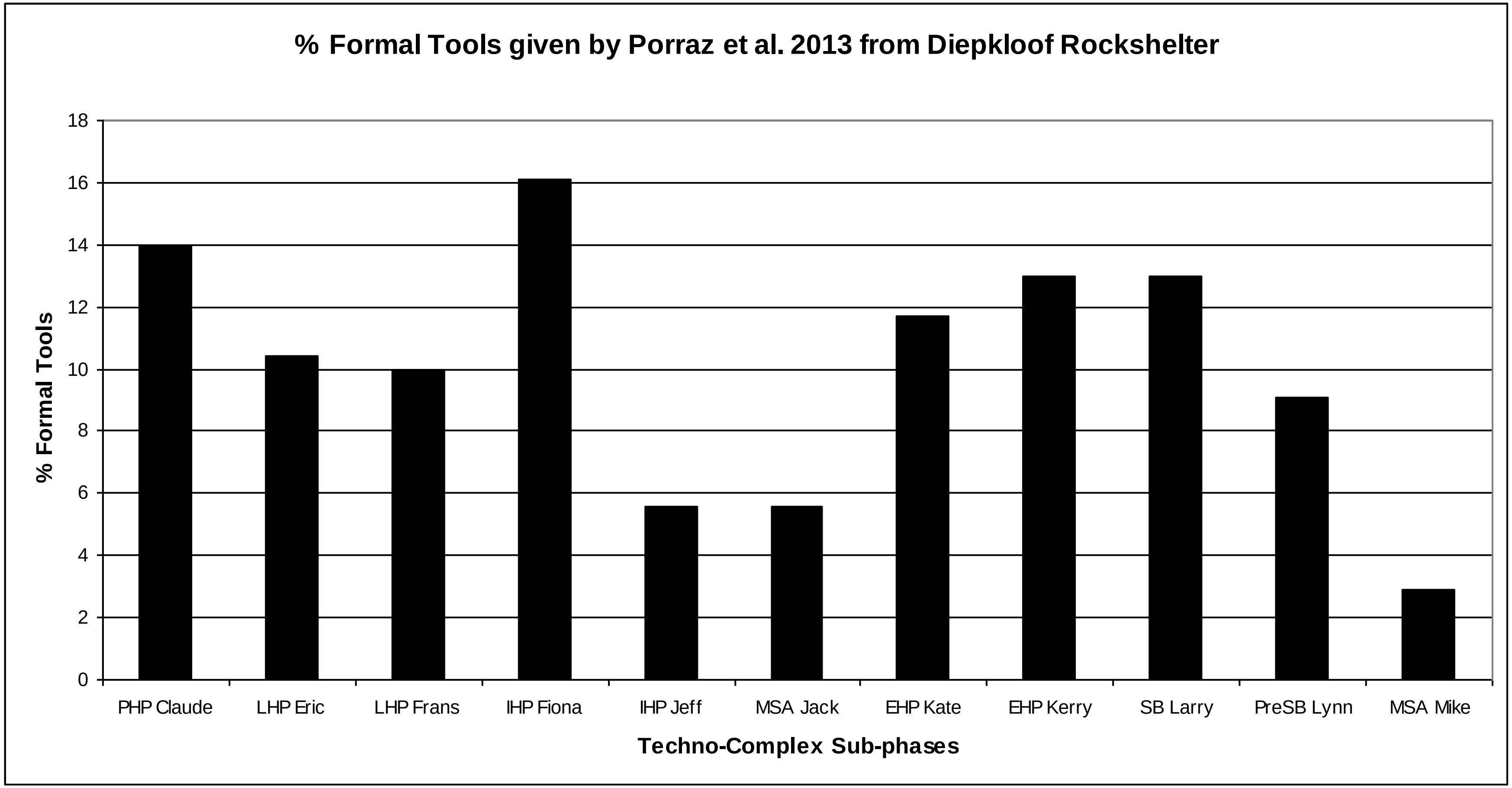


Figure 96: Graph showing Formal Tools at DKR

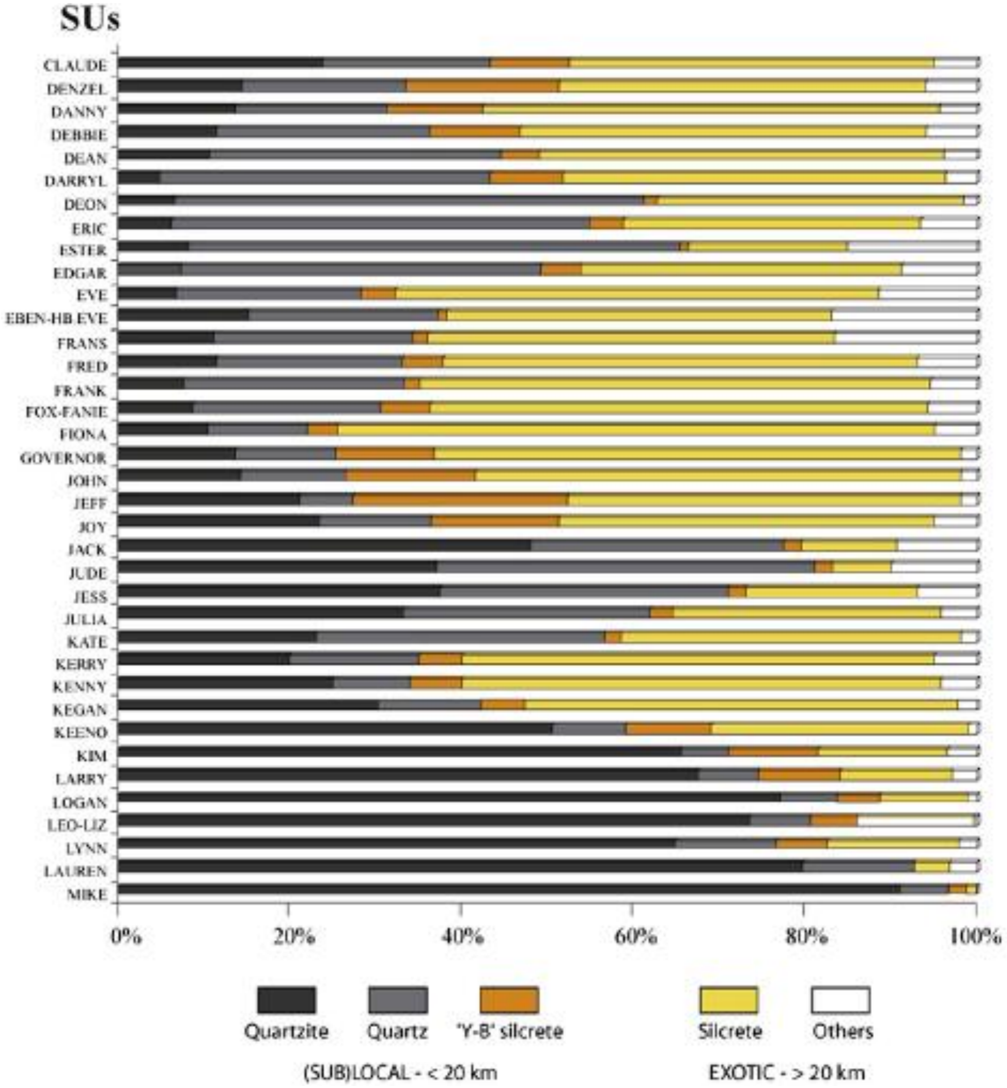


Figure 97: Graph showing distance of raw material procurement over time at DKR

6.6.3.2 Chronological trends in raw material use

It is possible to identify three broad changes in trends over time regarding raw material use at the site. Figure 98 shows raw material quantification for all pieces greater than 20mm in length. The first three sub-phases (Mike – Larry) are overwhelmingly dominated by quartzite (>60%). These early sub-phases are similar in most other respects, although silcrete representation is notably smaller in MSA Mike, in deference to what is the highest representation of quartzite in the sequence (86.3%). Over the next three sub-phases (Kerry – Jack) there is a trend in which silcrete decreases, and quartzite and quartz both increase. Early HP Kerry is generally comparable with intermediate and later stages of the Howieson's Poort, with Early HP Kate less similar, and Jack sufficiently different to be classified differently from the HP. Quartzite is higher in Kate and Jack than any other HP levels, as is quartz, with the exception of Late HP Eric in which it occurs most frequently. While apparently distinct from later HP phases, Jack is no more favourably comparable with earlier pre-HP phases either. Intermediate to post-HP phases (Jeff-Claude) represent the final trend in which silcrete tends to dominate comfortably over other materials, with the exception of Eric, in which it is slightly surpassed by quartz as the dominant material type. The fact that all material types are exploited to some degree no matter how minor in extent throughout the entire sequence demonstrates that material procurement ranges may have varied in frequency and nature rather than outright distance.

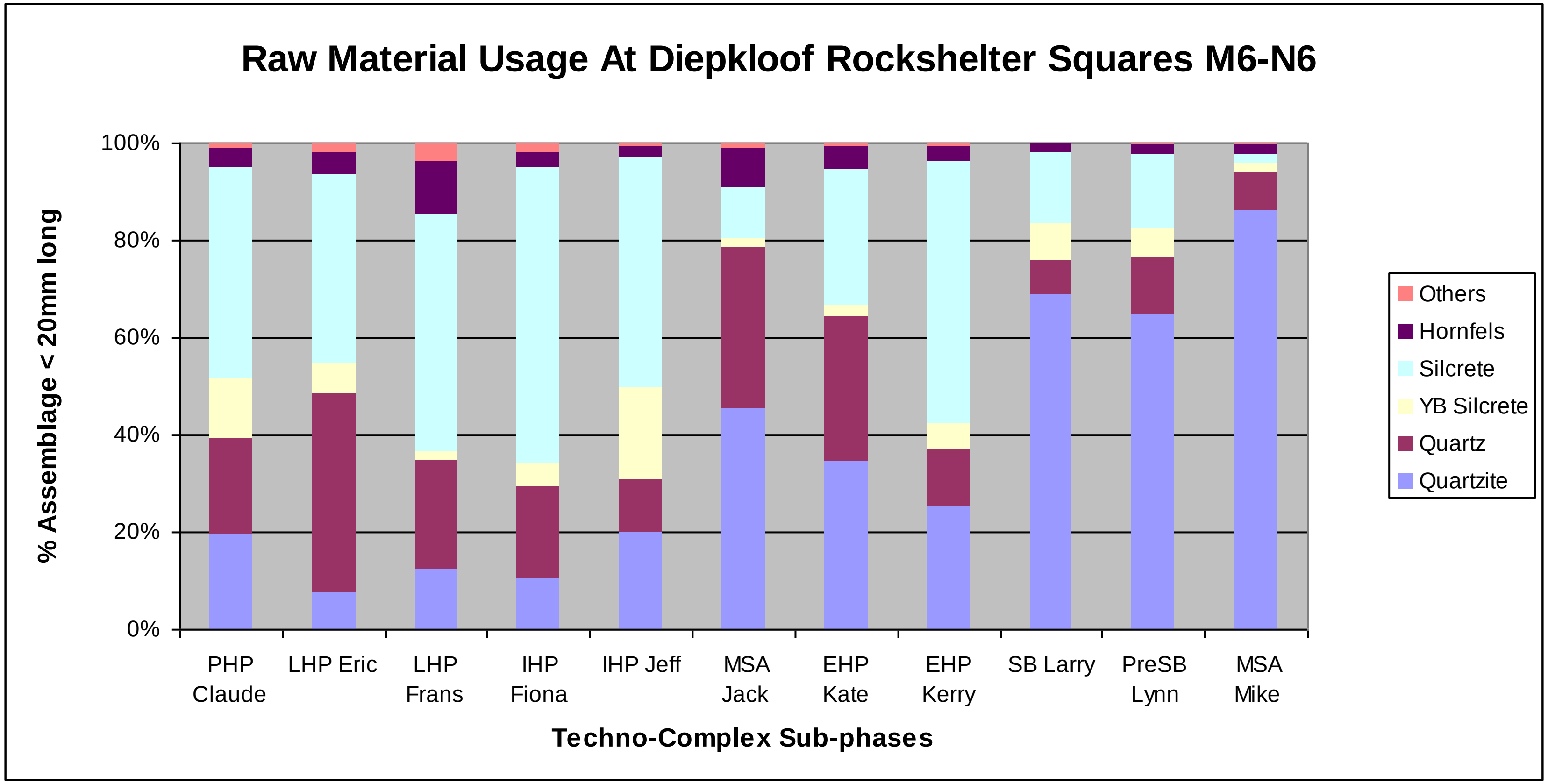


Figure 98: Graph showing raw material selection over time at DRK

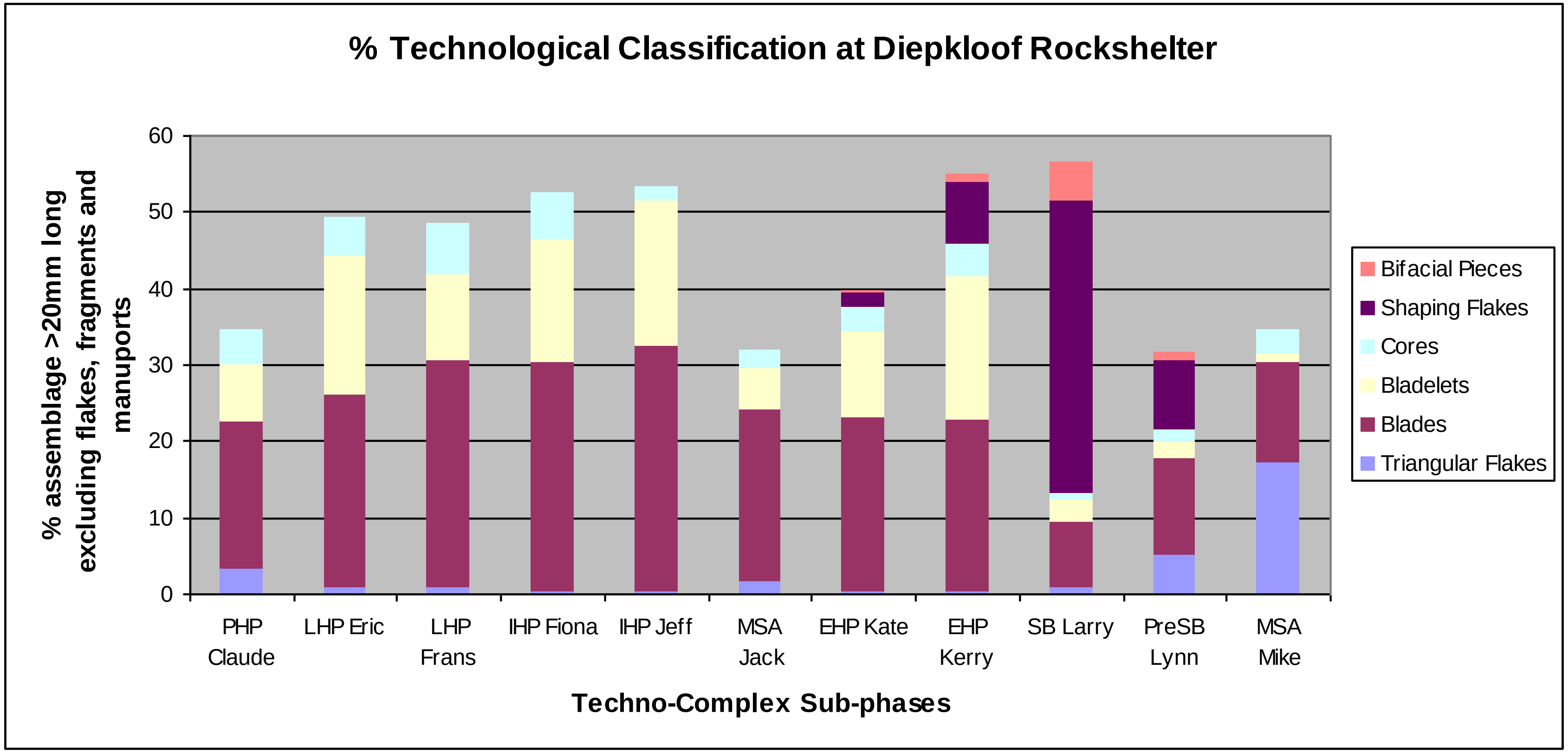


Figure 99: Graph showing "technological types" at DKR

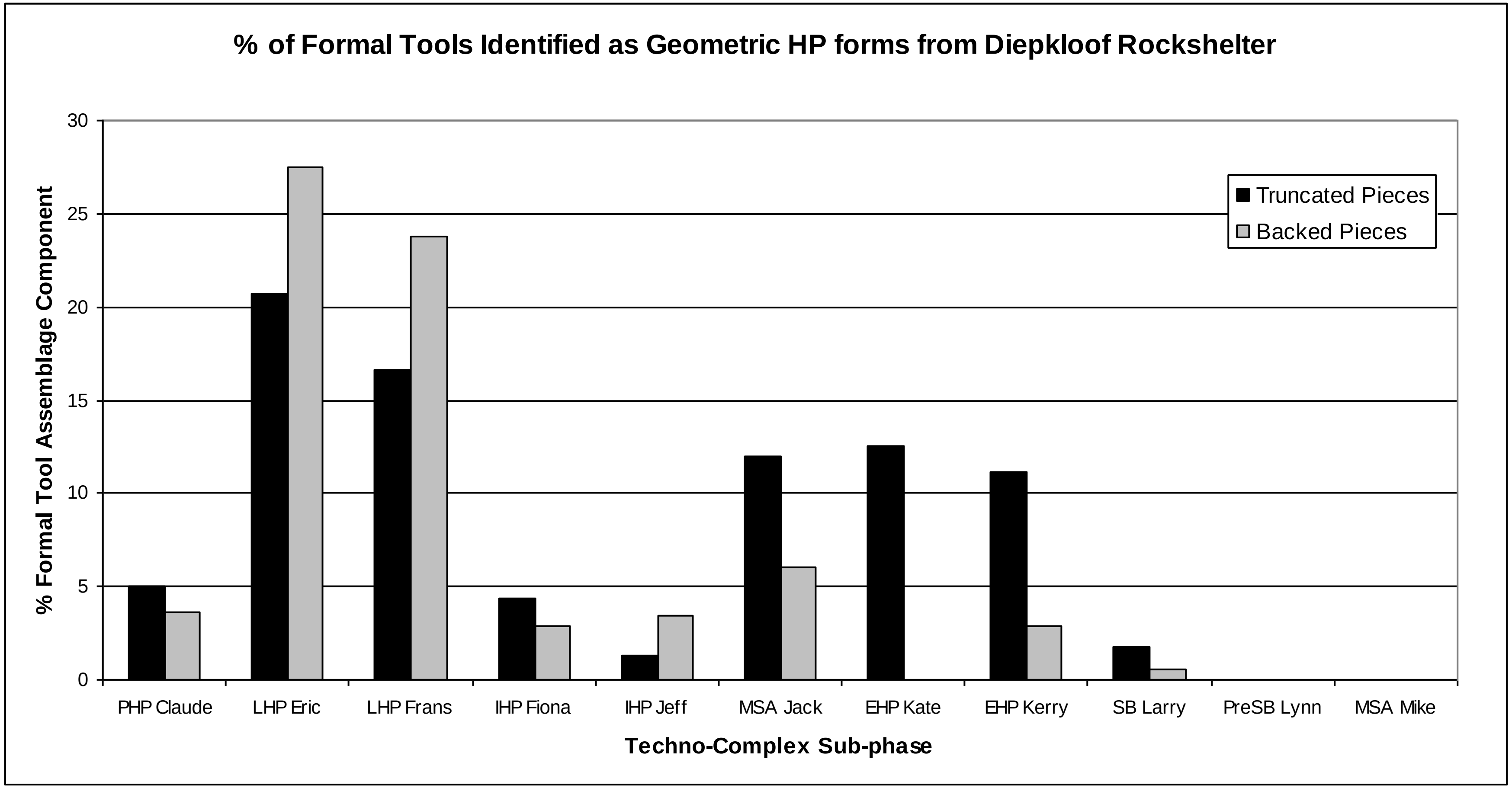


Figure 100: Graph showing truncated and backed pieces as a percentage of formal tools throughout DKR

6.6.3.3 Assemblage variability

Figure 99 shows the percentage of technologically classified pieces greater than 20mm in length excluding fragments and manuports, and also non-specific flakes, as this type accounts for a substantial majority (> 40%) of each assemblage. The most immediately noticeable trend is that generic flakes are least frequent in the Howieson's Poort and Still Bay designated phases. Blades account for a consistently large (>20%) portion of post-Still Bay phases, and bladelets increase dramatically in these levels with the exceptions of Jack and Claude in which they account for less than 8% of the assemblages. Cores are present in small quantities throughout, but are rarer than usual in SB Larry and Pre-SB Lynn. Bifacial pieces, as may be expected, are found in Still Bay phases and are fractionally represented in bracketing phases, even in early HP Kate. Shaping flakes are present only in phases Lynn – Kate, but account for the overwhelming majority (38.2%) of Still Bay Larry. Broadly speaking, there is a trend between silcrete use and bladelet frequency, and, to a lesser extent, blade frequency, although the correlation is clearly not strict as evidenced in Claude and Jack.

Figure 100 shows truncated (including trapezes, triangles and similar variants) and backed pieces (crescent segments) as percentages of the formal tool assemblages recognised at DRS. It is not made explicitly clear what is meant by "formal tools" in this case, but I believe it to refer to retouched pieces. In Porraz et al. (2013 table 3), a "percentage of formal tools" is given. I believe this refers to the percentage of the overall assemblage that formal tools comprise, although I could not find the values from which they were derived in their analysis. Nevertheless, this percentage of formal tools is shown throughout the sequence for each sub-phase (Figure 96). Formal tool representation is over 9% (9-17%) in all levels apart from MSA Mike, MSA Jack and, curiously, Intermediate HP Jeff, when it is less than 6%. Returning to Figure 100, both types of HP geometric are present from the Still Bay onwards, with the exception of the disappearance of backed pieces in EHP Kate. Generally, these crescent style backed pieces do not become important (> 6% of the formal tool assemblage component) until the Late Howieson's Poort (27.5 - 23.8%), which is also when truncated pieces (trapezes and similar forms) are most prevalent (20.7 - 16.6%). These truncated pieces are also represented with a lesser peak earlier in the sequence

(> 11%) in the Early Howieson's Poort and MSA Jack. In late HP Eric, a shift in raw material selection sees a higher use of quartz but seemingly exploited in the same manner as other rocks (Porraz et al. 2013, 3397) In many respects, the post-HP does not represent a significant departure from the preceding techno-complex aside from a greater number of flakes (Figure 99). The main difference is identified in the *chaîne opèratoire* process discussed by Porraz et al. (2013, 3397).

The specifics of the data utilised renders it difficult to draw any firm conclusions regarding interrelated patterning. It is worth noting that formal tool representation is low in the Late HP, when geometric forms are most prolific both numerically and proportionally a component of formal tools. There does not appear to be an immediately visible relationship between trends identified in technological classification and typological classification. This is perhaps to be expected, as the former categorisation should include a far greater sample size. Likewise, it is difficult to relate raw material use to formal tool counts because of the disparity in assemblage size, though it can be said generally that classic HP geometric forms and formal tools in general tend to co-occur with a greater diversity in raw materials.

It is curious that although MSA Jack and, to a lesser extent, Early HP Kate appear different when contrasted with raw material usage and the technological classification of bracketing sub-phases, they are less immediately anomalous in appearance when formal tool counts and geometric forms are considered. Likewise, it is unusual that the representation of geometric forms in the Intermediate Howieson's Poort is relatively low. Although the site's investigation team seem currently to be of the opinion that DRS is one of, if not the only site at which such a complete and extensive Howieson's Poort sequence has been documented (Tribolo et al. 2013; Porraz et al. 2013) I believe the matter to be open to debate. As much as sub-phases Kate and Jack could be regarded as anomalous developments within the trajectory of the Howieson's Poort, they could equally be techno-complexes with certain pre-emptive HP characteristics, rendering EHP Kerry a sub-phase with a precociously early affinity to the later Howieson's Poort.

As well as the summary detailed above, the DRS team also recorded basic *chaîne opèratoire* systems for the different sub-phases. This enabled the identification of a particular (but not exclusive) method of blade production during the Howieson's Poort, as noted at both Klasies River and Rose Cottage (Porraz et al. 2013, 3394). Among other trends highlighted by the research of Porraz et al. (2013) it has been noted that materials procured from greater distances generally tended to be subjected to a higher degree of retouch. The stratigraphic integrity of the sequence and *chaîne opèratoire* suggests that bifacial points were manufactured during the Early Howieson's Poort, and do not result from stratigraphic mixing. It is believed that these bifaces, when made on finer grained more exotic materials, were frequently circulated, curated, transported and maintained, while those made on local coarse-grained quartzite were less so, and were also more prone to breakage. Regarding the Howieson's Poort, geometric pieces are not regarded as characteristic of the early and intermediate phases (Figure 100), although it is my suspicion that it is these type-fossils that have earned the assignment of the techno-complex. There is also considerable variation in size and shape over time, with the most standardised pieces coming from the Earlier HP. Likewise, a trend of increasingly standardised microlithisation is not evident for blade and bladelet production, with the largest and most irregular blades occurring in the Intermediate HP.

6.6.3.4 Microwear Analysis

In addition to the basic analyses conducted by Porraz et al. (2013), studies of micro-wear and residue traces have also been conducted. The microwear analysis focussed on 135 artefacts from the Early Howieson's Poort sub-phase, including 20 truncated and bi-truncated pieces (trapezes and similar obliquely edged forms such as triangles), 4 segments (crescent backed pieces), and 73 blades and bladelets (Igreja and Porraz 2013). Table 33 shows the raw material divisions among the artefact types in question. The total of 21 truncated and bi-truncated pieces given in Table 33 reflects an error in the original analyst's quantification (Ibid 2013, 3483–3484), perhaps most likely in the silcrete sample considering the small sample sizes across different raw materials.

	Silcrete	Quartz	Hornfels	Total	Preservation: Weathered	Preservation: Good	Use-Wear
(bi)Truncated	18	1	2	21	9	12	10
Crescent segments	4	-	-	4	2	2	1
Blades/bladelets	67	6	-	73	24	49	10

Table 33: Results of DKR Early HP microwear analysis (Igreja & Porraz 2013)

Despite generally good preservation, only 20% (n=10) of the blades and bladelets examined exhibited microscopic use-wears, seemingly for use as cutting implements for a variety of materials (Igreja and Porraz 2013, 3484). The low incidence of detectable use-wears on these tools is interesting considering the assertion that, at Diepkloof at least, blades and bladelets were not primarily remnants from the manufacture of backed pieces (Mackay 2008). A cutting function was interpreted for all of the truncated and bi-truncated pieces upon which wears were detected (50% of the examined sample). This figure accords more closely with the number of pieces that were deemed as having preserved well. The analysts failed to note that the only segment upon which wears were detected is suggestive of impact damage, although if the paucity of positive results from the other categories assessed is problematic for inferring tool function, then such an anomalous detail as this is merely a curious footnote without further investigation. As mentioned earlier in the thesis, both the interpretation of blades/bladelets and truncated pieces as cutting implements and the low frequency of results identified may be due to a variety of factors regarding the use-life of these tools which we simply cannot ascertain. The good preservation of many pieces, indicative of their functional viability (Ibid 2013, 3486), may reflect that many pieces in the assemblage were prepared but not used. In addition to the microwear study conducted, residues, presumably from hafting adhesives, have been identified on a variety of Howieson’s Poort blades, bladelets, flakes and truncated pieces (Charrié-Duhaut et al. 2013).

6.6.4 **Faunal Analysis**

The MSA faunal remains from Diepkloof represent, along with those from Sibudu, the largest such assemblage from any sites with stratified Howieson's Poort *and* Still Bay deposits (Steele and Klein 2013, 3454). These remains were assessed along with those from LSA deposits by Teresa Steele and Richard Klein, the latter investigator having examined the fauna at Klasies and a number of other notable MSA sites. NISP and MNI data from the pertinent culture-stratigraphic units for main ungulate and other medium-large prey is detailed in Appendices 35-36. In addition to the levels represented in these tables, MSA data was also recorded for the "lower MSA" culture-stratigraphic unit underlying MSA Mike. These were excluded as being prior to the period of interest. Bovids, as already noted in the consideration of faunal analyses at Sibudu, are notoriously difficult to distinguish at a Linnaean level in the southern African MSA record. As was the case at Sibudu, these remains have been divided according to size, although seemingly not according to Brain's categorisation.

Faunal remains from the site are highly fragmented, and although no chewed bones were found, there is evidence of other carnivore activity at the site through the remains of species such as Leopard, Hyena and Cape Fox and the fact that three elements from small bovids exhibit evidence of gastric acid damage (Steele and Klein 2013, 3457). The preservation and representation of faunal remains at the site is further exacerbated by chemical degradation (and post-depositional crystal growth), burning and trampling (Miller et al. 2013), which renders assessment of pre-depositional damage difficult. Nevertheless, Steele and Klein tentatively conclude that despite visits from known scavenging carnivores such as Hyena, humans were the main accumulators of remains in the shelter, although raptor activity may be a primary contributor of smaller species such as hyraxes and hares etc (Steele and Klein 2013, 3457).

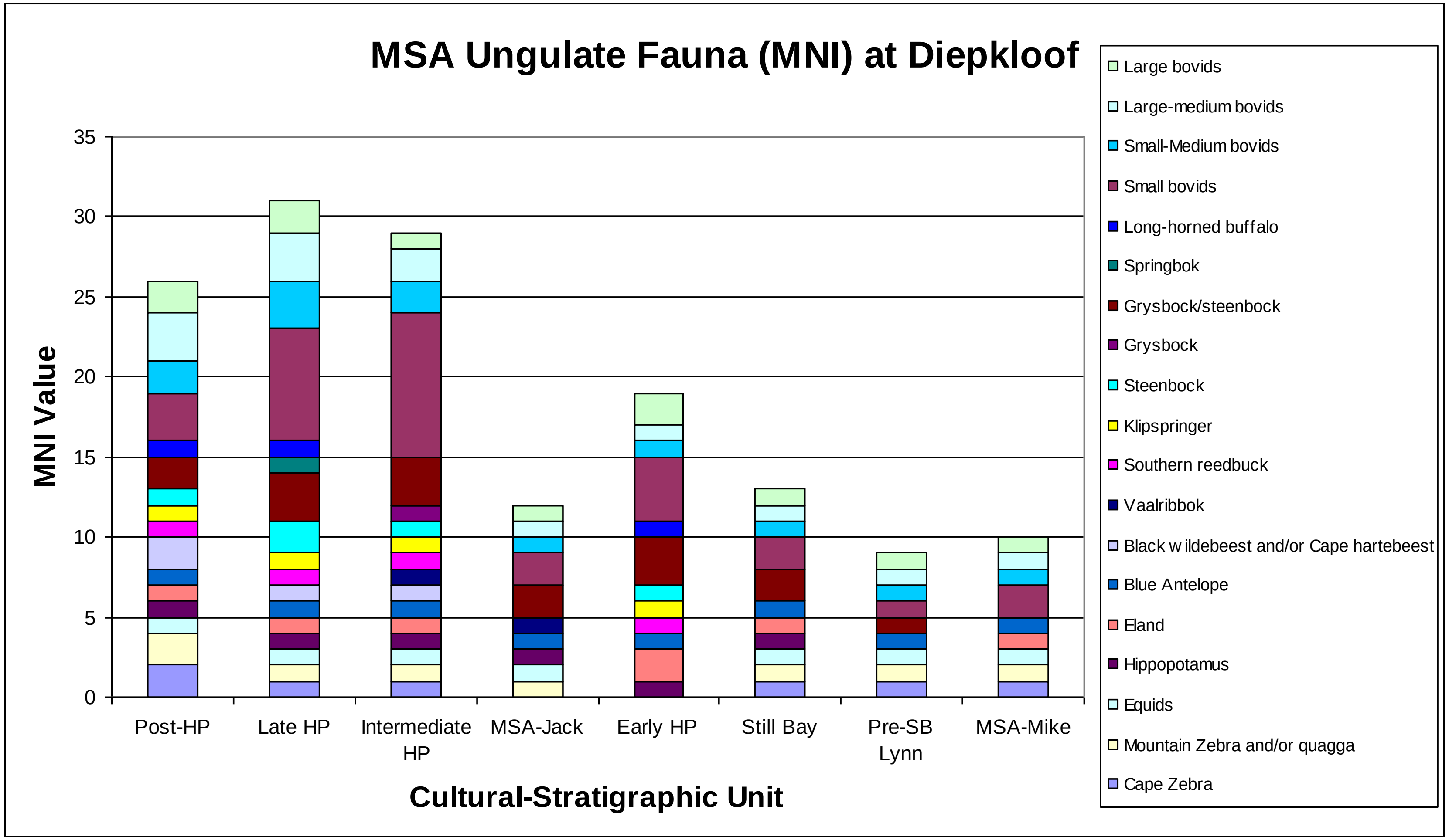


Figure 101: Graph showing macrofaunal MNI at DKR

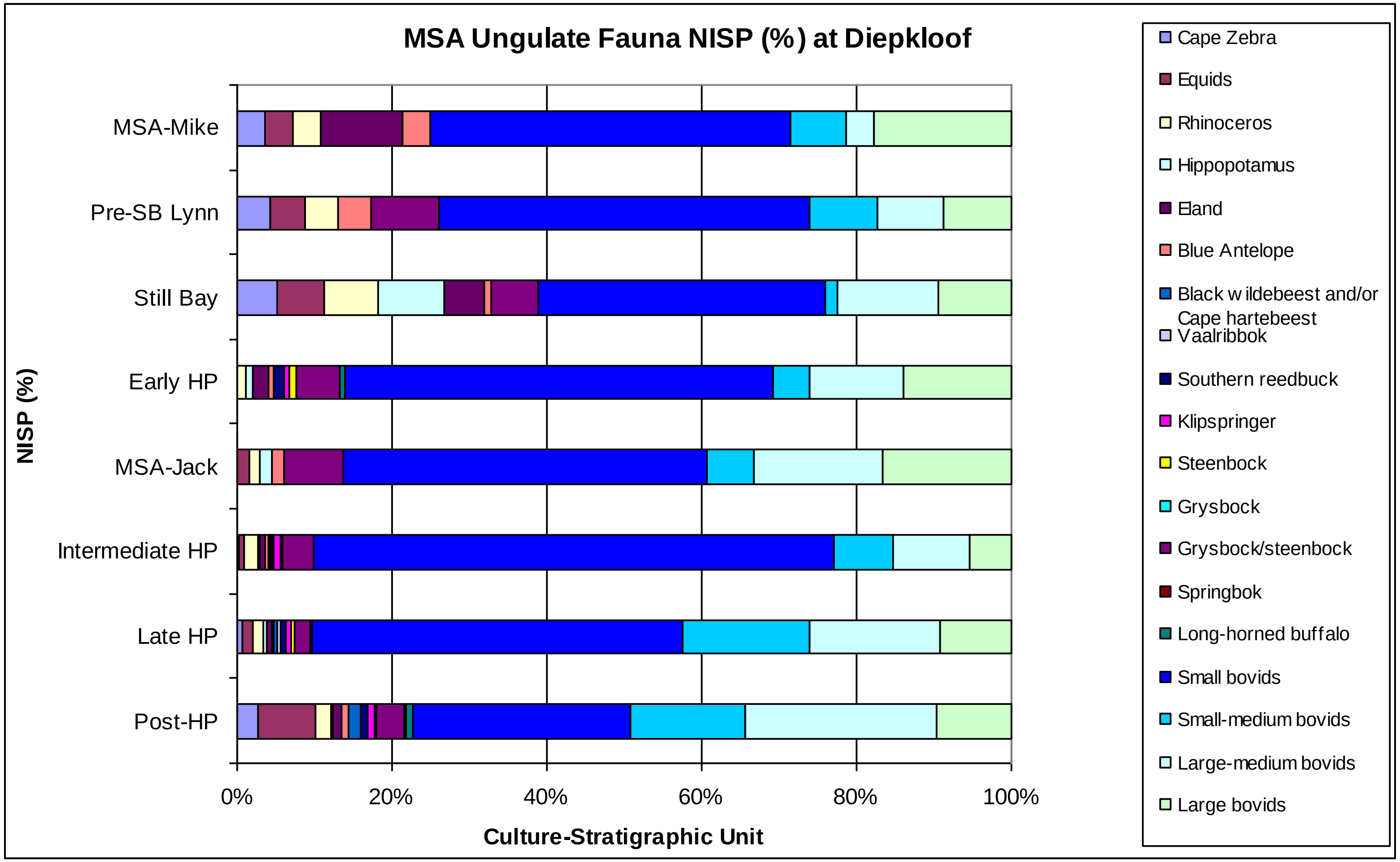


Figure 102: Graph showing macrofauna % NISP at DKR

As Figure 101 and Appendices 35-36 show, both the MNI and NISP values of earlier MSA levels tend to be lower than those from later in the period. This is perhaps partially due to the earlier cultural denominations generally comprising fewer stratigraphic units. Bovids are prominent throughout the Diepkloof sequence. NISP data is used for assessment unless otherwise stated. Large and large-medium sized bovids account for around 20% of the fauna in every phase apart from Pre-SB Lynn and the Intermediate HP. Small bovids account for the majority of remains in each phase, usually between 45 and 55% of the overall fauna. They are notably less prevalent in the Still Bay (37%) and post-HP (28%) phases however (Figure 102, Appendix 37). Although only ever a small portion of the total remains in phases where they are present, both cape zebra and equids are very poorly represented in Howieson's Poort deposits (although not altogether absent). Some larger species, such as rhinoceros, hippopotamus and possibly long-horned buffalo may be over represented on the grounds that their significantly larger and denser skeletal elements may have better survived fragmentation. Unfortunately, an assessment of element representation has not been conducted.

Bovid exploitation seems to have become an even more predominant focus in the Howieson's Poort, where non-bovid species account for less than 15% of the total fauna per phase. In the post-HP and pre-HP phases, non-bovid species account for between 20 and 30% of their respective assemblages, and nearly 40% of the Still Bay assemblage, which is bolstered somewhat by larger than usual quantities (>5%) of both rhinoceros and hippopotamus. The assemblage of MSA-Jack is fairly consistent in structure to the Howieson's Poort phases within which it is sandwiched, but with seemingly greater emphasis on large and large-medium bovids. Species diversity throughout the sequence is relatively consistent throughout the earlier phase of the sequence, with between nine and twelve different species per phase from MSA Mike until MSA Jack, but in the subsequent later portion of the sequence, 16 or 17 different species were identified per phase Figure 101. Despite this, phases MSA Mike, pre-SB Lynn and Still Bay have the greatest diversity of species representation. Although Cape zebra and other equids return in the post-HP, there is little other similarity in the composition of the non-bovid ungulate fauna with pre-HP phases.

6.6.5 Palaeoenvironment

The surrounding environment of Diepkloof during the MSA was likely much grassier than that of today or recent historic times. This assessment is based upon the large number of now regionally extinct grazing species identified from the remains including Cape zebra, blue antelope, southern reedbuck, black wildebeest, and long-horned buffalo. These species are characteristic of both glacial and interglacial Pleistocene sites from this region (Steele and Klein 2013), and consequently, it is difficult at this stage to differentiate more nuanced changes in habitat based upon the current faunal data. Prey such as Klipspringer, Vallribbok (or grey rhebuck) as well as baboon and hyraxes attest to the presence of the exploitation of rocky slopes within the vicinity of the site (Ibid 2013, 3457). Although no complete analysis of the microfauna recovered from the site has been conducted, it has been observed that among the dune mole rats, variation in size over time probably reflect changes in humidity. A greater presence of grasses is already suggestive of a moister climate, and analysis of the dune mole rat remains from the sequence have lead the analysts to suggest that during the Still Bay and prior MSA phases during the last Interglacial (MIS 5), conditions were particularly moist (Ibid 2013, 3458).

Analysis of charcoal recovered from pre-Still Bay, Still Bay and Howieson's Poort phases has allowed for recognition of some of the key vegetation communities exploited by occupants of the site. "Vegetation communities" are described because it is more meaningful when attempting to reflect changes in prevailing environment to observe patterns in associations of different genera rather than the presence or absence of individual species (Cartwright 2013, 3467). The pre-Still Bay charcoal samples are characterised by diverse afromontane forest taxa, with the remaining taxa as being from fynbos (Ibid 2013, 3468). The presence of afromontane species is perhaps surprising considering the elevation of the site (120m a.s.l today).

The Still Bay, in contrast, has a more diverse array of vegetation communities, which, coupled with an apparent increase in the procurement of non-local lithic materials, may suggest a greater sourcing range as the reason for this. These communities include afromontane, afrotemperate (a sub type of afromontane forest peculiar to the Western Cape), riverine woodland and fynbos among others. In the Howieson's Poort, this diversified further, but the increased presence of thicket and shrubland species, presumably within the expanding fynbos may suggest drier conditions than in previous periods, a trend that seemingly continued into the post-HP. It is also important to note that the large number of stratigraphic units comprising the Howieson's Poort compared to those from preceding cultural phases may help account for some of this variation.

The impressive level of detail of Cartwright's analysis to an extent belies efforts to invoke simplistic prevailing trends in climate change (2013, 3474), even though this remains the resolution that MSA archaeology is restricted to. The research at DRS is ongoing, and Cartwright is rightfully cautious of over extrapolating environmental proxies in acknowledgement of the limitations inherent to the nature of the data. Nevertheless, it seems that mosaic environments of varying composition and relation were exploited throughout the assessed portion of the MSA, with the diversity of represented species and vegetation communities increasing over time. Following analysis of the MSA fauna, it was concluded that grasslands must have figured more prominently in the landscape than in more recent times. Although the vegetation communities (such as fynbos) identified through charcoal analysis do not preclude the presence of grass species, grassland biomes themselves are probably underrepresented though studies such as these.

6.7 Summary

At each of the sites studied for this case-study, the Howieson's Poort started suddenly, although at Diepkloof, there is apparently some modest overlap between Still Bay and HP pieces. The sudden appearance of the Howieson's Poort is difficult to verify due to the small number of sites at which these horizons co-occur or are not separated by a hiatus in deposition. Similarly, understanding how and why the Howieson's Poort ended has also proved difficult due to dearth of well known post-HP MSA deposits. Although geographically disparate, the sites of Klasies River, Sibudu and Diepkloof are therefore of considerable importance. They broadly cover the extent of the area across which Howieson's Poort assemblages have been documented. Environmental contexts for these sequences have been considered individually due to problems with generalised inferences about prevailing climatic fluctuation.

Various approaches to dating these deposits have, until recently, seemed to indicate a terminal OIS 4 or early OIS 3 age range for the Howieson's Poort. New dates from Diepkloof and the discovery of microlithic and geometric assemblages outside of the conventionally accepted range, if verified, confronts archaeologists with one of two likelihoods: either the Howieson's Poort is substantially more variable in nature and duration than was commonly thought, or alternatively the small geometric pieces so distinctively characteristic of the industry may not have been so unique after all. Considering the geographic area across which the HP has been reported, and the generally poor archaeological resolution of non-HP and Still Bay phases of the MSA in southern Africa, perhaps these challenges should not be so surprising.

The geometric pieces synonymous with the Howieson's Poort are in fact just one defining feature of a broader shift in technological modes. Broadly speaking, shifts in material selection strategies appear to correspond to the appearance, although in some cases, these changes appear to have begun prior to, or continued some time after the appearance of these forms (Lombard 2006c; Cochrane 2008). It is difficult to correlate environmental change with technological phases due to the spatial resolution of sites (Chase 2010), and the gradual nature of habitat transformation documented at many of these sites (e.g. Guillaume Porraz, Parkington, et al. 2013). Nevertheless, it seems that HP technology was utilised in a variety of environmental settings. At Diepkloof and Sibudu, HP technology appears to coincide with a greater emphasis on bovids, although species diversity at all sites remains high even if many are only minimally represented. The faunal signature for the HP at Klasies River is particularly diverse, though this may relate to problems with the quantification of the assemblage being restricted to MNI (Dusseldorp 2012; Klein 1976).

The geometric pieces of the Howieson’s Poort may represent new technological adaptations relating to weapon-systems (Lombard and Phillipson 2010). Certainly their unique form may have facilitated new hafting possibilities, and the new production strategies that they, and other HP pieces represent, suggests a different mode of technological organisation. While I would hesitate to concur with those who advocate the use of these pieces as armatures for bow and arrow weaponry, I also believe that many of the more regular flake-blade/bladelet pieces of the MSA and smaller pointed flake blades (Singer and Wymer 1982) may have equally facilitated composite hunting technology. Further research directed to these pieces is required to test this belief and allow a greater appreciation of just how technologically significant the geometric pieces actually were.

7 Early Interior Alaskan Microblade Sites

Despite a long tradition of prolific archaeological research (Nelson 1935), driven largely by the belief that eastern Beringia holds the key to understanding the earliest settlers of the Americas, the record of late Pleistocene and early Holocene adaptations in Alaska remains in a somewhat myopic state. The sheer variability in the archaeological record both temporally and geographically has made singular narratives increasingly less tenable (Goebel and Buivit 2011b). With time, the impact of AMS radiocarbon dating has begun to show (Yesner 1996; Bever 2006; Mason et al. 2001; Potter 2008b; Wygal 2011; Dumond 2001; 2011), although attempts at refining chronological resolution have if anything further complicated matters. Although the archaeological industries identified in the region do not all have tightly delineated geographical bounds, the danger of normative thinking with regards to environmental variability across the vast expanse has been increasingly acknowledged as the resolution of the Beringian palaeoecological record has improved (Bigelow and Powers 2001; Alfimov and Berman 2001; Begét 2001; Brigham-Grette 2001; Muhs et al. 2001; Mason et al. 2001; Murray 2002; Hoffecker and Elias 2003). The sites considered in this investigation are geographically restricted to a region referred to as Interior Alaska to provide some control over this issue.

7.1 Interior Alaska: The Tanana and Nenana Valleys

Interior Alaska represents the best area for study for a number of reasons. For the purposes of this investigation, Interior Alaska comprises the Tanana and Nenana Valley systems (Figure 103). The latter is a tributary of the former (Figure 104). The majority of dated late Pleistocene and early Holocene sites known from across eastern Beringia are located within these two valley systems (Magne and Fedje 2007; Ackerman 2007). Although microblade activity was widespread well beyond these interior river valleys, these locales represent both the oldest confirmed occupation sites currently known in Alaska, and also represent relatively discrete geographical and topographical ranges within which to consider microblade function (Holmes 2001; Hoffecker 2001). The sites in these regions are also among the most extensively researched and widely published, providing the most suitable data-set for consideration relative to the time period which many of these sites span: the Pleistocene / Holocene transition across the Younger Dryas cold period.

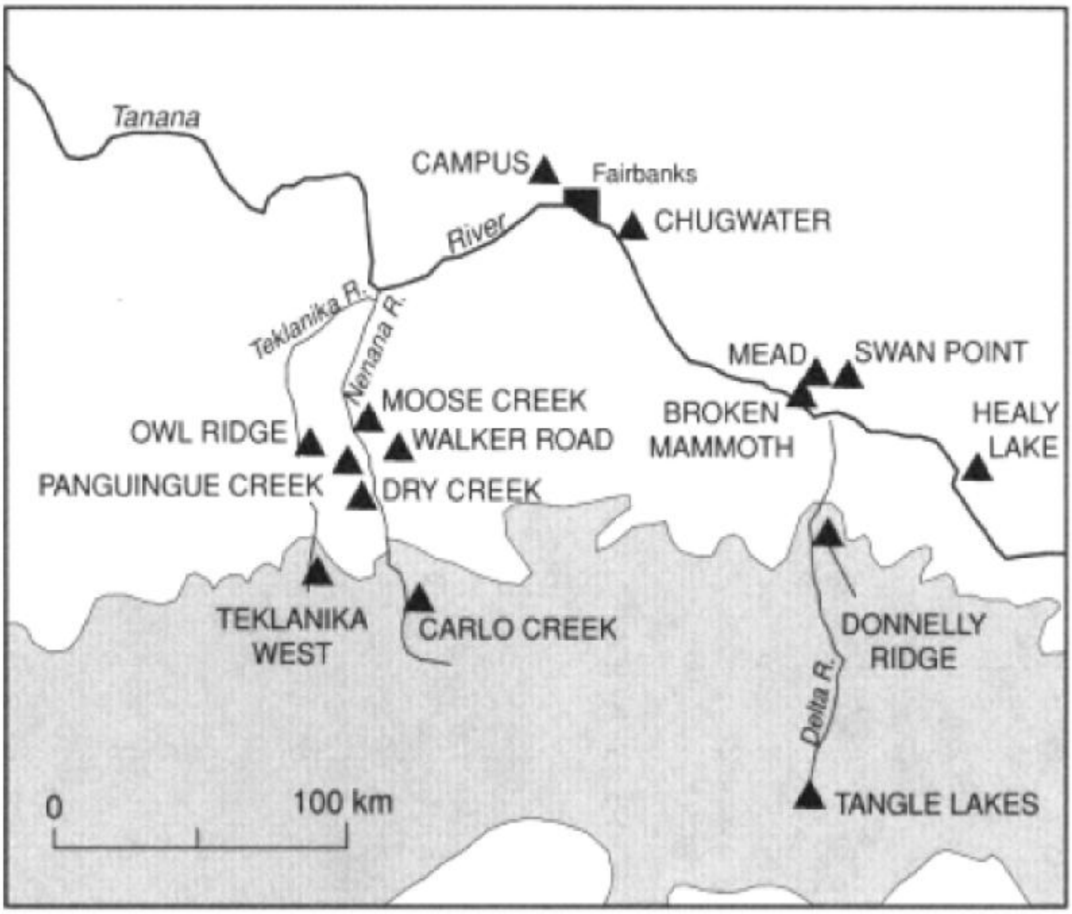


Figure 103: Map of Interior Alaska

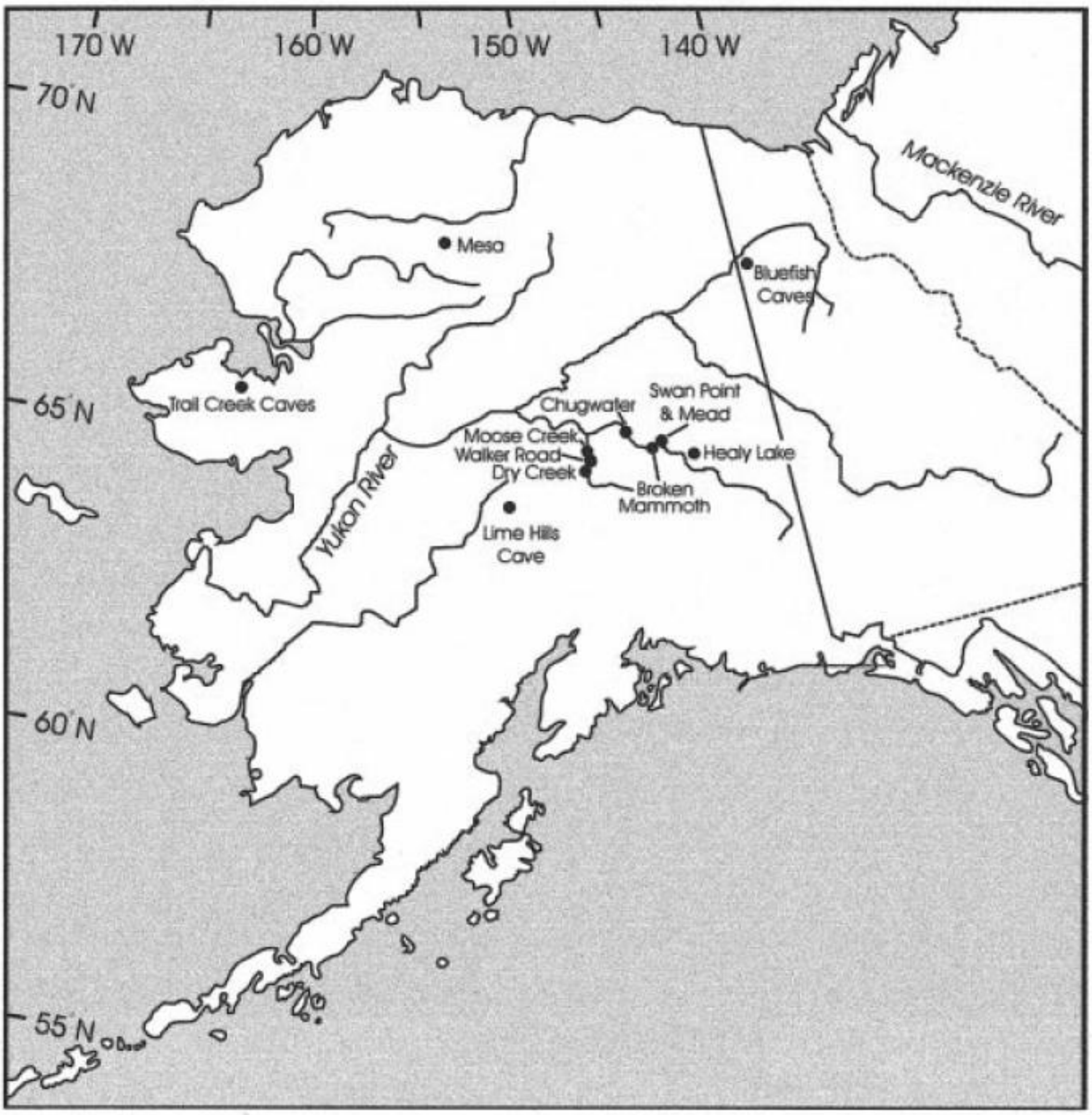


Figure 104: Map of early Alaskan sites showing interior cluster

7.1.1 Chronological Range

Early microblade industries from the late Pleistocene and early Holocene form the main focus of attention here. This time range covers the earliest known occupants of Alaska through the Younger Dryas and the post-YD Holocene Thermal Maximum (or Milankovitch Maximum). In central Alaska, these earlier archaeological components are better known and understood than those from the mid and late Holocene. While there are more known sites including those with microblade assemblages from the mid-late Holocene, these have been less extensively investigated, and lack the chronological control and environmental and faunal data of earlier period sites. The quantity of AMS radiocarbon dates from occupations of this period is much less than that from older sites, and the shallower stratigraphic depth from which many of these occupations are recovered renders many of the associated dates vulnerable to various complications arising from young buried forest soils in Alaska (Erlandson et al. 1991, 35; Yesner 1996; Wygal 2011, 236). Although there have been recent efforts to redress the imbalance of attention afforded to older sites in east Beringia (Potter 2008a; Potter et al. 2007), the quality and resolution of data still compares poorly with that of sites from earlier periods (Wygal 2011).

The chronological range of microblade industries in Alaska does not, at present, appear to have clear limits. Rather, it seems that microblade technology persisted to varying degrees throughout most of the extant Pleistocene and early-mid/late Holocene records (Wygal 2011). As mentioned above, the overwhelming majority of attention has focussed upon the earlier assemblages from the late Pleistocene and early Holocene which are generally agreed upon as pertaining to the Denali industry (Ackerman 2007). Revisions in the interpretation of the core-reduction process utilised in the oldest microblade assemblage from Swan Point have favoured distinction from the Denali (Holmes 2011; Graf and Bigelow 2011), though at present this occurrence remains an anomaly. Microblade assemblages are perhaps best differentiated according to assemblage variability because of their ubiquity as a technological mode throughout much of the early colonisation and occupation of Alaska (Wygal 2011). There is a lack of consensus over the definition and constitution of later Holocene techno-complexes, with multiple nomenclatures for different regional and chronological variations (Clark 2001; Ackerman 2007; Holmes 2008; Dumond 2011). Among these later microblade industries is included the “late Denali”, an industry known for its affinities with its earlier namesake industry, but dated to the later Holocene (e.g. Yesner and Pearson 2002; Pearson and Powers 2001), although acceptance of this classification has not been accepted by everyone (Holmes 2008). Until better agreement can be reached upon the classification of these assemblages, a focus upon the earlier Denali assemblages remains less contentious. As well as being the most extensively studied and dated of the various microblade industries in Alaska, early Denali components comprise a relatively rich site density in the interior valleys, and boast the best accompanying faunal and environmental datasets. This study follows the precedent of other assessments of microblade technology in focussing specifically upon the period between 14,000-9/7000 cal BP (Mason et al. 2001; Potter 2011; Wygal 2011).

7.1.2 **Criteria for Inclusion**

Only sites with microblade components reliably dated to the late Pleistocene and early Holocene are included in this investigation. From the Tanana Valley, these include Swan Point, Broken Mammoth, Gerstle River Quarry and Chugwater. From the Nenana Valley, the sites of Dry Creek and Panguingue Creek are included. A number of notable microblade yielding sites from these valley systems are excluded for failing to securely date to this period. The Donnelly Ridge site, which formed the basis for West's initial definition of the Denali (1967), is excluded as the site lacks stratigraphy and has not yet been successfully dated (West 1996b). The Campus site, which again played a notable role in the original definition of the Denali industry (Morlan 1970), is excluded as the microblade component of the site has so far only been securely dated to the mid / late Holocene (Pearson and Powers 2001). Likewise, while the site of Healy Lake appears to have been occupied during the late Pleistocene and Younger Dryas, problems with stratigraphic integrity have rendered it impossible to characterise the nature of this occupation and to reliably date its deposits (Erlandson et al. 1991; Cook 1996; Hamilton and Goebel 1999, 169). Little Panguingue Creek has yielded a Denali like assemblage that closely resembles that from Dry Creek, but seemingly has a much younger date, pertaining to the late Holocene (Hoffecker and Powers 1996). Moose Creek qualifies for inclusion (Pearson 1999; Hoffecker 2001), but unfortunately the lithic assemblages from the site have not yet been sufficiently detailed to be of any substantially informative value. Finally, from the valley adjacent to east of the Nenana river system, a Denali component was defined at Owl Ridge, but is excluded from consideration here because the assemblage lacks microblades (Hoffecker et al. 1996). Teklanika West is also excluded as dates from the site are too young to qualify as Pleistocene or early Holocene deposits (Goebel and Buivit 2011, 5).

Early Alaskan Assemblage Variability

Although the early Alaskan industries are among the best known, a range of opinions exists regarding how they should be classified and defined typologically, chronologically and geographically. The earliest widely recognised industries are the Nenana, Denali and Mesa technology types. Some researchers have also advocated the recognition of the Chindadn as a distinct technological entity. Although the small tear-shaped bifacial points unique to this classification (Figure 105) have been found in association with microblade technology, they also occur in assemblages that otherwise conform to the Nenana designation (Goebel 2011). Consequently, while Chindadn points represent a distinct tool type, the notion of their being associated with a separate cultural entity remains difficult to extricate from the traditional Nenana / Denali dichotomy (Holmes 2001, 165). For Interior Alaska, relative working definitions for the Nenana and Denali are necessary (see below), but not the Mesa industry. The hallmark of Mesa technology, named after the site at which the type-fossils were discovered, is large paleoindian points of a style not dissimilar to those of other North American archaic traditions such as the Clovis. Traditionally, it was largely believed that Mesa technology was geographically restricted to the North-West (Hoffecker 2011). Although large foliate points of a similar nature have been recovered in archaeological components from Interior Alaska, and while a connection has been posited (see discussion of Dry Creek component II) (Hoffecker and Elias 2007, 198; Hoffecker 2011, 171), the presence of Mesa technology requires further substantiation before it can be satisfactorily recognised as part of the techno-historical trajectory of the region.

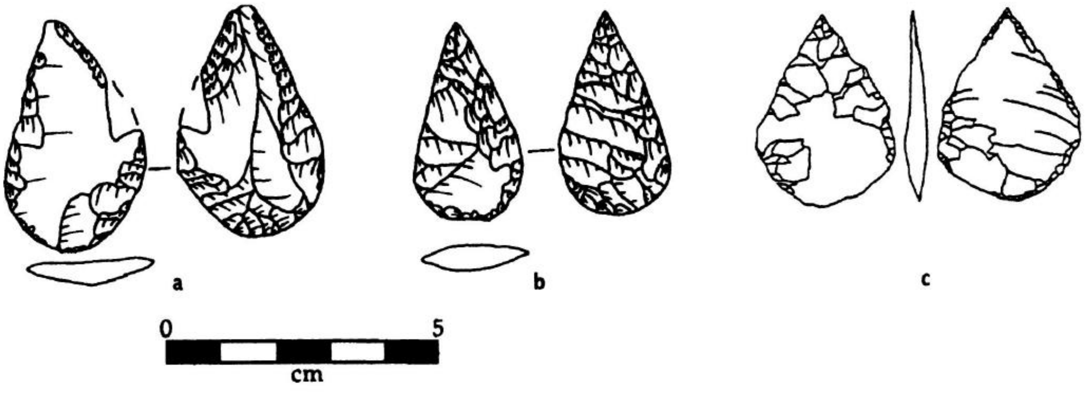


Figure 105: Chindadn Point "Teardrop" Bifaces. Points a and b from Walker Road, and c from Moose Creek.

7.1.3 Alaskan Microblades

Microblades, as understood within the context of the late Pleistocene and early Holocene archaeology of eastern Beringia (Alaska and Yukon Territory) are most clearly defined as regular, elongated prismatic flakes (usually with three longitudinal facets on one side, and a plain face upon the reverse side), and generally between 0.4 and 0.8cm wide and 2 and 3cm long (Clark 2001, 64). There is no universally recognised regional definition however, and varied standards continue to be used among Alaskan archaeologists (Wygal 2011, 234). Although they may be subsumed within the generalised category of microlithic technology, the general attributes detailed above allow for the development of a more nuanced categorisation and understanding (Kuzmin et al. 2007, 3). Brian Wygal distinguishes microblades from bladelets (and other blades) by suggesting that they were manufactured specifically for the purpose of hafting in composite tools, whereas he considers bladelet production to lack the control of standardisation necessary for this intention (2011, 234). Mason et al. concede that while it is unquestioningly assumed that microblades were used in the fashion advocated by Wygal, firm evidence for this practice from Alaskan contexts remains scarce (Mason et al. 2001, 526).

7.1.4 **Denali**

The Denali was first defined by Fred Hadleigh-West from assemblages from four sites, including (and primarily from) his work at Donnelly Ridge (West 1967). The ambitiously well defined criteria he set forth for determining what constitutes the Denali has subsequently been abandoned as too restrictive as the discovery of more sites has highlighted the range of variability typical of early Alaskan lithic assemblages (Mason et al. 2001, 526). Although currently, definitions of the Denali vary, most characterisations continue to emphasise microblades (and associated pieces: e.g. prismatic cores and burins) and bifacial knives as among the more diagnostic elements (e.g. Vasil'ev 2011, 120). Despite this, the Denali cannot be regarded as synonymous with microblade technology, and several occupations lacking microblade technology have also been assigned to the techno-complex (Mason et al. 2001; Hoffecker et al. 1996). Not long after West's proposition of the Denali, another similar schema was proposed for the recognition of many early Alaskan microblade assemblages, the "American Paleo-Arctic Tradition" (Anderson 1970). Definitions of both the Denali and Paleo-Arctic Tradition have undergone substantial revisions since their initial formulation, and although neither have been formally accepted or rejected (Goebel and Buivit 2011), Denali seems to have prevailed among many researchers concerned with early Alaskan microblade technology (Powers and Hoffecker 1989; Hoffecker et al. 1993; Mason et al. 2001; Bigelow and Powers 2001; Yesner and Pearson 2002; Potter 2011; Wygal 2011; Graf and Bigelow 2011), particularly in

Interior Alaska where West's work has been of the greatest influence (West 1967); the Paleo-arctic Tradition was initially designated specifically to industries in the north-west (Bever 2001, 147).

7.1.5 **Nenana**

The Nenana industry, initially proposed as a regional phenomenon restricted to Interior Alaska, was formulated following excavations at Dry Creek and other sites within the Nenana Valley (Powers and Hoffecker 1989; Goebel et al. 1991). As with many other attempts at classifiying technological traditions in Alaskan prehistory, definitions can be quite variable. The main defining feature upon which Nenana assemblages are distinguished is their lack of microblade technology (Powers and Hoffecker 1989, 280). Consequently, the Nenana is most frequently characterised in juxtaposition or contrast to the Denali (Yesner and Pearson 2002). Other commonly cited assemblage characteristics include bifacial knives, macro-blades, unifacial scrapers and knives, gravers, end scrapers, choppers and anvils (Vasil'ev 2011, 120). The discovery of microblades in deposits previously typologically attributed to the Nenana (Swan Point CZ4 and Broken Mammoth CZ3) highlights the fragility with which these terms can be effectively employed.

7.1.6 **Microblades vs. Non-Microblades Dichotomy**

When the definition of the Nenana complex was first proposed, the absence of microblades was considered a stark contrast to the other Denali assemblages. Deposits assigned to the Nenana typically underlie the Denali stratigraphically. Consequently, the notion of a temporally dichotomous relationship between microblade and non-microblade technology, Denali and Nenana, has dominated discussions of early Alaskan prehistory in recent decades (Wygal 2011). The discovery of microblades in the oldest deposits at Swan Point CZ4 and CZ3 (the former being the oldest confirmed archaeological deposit in Alaska) and also Broken Mammoth CZ3 shows that the microblade and non-microblade technology were likely contemporaneous with one another, and brings the effective utility of these definitions into question (Goebel and Buivit 2011, 14–16). While the Nenana continues to underlie the Denali in most instances where the two are recorded at the same site, the range of overlap in radiocarbon dates has further exacerbated attempts to chronologically distil one from the other. As it is impossible to completely eschew existing paradigms, the nomenclature of Denali and Nenana is maintained in this investigation, but the emphasis remains upon the microblade aspect.

7.1.7 **Type Sites**

Although Alaska lacks sites with secure, deep stratigraphic sequences of human occupation, type-sites nevertheless come to dominate discussion through their use in the characterisation of assemblage variability, or through other unique analytical insights or combinations thereof that investigations have proffered. In this sense, Broken Mammoth may be considered something of a type-site for the unique inference of faunal exploitation that analysis of the site has provided from oldest occupations CZ3 and 4, while the lithic assemblages from these components remain not yet extensively detailed and, until recently, small in size. As far as lithic variability is concerned, Dry Creek (Component I) has been acknowledged as the type-site for the definition of both the Nenana complex (Graf and Goebel 2009, 57) and the Denali (Mason et al. 2001, 526), as for a long time Component II at the site represented the most substantial collection of early Denali pieces from a securely dated deposit. Subsequent work at the site of Walker Road has established a larger more definitive Nenana complex and has become the type-site for the industry, largely through confirming details derived initially from Dry Creek Component I (Goebel 2011). Given that some scholars now question the certainty with which these techno-complexes can be successfully demarcated (Potter 2011; Wygal 2011), the utility of a "type site" even in this regard is reduced to functioning as a reference for the terminology used in research.

7.1.7.1 Alaskan Sites Diagram

The diagram generated for this case-study area differs from those created for the south-african and cantabrian studies. Whereas previous diagrams have focussed upon a single, well-documented site capable of providing an extended and relatively continuous stratigraphic and chronological sequence, such an approach was not possible for the Alaskan study area due to the substantially different nature of the sites in question. Sites with extended stratigraphic and chronological ranges comparable to La Riera and Klasies River simply do not exist in Alaska. As a compromise to this problem, the Alaskan diagram amalgamates all the sites investigated in one pictograph. By using multiple sites, the vertical axis (change over time) is measured in uncalibrated radiocarbon years as a replacement for a singular internally concordant stratigraphic sequence. The inclusion of multiple sites also helps compensate the relative scarcity of data gathered; while early Interior Alaskan sites are among the most extensively studied in eastern Beringia, none have been studied in any level of detail approximating the investigations of La Riera or Klasies River.

7.1.8 **Occupation of Eastern-Beringia Prior to Swan Point**

Swan Point represents the only site assessed in this investigation where there is no antecedent occupation either at the site or in the broader region with which to contextualise the occurrence or proliferation of microlithic technology. Concerns regarding the stratigraphic integrity of the site have been sufficiently allayed to allow widespread recognition of component CZ4 at Swan Point as, at present, the oldest identified occupation of Eastern Beringia (Goebel and Buvit 2011; Vasil'ev 2011; Ackerman 2007; Hoffecker and Elias 2007) currently dated to 14,800 cal BP (12,360 RCYBP) (Holmes 2011, 182). Microblade traditions in Eastern Beringia are generally characterised as having been transmitted with an influx of people across the land bridge, or alternatively as having developed in-situ as an adaptive response to the conditions of the changing environment. The acceptance of CZ4 at Swan Point greatly favours the former interpretation (Vasil'ev 2011; Wygal 2011). A variety of microblade types, or rather production techniques, have been identified throughout eastern Siberia, China and Japan (Chen 2007), and although the Diuktai tradition of eastern-Siberia is often cited as the ancestral tradition of both the Swan Point assemblages (Holmes 2011, 184; 2001, 165) or later east Beringian microblade complexes in general (Yesner and Pearson 2002, 156), there are sufficient divergences both within non-microblade assemblage components (Vasil'ev 2011) and within microblade production techniques (Chen 2007) to merit caution in stressing the connection between the Diuktai and later Denali technologies.

The anomalous date of the Swan Point microblades from CZ4, currently the only example of a confirmed microblade assemblage underlying a Nenana component (Ackerman 2007, 154), renders the question of origins speculative pending the discovery of further contemporary deposits (Vasil'ev 2011; Wygal 2011). Several sites outside of the Tanana and Nenana valleys currently under investigation (Bluefish Caves, Lime Hills Caves, and Trail Creek Caves) have been suggested as similarly ancient if not older components than the Shaw Creek sites (Morlan 2003; Sattler et al. 2001; Cinq-Mars and Morlan 1999), but have proven impossible to date satisfactorily due to various stratigraphic and taphonomic problems (Yesner 2001, 316; Hoffecker and Elias 2007, 130). While the earliest occupation of Eastern Beringia may currently lie beyond our grasp, obsidian sourcing studies on material from Broken Mammoth and Swan Point may be interpreted as implicit evidence of good knowledge of the extended landscape and perhaps social groups (Holmes 2001, 167), belying an even older presence in the region (Hoffecker and Elias 2007, 130; Dixon 2011, 363). Furthermore, with the extension of dates for the Clovis and the widespread acceptance of pre-Clovis industries in North America, along with the site of Monte Verde and possibly other ancient sites in South America, it seems rational to suppose an earlier human presence within eastern Beringia if indeed this was the main or only entry point for peoples into the Americas (Bever 2006).

7.2 Palaeoenvironmental Data

While palaeoenvironmental reconstruction is partly possible at sites where faunal remains have been recovered from securely dated contexts, the scantiness of these assemblages means archaeologists must defer to other sources of information to supplement their understanding of conditions. Among the most important of these are general trends in faunal extinction (Guthrie 2001; 2006) and pollen and vegetation reconstructions (Edwards and Barker Jr. 1994; Bigelow and Edwards 2001; Bigelow and Powers 2001). Recent studies have incorporated this information into their own investigations to good effect (Mason et al. 2001; Wygal 2011; Graf and Bigelow 2011).

In a recent survey, Guthrie collated a large database of dated faunal remains from across Alaska and plotted them against one another along with estimated changes in vegetation (Guthrie 2006). His results are best represented in (Figure 106). Both mammoth and horse seem to go extinct in Alaska not long after the earliest evidence of human presence. The overlap between human presence and the decline of these species has been interpreted as insufficient to substantiate hypotheses of human predation as a driving factor in these extinctions (Guthrie 2006). Horse body size began to decline long before humans are documented in Alaska (Guthrie 2003). That said, it is likely that horse at least may have featured among the diet of Alaska's earliest inhabitants (Holmes 2011). Holmes also believes that mammoths were hunted by the occupants of Swan Point CZ4, perhaps using microblade technology, although this particular scenario seems perhaps unlikely. Mammoth remains have been found at a number of early Alaskan sites, even as late as 8860 RCYBP in Component III at Gerstle River Quarry (Potter 2001). So far, no post-cranial mammoth remains have been found associated with human occupation in Alaska (Table 34). Several of the ivory fragments, which comprise the majority of mammoth remains from archaeological deposits, significantly predate the archaeological deposits they are associated with. This has led other researchers to suggest that remains were primarily scavenged rather than hunted (Yesner 2001, 323).

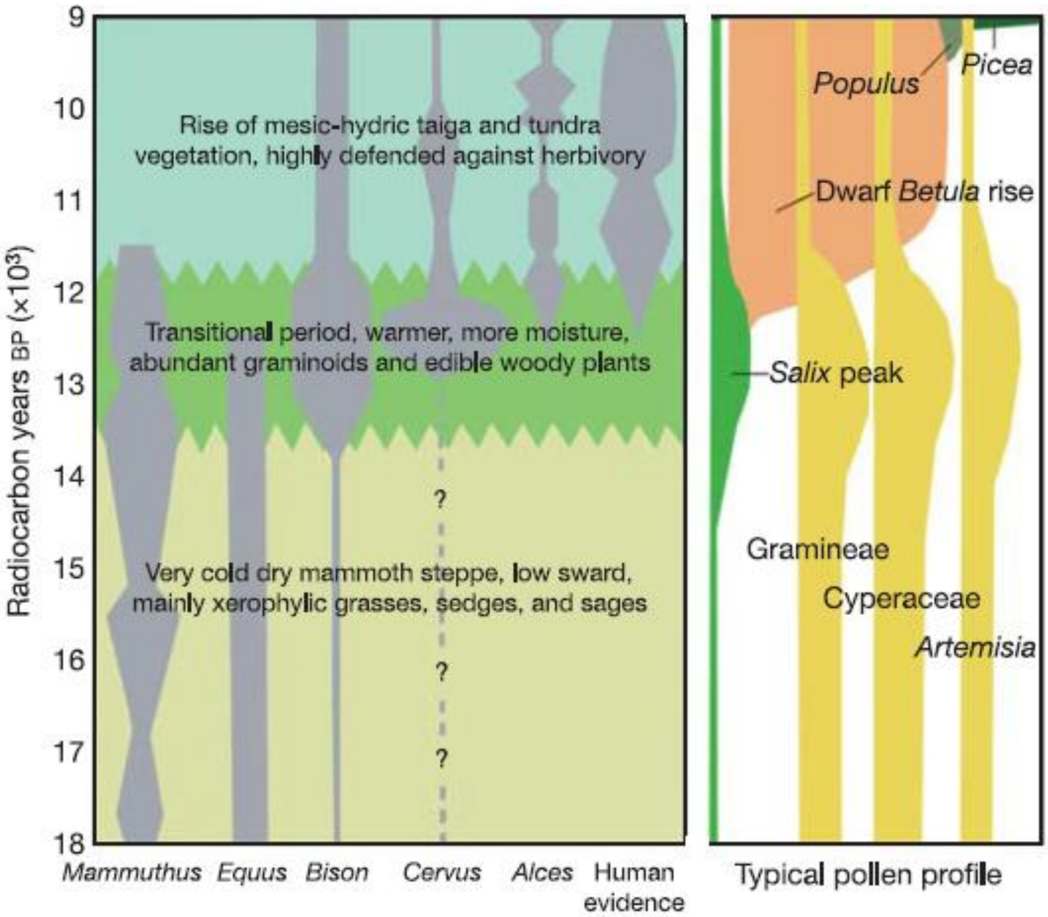


Figure 106: Diagram showing timing of increase and decrease in various species (floral and faunal). From Guthrie (2006).

More pertinent perhaps than the extinction of various megafauna for inhabitants of Alaska at this time was the emerging dominance of new grazing species: bison, moose and wapiti just prior to Swan Point CZ4 (Figure 106). The arrival (wapiti and moose) and expansion (bison) of these species was likely a result of a change in climate that allowed for a higher abundance of graminoids, tree willow, and edible woody plants than had previously been available across the mammoth steppe (Guthrie 2006, 208). Wood was likely still scarce for the earliest populations at Swan Point CZ4 however, as hearth residue analysis suggests bone was the main source of fire fuel (Crass et al. 2011). This matches with evidence from pollen cores sampled from around the study area (Bigelow and Powers 2001; Bigelow and Edwards 2001). Discordance exists within the record because of the disparity in AMS and non-AMS dates used. Windmill Lake at the southern end of the Nenana Valley and Birch Lake downstream to the east of the Shaw Creek flats are considered here as the most reliable proxies as these cores have been AMS dated (Bigelow and Powers 2001, 182). These show that by 12,500 RCYBP, and beginning around a thousand years earlier (Guthrie 2006), a slight increase in moisture likely precipitated a greater abundance of many species, particularly sedges and willow prior to the establishment of widespread birch shrub tundra by 11,800 RCYBP, perhaps even earlier in lowland areas (Bigelow and Edwards 2001, 211). Artemisia, a group of hardy herbaceous shrubs, appears to have been important at this time among the Tanana lowlands (Bigelow and Powers 2001, 183).

Source	**Site**	**Find Description**	**Find Date Uncalibrated**	**Associated Occupation**
Holmes (2001); Potter (2001)	Gerstle River Quarry	Ivory Rod	Undated	Component III
Holmes (1996; 2001), Yesner (1996; 2001)*	Broken Mammoth	Ivory Fragment Ivory Fragment	15,830 ± 70 BP 11,540 ± 140 BP	Cultural Zone 4
Yesner (1996; 2001)*	Mead	Ivory Fragment	17,370 ± 90 BP	Cultural Zone 4
Holmes (2011)	Swan Point	Tusk Midsection Large Ivory Flake Mammoth molar plate	12,060 ± 70 BP 12,050 ± 120 BP 12,110 ± 120 BP	Cultural Zone 4
Gelvin-Reymiller et al. (2006)	No Associated Site	Incomplete tusk	35,150 ± 530 BP	N/A

Table 34: Dated Mammoth remains associated with human activity in Alaska

Prior to this time the landscape was sparsely vegetated, and glaciers may have persisted on the upland perimeter of interior valley systems. Once birch was established as the dominant vegetation type however, it remained so throughout the ensuing millennia. The landscape was far from homogenous though, and likely formed a variable mosaic habitat, with shrub species more prevalent in wind scoured areas (Ibid 2001, 188), perhaps as the Tanana Valley floodplain may have been at times (Mason et al. 2001, 536). Graminoids and sedges also prevailed throughout much of the period providing a food source favoured by bison. Spruce did not become widely established until around 8500 RCYBP, and poplar and alder even later (Bigelow and Edwards 2001, 213). It is not clear how significantly the Younger Dryas affected the landscape, but increased aridity during the latter half seems to have retarded and perhaps temporarily diminished the expansion of birch in favour of *Artemisia* across much of Alaskan plains at this time (Ibid 2001, 212).

7.3 Sites

7.3.1 Swan Point

Swan Point (grid reference: 63º18'N, 146º02'W) is located approximately 7km north east of the Broken Mammoth site and 5km west of a tributary of the Shaw Creek river (Hoffecker and Elias 2007, 119), which itself feeds into the Tanana River to the south (Figure 107). The site is situated upon a small knoll at the eastern end of a 1km long ridge, 25m above the surrounding lowlands of the Shaw Creek Flats (Holmes 1996). Swan Point has been known about since the early 1990's, and ongoing excavations and investigation at the site has led to the identification of 4 "cultural zones" (CZ 1-4) of archaeological materials, spanning from the terminal Pleistocene to the early Holocene. Excavations originally consisted of a $1m^2$ test pit, but have subsequently been expanded in area to around $60m^2$ to allow the delineation of identified hearth features in both CZ4 and CZ3 (Potter 2011; Holmes 2011).

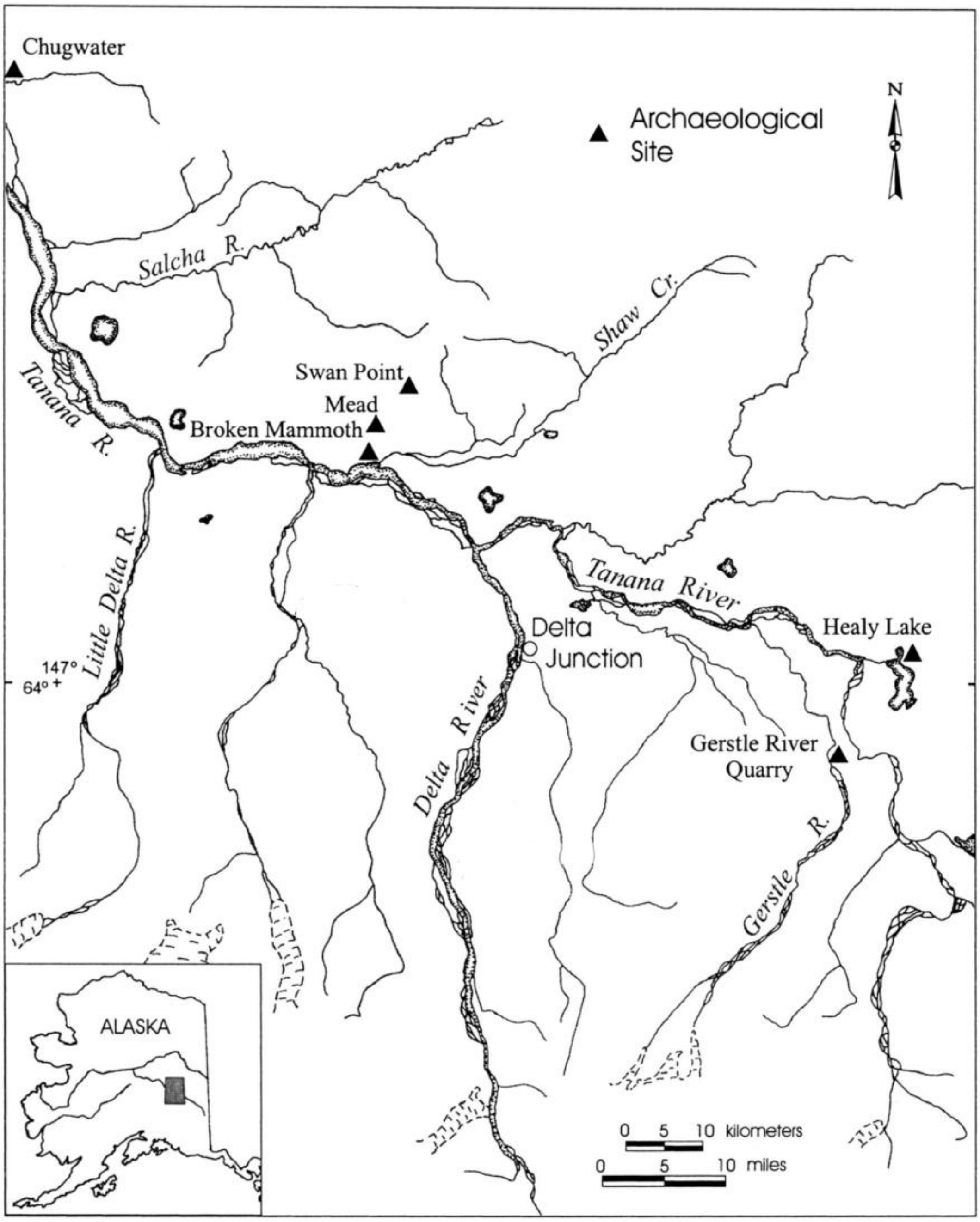


Figure 107: Map of the Tanana Valley showing sites mentioned in text

Swan Point has yielded the oldest evidence of Alaskan occupation currently known although, as discussed earlier, there is reason to believe that there earlier sites may or may have existed (Speakman et al. 2007). The oldest component at the site is designated as CZ4, and is the only occurrence of microblade technology dated prior to 13,000 cal BP in Alaska (Potter 2008b, 189). As already discussed, the association of this date with the presence of microblade technology (Appendix 38) served to seriously challenge existing hypotheses regarding both the nature of America's initial colonisation (previously supposed to pertain to the Nenana complex), and the role of microblade technology as a clear-cut marker of ethnicity (Vasil’ev 2011).

7.3.1.1 Stratigraphy and Dating

The stratigraphy of Swan Point is very similar in sequence to that of Broken Mammoth (Figure 108) (Holmes 2001; Hoffecker and Elias 2007). With the exception of the apparent intermission between CZ4 and CZ3 believed which coincides in part with the onset of the Younger Dryas, occupation of the site occurred throughout much of the Holocene (Holmes 2011, 182; Graf and Bigelow 2011, 437). The stratigraphy consists of one metre of aeolian sediments (greyish-brown sand) overlying basal colluvium and sand deposits and frost-shattered bedrock, consisting of two main phases of loess containing various palaeosols associated with CZ3 human occupation (Figure 109) (Holmes et al. 1996, 320). Deposition of the loess started rapidly during the Younger Dryas but decelerated increasingly thereafter (Holmes et al. 1996, 320; Holmes 2011, 180). Wind polished fragments within the lag deposits that precede the earliest deposition of loess suggest an open landscape susceptible to the elements at the time of CZ4, while it is hypothesised that CZ3 co-occurs with the so-called “transitional period” (Holmes 2011, 182) featuring the YD and immediately post-YD. CZ4 is separated from CZ3 by around 10-15cm of loess, estimated to represent a hiatus of around 1000 years (Holmes 2011, 183). Maximum estimates for dates acquired from CZ4 span between 12,360 – 11,770 RCYBP, while the age range for CZ3 is 10,570 – 10,010 RCYBP (Holmes 2011; Holmes 2008; Holmes et al. 1996). CZ2 is located near the interface between the two loess deposits about 38cm from the top of the sequence, and is dated to 7400 RCYBP, while CZ1 is divided into two sub components (CZ1a and CZ1b) within the uppermost portion of the sequence (Figure 109), dated to between 1750 and 1220 RCYBP (Holmes et al. 1996, 320).

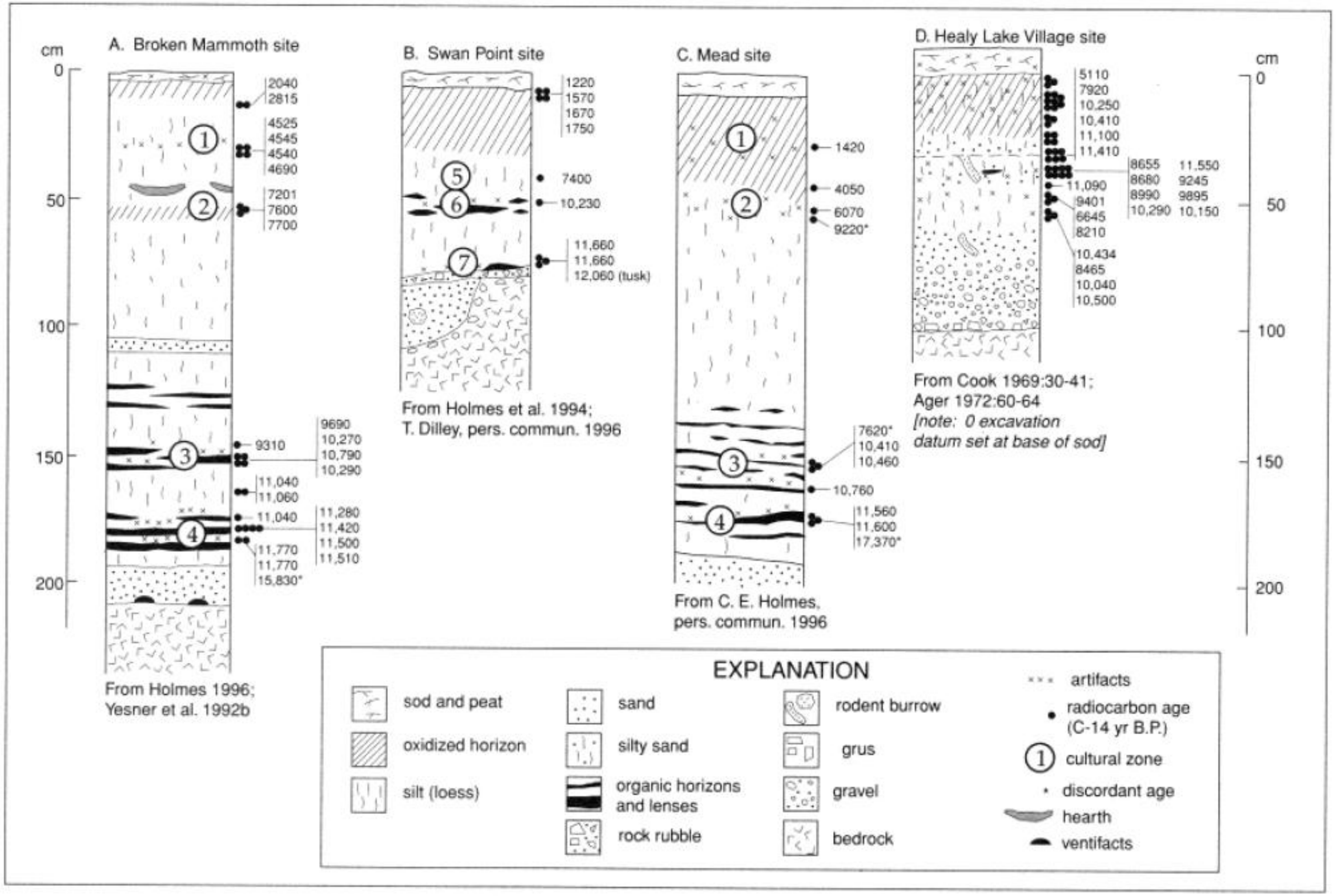


Figure 108: Comparison of stratigraphy from Shaw Creek sites

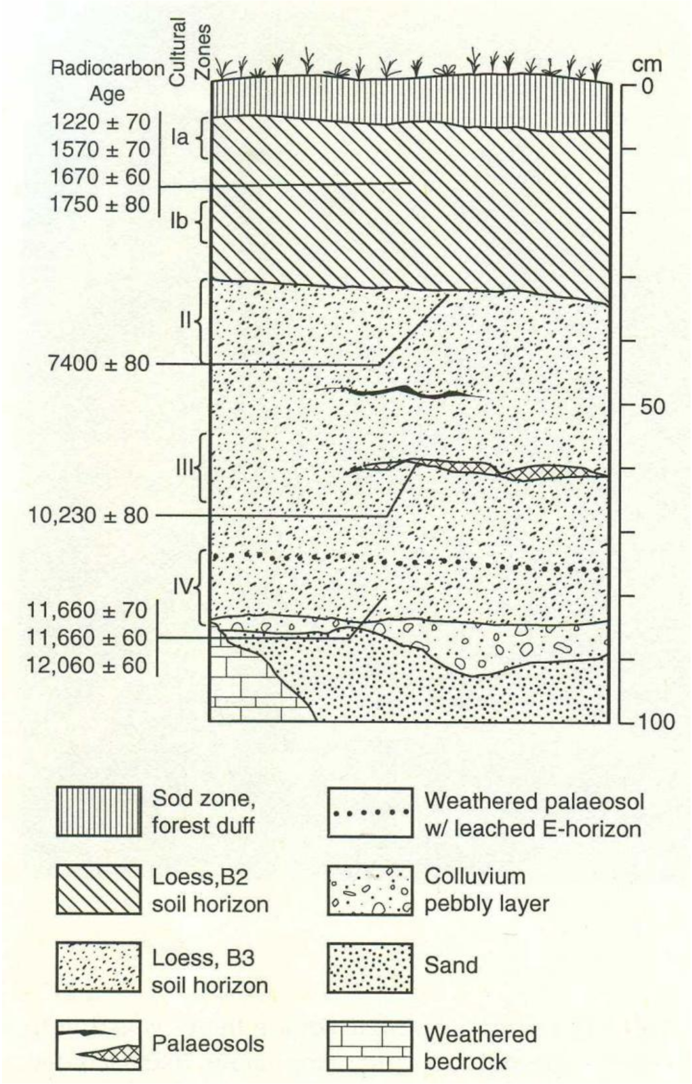
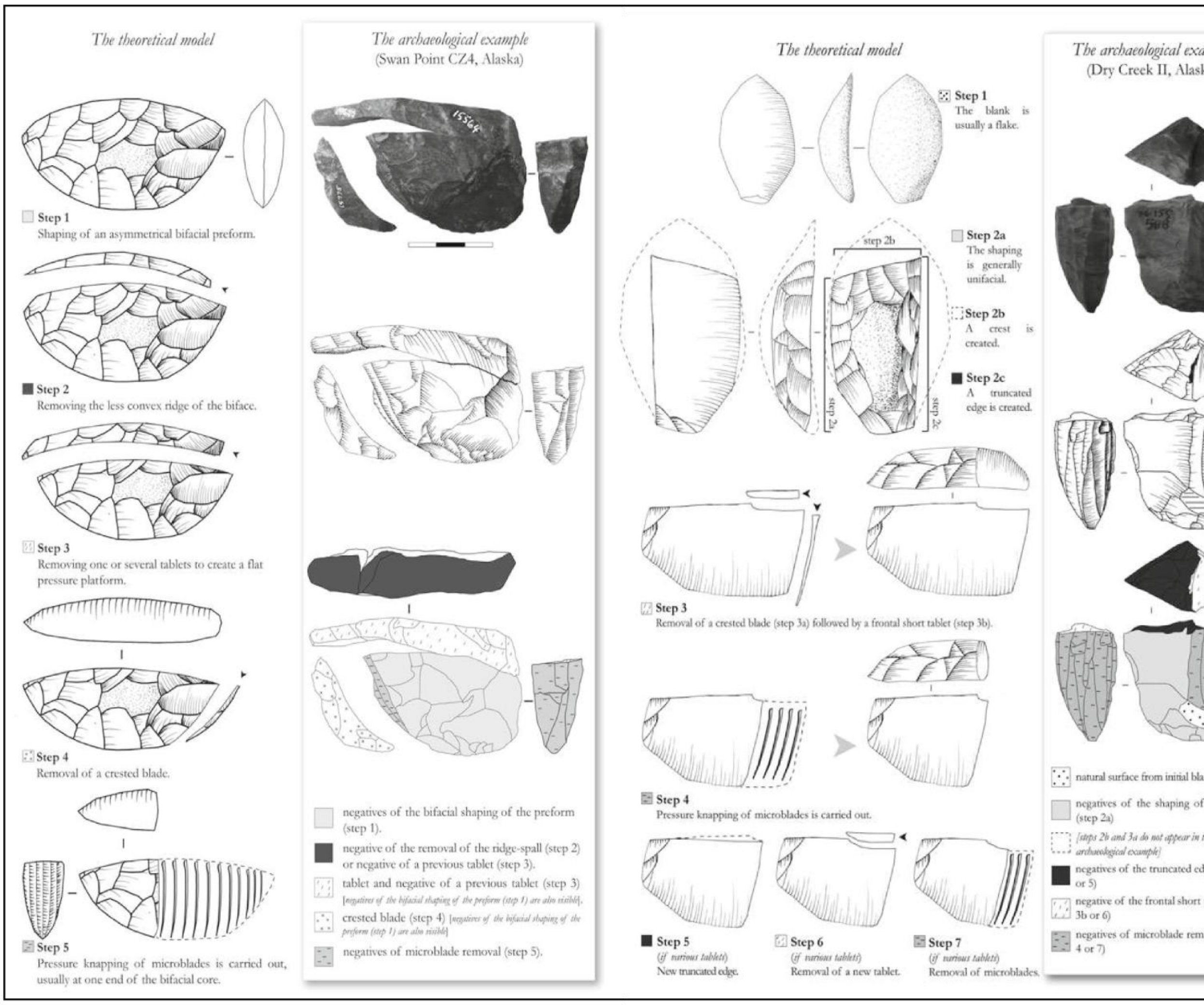


Figure 109: Swan Point Stratigraphic Section

7.3.1.2 Lithics

Although the lithic assemblages from Swan Point have not yet been completely analysed, preliminary details of the assemblages from CZ4 and CZ3 have been made available. So far around 800 microblades have been recovered from CZ4 compared to just 36 from CZ3 (Holmes 2011). A small number of the CZ4 microblades exhibit retouch, seen by Holmes as qualifying them as projectile insets or knives (2011, 184). In earlier reports, it was noted that finished forms were not common among the assemblages (Ibid 2001, 162). The CZ4 microblades are made of chert, rhyolite and obsidian, and are found along with core preparation flakes, with geochemical analysis of three obsidian microblades suggestive of an unknown source (Speakman et al. 2007). Even less is known of the assemblage from CZ3, although the microblades are found in association with chindadn points (Potter 2008b, 189). Holmes believes that microblades from CZ3 were made in a fundamentally different way to those from CZ4 (Holmes 2011), although this interpretation is difficult to verify in the absence of any cores. Those from CZ4 are apparently made with the Yubetsu or Diuktai/Dyuktai method (**Figure 110**), a tradition confined, with the exception of this occurrence, to western Beringia, while those from CZ3 are assumed to be made using the Campus core technique of traditional Alaskan wedge-shaped microblade cores, which utilise platform rejuvenation techniques



(

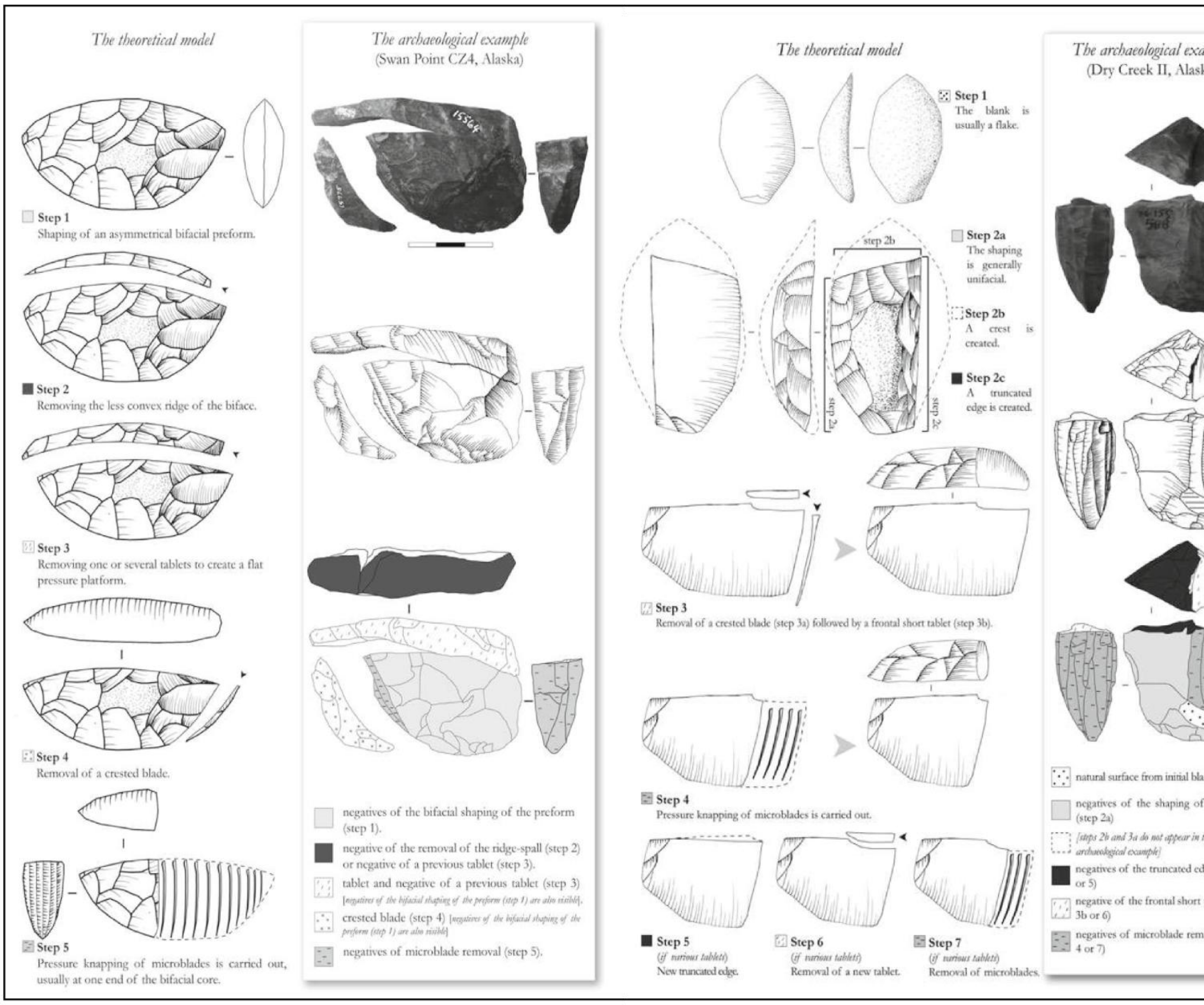


Figure 110) (Coutouly 2012). The Diuktai method uses bifacial cores to produce microblades (Flenniken 1987) and the identification of this method in CZ4 has been used to suggest a connection between west and early east Beringian populations (Holmes 2011; Coutouly 2012). Although a range of other microblade core types occur in Alaska (Figure 111) (Morlan 1970), the Campus wedge-shaped method has been suggested as a historical development of the Yubetsu style (Coutouly 2012).

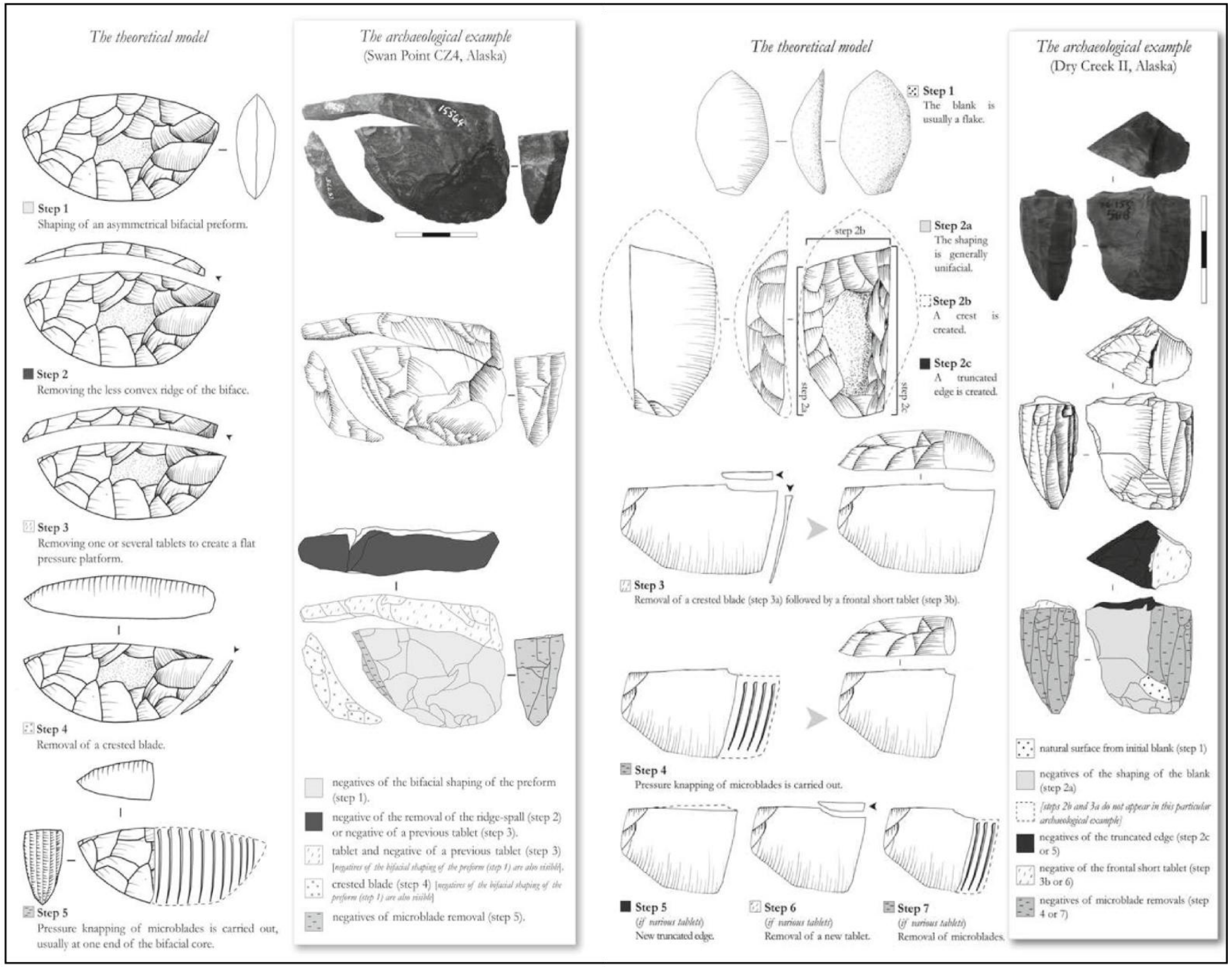
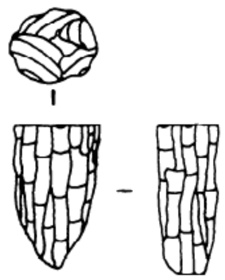
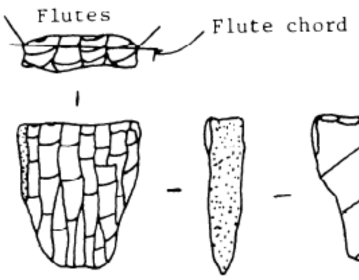


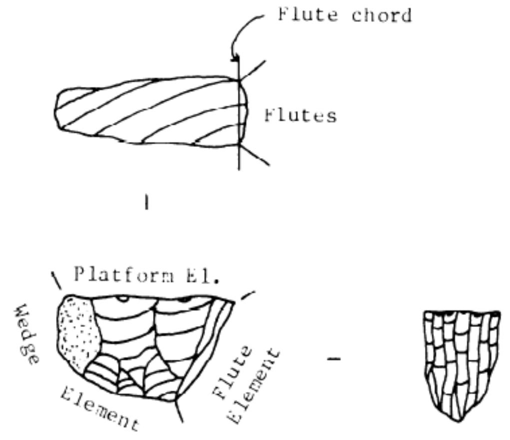
Figure 110: Comparison of Dyuktai and Campus microblade reduction techniques. From Coutouly (2012).



Conical core with continuous fluting



Tabular core with fluting on one face parallel to long axis of platform



Wedge-Shaped core with fluting on one face perpendicular to long axis of the platform

Figure 111: Alaskan microblade core types. From Morlan (1970)

Microblades were also recovered from cultural zones 2 and 1b (Figure 109) (Holmes et al. 1996), although even less is known about these assemblages. Microblade cores from CZ2, dated to around 7400 ± 80 BP, are sub-conical or tabular, distinguishing them from other later Denali microblades in the region, i.e. the classic wedge shaped cores of CZ2 at Broken Mammoth, dated to c. 7700-7200 BP (Ackerman 2007, 155–156), see (Figure 111). Without further specifics regarding the quantification of both the lithic and faunal assemblages, it is difficult to attempt a more nuanced interpretation of behaviour at the site.

7.3.1.3 Fauna

The faunal assemblages collected from Swan Point are generally smaller in quantity and less well preserved than those from nearby Broken Mammoth (Holmes et al. 1996, 321). The CZ4 fauna are particularly sparse, although ducks, geese, upland game birds (grouse/ptarmigan) have been identified alongside horse and antler fragments from large cervids, likely moose, caribou or elk (Holmes et al. 1996, 321; Holmes 2011, 184). Most notable among the faunal remains from this component are fragments of mammoth tusk ivory, including some worked pieces, clearly attesting to the scavenging if not hunting of these large megafauna (Holmes 2001; 2011). The CZ3 assemblage contains similar species to those from Broken Mammoth CZ3, with an assemblage dominated by elk and bison, and also a continuation in the exploitation of waterfowl and game birds, but with the notable addition of fish remains (Holmes 2011, 186).

7.3.2 **Broken Mammoth**

Broken Mammoth is arguably the most extensively investigated early Alaskan site to date, and consequently, also the best known. The site has provided unique insights into the palaeoecology and archaeology of early Alaskan occupation, rendering any discussion of Alaska’s earliest inhabitants obliged to give consideration of the site.

More so than any other site included for this study, Broken Mammoth perhaps closest matches the criteria necessary to qualify as a type site as defined for the purposes of this study, representing an example of well preserved fauna (Yesner 2001) and lithic assemblages (Krasinski and Yesner 2008) from securely dated stratigraphic contexts deposited over an extensive period of time (Yesner 1996). However, given the lack of consensus both in the interpretation and clarification of technological traditions geographically and chronologically, the Broken Mammoth site cannot be considered a “type site” in any conventional sense. The ability to directly compare other sites in the Tanana Valley (e.g. Swan Point and Mead) stratigraphically (Yesner 1996; Holmes 2001), and even in the neighbouring Nenana Valley (Hoffecker 2001) through proximity (Figure 103) has given Broken Mammoth a strong role in discussions of late Pleistocene and early Holocene archaeology of early Alaska (Yesner and Pearson 2002).

The site is located near the confluence of Shaw Creek and the Tanana River (64º16’N, 146º07’W) on a 30m high, well drained, south-facing bluff overlooking the river system (Figure 107) (Yesner 1996). The site was discovered in 1989 from material eroding from the face of the bluff, and excavated intermittently throughout the 1990’s and ensuing decade, although unfortunately a sizeable area of the site was destroyed during roadway construction during the 1970’s (Holmes 1996, 312). Discoveries at the site have been published as research has progressed, but a full report for the site is yet to emerge, although such is the site’s importance as previously established, it has already assumed a dominant role in the prehistoric archaeology of the region. The main details of investigation that have so far been made available are accessible through a handful of disparate sources (Holmes 1996; Yesner 1996; 2001; Yesner and Pearson 2002; Krasinski and Yesner 2008). To date, information from the site is limited to material excavated up until 2002 (Krasinski and Yesner 2008). Four cultural zones delineating densities of archaeological materials in the stratigraphic sequence of the site have been identified. The oldest two zones, CZ4 and CZ3, extend the chronology of the site back to the early Holocene and late Pleistocene, and have received the majority of attention thus far (Holmes 2001).

7.3.2.1 Stratigraphy

The sequence of the site has been divided into four broad stratigraphic units, within which the four cultural zones delineating densities of archaeological materials have been identified. The close proximity of the site to the river system is likely responsible for the greater mass of loess deposits documented at the site compared to other Tanana sites further from the water (e.g. Swan Point) (Holmes et al. 1996, 321). As with other sites in the Tanana valley, loess deposits accumulated rapidly at Broken Mammoth, particularly thanks to the site's close proximity to the river. These thick deposits are responsible for the excellent organic preservation at the site, unique among archaeological horizons of similar antiquity in the region, and have also afforded protection against taphonomic disturbance (Yesner 1996, 260).

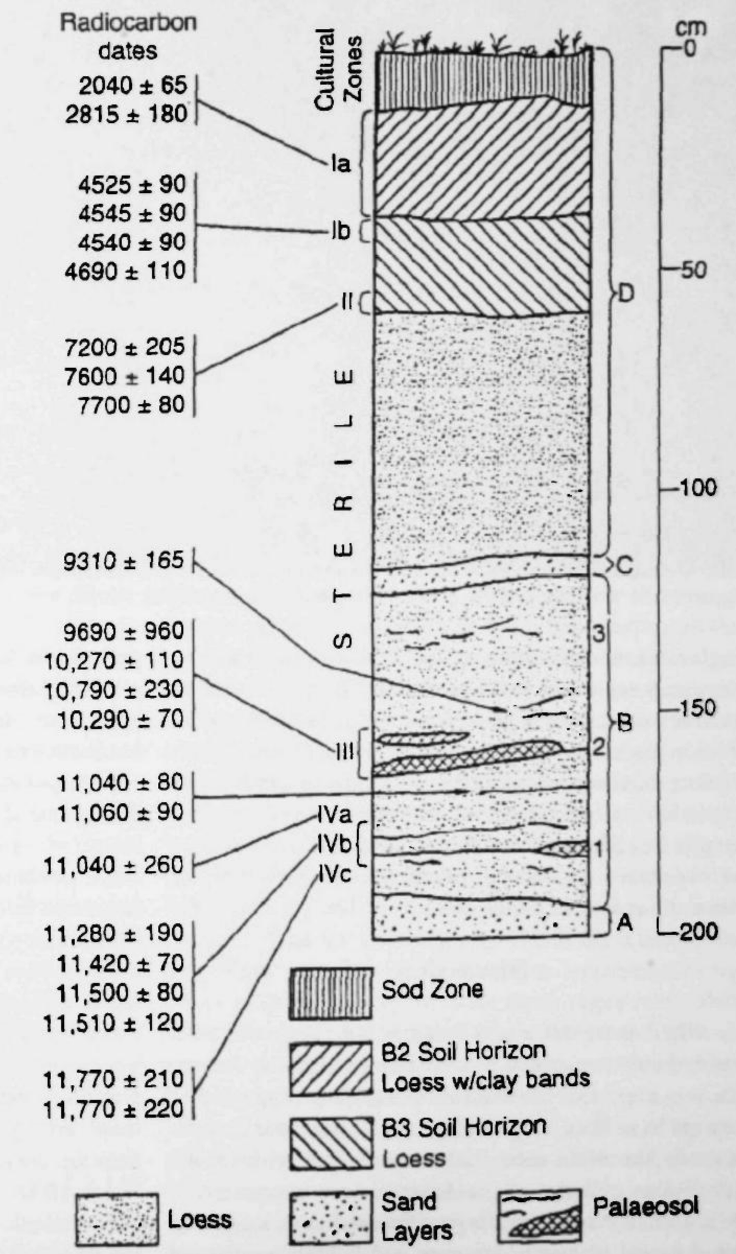


Figure 112: Broken Mammoth Stratigraphic Section

Figure 112 shows the stratigraphic sequence of the site. An area of up to 326m^2 has been excavated at the site (Potter 2011, 225), with the total area of the extant site estimated to be around 650m^2 (Holmes 1996, 313). Most of the palaeosols associated with the cultural zones 3 and 4 are regular, flat-lying, and extend for tens of meters across the site surface, attesting to the lack of cryoturbation at the site (Yesner 1996, 260). As with other sites in the Tanana basin, deposits comprise of loess and aeolian sands. Figure 112 shows the four "geological units" to which the deposits pertain. Figure 108 shows how this sequence compares to depositional units recorded at the nearby sites of Swan Point and Mead. The grey sand of unit A is the oldest deposit at the site, overlying frost-shattered gneissic bedrock, with a *terminus ante quem* deposition date of 12,000 BP (Holmes 1996, 313). Units B and D represent large compact loess deposits (B = Lower and D = Upper), within which the four cultural zones of the site were identified. Unit C, which separates B and D is a thin layer of fine grey sand between 1 and 5cm thick deposited some time after 9000 BP (Ibid 1996). Unit D comprises silty sand deposited over the last 8000 years capped with two distinct soil horizons (containing CZ2 and 1) and the sod (Figure 112).

Unit B is a large silt deposit subdivided into three phases according to associated palaeosol complexes (Figure 112), with only middle and basal palaeosols (B2 and B1) associated with cultural zones (CZ3 and 4 respectively). Unit B2, associated with CZ3, represents the strongest palaeosol formation at the site (Holmes 1996, 313). Cultural zone 4 is sometimes divided into three sub-phases (Figure 112) in reference to the different sediments sampled to acquire dates. CZ1 was also divided into two substages for similar reasons, but with the added distinction that CZ1a and 1b pertaining to different soil horizons within unit D. CZ4 is separated vertically from CZ3 by about 15-25cm, which is in turn separated from CZ2 by around 75-90cm of overlying sediment (Yesner 1996).

7.3.2.2 Dating

Dates for much of the Broken Mammoth sequence remain unchanged from Holmes' original catalogue (1996, 315). Dating efforts focused upon cultural zones meaning that precise dates for geological units A and C are unavailable. Twenty three dates associated with cultural zones 1-4 were acquired from charcoal and bone from throughout the sequence, with CZ3 and 4 the best dated zones. Table 35 shows the minimum and maximum date range (RCYBP) of the different cultural zones after Hoffecker and Elias (2007) and Holmes (1996).

	CZ 1	CZ 2	CZ 3	CZ 4
Uncalibrated C^{14} date range	2040 – 2815 BP	7200 – 7700 BP	10,790 – 9310 BP	11,770– 11,040 BP

Table 35: Dating of Broken Mammoth Cultural Zones

7.3.2.3 Lithics

Some preliminary details of the lithics from cultural zones 2-4 have been detailed to varying extents, although not comprehensively in any currently accessible format (Table 36) (Yesner 1996; Yesner and Pearson 2002; Krasinski and Yesner 2008). Krasinksi and Yesner's spatial analysis of the site's faunal and lithic assemblages is the most contemporary collation of data, spanning excavations from 1993-2002 (the 1993 material remains incomplete). Their analysis is restricted to cultural zones 3 and 4 and microblades and formal tools are excluded from it as they are deemed too small in population size for the purposes of their investigations (2008, 32). The most notable revision in the archaeology of the site in recent years has been the recognition of microblade technology as a component of the cultural zone 3 assemblages, albeit a relatively minor one (n = 44), whereas it has previously been assumed they did not appear at the site until the Holocene in cultural zone 2 (Yesner and Pearson 2002). They remain seemingly absent from the CZ4 assemblage. The stratigraphic security of the site (Yesner 1996, 260) eliminates the possibility of mixing as an explanation for their provenance in CZ3.

	Flakes	Tools	Microblades
CZ3	39890	41	44
CZ4	1284	35	0

Table 36: Broken Mammoth CZ4 & 3 lithics

CZ3 and CZ4 have both been identified as comparable to, if not directly pertaining to the Nenanan techno-complex (Yesner and Pearson 2002, 145). The confirmation of microblades within CZ3 complicates this assessment, and other researchers have expressed reticence in defining CZ4 and CZ3 as a Nenanan industry (Ackerman 2007, 155; Holmes 2001, 165; Graf and Bigelow 2011). Prior to the discovery of microblade technology within CZ3 assemblages, those from CZ1 and 2 were notable for seemingly further confirming a late date for the persistence of microblade technology in the region comparable to that of the Denali, recognised as Late Denali (Yesner and Pearson 2002, 145; although see Holmes 2008 for an alternative interpretation). More details regarding the assemblages from these later cultural zones have not been made widely available, although it is known that over 8000 microblades have been recovered from CZ1 and 2 so far (Yesner and Pearson 2002, 152). Around 75% of these later miroblades are confirmed as having been snapped, with many broken during the manufacture process, while others may have been broken during use (Ibid 2002). The absence of edge retouch and preliminary results from unpublished microwear analyses suggests their use as insets within slotted bone tools (Kononenko, pers.comm in Yesner and Pearson 2002, 152). The majority of faunal data from the site currently available is unfortunately limited to the earlier cultural zones.

7.3.2.3.1 Raw Materials

Precise details regarding assemblage material variability are not available, although generalised descriptions have been given for CZ3 and 4 (Yesner 2001, 324). Although no clear definition as to what constitutes exoticness is given, obsidian from the Batza Tèna region in NW Alaska present in CZ4 (Yesner 2001; Cook 1995) suggests that the procurement of material from distant sources was not necessarily a correlate of microblade technology. This is further supported by the fact that the percentage of “exotic” materials increases greatly in CZ3 (Yesner 2001, 324), although microblades remain a relatively small component of the assemblage (Appendix 38). This suits Yesner and Pearson’s belief that microblade technology represented a technological adaptation to the lack of access to high quality raw materials (2002, 150). They are also posited as a cold-adapted tool-kit, known to be less prone to costly breakage in extremely cold temperatures (Elston and Brantingham 2002).

More precise details for CZ2 and 1 are not available, but Yesner and Pearson's argument explicitly relates to the notion that the earlier occupants of Broken Mammoth were not as well aware of resources available within the extended landscape (Yesner 2001, 324). Presumably, knowledge of these sources, if not access, would have increased over time, which does not sit comfortably with the idea that microblade technology is a greater feature of later, likely warmer occupations of the site. I am inclined to believe that while microblade technology may indeed have mitigated the risk-costs of technologies that would have utilised larger stone components, particularly in times of great coldness, the presence of apparently exotic materials in CZ4, even in small quantities, demonstrates knowledge if not regular access to or appreciation of them.

7.3.2.4 Fauna

The good quality of organic preservation at Broken Mammoth is largely attributable to three factors: the calcareous nature of the deposits, themselves facilitated by the arid conditions of the early Holocene, the thickness of the loess cap at the site preventing destruction of deposits by the development of acidic podzols throughout the Holocene, and a probable higher than usual permafrost table that seemingly did not subject deposits to cryoturbation (Yesner 1996; Yesner 2001). The quality of preservation, while unique, is also relative, and the vast majority of bones were less than 1cm in dimension (Krasinski and Yesner 2008, 33). Over 10,000 fragments had been recovered from Cultural Zones 3 and 4 as of 2001, when the most detailed report of the Broken Mammoth faunal remains thus far was published. Of these 10,000 fragments, 3303 were identifiable to taxonomic categories of ungulate fauna, carnivores, small mammals, rodents, fish and birds. In some cases where the assignment of specific taxonomic classes was not possible, classification based upon size was still possible. Of these, unidentified "large / medium fauna" and "small mammal fauna" categories are included. The more ambiguous "unidentified mammal" category is excluded because of the lacking qualification of size. The NISP values for these categories are given in tables (Appendix 39) and Figure 113. Ungulate fauna, which are assumed to have constituted a main source of prey are presented in tables (Appendix 40) and Figure 114.

The character of the CZ3 and CZ4 assemblages differ notably. Birds account for 47% of the CZ4 assemblage, but only 12% of CZ3, whereas rodents are much more prevalent throughout CZ3 (27%) than CZ4 (19%) (Figure 113). Fragments of woolly mammoth tusk have been found from CZ4, but are not included in analysis; they should not be considered a regular prey species until more convincing evidence of their exploitation can be found contra Haynes and Krasinski (2010). Whereas ungulate fauna accounts for an appreciable 14% of the CZ3 assemblage, it represents just 3% of the CZ4 assemblage according to estimates based on data from Yesner's most recent data (Figure 113). Although the unidentified large / medium fauna cannot be restricted in reference to ungulate data, the relatively small portion of identifiable large-medium non-ungulate species suggests that this category probably comprises mostly ungulate specimens. The ratio of identifiable ungulate species compared to unidentified large / medium fauna shows little variation between the two cultural zones. Examination of the ungulate component shows that elk / wapiti go from being the dominant species in CZ4 to second most dominant in CZ3, replaced by wisent bison, which had been second most dominant in CZ4. Other species, including mountain sheep, moose and caribou account for a greater percentage of the CZ4 ungulate NISP than CZ3 (Figure 114).

The wide variety of fauna in the Broken Mammoth assemblages testifies to the exploitation of a variety of nearby biomes. Bison, elk and moose were most likely available from open parkland, while mountain sheep and potentially caribou indicate forays into upland environments (Yesner 2001, 322). Fish and waterfowl, and particularly Tundra Swan in CZ4 (Appendix 39), show that nearby wetlands were also a profitable source of prey (Ibid 1996, 266).

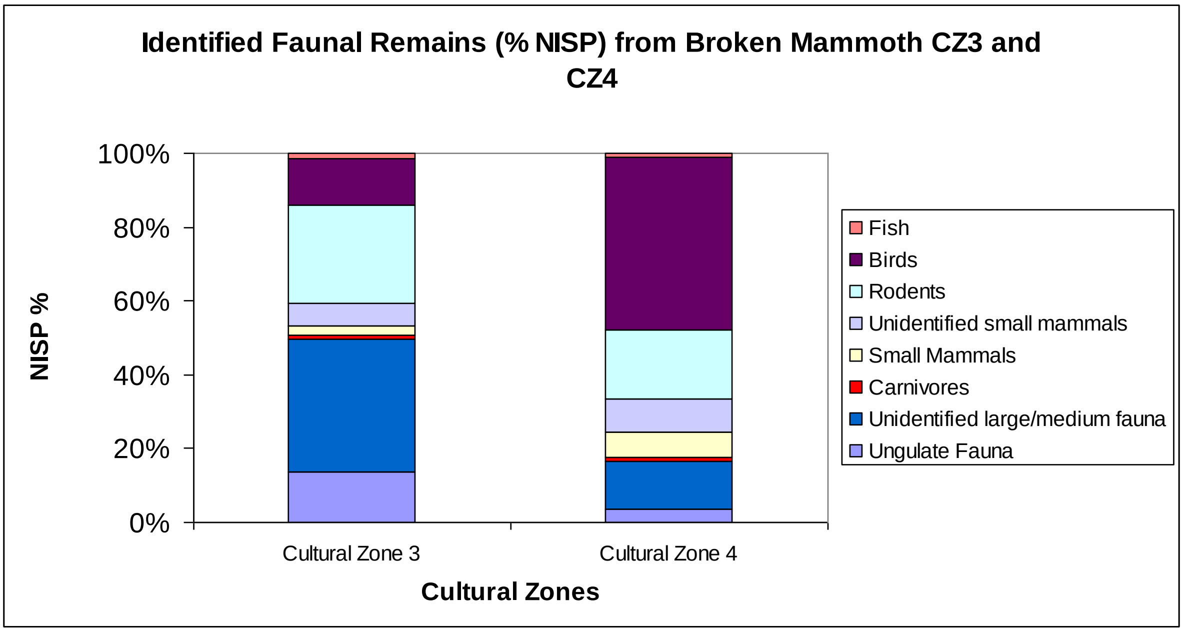


Figure 113: Graph Comparing Broken Mammoth CZ3 & 4 NISP data

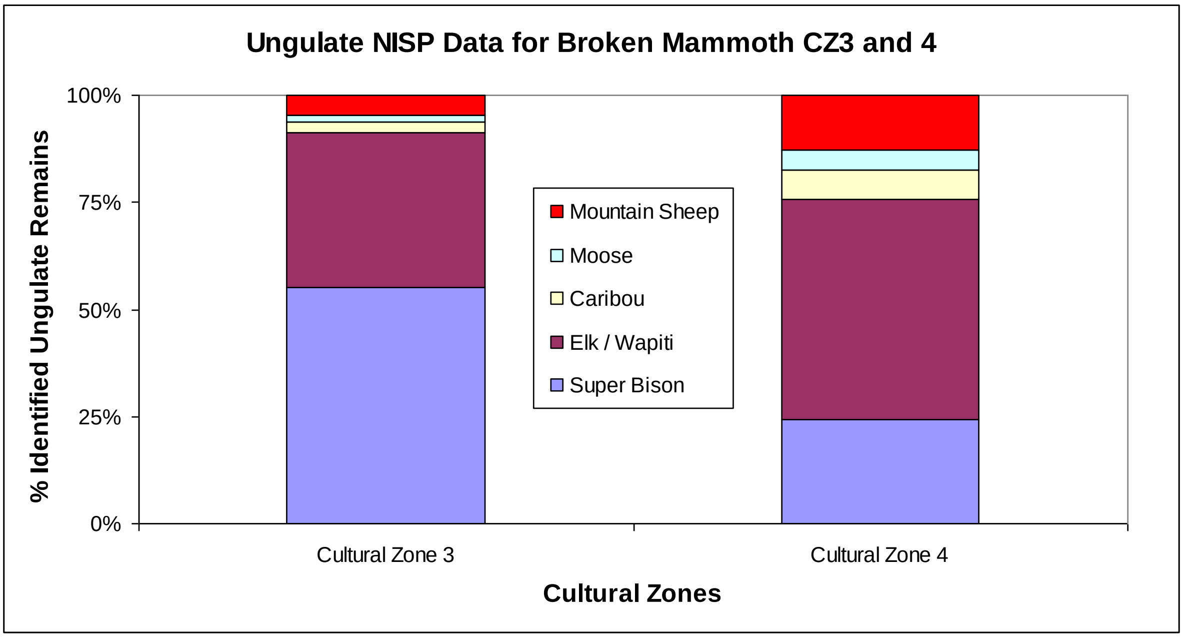


Figure 114: Graph comparing Broken Mammoth CZ3 & 4 Ungulate NISP data

These microenvironments were probably all within close proximity of the site, and the even distribution of skeletal elements among bison and elk suggest that at least these species were not acquired from too far afield (Ibid 2001, 322). It has been suggested that the differences between CZ4 and 3, the shift from elk to bison as the most dominant ungulate and the drop in bird representation most likely reflects a shift in the seasonality of occupation (Ibid 1996). Section analysis conducted on the teeth of elk and bison from CZ3 indicates an occupation focussed around autumn, while a spring season of occupation is inferred for CZ4 from the species of waterfowl recovered (Yesner 2001, 319).

7.3.2.5 Spatial Analysis

Although the spatial analysis conducted by Krasinski and Yesner does not give special consideration to the small microblade component of CZ3, they still elicited some general interpretations worth noting. Spatial analysis of debitage and faunal remains from CZ3 and 4 allowed for the delineation of activity zones throughout the site, although it is difficult to fully ascertain the nature of these activities beyond generalised processing (Krasinski and Yesner 2008). The increased lithic assemblage size of CZ3 is perceived as reflecting both a greater emphasis on lithic manufacturing and larger general population size during this period in comparison to CZ4, when faunal processing remained substantially the dominant activity.

7.3.3 **Chugwater**

The Chugwater site (64º41’30”N, 147º) is located 35km to the southeast of Fairbanks upon the eastern summit of a bluff known locally as Moose Creek Bluff, after Moose Creek village, which lies half a kilometre to the south (Lively 1996). The bluff itself is an extension of the Yukon-Tanana upland approximately 5km west of the uplands in the Tanana River Valley. Chugwater is situated 224m above sea level, and 67m above the surrounding flood plain of Moose Creek, which flows into the Tanana River 3km to the west of the site (Ibid 1996). Initially surveyed in the 1970’s, the site has been excavated twice, between 1982-83 and 1984-87. The first excavations there were conducted by members of the US Army Corps of Engineers. A total area of around 400m^2 was uncovered, from which approximately 25,000 artefacts were recovered (Erlandson et al. 1991, 37).

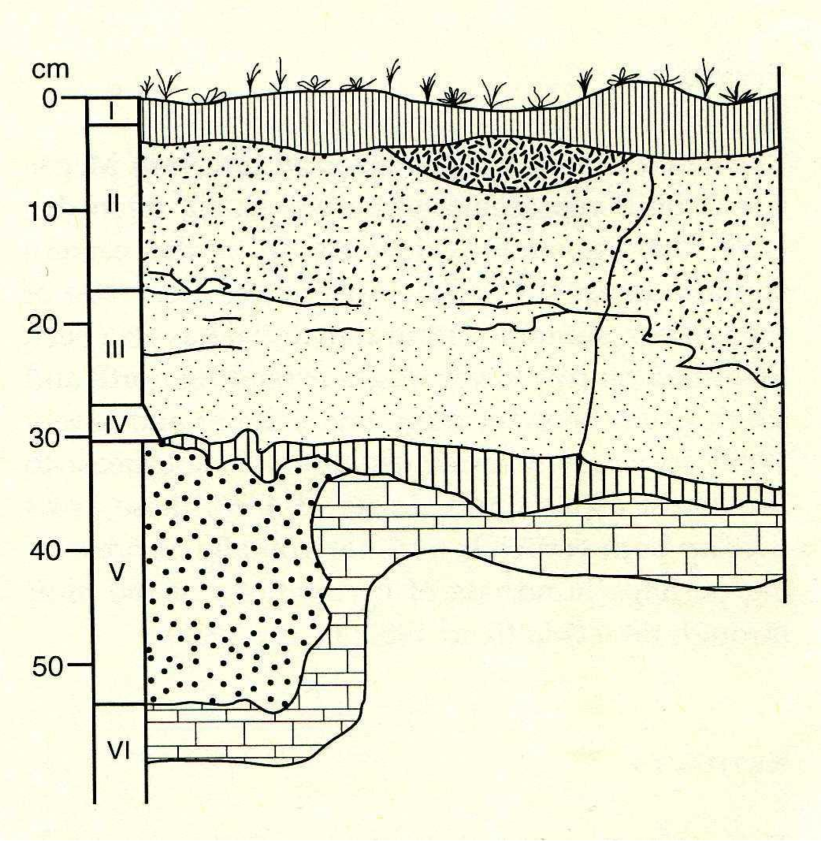


Figure 115: Chugwater Stratigraphic Section

7.3.3.1 Stratigraphy and Dating

The stratigraphic sequence for Chugwater is generally quite shallow, with loess deposits rarely exceeding depths of 25cm (Figure 115). Overlying the bedrock and basal sands (stratums VI and V respectively) is coarse mixed colluvium deposit (stratum IV) comprising rubble, sand and silt (Lively 1996, 309). This deposit marks the base of the loess silt, which is divided into two deposits, an upper (stratum II) and lower (stratum III). A buried organic soil is used to demark the boundary between these deposits, and the upper silt deposit is oxidised, presumably as a result of soil formation processes (Ibid 1996). Stratum I refers to the modern soil cap of the sequence (Figure 115). Despite the shallow depth of the sequence at Chugwater, three discrete archaeological components have been identified within the loess. The shallow sedimentation at the site has left deposits taphonomically affected by cryoturbation, root penetration and subsequent human activities, rendering dating the site problematic. While a suite of radiocarbon dates have been obtained from throughout the sequence, it has proved possible to relate just one of the archaeological components to any of these dates, and even this association is regarded with caution (Erlandson et al. 1991, 42). These dates, associated with component II are: 8960 ± 130 and 9460 ± 130 RCYBP, and represent the oldest dates acquired from the sequence, with most other dates at the site purporting to an age younger than 2500 years old (Erlandson et al. 1991, 37–40).

	Component I	Component II	Component III
Unretouched Pieces	178	1203	1770
Formal Tools	11	20	57
Microblades	0	22	32

Table 37: Chugwater Lithics Assemblage

7.3.3.2 Lithics

A total of 3239 artefacts have been recovered from Chugwater, encompassing a wide range of raw material variability, including 100 colours and textures of chert, chalcedony, obsidian, moss agate, quartzite, rhyolite, siltstone, slate, sandstone and miscellaneous others (Lively 1996, 310). Although a small number of animal bones have been found, they were too fragmented to be identified, although it is believed that some represent the presence of small mammals and avifauna, with the presence of gastroliths, similar to those discovered at Broken Mammoth, serving as further evidence for the latter (Ibid 1996, 310). Table 37 details the lithic inventories for the three archaeological components at the site. Component I stratigraphically underlies component II, and shares typological affinities with Nenana assemblages (Erlandson et al. 1991). It contains at least one tear-drop shaped chindadn point and end scrapers typical of other Nenana assemblages (Erlandson et al. 1991, 42). The component II assemblage, characterised by bifacial knives and microblades, and with the aforementioned tentative date estimates, has been assigned to the Denali. This assemblage also contained a wedge-shaped microblade core, gravers, scrapers and point fragments (Lively 1996, 311). Component III lacks any clear chronological markers, although the assemblage contained microblades (late Denali?) and Northern Archaic point types (Ibid 1996, 311; Holmes 2008). Among the varieties of point type found in component III are leaf-shaped, notched, triangular, corner-notched and foliate points (Erlandson et al. 1991, 42). More detailed quantification of these assemblages is, unfortunately, not published in widely available sources.

7.3.4 **Gerstle River**

The site of Gerstle River is located within the Tanana Valley, upon a south-facing “bench” or knob on a loess-mantled bedrock outcrop hill that rises 137m above the surrounding plain of the Gerstle River, a braided river system approximately one mile to the west of the site (Potter 2002, 73). It is somewhat unique among late Pleistocene and early Holocene sites in Beringia due to the association of cultural material and preserved faunal remains recorded in some deposits. The site is divided into two separate main areas of excavation (Figure 116), referred to as Upper and Lower loci, separated by around 30m (Ibid 2001, 52). Much of the southern part of the hill, overlooked by the Lower Locus, has been destroyed by quarrying (Potter 2002, 73). In general, the vegetation of the surrounding area can be characterised by bottomland spruce forest, with an understory of sphagnum moss at the Upper Locus, and aspen and grass around the exposed Lower Locus (Ibid 2002). Work at the site has been conducted since the 1970’s by several different teams of investigators.

As a result of these investigations, excavation has been piecemeal in nature, and publication of data has been largely restricted to grey literature and is difficult to collate. Following the most recent excavations by Potter, it has been possible to correlate different portions of stratigraphy and dates sufficiently to delineate six archaeological components (Ibid 2002, 90), whose location and estimated date ranges are provided within a generalised stratigraphic section profile (Figure 117). While detailed records of archaeological materials remains largely inaccessible (Ibid 2005), summary details have been made available, and the faunal analysis conducted on one of the components at the site is arguably the most extensive of it’s kind among early Holocene sites in interior east Beringia (Ibid 2007). It is only with Potter’s work that any information on the site has become more widely available.

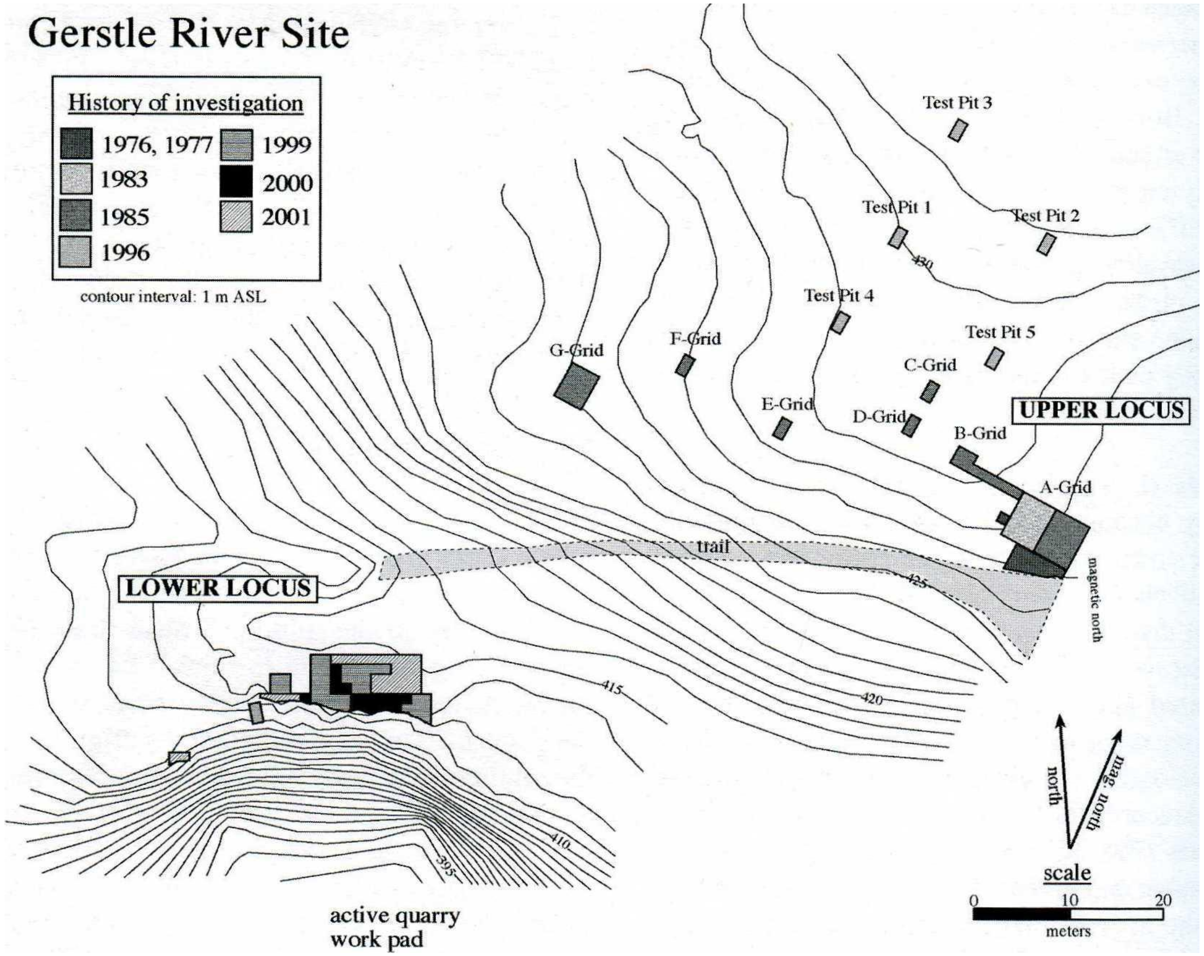


Figure 116: Gerstle River Quarry Excavation Plan

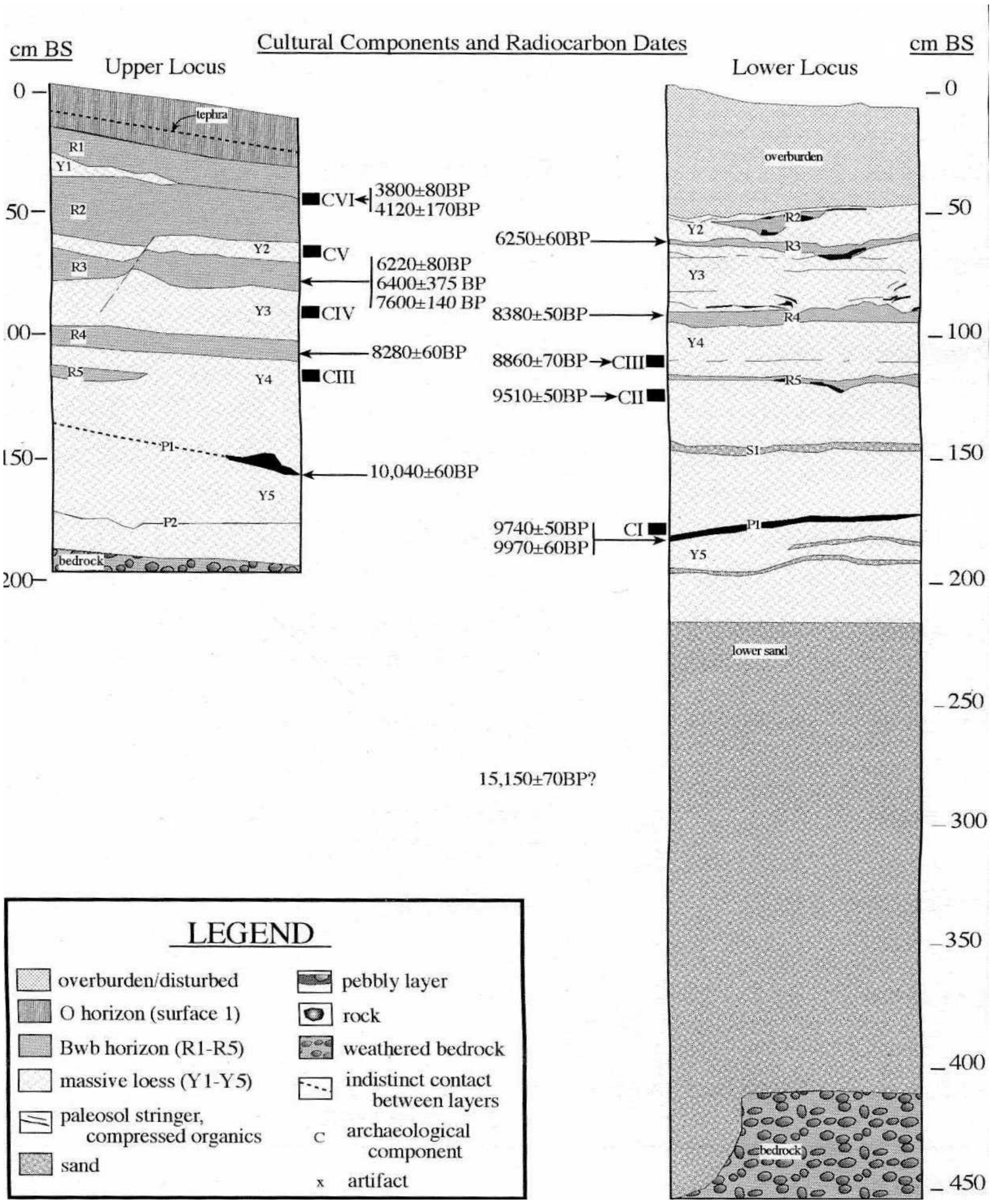


Figure 117: Gerstle River Stratigraphic Section (Upper and Lower Locus aligned)

The pertinent details of the lithics data made available thus far is presented in Table 38, along with calibrated radiocarbon dates for the identified archaeological components. The dates used in (Appendix 38) are uncalibrated to conform with those from other sites. In addition to the components discussed here, a variety of artefacts were also recovered from disturbed or surface contexts (Ibid 2002, 90). Component III, the main focus of investigation so far, also boasts a worked mammoth ivory rod or point, seemingly without the grooves assumed necessary for the hafting of microblade insets (Ibid 2001).

	Technological Complex	Dates (cal BP)		Total Lithics	Unmodified flakes		Microblades	
		Lower Locus	Upper Locus		Total	% Total Lithics	Total	% Total Lithics
Component I	Unassigned	11,200		355	282	79	0	0
Component II	Denali	10,800		474	361	76	102	22
Component III	Denali	9,920	9,920	4355	3896	89	428	10
Component IV	Denali		~8200	211	200	95	8	4
Component V	Unassigned		~6,300	1	0	0	0	0
Component VI	Unassigned		4,200	82	75	91	0	0

Table 38: Lithics data and radiocarbon dates from Gerstle River. "~" denotes age average based off of bracketing dates.

7.3.4.1 Stratigraphy

The stratigraphic sequence of Gerstle River is up to 4m deep, comprising aeolian silt and sand deposits, containing several palaeosol horizons. Figure 117 shows the full extent of the sequence through two coordinated sections covering the upper and lower portions of the section. Post-depositional disturbances in the form of krotovinas (animal burrows) and microfaults have affected sediments from both the upper and lower loci, but these are all relatively minor and do not obfuscate the delineation of strata (Potter 2002, 76). Although a total area of 182m^2 has been excavated (as of 2002), the full extent of the sequence has not been established in every trench. Bands of loess are generally labelled Y or R according to colour (Yellow and Red). The approximate vertical placement of archaeological components is shown in Figure 117.

7.3.4.2 Fauna

The overwhelming majority of remains recovered were from component 3, where all sediments were screened through 3.2mm mesh, and fragments over 3cm in size were mapped in place for the purposes of spatial analysis (Potter 2007; 2011, 226–227). The assemblages were quantified using NISP, MNE (minimum number of elements), and MAU (minimum number of animal units), essentially MNI but without accounting for size, side, sex or age. 4224 fragments were recovered, weighing a total of 12.067 kg, from which 192 specimens were identifiable, accounting for 71% of the total assemblage weight (2007, 5). Taxa identified were restricted to Wapiti and Bison (Table 39), although Mammoth is present in the form of a single worked ivory rod/point (2001, 53). In Potter's faunal analysis, Wapiti are detailed as (a subspecies of) *Cervus elaphus* (2007, 5), although this has recently been found to be a misconception, with classification of the species revised as *Cervus canadensis* (Ludt et al. 2004). Classification of Bison is deferred to *Bison* sp. but is likely *Bison priscus* (Potter 2007, 5).

	Total	Wapiti	Bison	Mammoth	Unidentified
NISP	192	73	33	1	85
MNE	134	67	31	1	35
MNI	-	5	3	1	-

Table 39: Gerstle River faunal data. Unidentified specimens were identified as large or very large artiodactyla, likely wapiti or bison, but possibly also moose (Alces alces)

Analysis has focussed upon the remains from component 3 as the most prolific assemblage both faunally and archaeologically. Although remains were generally recovered in fragmented or fragile condition with only 28 complete elements, detailed information for assemblages from other components is not yet available, but seem to suggest that the absence of medium and small game from component 3 is not the result of bias in preservation (2007, 5). Potter concluded that carnivore or rodent modification was not a major contributing factor in the formation of the assemblage (Ibid 2007, 8). Reconstructions of age among the wapiti remains are suggestive of a prime-dominated mortality profile, possibly suggestive of selective ambush hunting; the age range of bison appears to be more mixed (Ibid 2007, 18). The presence of predominantly high meat yielding elements among the assemblage has been used to support an interpretation of efficient hunting technology consistent with high residential mobility as inferred from Potter's assessment of the lithic assemblage (2007, 21). It has not been possible to assess seasonality with confidence, although circumstantial evidence combined with the presence of both male and female wapiti, which spend most of the year apart but rut in the autumn, may suggest this as the period during which the site was occupied, similarly to Broken Mammoth CZ3 (Ibid 2007, 22).

7.3.5 **Dry Creek**

The site of Dry Creek lies on the west side of the Nenana Valley in the north-central foothills of the Alaska Range (63º53'N, 149º02'W), approximately 470m above sea level, overlooking its namesake creek which forms a braided flood-plain (Hoffecker 2001, 141; Hoffecker et al. 1996). The site is situated upon a southeast-facing bluff upon an outwash terrace (known locally as the Healy outwash after the nearby town of the same name) deposited during a pre-LGM glaciation (Graf and Goebel 2009). This position allows a view-shed that encompasses the upper valley and mountain front (Figure 118).

The site was excavated by a team led by William Powers between 1974 and 1978. During this time, geological investigations at the site were also conducted by R.M. Thorson and T.D. Hamilton (Thorson and Hamilton 1977). Excavations were renewed in the early 1990's to conduct geoarchaeological investigations and acquire additional radiocarbon dates (Bigelow and Powers 1994). Through these excavations, which uncovered an area of $347m^2$, three delineable archaeological components were identified. Initially, there were four components, and the third component remains known as component IV, but subsequent revisions have amalgamated components III and component II under the latter's title (Hoffecker et al. 1996). Although the main excavation reports are restricted to grey literature, many details pertinent to components I and II (those important for consideration here) from these and subsequent investigations have been made available through assorted published materials (Powers and Hoffecker 1989; Hoffecker et al. 1993; 1996; Hoffecker 2001; Bigelow and Powers 1994; Graf and Goebel 2009; Graf and Bigelow 2011; Goebel et al. 1991). R.D. Guthrie's faunal analysis is restricted to the original grey literature reports, but details can be inferred from the above listed citations and other sources (e.g. Yesner 2001; Hamilton and Goebel 1999).

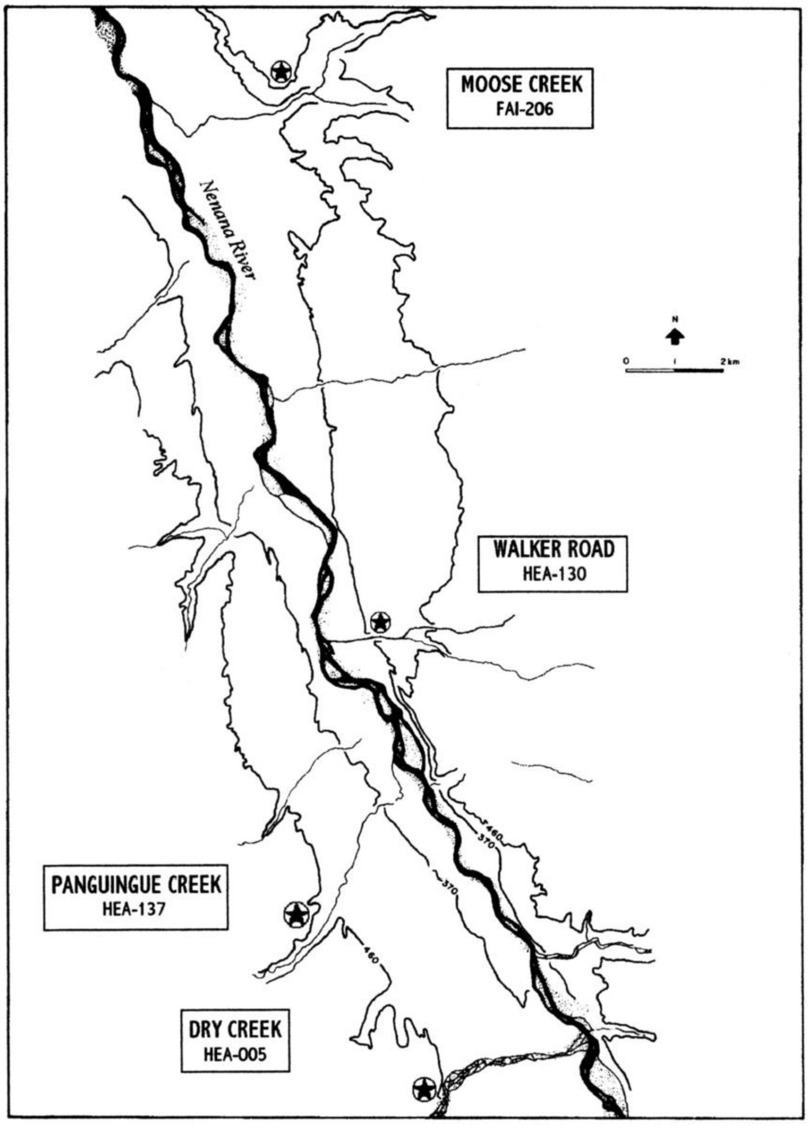


Figure 118: Map of Nenana Valley showing sites mentioned in text

7.3.5.1 Stratigraphy and Dating

The sequence at Dry Creek is about 2m deep. At the base of the sequence overlying the outwash gravel is a sterile loess deposit of minor silt with sand, probably formed between 15 and 14kya (Hoffecker and Elias 2007). Above this deposit is another sandy silt loess bed within which component 1 was identified and radiocarbon dated (11,120 ± 85 RCYBP), putting the earliest occupation of the site as pre-YD (Hoffecker 2001). Component II occurs in a third loess deposit, also described as sandy silt, and separated from loess 2 (Figure 119) by an intermittent band of sand.

This third loess deposit contains a number of stringy organic lenses, divided into two palaeosol horizons.

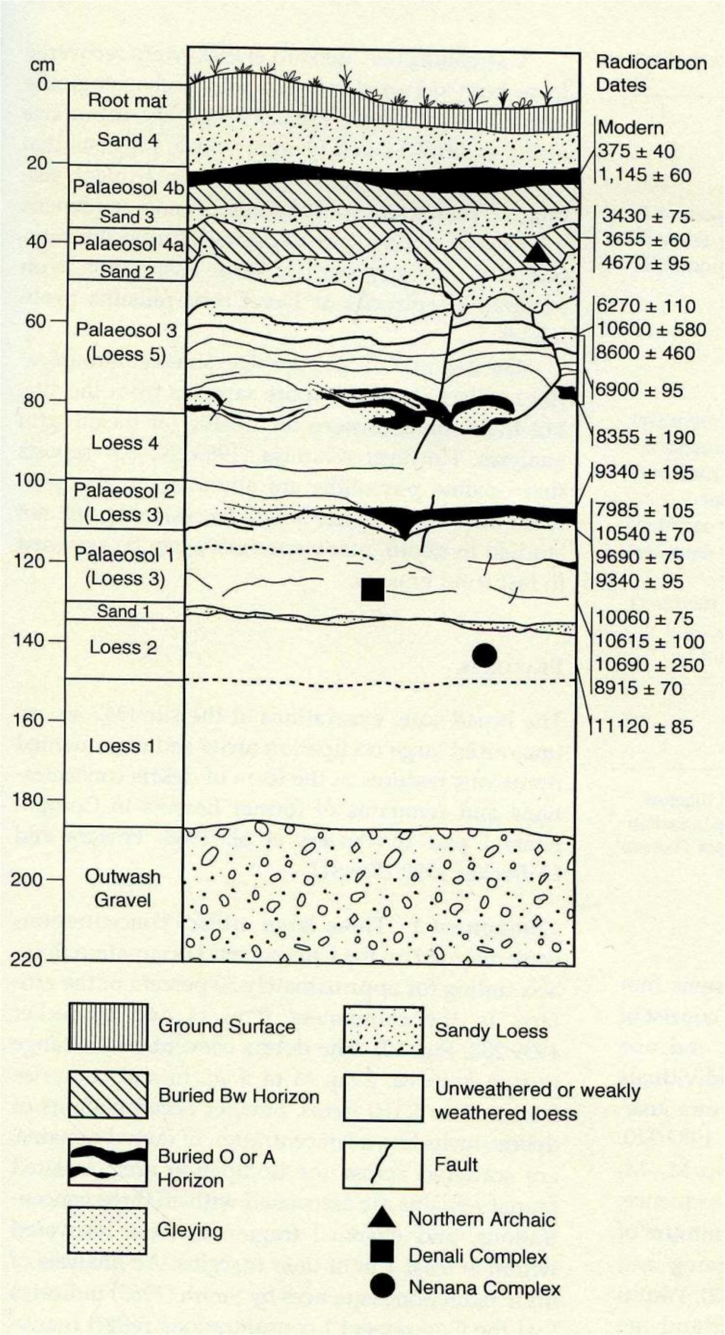


Figure 119: Dry Creek Stratigraphic Section

Component II is most clearly associated with the first of these horizons, and has been dated within the range of 10,690 – 10,060 RCYBP (Graf and Bigelow 2011). A date from palaeosol 2 that is perhaps also associated with this archaeological component potentially extends the *terminus post quem* of the occupation to as young as 9340 RCYBP (Hoffecker et al. 1996). The remainder of the sequence comprises alternating loess and aeolian sand deposits, and spans much of the Holocene. The third component, component IV, is about 90cm higher in the sequence than component II, and is associated with the lower part of Palaeosol 4a, a buried forest soil (Figure 119). Based upon the dates from this component (3430-4670 RCYBP) and typological assessment of the materials recovered, the archaeological assemblage has been assigned to the Northern Archaic tradition (Hoffecker et al. 1996). Although some of the dates (Figure 119) appear anomalously old, the overall chronology of the sequence compares favourably with other contemporary sequences in the Nenana valley such as Walker Road and Paguingue Creek (Powers and Hoffecker 1989, 269–270). A small sample of pieces from both components is shown in Figure 120.

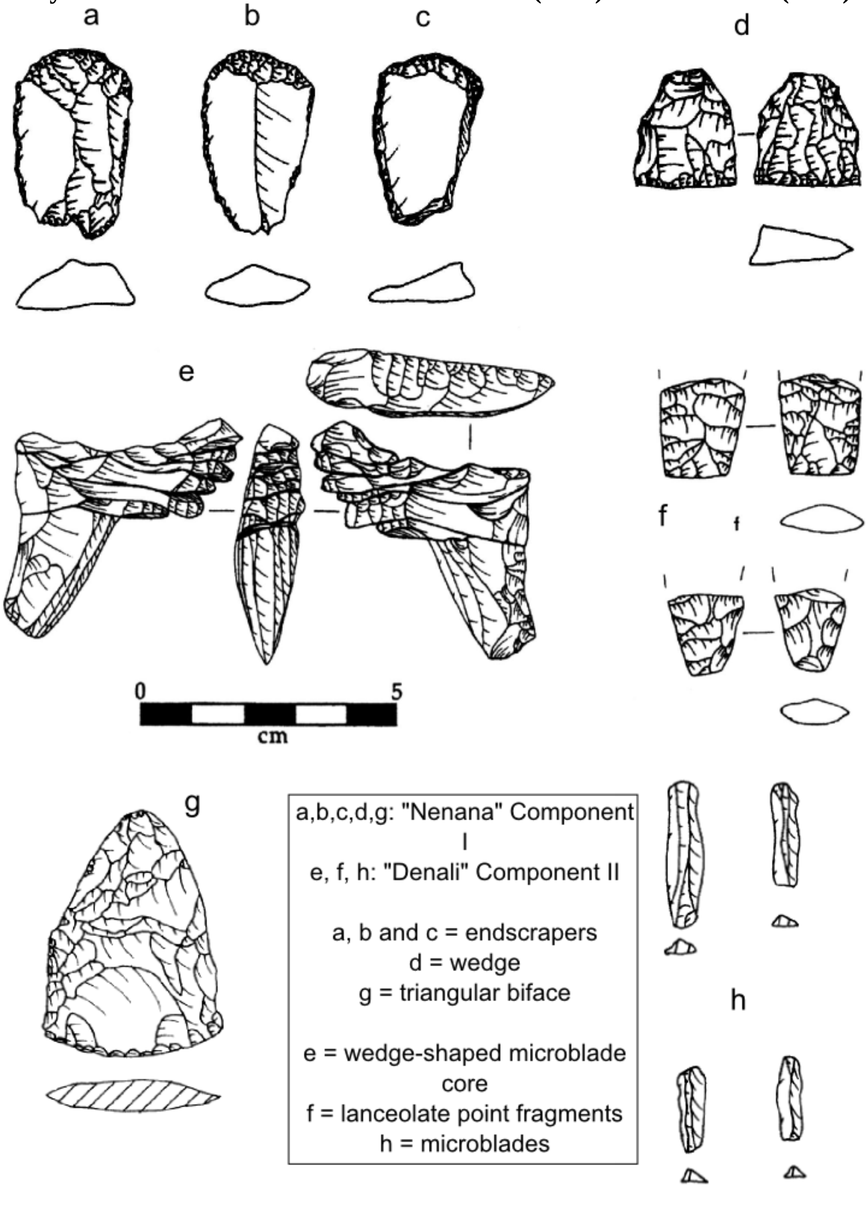
7.3.5.2 Lithics

7.3.5.2.1.1 Tools

In total, 34,811 artefacts were recovered from the site during the 1970’s excavations. Component I yielded 3517, while 28,529 came from component II, and 2372 from component IV. The combined total of these components is 34,418. It is known, although not quantified, that some tools were found in isolation in otherwise sterile portions of the site sequence (Hoffecker 2001, 143). Such pieces must account for much if not the entirety of the remaining figure.

An inventory of the lithics collected from Dry Creek components I and II is given in (Appendix 41) based upon subsequent syntheses of the site (Powers and Hoffecker 1989; Hoffecker et al. 1996; Hoffecker 2001). The lithics are divided according to whether or not the excavators considered them to be tools (Powers and Hoffecker 1989; Hoffecker et al. 1996). Comparison of different syntheses shows there to be some confusion regarding the typological categories used to constitute these definitions. The total number of tools in component I is described variously as 39 (excluding cores n = 4 and retouched flakes n = 6) or 43 with cores, and 49 with cores and retouched flakes. Graf and Goebel note the inclusion of retouched blades within the component I tool assemblage (2009, 57), although it is not clear according to Powers and Hoffecker's inventory how such pieces were classified (Appendix 41). In component II, there are 194 tools. Appendix 41 compares these tool assemblages according to the categories used by the excavation team. The table presents tools without cores, although burin / cores (n = 8) are included for component II as these pieces may have served in a capacity other than for flake reduction on the basis of macroscopic traces of edge-wear identified (Hoffecker et al. 1996, 347).

Figure 120: Dry Creek Lithics from Hoffecker & Powers (1989) and Hoffecker (2001)



Superficially, it appears that the tool component of the Dry Creek assemblages differs vastly, but I believe that this is due to semantic obfuscation. From various reports

(Powers and Hoffecker 1989; Hoffecker et al. 1996), it is clear that while differences in size and exact morphology of tool types do exist between the two archaeological components, these do not always merit distinct classification. Bifacial tools and scrapers are two such examples. Unfortunately, without further details, it is impossible to know whether or how these categories should be further segregated. It is mentioned that 9 of the component II bifaces may be classified as projectile points or point fragments, and that many more may be considered bifacial knives, but a substantial number including all those termed "heavy bifaces" (Hoffecker et al. 1996) are not further differentiated, although these are referred to elsewhere as heavy-percussion flaked implements (Powers and Hoffecker 1989, 273) and are, under this description, not necessarily bifacial! Among the component I bifaces, the whole point and at least one of the bases appears to be of the Chindadn tradition (Hoffecker 2001, 142) which are sometimes associated with microblades (Wygal 2011, 235; Holmes 2008, 71), although not in this case. The three bifacial knives from component I (Appendix 41) do not resemble Denali style knives in form (Powers and Hoffecker 1989, 281). Out of the nine projectile points and point fragments noted in component II, there is one small concave based point, two tips, and six point bases likely derived from lanceolate or stemmed points (Hoffecker 2001, 143). Likewise, a variety of sub-types are included under the category "scraper", many of them apparently side scrapers (Graf and Goebel 2009), but precise details are not available.

Once these discrepancies are adjusted for, a more accurate comparison of the morphologically supposed functionality of the lithic assemblages is possible. Table 40, shown graphically in Figure 121, represents re-assessments of tool-diversity presented proportionally. It is clear that, combined, bifaces and scrapers account for between 50 and 60% of both component tool assemblages, although scrapers are more numerical in component I whereas bifaces are in component II. The only other notable similarity between the two components is the percentage of retouched flakes. Otherwise, the assemblages comprise quite different tool types.

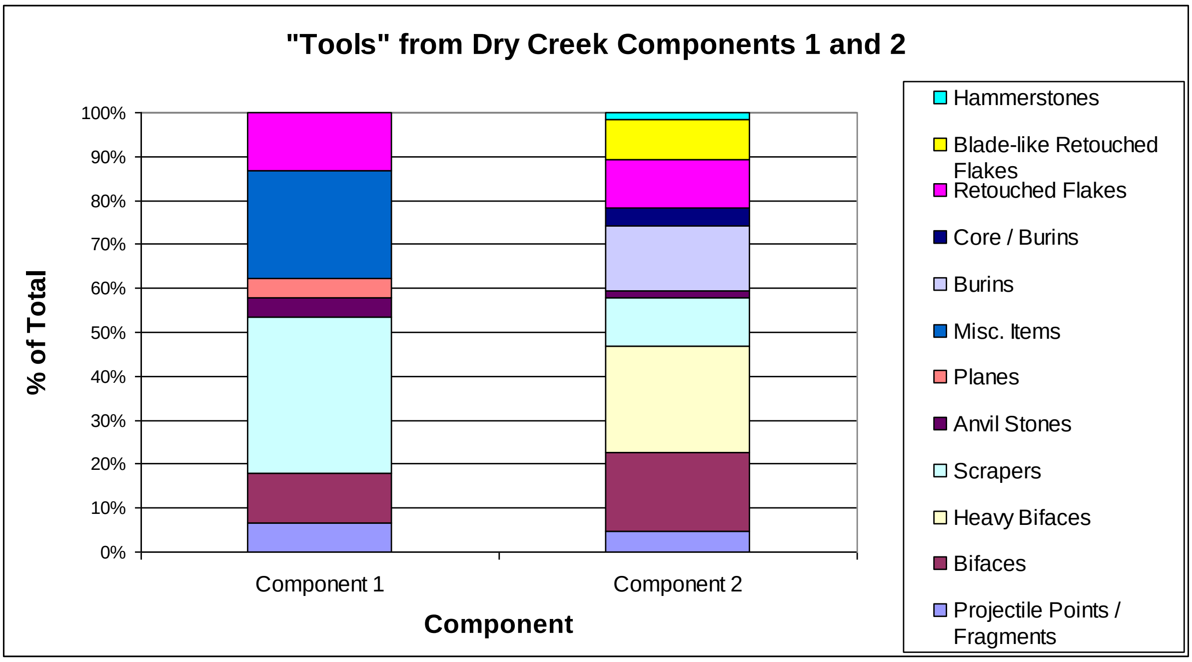


Figure 121: Graph comparing "tools" from Dry Creek components I and II

7.3.5.2.1.2 Non-tool component

The debitage elements of the component I assemblage are described as flakes and fragments, whereas those from component II are labelled flakes and blades, suggesting a difference in composition, although other descriptions of component I do mention blades and blade-like flakes. Out of the 28,529 flakes and blades in component II, 1772 are microblades. The microblades are not regarded as formal tools as they lack retouch. The microblades, along with burins and many of the bifacial knives found in this component are typical of the Denali as defined for Interior Alaska (Hoffecker 2001, 143). The vast majority (90%) of these microblades are deemed to be incomplete (Powers and Hoffecker 1989, 276) although it is not clear what is meant by this; presumably that they are broken. Component I also includes unretouched blades and blade-like flakes, but not microblades (Graf and Goebel 2009, 57). Only four cores were found from component I, compared to 126 from component II, a number that includes core fragments. Component I cores include a bipolar flake core, unidirectional prismatic blade core fragment, a platform rejuvenation spall and unidentified core fragments (Graf and Goebel 2009, 57). The types of core product found in component II are detailed in Table 40. In addition to these cores, there are also burin / cores (n=8). Notable differences in diagnostic tools and debitage components have facilitated the distinction of the Nenana industry in component I and the Denali in component II.

	Component 1	Component 2
Projectile Points / Fragments	3	9
Bifaces	5	35
Heavy Bifaces	0	47
Scrapers	16	21
Anvil Stones	2	3
Planes (quadrilateral unifaces)	2	0
Miscellaneous Items	11	0
Burins	0	29
Core/burins	0	8
Retouched Flakes	6	21
Blade-like retouched flakes	0	18
Hammerstones	0	3
Total	45	194

Table 40: Dry Creek table of lithics for Component I and II

7.3.5.2.2 Raw Materials

In 2007, Kelly Graf and Ted Goebel conducted a survey of raw materials found within the landscape surrounding Dry Creek, an area with a circumference of 2km. The results of this study, in contrast to a similar survey conducted on the West Beringian site of Ushki 5, were published in 2009. In particular, the investigators focussed on the distinction between the processes of material procurement and material selection, with the former a controlling influence on the latter (Graf and Goebel 2009). Microblades were compared to non-microblade technologies to observe differences in material preference.

Knappable materials locally available to the inhabitants of Dry Creek include cryptocrystalline silicates (CSS cherts and chalcedonies), dark grey degraded quartzite, which are common, and rhyolite, diabase (both Fine-Grained Volcanic materials or FGVs) and argillite, which are rare (Graf and Goebel 2009, 61). These toolstones would have been available from the floodplain deposits of the nearby Nenana river and exposures from other older fluvial deposits in the area. The overwhelming majority of the component I assemblage (95% in total) is made from degraded quartzite (63.1%) or various types of CCS (31.6%) (Ibid 2009, 62). These materials are also dominant among the component II assemblage, although less so than in component I. CSS accounts for 43.1% of the assemblage, being the most dominant material, with degraded quartzite covering 34.8% of the assemblage (Ibid 2009, 63). The types of CSS used vary between the two assemblages however, with gray CSS and chalcedony the dominant types in Component II compared to brown CSS which predominates in component I. FGVs, which are only minimally represented in component I, account for 17.5% of the component II assemblage, with rhyolite the dominant sub-type, while other materials such as obsidian comprise a minor portion (Ibid 2009).

In terms of dominant materials, Graf and Goebel found that toolstone selection was not patterned according to formal or informal tool types in component I, while in component II, CCS was the preferred material for formal and informal unifacial tools, but more evenly selected along with degraded quartzite and FGVs for bifaces (Graf and Goebel 2009, 65–57). Concerning microblades and burins, it was found that durable, high-quality materials, mostly CSS and both local and exotic (> 300km away) obsidian were favoured (Ibid 2009). By contrast, obsidian was not used for blades and is absent altogether from component I. Argillite, a fine-grained slate-like material also entirely absent from component I, was also used predominantly for microblade production in component II, although it is not a major constituent material overall for this artefact class (Ibid 2009, 63).

Concluding their study, Graf and Goebel appeal to the notion that those responsible for the component I Nenana industry were less familiar with their broader landscape and early stage migrants to the region (Graf and Goebel 2009, 73–74). The microblade utilising Denali occupants of component II are considered to have greater knowledge of the surrounding area, as evidenced by their use of exotic materials and clearer patterning of material selection according to artefact type (Ibid 2009). Coutouly believes that obsidian is a markedly preferable material for microblade manufacture, and that the lack of close-by sources in the Alaskan interior perhaps underwrote the development of the Campus core reduction technique, which he perceives to be a more reliable and conservative method (Coutouly 2012, 360–362). Regardless of whether this particular interpretation is true, it appears that the different technological modes exhibited between the two archaeological components were accompanied by, if not at least partially underwriting different raw material provisioning strategies. Until similar analyses are conducted on other Alaskan sites, it is impossible to know whether this is a general truth in the microblade / macroblade dichotomy typified by the traditional contrast of the Nenanan and Denali industries.

7.3.5.3 Fauna

Only a small quantity of faunal remains was recovered from the site, and unfortunately these were poorly preserved (Hoffecker et al. 1996). The Dry Creek assemblages are nevertheless important, as prior to the discovery and assessment of the Broken Mammoth remains, they represented one of the only informative sources of faunal data from interior Alaska directly associable with datable Pleistocene archaeological materials; remains from other sites are mostly either too heavily calcined for analysis or non-existant. Identification of taxa and the inference of other details such as estimations of age were possible thanks to fragments of tooth enamel. Remains from component I were identified as either Mountain sheep (*Ovis dalli*) or wapiti (*Cervus canadensis*), while those from component II were identified as steppe bison (*Bison priscus*) and Mountain sheep.

Tentative estimations of MNI based upon these teeth accounted for two wapiti in component I, with one adult and one elderly adult, and five bison from component II, with three young and two adults (Hoffecker et al. 1996). Five sheep, with one juvenile, one juvenile/adult and three adults were discerned from the combined materials of component I and II (Hoffecker et al. 1996). In addition to these details, gastroliths (gizzard stones) have been assumed as evidence of ptarmigan at the site, and are suggested as having been deposited in summer, autumn or early winter (Hoffecker and Elias 2007, 194). Gastroliths were also recovered from sterile deposits at the site, rendering their association with occupation episodes problematic (Hoffecker et al. 1996, 346). The age range of the sheep from both levels and presence of bison in the vicinity of the site in Component II has also led to tentative support for the assumption of an autumn – early winter season of occupation (Graf and Bigelow 2011, 446).

7.3.5.4 Spatial Analysis

Across the 345m^2 area uncovered through excavation, it was clear that artefacts clustered in fourteen different zones of concentration of varying size labelled A-N

(Figure 122). Ten were associated with weathered faunal remains and all were associated with charcoal deposits; C or D were associated with bison teeth (Hoffecker and Elias 2007, 196). Five concentrations, those highlighted (A, B, C, G and N) contained large numbers of microblades, microblade fragments and associated microblade production materials. Biconvex knives were associated with debris clusters D and F, meaning these clusters also attributed to the Denali. Bifacial projectile points were found in E, J and K (highlighted). Clusters H, I, L and M all lack diagnostic artefact associations (Ibid 2007, 196).

The interesting variability in the spatial patterning of artefacts at Dry Creek component II most likely reflects the different behaviours these toolkits were associated with. This cautions against conflating the use of bifacial points and microblades as necessarily simultaneous based solely upon stratigraphic positioning. While the patterning may reflect different behaviours in time and space at the site from one group, a more extreme interpretation may also be advanced. Hoffecker has suggested, based upon comparison with the larger palaeoindian points found at the Mesa site in NW Alaska and the supposed lack of an associated microblade component with this industry (Bever 2008), that these points and also some from Moose Creek that lack a clear chrono-stratigraphic affiliation with the Denali or Nenana (Hoffecker and Elias 2007, 198) in fact belong to the Mesa industry (Hoffecker 2011). This suggests a geographical and chronological overlap in the two techno-complexes, as well as an ethnic distinction within these different facets of previously assumed Denali assemblages. While this interpretation is perfectly valid, I feel that there is insufficient evidence to confidently make such a claim. The artefacts in question comprise a very small portion of the overall assemblage. An alternative more moderate interpretation remains that the spatial patterning of artefacts in Dry Creek component II reflects different activities that necessitated different toolkits, and perhaps reflect different temporal occupations.

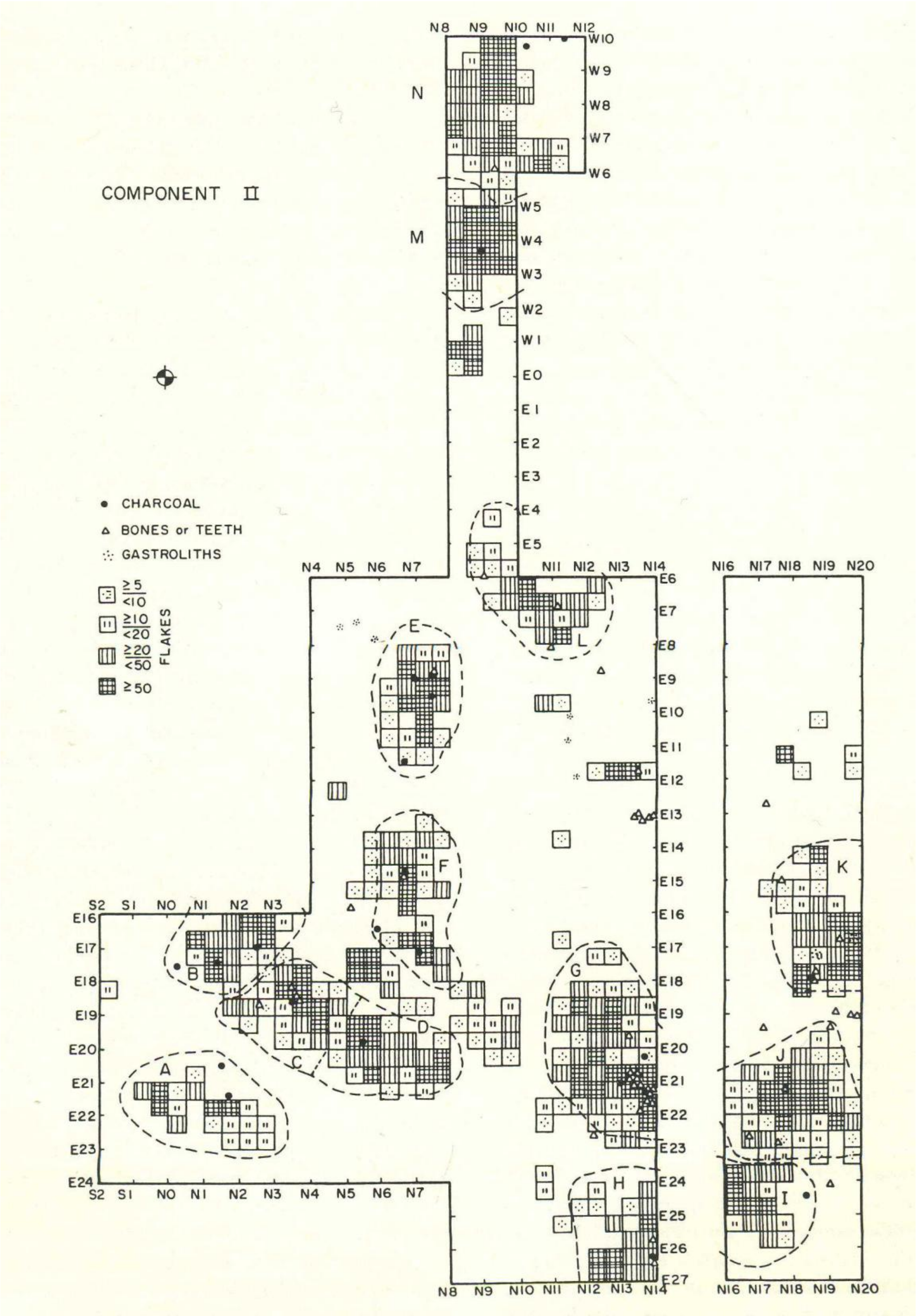


Figure 122: Spatial Analysis of find clusters from excavated area for Dry Creek component II

Spatial analysis was also conducted upon the component I assemblage, and revealed three distinct artefact clusters. These concentrations are fairly homogenous and appear to represent butchering and hide processing and tool production (Hoffecker et al. 1996). Despite the clear difference in spatial patterning of toolkits and presumably behaviour, both component I and component II were judged to represent a hunting spike camp and processing station (Graf and Goebel 2009, 58).

7.3.6 **Panguingue Creek**

The site of Panguingue Creek was discovered in 1976 but not excavated on a larger scale until 1991 (Goebel and Bigelow 1996). It is located on the north bank of its namesake creek, a tributary of the Nenana River, and is around 5km northwest of the town of Healy and downstream of Dry Creek (Figure 118). The site occupies a position among the foothills on the same outwash terrace as Dry Creek about 490m above sea level and 200m above the present day river level (Ted Goebel and Bigelow 1992). Three archaeological components were identified at the site.

7.3.6.1 Stratigraphy and Dating

Following the most recent excavations, an area of around 100m^2 was uncovered, and a stratigraphic depth of around 2m in total was uncovered (Hoffecker et al. 1993; Powers and Hoffecker 1989). A truncated version of the sequence is presented here, as archaeological materials were only recovered from the upper 50cm of the stratigraphy (Figure 123). For stratigraphic correlation of deposits from the lower extent of the section with other sequences in the Nenana valley, Figure 124 should be consulted. As with other sites in the valley, archaeological components are associated with humic palaeosol horizons. Four of these soils are present within the upper extent of the Panguingue Creek sequence. Archaeological components are associated with the upper three palaeosols 2-4 (Figure 123). Palaeosol 2 and component I mark the interface between a deposit of sandy silt, which contains palaeosol 1, and another thick (c. 30cm) homogenous deposit of silt which contains palaeosol 3 and component II. The modern day soil cap of the sequence includes the most recent buried organic soil and associated archaeological component. The associated dates for the three archaeological components at the site are presented in Table 41.

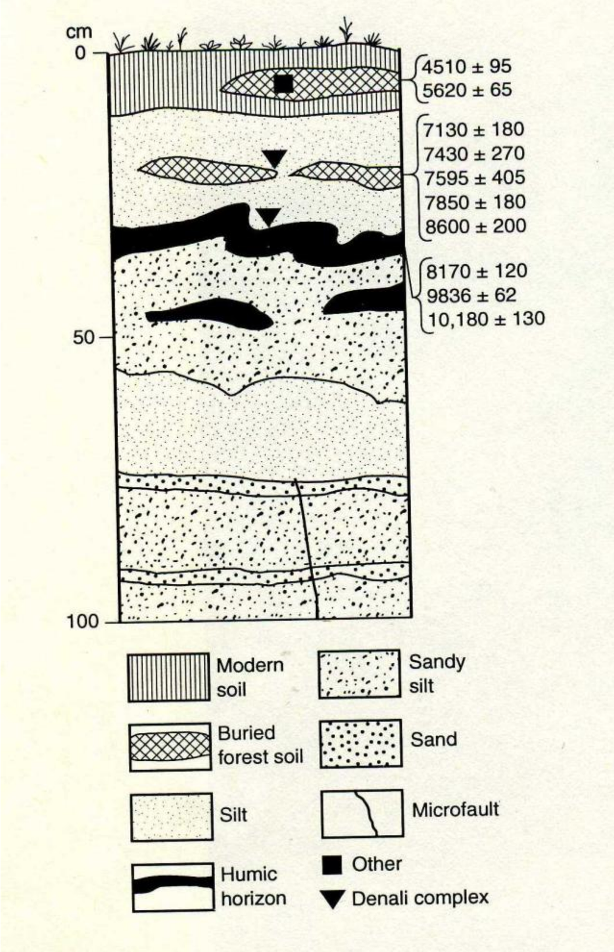


Figure 123: Panguingue Creek Stratigraphic Section

	Uncalibrated Radiocarbon Years BP		
	Lower Date Estimate	Upper Date Estimate	Mean Age Estimate
Component III	4510 ± 95	5620 ± 65	5065
Component II	7130 ± 180	8600 ± 200	7721
Component I	8170 ± 120	10,180 ± 130	9395

Table 41: Panguingue Creek Radiocarbon dates

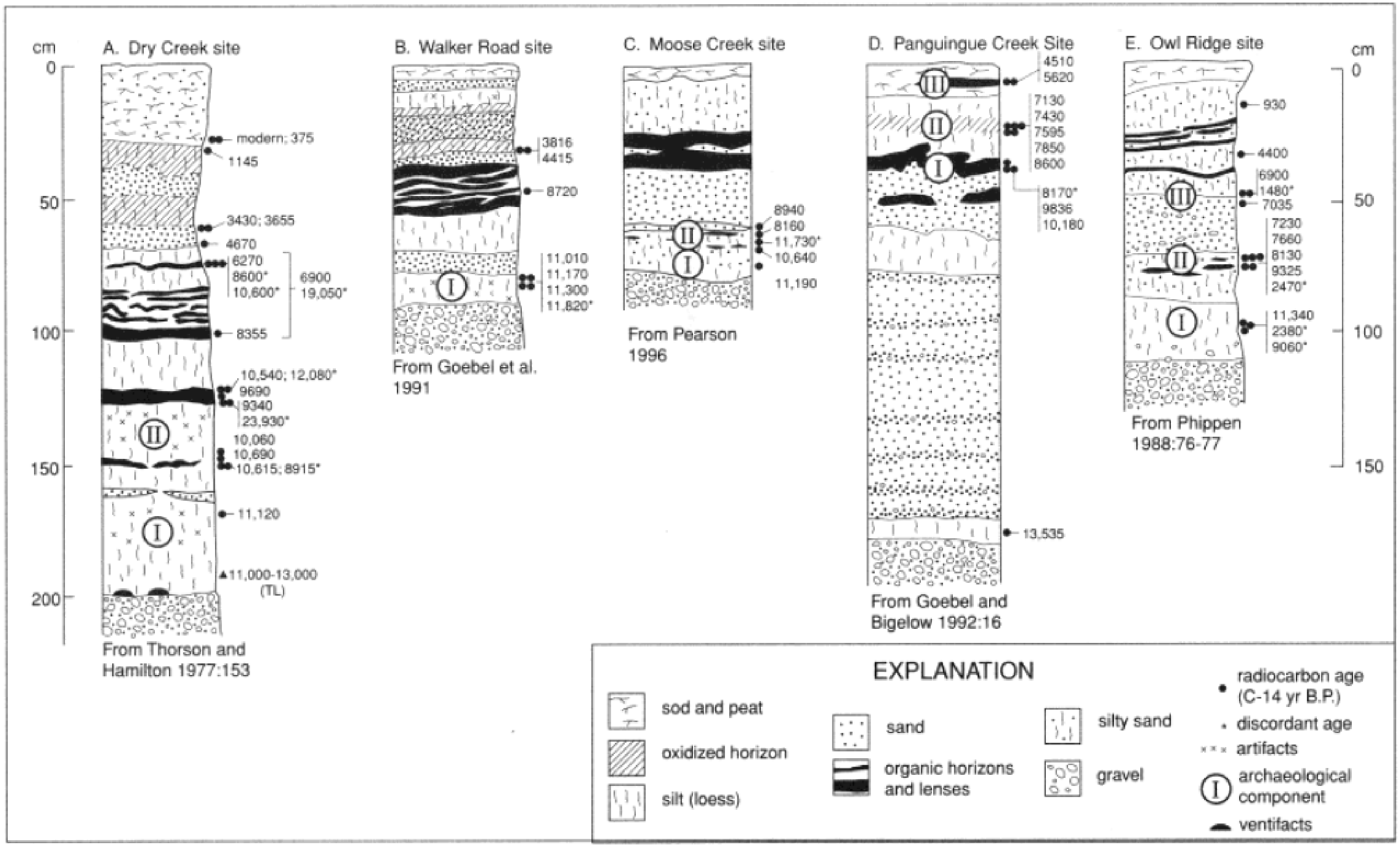


Figure 124: Stratigraphic Comparison of early Nenana Valley sites

7.3.6.2 Lithics

Although three archaeological components were delineated at Panguingue Creek, only component II, associated with palaeosol 3, yielded an artefact assemblage of greater than a hundred pieces. Table 42 and Table 43 show the lithic inventory for these three components. Exact figures for the quantity of microblades and unretouched flakes from component II were not provided (Goebel and Bigelow 1996), but both categories, and particularly the unretouched flakes, far outnumber the quantity of other lithic types from the assemblage (Table 42). Only lithic remains are discussed in this section, as although a concentration of faunal remains was found in component II, identification of taxon was not possible due to the extent of which the assemblage was fragmented and calcined (Goebel and Bigelow 1996, 369).

	Component I	Component II	Component III
Unretouched Flakes	60	>5000	20
Burin Spalls	0	10	0
Microblades	0	>150	0
Formal Tools	6	60	3
Cores	1	9	0
Total	67	>5229	23

Table 42: Panguingue Creek table of lithics

	Component I	Component II	Component III
Transverse Scrapers	2	0	0
"Tci Tho" Bifacial Side Scraper	1	2	0
Lanceolate projectile points	2	5	0
Ovate bifacial knives	0	2	0
Side Scrapers	0	7	1
End Scrapers	0	5	2
Burins	0	5	0
Retouched Flakes	0	16	0
Choppers	0	2	0
Hammerstones	0	2	0
Anvil Stones	0	2	0

Table 43: Panguingue Creek table of lithic tool types

Table 43 compares the formally recognised tools from these assemblages. Ultimately the disparity in assemblage size limits the interpretive value of comparing these assemblages, but there are nevertheless some clear differences in their basic constitution. Complete details for the specific categorisation of formal tools is not given for components I (5/6 tools accounted for) and II (48/60 tools accounted for), with no clear reason as to why. Component II has been assigned to the Denali technocomplex (Goebel and Bigelow 1992; 1996). The dates associated with this component, however, place it later than the Denali assemblage found at Dry Creek, as part of an early Holocene occupation rather than late Pleistocene (Ted Goebel and Bigelow 1996, 369). This contention, along with differences noted between the non-microblade elements of the assemblage in comparison to Dry Creek component II (Powers and Hoffecker 1989, 276) has left some researchers wary of its affiliation (e.g. Hoffecker 2001, 145), but the subsequent establishment of a late Denali , or at the very least a Holocene industry, sometimes much younger than Panguingue Creek component II, that in part resemble the Denali should allay cautions over this matter (Clark 2001; Yesner and Pearson 2002; Ackerman 2007; Wygal 2011).

Component I was also assigned to the Denali technocomplex (Powers and Hoffecker 1989; Ted Goebel and Bigelow 1992; 1996; Hoffecker 2001), based solely upon the date of the associated horizon, as the assemblage was seemingly too small to yield any diagnostic artefacts that could facilitate a more confident assignment. This interpretation still stands with some researchers (Graf and Bigelow 2011, 440), but considering the lack of diagnostic artefacts, and the recent question of overlapping chronological ranges for early east Beringian technocomplexes, perhaps greater caution should be exercised. Likewise, although the assemblage is prohibitively small, component III has been assigned to the Northern Archaic period primarily due to associated dates (Hoffecker 2001, 145).

7.4 **Summary**

Reconstructions of the earliest evidence of occupation in Alaska are inherently piecemeal in nature. The sites included in the study provide examples of human activity in lowland and higher elevation foothill settings that cumulatively span an almost continuous stretch of time. There are no sites from upland areas. Although the sample size is small, it is clear from diagram (Appendix 38) that microblades were used more or less continuously throughout the early prehistoric record in Alaska, with the only notable absence in the dataset occurring between 11750 – 10750 years ago. The significance of this gap is weakened by three caveats:

- Microblades predate non-microblade occupations at Swan Point CZ4.
- Sites dating to this period are from a relatively limited geographical distribution (Graf and Bigelow 2011, 444).
- Using the presence or absence of microblades as the main criterion for techno-complex designation is problematic given the association of microblades with a wide range of other diagnostic tool types (Wygal 2011, 235). This is best exemplified by sites coded as "unassigned", where either the presence of microblades or an otherwise lack of diagnostic tool-types precludes confirmation of assemblages being designated as Nenana. This means that microblades may essentially just be missing from the record for this period rather than technologically absent.

This final point is particularly problematic for attempts at interpreting meaningful chronological patterning among different assemblage types. These difficulties have been reported in other recent studies (Potter 2011; Wygal 2011; Graf and Bigelow 2011). It is not entirely clear how changes in climate affected microblade use (Graf and Bigelow 2011, 441), but studies showing changes in microblade component frequency relative to overall site density suggest that fluctuations are primarily affected by biases in site visibility. The best explanation for this pattern is that assemblage variability was primarily affected by habitat, with behaviour specific technologies associated with different locales in the landscape. In addition to the idea that different behaviours were associated with different areas of the landscape, spatial analyses conducted at a number of sites suggest that specific activities associated with distinct tool-types can sometimes be identified at an intra-site level (Hoffecker et al. 1996; Potter 2005; Krasinski and Yesner 2008; Goebel 2011). Regarding microblade use, this is best exhibited in the study of Dry Creek Component II, where they are associated with distinct artefact clusters in different areas of the site. It has been suggested that microblades were primarily used in lowland-adapted hunting strategies for targeting bison, moose and wapiti (Potter 2011), although this pattern is by no means exclusive. Although not an upland site, Dry Creek Component II is suggestive of bison being hunted with microblade technology at higher elevations.

Similar to the confusing continuation of microblade technology throughout much of early Alaskan prehistory, faunal exploitation patterns do not seem to be markedly affected by time (Appendix 38). This may relate to seasonal mobility patterns, again obscured by a lack of clear archaeological visibility, or alternatively may just suggest that many more warm-tolerant species (such as bison) survived in reasonable numbers throughout much of the Younger Dryas as indeed they also did on the mammoth steppe prior to the arrival of humans (Guthrie 2006). It should be remembered, however, that faunal data for early Alaskan occupation is minimal from most sites. Although seasonal shifts in subsistence may have been important factors behind the patterning of tool-kits in the landscape, evidence is currently too restrictive to effectively demonstrate this (Graf and Bigelow 2011, 447). It appears that the Younger Dryas may not have been as harsh as may often be assumed (Bigelow and Powers 2001), and perhaps even increased the diversity and numbers of key prey species. The technological variability during this period (Graf and Bigelow 2011) is clearly evinced by ambiguity of archaeological occupations from this time (Appendix 38). It is not yet clear how population size was affected at this time. Microblades and assemblages formally recognised as Denali continued in Alaska. Dominant ungulates seem to have continued at this time as moisture increased and birch mosaic woodland began to expand once more with a diversifying array of sub-community species. As a final consideration, there are many potentially fruitful areas of investigation that are yet to be adequately explored, including use-wear analysis and raw material procurement studies. Work at Dry Creek suggests that microblade technology may have accompanied a shift in the exploitation of different working materials (Graf and Goebel 2009), but similar studies are necessary at other sites to further support this interpretation.

8 Discussion

This section presents a synthesised review of the findings from the case-studies, explores their implication for understanding regional strategies of microlithic based hunting practices, and compares these findings along with exploring more general issues identified throughout the course of the investigation.

8.1 Regional Trends Synthesised

8.1.1 Cantabrian Spain

The time period focussed upon for Cantabrian Spain spanned the end of the Last Glacial Maximum and through the fluctuating amelioration of the terminal Pleistocene. At the beginning of this period, Cantabria was likely a glacial refugium, cut off from the Spanish interior by the Picos de Europa to the south, and possibly during extremely colder periods from the Aquitane basin in the south-west of France, by the Pyrenees. Lawrence Straus believes that the relative containment of people within this region during the LGM resulted in a growth in population reflected by increased site density during this time (L. G. Straus 2000). Population density seemingly did not increase substantially again until the mid-late Magdalenian (Ibid 2005). Difference in the morphological form of Solutrean points from either side of the Pyrenees suggests limited contact between these two areas at this time, or perhaps regionally distinct traditions of design. It remains unclear as to how much this may have changed over time, and whether the inception of the Magdalenian techno-complex in Cantabria reflects an *in situ* development or the influence of developments across the border (Straus 2013, 244; Straus et al. 2008; Aura et al. 2012).

For this case study, the extensive stratigraphic chronology of La Riera served as a master sequence. El Miron, Rascano, La Fragua, Berniollo, Santa Catalina and Laminak II comprised the other sites considered. This sample of sites includes a variety of investigative analyses, and ensures that materials from a variety of different locations within the Cantabrian landscape were assessed. Collectively these sites span from the Solutrean through to the Azilian. The Last Glacial Maximum, which terminates with the end of the Solutrean, is characterised as having been inhospitably harsh for much of the time, and the Cantabrian plain is widely understood to have served as a glacial refugium at this time. Consequently, during this period the region is normatively assumed to have undergone substantial technological and environmental change.

Microlithic tools from the Solutrean, Magdalenian and Azilian of Cantabria overwhelmingly take the form of bladelets. Geometric pieces from this region are more commonly associated with Asturian and Mesolithic traditions (L. G. Straus 2008). It has become common convention within Cantabrian research to focus primarily upon backed bladelets, pieces which exhibit evidence of retouch, as these pieces were clearly further modified from their basic form with some intention in mind. Unretouched bladelets are generally consigned to classifications of debitage and afforded comparatively little attention. Within the category of backed bladelets, a variety of sub-variants have been identified. After some consideration, I argued that these variants are rarely found in sufficient quantities relative to their parent assemblages to be meaningfully discussed in terms of function. Furthermore, many of the distinctions designed and used to segregate these sub-categories of bladelet may emphasise morphological variability over design functionality. Backed bladelets occur throughout almost the entirety of the La Riera sequence, but do not occur in prolific quantities until the final Solutrean / Magdalenian (Appendix 1).

The Magdalenian appears to represent a notable technological departure from the preceding Solutrean. Although only present in certain deposits, Solutrean technology is most recognisably characterised by large foliate bifaces which likely served as armature tips or perhaps cutting implements. In general, the common constituent tool types of Solutrean and Magdalenian assemblages contrast quite strongly with one another, and at La Riera this is also reflected by a clear shift in material selection towards more fine-grained rocks. The Magdalenian is also typified as having a greater emphasis on bone point technology, many of which may have been hafted with bladelets. Unretouched bladelets occur in consistently small amounts (less than 15% of debitage assemblages) throughout the sequence. Backed microlithic points (Azilian, Microgravette and Font Yves types) also occur in small quantities in the final Magdalenian and Azilian, predominantly in levels in which backed bladelets are less prominent (Figure 20).

Microwear analyses have been conducted upon samples from Upper Palaeolithic assemblages variously spanning the Magdalenian and Azilian from the sites of Rascano, Berniollo, Santa Catalina and Laminak II. At Rascano, a sample of backed bladelets was found to have traces largely conforming to those expected from use as projectile armatures, with more rectangular pieces suggested as barbed elements and pointed pieces more likely as armature tips (Keeley 1988). Analyses conducted at the other sites showed that larger backed bladelets bore traces conforming to those expected of butchery activities, but smaller pieces lacked any clear traces at all, leading the investigators to suggest that they may have been preferred as hunting armatures (Ibánez Estevez and González Urquijo 1996; 1998). The sample from Berniollo, Santa Catalina and Laminak II also included a small number of backed microlithic points which were variously used (although not interchangeably) as projectile tips or cutting implements. From these results, an apparent preference for narrow and straighter microgravette types as armature tips and curved azilian points as cutting implements was inferred.

Throughout much of the final Palaeolithic in Cantabria, the faunal economy appears to have been dominated by red deer and ibex. In the mid-latter Magdalenian, faunal assemblages began to diversify with the appearance of more temperate deciduous species such as roe deer and wild boar. Generally speaking however these species did not become more significant constituents until the Mesolithic. Models of habitat variability suggest that site location within the landscape often suited the exploitation of ibex and other montane species, or red deer, or some mixture of the two (Arroyo 2009b). A seasonal round was probably constructed whereby different ecotones were exploited at different times, however attempts to elicit this archaeologically have proven problematic. A common theme among the faunal assemblages considered here has been a preference for taking various species during the summer and early autumn months when infants are easily targeted. At many sites there is often evidence of prey being taken at different times of the year however (e.g. Rascano), and juveniles may be over-represented archaeologically as it may be easier to transport more of the carcass back to the site. Any seasonal patterning of land-use was likely far more nuanced and complex than the current resolution of archaeological data can show. Red deer are relatively catholic in their habitat preference, which perhaps explains why they continued to figure prominently in subsistence strategies even as more temperate species were exploited. As conditions ameliorated into the Upper Magdalenian and Azilian, the preferred habitat of ibex and other montane species probably contracted (Arroyo and González Morales 2007). Despite these gradual shifts in faunal economy, backed bladelets seem to have prevailed as a popular hunting technology throughout this time, perhaps because of the continued dominance of red deer and ibex.

Few Upper Palaeolithic sites in Cantabria boast a sequence as extensive as that of La Riera. The stratigraphic sequence at El Mirón rivals it in extent, but investigation at the site remains ongoing and as yet insufficiently detailed to permit attempt at correlation. The relatively monotonous duality of red deer and ibex throughout much of the period means that archaeologists look to other species as indicators of climate change. The increasing presence of woodland species such as roe deer and wild boar in the Magdalenian and Azilian presages the more temperate conditions of the Mesolithic, and the occasional appearance of reindeer and some species of particularly niche microfauna attest to sharp cold fluctuations. Although the Solutrean is characterised as a period of extreme cold, it has become clear that both climate and environment were not homogenously monolithic during this time, and although conditions began to significantly ameliorate in the Upper Magdalenian, much of this period can also be typified as cold under the influence of the Older Dryas (Straus 2014, 9). The amelioration of the Upper Magdalenian was itself swiftly curtailed by the Younger Dryas, which is effectively synonymous with the Azilian.

Open habitat preferring species from the Solutrean Cantabrian plain, including horse and bison, appear to have diminished in economic importance over time as the dual economy of red deer and ibex became established. This pattern, evidenced at La Riera, continued into the Magdalenian, when backed bladelets became a much more prominent feature of many site assemblages. Conversely, the Azilian, which may have had a significant impact on the expansion of temperate species (e.g. at La Fragua) prior to the Mesolithic, remains in many instances difficult to confidently distinguish techno-culturally from the preceding Magdalenian (Straus 2011). Backed bladelet armatures and microlithic points are most commonly assumed to have functioned as replaceable barbs on wood and bone spears and darts, contrasting with Solutrean spears which presumably relied upon one large armature tip. This lighter form of weaponry may have been accompanied by new delivery systems: the oldest atlatl in Western Europe has been recovered from Magdalenian deposits at El Mirón (González Morales and Straus 2009). Although backed bladelets were known and made by Solutreans of Cantabria, their proliferation in the Magdalenian lacks a clear environmental correlate, and appears to be part of a broader series of socio-technological changes that allow the distinction of a new cultural phase. More nuanced fluctuations throughout the Magdalenian and Azilian are difficult to interpret, but it appears that they are most prevalent in assemblages at times of cold conditions, when the broader landscape would have been relatively open.

A more significant unknown quantity that requires investigation is the many debitage bladelets, lacking in retouch, that have perhaps been too readily dismissed as lacking utility. These pieces are found in large numbers throughout the Solutrean at La Riera and in Upper Palaeolithic contexts at many other sites, although they are rarely detailed due to a lack of interest. In general, it is easy to depict a dichotomous relationship between the Solutrean as an industry recognised by foliate bifaces and the Magdalenian with backed bladelets (Straus 2002, 74), but it is clear that these technological practices did coexist alongside one another, and greater focus on individual sites may help explain how these pieces complimented one another, and why one practice went out of fashion while the other apparently became much more important.

8.1.2 **Southern Africa**

As already explained, the geometric backed pieces that characterise the Howieson's Poort are not strictly microlithic in nature according to many definitions that use restrictive metric criteria. Many of these pieces are microlithic however, and I have argued, similarly to Ambrose (2002, 12), that the unique form they take and small size relative to typical MSA tools qualifies them as a unique tool-type in the sense that microliths are generally believed to be. The Howieson's Poort represents a stratigraphically discrete phase that occurred during the late MSA throughout much of southern Africa. It was preceded by the Still Bay, a phase characterised by large bifacial foliate points (not dissimilar in basic shape to those of the Solutrean), or other regional sub-facies of the MSA as at Klasies River which are typically characterised by unifacial levallois points and unretouched irregular flake blades. Both the Howieson's Poort and Still Bay have been the subject of considerable interest following the recognition of various archaeological traits perceived as indicative of a capacity for modern behaviour (Lombard 2012). The unique type-fossils that characterise the Howieson's Poort and Still Bay contrast greatly with other MSA industries. The three sites included for this case study cover the far-reaching geographical extent of these industries (Figure 32). Although the spatial resolution of HP sites has improved greatly in the last two decades, it remains a remarkably disparate phenomenon spanning a huge geographical area.

Of the utmost importance in clarifying the circumstances under which these distinct technological practices were adopted is the establishment of some consensus regarding their age. It is only recently that systematic dating programmes have been able to provide a more coherent series of ages, with Jacobs and colleagues providing estimates that seemed to confirm the growing opinion that the Howieson's Poort pertained to a relatively discrete 5000 year period between 65 and 60kya (Jacobs et al. 2008; Jacobs and Roberts 2008). According to these results, the Howieson's Poort seems to have developed during the final millennia of OIS 4. Some other researchers have contested these findings however. The discovery of microliths in pre-HP MSA assemblages at Pinnacle Point (Brown et al. 2012) suggests that a re-examination of the definitions used may be necessary. Most recently, claims that the Howieson's Poort spanned discontinuously from between approximately 100kya and 55kya at the site of Diepkloof (Tribolo et al. 2013; Porraz, Parkington, et al. 2013) poses significant challenges to conventional views of MSA chronology in southern Africa.

Within the historical trajectory of the MSA in southern Africa, it remains a consensus view that the Still Bay preceded the Howieson's Poort, as has been shown both stratigraphically and chronometrically. At present, there are only seven sites where both industries have been identified within the same sequence (Henshilwood and Dubreuil 2011). Likewise, sites with well studied post-HP MSA sequences are also not common (Cochrane 2008, 158; Ambrose 2002, 12). Despite being geographically removed from one another, the combination of Klasies River, Diepkloof Rockshelter and Sibudu provides a deep chrono-stratigraphic span for investigation. Klasies River, as the most extensively investigated and widely known of these sites, was used for the construction of the master diagram. A significant portion of this section was devoted to a re-calculation of assemblage details after the identification of various inconsistencies within their tabulation in the original report.

The majority of literature on the investigations conducted at these sites has focussed primarily upon the technological traditions of the Howieson's Poort, and in the case of Sibudu, particularly the geometric pieces that make the industry so distinct. These most often take the form of lunate/crescent segments, trapezes, or variations upon these types. The assessment provided in this thesis reflects this emphasis, but small cutting implements in the form of bladelets (Diepkloof) or flake-blades (following Singer and Wymer's account of the Klasies River material) were also found at these sites. These pieces mostly lack retouch, and so are perhaps more comparable to the so-called "debitage" bladelet blanks found throughout much of the sequence at La Riera. At Diepkloof, these pieces are most strongly associated with the HP phase, whereas at Klasies River, they are found in large quantities throughout the site sequence, although with an apparent proliferation of smaller pieces (i.e. not blade length) during the later Howieson's Poort (Figure 58). At Klasies, many pointed varieties are also documented. Although research into these pieces has been limited, I believe that many of these may also qualify as potential candidates for microlithic armatures.

It appears that the Howieson's Poort was generally associated with a shift in raw material selection, which in turn likely reflected a change in procurement strategies and perhaps the size and nature of intergroup networks (Ambrose and Lorenz 1990; Ambrose 2006). Although new investigations have more successfully explored material provenance (Porraz et al. 2013; Delagnes et al. 2006), it remains a gap in our knowledge regarding many HP and MSA sites in general (Minichillo 2006). At Klasies River, a generalised preference for more non-local and fine-grained materials in the Howieson's Poort actually reveals more nuanced trends in favour of specific types throughout time. The selection of these materials is not restricted exclusively to geometric pieces, meaning that the assemblages contrast greatly with the MSA phases of the site where local quartzite overwhelmingly prevails. The trend towards non-local materials in the Howieson's Poort actually begins in the final MSA levels prior to the formally recognised inception of the period and begins to shift towards local quartzite again during its latter stages (Lombard 2006b, 38).

At Sibudu, it has been suggested that different materials among HP segments were preferred for different functions, noting a particular association between quartz pieces and hypotheses of functioning as arrowheads (Wadley and Mohapi 2008; Lombard 2011). The majority of segments are made from dolerite and hornfels however. Unlike at Klasies River, the preference for dolerite and hornfels abruptly changes in the immediate post-HP MSA to quartz and quartzite (Cochrane 2006). Material selection at Diepkloof fluctuates throughout the Howieson's Poort, as may well be expected of an industry spanning some 40,000 years. Broadly speaking, the most notable contrast between Howieson's Poort units with preceding Still Bay and MSA deposits is the higher proportion of silcrete and quartz, along with an otherwise greater diversity of material selection in general (Figure 98).

The application of micro-residue and use-wear analyses to Howieson's Poort assemblages has had a significant impact upon interpretations of function, particularly regarding pieces from Sibudu, where analysts strongly believe that smaller quartz segments were specifically used as arrowheads. Such an argument has strong implications both for previously held notions about the antiquity of bow and arrow projectile technology and the overall technological capacity of MSA humans and subsequent populations (Lombard and Haidle 2012). Several researchers have expressed doubt and reticence in the acceptance of Lombard's interpretations, most notably Paola Villa (Villa and Roebroeks 2014). While I believe that the results from Lombard and colleagues analyses suggests segments were hafted and likely used in weaponry, I also feel that current evidence for the use of the bow and arrow from MSA contexts is as yet too scant and contrived to be convincing. Results from assessments of backed pieces at Klasies have revealed impact scars on a small proportion of the studied sample population (Wurz and Lombard 2007; Villa et al. 2010), while at Diepkloof, analysis suggested that traces on 50% of the segments examined accorded with those expected of cutting implements, with similar results recorded on 20% of the examined blade and bladelet assemblage (Igreja and Porraz 2013). So far, these investigations have been limited to materials from the Early Howieson's Poort.

The vast geographical extent across which the Howieson's Poort occurs renders generalised palaeoenvironmental reconstructions problematic, especially when compared to the smaller study areas of Interior Alaska and Cantabrian Spain. Most estimates place the Howieson's Poort in the final stages of OIS 4 or early OIS 3 (Tribolo et al. 2005; Jacobs et al. 2008; Villa et al. 2010), although the date of early HP assemblages at Diepkloof suggest an origin in OIS 5. It is likely that the sub-continent experienced great heterogeneity during each of these stages, due to the interplay of a variety of forcing mechanisms responsible for environmental change (Chase 2010). Consequently, site-level indicators (primarily macro and microfauna and palaeobotanical data) of environment and climate represent a more appropriate and nuanced record for inference. At Klasies River, the surrounding landscape started becoming more open towards the end of MSA II and progressed throughout the HP and into MSA III. This accords with the idea that the shift in faunal representation at KR also began prior to the Howieson's Poort. It seems that the vegetation communities of the surrounding landscape diversified over this time. The site itself would have been further inland during this period; the general prevailing biome appears to have been one of Dune Fynbos with Kaffrarian Thicket developing towards the top of the sequence (Avery 1987).

Sibudu, by contrast, appears to have been ideally located within a mosaic landscape, enabling inhabitants to exploit a variety of ecosystems at different times of occupation. Although data regarding the Still Bay occupation of the site remains slim, preliminary estimates suggest a faunal composition similar to that of the Howieson's Poort. During the HP, the site experienced warm, humid conditions, and was surrounded by evergreen forest and riverine vegetation, with deciduous woodland and open savannah landscapes both within relatively close proximity. Details for the local environment immediately after the HP are sparse at present, but it appears that a gradual development towards cooler and more arid conditions began transitioning from predominantly evergreen taxa to deciduous woodland between 60 and 50kya (Wadley 2006, 220). Finally, at Diepkloof, attempts at environmental reconstruction suggest a general trend of increasingly diverse vegetation communities (building upon afromontane and grassland with afrotemperate, riverine and fynbos taxa) throughout the MSA sequence.

Faunal reconstructions at both Diepkloof and Sibudu show that bovids, and particularly smaller sized bovids appear to have been a main prey species throughout the Howieson's Poort relative to other periods. A clear preference for Blue Duiker at Sibudu (Clark and Plug 2008) has been explained as more likely reflecting the use of trapping technology rather than innovative hunting weaponry (Wadley 2010). At Klasies River, the fauna contrasts greatly with this pattern, with a more diverse array of species present including species such as zebra, which are notably absent from the HP phases of Diepkloof, and large bovids such as Giant and Cape Buffalo. This diversified faunal pattern seems to have continued into the MSA III and began towards the end of MSA II. Ironically, although studies of the Klasies assemblage were pioneering at the time (Klein 1976; Binford 1984), the analyses of both the Sibudu and Diepkloof assemblages far surpass these in detail. Facing the present limitations of a small and disparate dataset, it is not possible to elucidate a coherent trend between the appearance and disappearance of the Howieson's Poort with changes in faunal composition, although it does seem that generally the industry was associated with relatively diverse faunal assemblages, often with large numbers of small to medium sized bovids. The contrast in composition between the Klasies assemblage with those of Sibudu and Diepkloof may relate to differences in species representation based upon MNI rather than NISP counts (Dusseldorp 2012).

As a technological phenomenon that seemingly spanned a vast geographical area, it is perhaps unreasonable to over-zealously seek unity and coherence in the archaeology of the Howieson's Poort. The extensive chronology attributed to the Howieson's Poort at Diepkloof Rockshelter further undermines attempts to observe singular associations in faunal and environmental data. The site's investigators acknowledge this by dividing the Howieson's Poort into sub-stages according to internal variation, but further data and sites with similar chrono-stratigraphic sequences are needed to confirm this trend. If verified, many recent directions in Howieson's Poort research over the last two decades may require revision, and John Parkington's initial estimation of the phenomenon as far more disparate and lacking in cohesion (1990) may be closer to the truth than has previously been thought. The specific question of why geometric forms appear at these sites remains unanswered. It seems that they are generally associated with a shift in raw material selection, but their abrupt appearance and disappearance both at Klasies and Sibudu do not match neatly with changes in fauna and environment.

Greater research is required into other sub-stages of the MSA in order to understand the technological context from which the Howieson's Poort emerged, particularly as there are other pieces within these assemblages which I believe may equally have qualified as small armature tips. The consensus view remains that the geometric forms of the Howieson's Poort primarily, but perhaps not exclusively, represent a development relating to designs of hunting weaponry. As it stands, I am not yet ready to accept the hypothesis that some pieces related specifically to bow and arrow technology. Attempts at understanding internal variation within the Howieson's Poort have been very limited, most likely due to the poor resolution of data available. It has also been difficult to contrast the industry with preceding and following technological trends due to the lack of well excavated sites in which Still Bay, Howieson's Poort and post-HP MSA deposits occur. Even though the backed pieces of the Howieson's Poort contrast greatly with the large bifaces characteristic of the Still Bay and more crude MSA assemblages of OIS3, this shift in technology has not been so clearly reflected in shifts in faunal or environmental data. Although there is no way to know for certain which species were targeted specifically with this technology, MSA and particularly HP hunters appear to have been able to exploit a wide variety of species from a diverse array of habitats.

8.1.3 **Interior Alaska**

It is difficult to extricate any consideration of early Alaskan prehistory from the discourse of the earliest colonisation of the Americas. The interior Alaska sites assessed in this thesis include some of the oldest sites in the region. Antecedent dates from a handful of sites across the Americas may suggest that the earliest occupation of this region has, to date, eluded archaeologists. Nevertheless, these sites are often considered implicitly if not explicitly within the framework of early colonisation. The true extent to which these sites represent the earliest occupants of Alaska remains, at this stage, unverifiable.

Within the narrative of interior Alaskan sites representing early colonisers of the Americas, the earliest expressions of technological variability are sometimes explained using the concept of “learning the landscape”. The Diuktai / Yubetsu core technique recorded at Swan Point CZ4 has been used to suggest a direct connection between the earliest known peoples of Alaska and those from across the Bering strait where all other instances of this technique are documented (Holmes 2011). Furthermore, it has been posited that it was from this method that the campus core reduction technique was developed, used in most subsequent instances of microblade technology found at interior sites (Coutouly 2012). At Dry Creek, the microblade assemblage of component II is associated with durable, high-quality cryptocrystalline silicate, as well as exotic and rare materials such as argillite and obsidian, which do not occur at all in the preceding component I assemblage. The synchronous appearance of microblades with these materials has been used to suggest a better knowledge of the broader landscape (Graf and Goebel 2009). Such a theory conforms well with the idea that microblade technology produced with the campus-core technique reflected an appreciation and conservation of certain materials (Coutouly 2012). The presence of some obsidian in CZ4 of Broken Mammoth, albeit in very small quantities, shows that knowledge of these materials was not restricted to microblade using peoples.

Although there is a wide consensus that microblades were hafted as insets for composite tools, most likely as hunting armatures (Yesner and Pearson 2002; Wygal 2011), this supposition remains largely untested. The only direct evidence of them hafted in this manner comes from the site of Trail Creek located on the Seward Peninsula (Larsen 1968 cited in Mason et al. 2001). Traditionally, it has been generally assumed that the bow and arrow was not introduced in Alaska until after 3500 BP (Hare et al. 2004), which coincides with a shift away from lithics towards copper armatures in the Late Taiga Period (Holmes 2008). It has been argued by Robert Ackerman that slotted antler points found at Lime Hills Cave in south-western Alaska along with those found from Trail Creek served as arrow shafts for microblade insets (1996; 2007). Although this proposition remains unverifiable until further evidence is recovered, if it is true it means that the bow and arrow was likely utilised by early microblade users in Alaska from 12,000 BP onwards (Maschner and Mason 2013), although no such evidence has yet been recovered from interior sites.

Unlike the other two case-study regions, early prehistoric Alaska is, at present, the subject of considerable debate as to what meaningfully constitutes different chronological and geographical variations in material culture. The typological and chronological bounds of different techno-complexes vary according to interpretation. The presence and absence of microlithic technology is at the centre of this debate, even though the importance stressed upon this dichotomy may be misguided. It is not yet clear whether the cultural-framework of early Alaskan prehistory can be brought into better resolution within the strictures of the current cultural-historical tradition. The original interpretation of the Nenana as a non-microblade industry that precedes the Denali has only really remained tenable as a geographically discrete trend restricted to sites within the Nenana valley (Hoffecker 2001). I am inclined to favour the belief extolled by Potter (2011) that current attempts to categorise sites strictly as Nenana or Denali ignores the true variability of these assemblages as they are presently understood. Although reductionist, focussing on microblades as a particular technological type is perhaps more fruitful than attempting to adhere to increasingly unsatisfactory cultural descriptors (e.g. Graf and Bigelow 2011). In acknowledgement of this predicament, in Appendix 38 the term Nenana refers to assemblages that are firmly non-microblade, and Denali (and Post-Denali) refer to assemblages in which microblades are present.

Sites with multiple archaeological components are favourable for contrasting change over time at a particular location within the landscape, even as vegetation communities developed and diversified in the wake of the preceding steppe landscape of 14,000 RCYBP. Out of all the sites considered for this investigation, Broken Mammoth and Dry Creek are perhaps best suited for such comparison. Broken Mammoth is situated on a small knoll on the floodplain of Shaw Creek, while Dry Creek occupies a higher elevation among the Nenana Valley foothills. There appears to be no substantial difference in the ungulate prey base of cultural zones 4 and 3 at Broken Mammoth in terms of composition that correlates with the appearance of microblades. The most notable changes relate to the representation of avifauna and small rodents. At Dry Creek, the contrast in fauna between non-microblade and microblade components is more stark but also derived from a significantly smaller database, highlighting the potential pitfalls of over-extrapolating limited sample sets. Nevertheless, as shown at the post-Younger Dryas Gerstle River component III where wapiti are the dominant fauna associated with microblades, a variety of large ungulates have been found in microblade yielding contexts (Appendix 38). If microblade based hunting weaponry were focussed specifically on a few species, it is not particularly apparent. As discussed earlier however, we should perhaps be more cautious regarding claims that they were utilised in the pursuit of megafauna such as mammoth. It has been suggested that microblades were predominantly used for hunting in lowland environments, but this pattern is far from binary (Potter 2011), and has not been made apparent in my own assessment, probably because of limitations of the sample population.

Various investigators have sought to examine how the use of microblade technology changed relative to broad-scale climatic shifts (Mason et al. 2001; Wygal 2011). Microblades have been advocated over bifacial armatures in extreme cold environments as they generally have a lower propensity for fatal breakage (Elston and Brantingham 2002), yet it is clear from Appendix 38 that they were used both during conditions of extreme cold and much ameliorated climate. Although the cold and arid Younger Dryas certainly temporarily impeded the development of dense birch forest across much of the landscape and likely altered the distribution and composition of flora and fauna within the landscape (Graf and Bigelow 2011), the database of well excavated sites from this time period and before is perhaps simply too small to permit meaningful inference regarding the human impact of these changes. In any case, the main response of interior Alaskan peoples during this time seems to have been a proliferation in the diversity of tools used, with a variety of bifacial points and microblade assemblages from this period (Ibid 2011). Thus it is difficult to observe any specific conditions that invoke a preference towards microblade technology. They were seemingly utilised in both sparsely vegetated and open environments as well as more wooded landscapes for seemingly a variety of mid-large sized ungulates or other prey.

In the terminal Pleistocene and early Holocene, the early inhabitants of interior Alaska utilised microblade based hunting equipment. Microblades may have served as barbs for spears and atlatl darts, but equally may have been hafted in arrow designs (Maschner and Mason 2013). Recent discoveries have served to dismantle traditional chronological frameworks for the region, with it now seeming as though various biface traditions were largely contemporaneous with microblade technology. It is difficult to envisage two ethnically distinct groups coexisting within such an area with fundamentally different toolkits. Rather, it seems more plausible that different sites within the landscape were used for different activities, and that any associations (positive or negative) between certain types more likely relate to the patterning of behaviour in this way. This may also explain the continued use of microblades throughout the climatic fluctuations of the Younger Dryas and Milankovitch Thermal Optimum alongside other types of hunting weaponry. It has been suggested that microblade technology may have served to conserve exotic materials (Graf and Goebel 2009), and it is likely that small armatures hafted in multi-element hunting tools would have fared better in extreme cold conditions than singular bifaces (Wygal 2011), although it is clear that microblades were not restricted to use in these temperatures.

It has been argued that because the Younger Dryas did not in itself appear to have stimulated the wholesale adoption or abandonment of a particular technological type, its effects were in fact not as severe as may often be imagined (Graf and Bigelow 2011). I would suggest that alternatively, early Alaskan peoples were familiar with a variety of prey, hunting technologies and survival strategies that, despite the fluctuation brought about at this time, they were sufficiently able to cope. Several researchers have attempted to associate specific taxa with microblade technology (Mason et al. 2001; Potter 2011; Maschner and Mason 2013), but it seems that the situation was perhaps more complex. The wide breadth of fauna documented in the earliest archaeological levels of Broken Mammoth, particularly the wildfowl, fish and smaller mammals and rodents, attest to a wide resource base (Yesner 2001), and perhaps suggests that the dominance of ungulate species in subsistence strategies may have been overrated. Both Potter (2011) and Ackerman (2007) invoke Churchill (1993) in their attempts to explain selection preferences for microblade technology, suggesting that they suit encounter-based hunting strategies for various species such as bison and wapiti. Although it is beyond the resolution of the available data to elaborate further on this interpretation, it perhaps best accounts for the multitude of complexities in the spacing, timing and association of early Alaskan microblade technology relative to other lithic technologies, species of fauna and climatic phases.

8.2 Microlithic Based Hunting

8.2.1 Cantabrian Spain

In Cantabrian Spain, hunting weaponry utilising inset backed bladelet armatures appear to have become a main technological focus in the Magdalenian, although these armatures, and likely the weapon systems that utilised them, co-existed alongside Solutrean spears. These microlithic weapon systems are primarily associated with subsistence strategies focussed upon red deer and ibex which predominate throughout the terminal Pleistocene faunal assemblages of Cantabria. Red deer may have been found throughout much of the Cantabrian coastal plain, while the latter was more likely restricted to higher elevations and generally more rocky terrain (Straus 1987). Backed bladelet based weapon designs were seemingly equally capable of dispatching both these species, despite the different strategies required of their habitats. Although unretouched bladelets may have also served as armatures, little can be said about their role until they are subjected to further investigation. Nevertheless, it is curious that the preference for retouch became so popular in the Magdalenian. Retouching in this manner allows for greater influence over the final size and morphology of the piece, as well as the manufacture of variants including microlithic points. Control over these attributes may have been important, as some use-wear studies suggest that size may have influenced the choice to use backed bladelets as hunting armatures or insets for butchery tools. Generally, it is assumed that the backing of these pieces through retouch is what made them suitable for hafting. Certainly, this and other forms of retouch would allow for greater control over the regularity of the final product, meaning a greater potential value for weapon-systems that benefit from a high degree of standardisation. Reasons as to why bladelets lacking retouch or backing would be unsuitable, rather than simply less suitable, have not been satisfactorily explained.

Throughout much of the Upper Palaeolithic, the Cantabrian plain would have been a predominantly open landscape, not to say that vegetation coverage was sparse, but rather that dense forest habitats were rarely able to develop and expand more extensively until the Upper Magdalenian and post-Younger-Dryas. The dual ungulate economy of red deer and ibex that dominates many faunal assemblages from this period suggests that the hunting strategies of Cantabrian peoples were specifically geared towards these species. It is clear that by the Magdalenian at least, hunters in

Cantabria had more sophisticated delivery systems in the form of the atlatl spear-thrower. Such delivery systems may also have been present in the Solutrean, as they are documented at French sites from this period (Straus 2002, 74), and would have been particularly effective used in conjunction with projectiles fitted with microlithic armatures. The bow and arrow has also been mooted as a possible weapon system in use at this time (Ibid 2002), although this ultimately remains a matter of conjecture.

Spear-throwers are generally believed to offer at least two advantages over conventional hand delivery, by increasing both the effective distance and velocity of the projectile. The first advantage enables the hunter to approach his/her quarry from a greater distance, thus reducing the chance of the target scaring into flight. The second advantage may have been particularly effective in compensating for the lack of a large and heavy cutting tip assumed of spears fitted with Solutrean points. Experimental reconstructions of these weapons stress that penetration upon impact is essential for laterally hafted barbs to effectively damage or lodge within the target (Pétillon et al. 2011). The successful delivery of several of these projectiles in quick succession into the target prey of either red deer or ibex would likely bring the animal down relatively quickly. Aside from the shock of the impact, laterally hafted barbs may increase damage and blood-loss, or debilitate movement once lodged within the target. In the rockier climes of the ibex's preferred habitat, where pursuit may have been quite difficult, such a strategy might have been particularly effective. At times when the ground was under snow, weaponry designed to maximise blood-letting would potentially facilitate tracking of the wounded individual. The use of such a weapon system to this end would have been particularly effective in the targeting of juvenile animals with smaller body masses.

Although chronologically there is overlap between bifacial Solutrean points and backed bladelet technology, Lawrence Straus, arguably the foremost expert on the Upper Palaeolithic of Cantabria, has noted in his own experience a tendency towards an inverse relationship between these two technological modes (Straus 2002, 74). It seems fairly clear that whilst not mutually exclusive, they most likely represent two quite different types of weapon design. A shift towards microlithic technology may have represented a more conservative option in terms of material costs, particularly considering the high breakage rates commonly suggested among Solutrean points.

While bladelets may have broken just as frequently if not more so, they are relatively easy to replace, and the failure of one hafted element is also offset against the utility of several others. Less frequently discussed is the conservative potential bladelet technology offers for hafting materials. By investing in more complex multi-component weapon systems, it is possible to reduce stress upon the projectile shaft. Assuming the shaft can be recovered, the armatures may easily be replaced, extending the potential used life of the shaft. This concern may also explain the popularity of bladelet technology in Cantabria at times when the landscape was notably cold and open, when wood as a raw material may have been more precious. As a final consideration, the properties of a projectile may be quite variable according to shaft design and hafting arrangements without this necessarily being clearly reflected in the bladelets themselves, allowing such toolkits to adapt independently of the armatures that make them lethal.

8.2.2 **Southern Africa**

The Howieson's Poort was preceded by the Still Bay or local variants of the MSA, and was followed by a return to regional MSA variant traditions. The geometric pieces that characterise the industry and comprise the microlithic elements of interest appear and disappear quite suddenly. These elements typically comprise backed lunate or crescent (segment) pieces, trapezes, and various derivative or otherwise modified forms. They are most widely believed to have functioned as armature insets for composite hunting weaponry, though this view has recently been challenged at Diepkloof Rockshelter (Igreja and Porraz 2013). Generally, it seems that fine-grained materials such as hornfels and silcrete were preferred for the manufacture of these pieces, although quartz was also used, which is notoriously difficult to control when knapping (Wadley 2008, 123). There may also have been more nuanced discrimination in the selection of particular materials for different types of armature and weapon design, as suggested by analyses at Sibudu (Wadley and Mohapi 2008) and possibly at Klasies River (see analysis).

In addition to the geometric pieces most commonly discussed, it has also been suggested that bladelet manufacture became more sophisticated (utilising soft or indirect percussion techniques) during the Howieson's Poort (Porraz et al. 2013; Villa et al. 2010; Wurz 1999). Even if these pieces are indeed technologically distinct from other MSA traditions of manufacture, MSA assemblages from southern Africa in general are replete with pieces of varying regularity that may qualify as microlithic: small laminar bladelet-like pieces, some of them pointed (Singer and Wymer 1982). These pieces lack retouch and did not merit investment in non-local fine-grained materials. They have been overlooked in favour of the more precocious and visually distinct types associated with the Still Bay and Howieson's Poort, but I believe that they merit investigation as a potential alternative form of MSA microlithic technology, which could re-contextualise the geometric pieces of the HP as a development rather than a totally new innovation. In keeping with popular consensus and the prevailing subject of attention, the focus here remains upon geometric HP pieces.

The question of delivery method has been keenly discussed thanks to the pioneering application of various investigative methods focussed upon questions of functional variability, particularly at Sibudu (Wadley and Mohapi 2008; Lombard 2008a; 2011; Lombard and Phillipson 2010). After reviewing these arguments, I have come to the conclusion that evidence of bow and arrow technology remains inconclusive and requires further substantiation before it should be more widely accepted. The possibility remains however, and considering the early date for the Howieson's Poort, potentially carries significant implications for consideration of subsequent uses of the bow and arrow elsewhere. It is more agreeable that HP backed pieces would have been hafted in hand delivered (thrusting or thrown) spears, or perhaps atlatl darts, although evidence for the latter also remains highly circumstantial (Wadley and Mohapi 2008). The HP segments would have facilitated a variety of different tip and armature designs in contrast to the preceding blade/bladelets and levallois points of the MSA and particularly the large bifaces of the Still Bay. The distinct shapes of the pieces, with curved or trapezoidal edges may have facilitated novel and versatile possibilities of hafting arrangement.

Characterising the fauna targeted by hunters of the Howieson's Poort has proved difficult. It is difficult to confidently associate these weapon systems with specific taxa, and a diverse array of taxa is present even when representation favours an emphasis on particular fauna. Only at Klasies River, which lacks a confirmed Still

Bay phase, is there a significant shift in faunal data. At Sibudu and Diepkloof, the Howieson's Poort appears to have accompanied an increased emphasis on bovids, and particularly smaller species, although not as exclusively at Diepkloof. At Klasies, the assemblage appears much more diverse, but this may reflect the difference in quantification, using MNI rather than NISP. It has been suggested that the high NISP counts for smaller bovids and other small taxa at Sibudu may reflect differences in carcass transportation to sites (Dusseldorp 2012, 74). Although the preference for smaller bovids is less emphasised in the post-HP at Sibudu and Diepkloof, bovids remain in general an important focus of subsistence. Clearly, Howieson's Poort hunters, and indeed hunters of the MSA in general, were adept at taking a wide variety of game, both large and dangerous prey and much smaller non-ungulate species not considered in this study but nevertheless a potentially important source of prey (McCall and Thomas 2012, 74).

The surrounding habitat of Sibudu was characterised by cool and wet evergreen forest during the Howieson's Poort. It appears that these conditions did not change significantly in the immediate post-HP MSA. Likewise, floral and faunal data from Diepkloof suggests a continuum of gradual habitat change throughout much of the MSA rather than rapid contrasting states accompanied by drastic fluctuations in climate (Porraz et al. 2013, 3545). The forested environment of Sibudu contrasts with the open landscape of Klasies River and grasslands around Diepkloof. The diverse array of species at all of these sites likely reflects the fact that each one occupied a location well suited to exploit different habitats. The sudden appearance of Howieson's Poort technology does not seem to neatly correlate with sharp adjustments in environment or faunal exploitation. The hunting weaponry that utilised these geometric pieces may have been quite versatile having been utilised in a variety of habitats.

The geometric pieces that characterise the Howieson's Poort are perhaps just the most consistently visible component of a much broader development that became adopted throughout much of southern Africa. These armatures most likely facilitated a variety of new weapon designs, and potentially reflect the development of new delivery methods, although evidence for this is contentious. The assumed maintainability and flexibility of design facilitated by these pieces allowed for weapon systems that could likely target a range of small to medium game if not also larger targets.

8.2.3 **Interior Alaska**

Microblades appear throughout much of the early Alaskan archaeological record. They are temporarily absent at a regional level, as shown in the Nenana Valley (Hoffecker 2001), but are arguably too ubiquitous to be an effective discriminatory criterion in the distinction of more nuanced variation among different technological traditions and archaeological cultures. In interior Alaska, it is increasingly difficult to confidently identify chronologically extant technological traditions according to the presence or absence of microblade assemblages. Compounding this problem is the fact that many Alaskan point types, both bifacial and unifacial, were likely small enough to use as dart tips, and some may even be considered microlithic at least in size. Confusion over different technological traditions may be alleviated by the refinement of chronological control and the discovery of new datasets. At present, however, the archaeological record seems to contradict the view that different ethnic groups replaced one another with different technological traditions. The main alternative hypothesis is that different bifacial projectile tips and microblades reflect different technological adaptations towards different tactical requirements or cultural traditions.

Microblades are most commonly assumed to have served as tips or inset barbs for hunting weaponry including spears and, in predominantly coastal settings, harpoons (Yesner and Pearson 2002, 150; Wygal 2011). Traditionally, the bow and arrow was not assumed to have become utilised until later in the Holocene (Hare et al. 2004), but recent discoveries have raised the possibility that early Alaskan peoples may have been familiar with this technology (Maschner and Mason 2013; Ackerman 2007; 1996). Certainly, if arguments similar to those invoked by proponents of bow and arrow technology in the MSA (Lombard and Haidle 2012) are to be believed, then other suppositions regarding the technological capabilities of early Alaskans e.g. the use of nets for fishing and hunting (Yesner and Pearson 2002, 151) make the bow and arrow a distinct possibility. As with the MSA, however, I feel that evidence is as yet insufficient to convincingly demonstrate that this was indeed the case. Early Alaskan microblade hunting weaponry likely comprised projectiles delivered by hand as thrusting spears (Potter 2011) or as darts from an atlatl, with direct evidence of the latter in use from southwest Yukon dating to at least as far back as 8360 ± 60 RCYBP (Hare et al. 2004).

Microblades have been championed as a specifically cold-adapted hunting technology; a response to the vulnerability of larger pieces to breakage in extremely low temperatures (Ackerman 2007, 168), and also as a strategy for conserving valuable lithic materials when regular access could not be guaranteed (Yesner and Pearson 2002, 151). Although these advantages would have been undoubtedly valuable attributes, they do not explain their continued use. Certainly, it seems that microblade technology was successful, or rather versatile enough to endure various periods of climatic fluctuation over which the landscapes in which they were used changed quite substantially. Although the Younger Dryas may not have been as severe as is sometimes presumed (Hoffecker and Elias 2003, 39; Graf and Bigelow 2011) microblade technology was in use prior to, during and after this period. Over the course of this time, the landscape of the Alaskan interior went from a mostly open herb tundra steppe with sparse vegetation, when surrounding mountain ranges were still glaciated, to a range of more ecologically diverse biomes, with more fully developed forest communities in many areas following the post-Y.D. climatic optimum. Some researchers maintain a 700-900 year absence of microblade technology immediately prior to the Y.D. (e.g. Graf and Bigelow 2011, 448), but this requires dismissal of the microblade assemblages from Broken Mammoth CZ4 and Swan Point CZ3 from a period which has incredibly few archaeological sites.

At some time during the earliest stages of this occupation, both mammoth and horse became regionally extinct. Bison, elk/wapiti, moose and mountain/Dall sheep appear to have constituted the main ungulate base for subsistence throughout the ensuing millennia. Faunal assemblages are sparse from the earliest Alaskan record, and so documenting change across time has largely proved beyond capability. Caribou may have been particularly favoured during the Y.D. (Mason et al. 2001), although there is as yet little evidence of this having been the case (Graf and Bigelow 2011). Analysis of taxa from cultural zones 3 and 4 of Broken Mammoth, which boast excellent organic preservation, suggest that the subsistence base may have been substantially complemented by a variety of smaller species including fish and wildfowl on at least a seasonal if not full year basis (Yesner 2001).

At present, it seems that variability in the archaeological record of different technological systems at least partly reflects differential use of the landscape. Ben Potter has suggested that microblades were preferred for thrusting spears, targeting bison, moose and wapiti in lowland settings (Potter 2011) using disadvantage strategies (after Churchill 1993). The association of fauna, habitat and technology is not exclusive however, and it seems that microblades were used in a variety of topographic settings. Microblades may have been hafted in a variety of different weapon-systems. Their co-occurrence at some sites with a variety of other bifacial technologies (e.g. Dry Creek component II) may reflect that they served as part of or alongside various other hunting tool-kits. This would fit with ethnographically documented technological variability among arctic based hunter-gatherers (Oswalt 1973; 1976). Even in the scenario posed by Potter, in which mid-large, potentially dangerous (particularly at close proximity) game were targeted, it would probably require several spears to be delivered before the animal was sufficiently slowed to administer a more fatal wound, perhaps with another weapon. Such spears may have required a non-microblade tip armature to facilitate greater initial impact penetration.

Considering the flexibility commonly assumed of microblade based weapon systems, it may be that these various biface types were catered towards more specific niches. If technology varied across the landscape according to the exploitation of different resources, then it may be expected that seasonal rhythms were also factored into consideration. Unfortunately, the current resolution of faunal data prohibits the effective reconstruction of a seasonal round. Nevertheless, microblade hunting weaponry was suitably effective or adaptable in the wake of the Younger Dryas, unlike some biface variants (e.g. chindadn points). While it may have been preferred for particular taxa, it perhaps additionally offered greater versatility in the face of unexpected encounters, and greater flexibility for changes in strategy and weapon design necessitated by the variable conditions of hunting game within different environments. As in Cantabria, microblade tool-kits may have been particularly preferable in conditions when shaft materials may have been sparse, or when increased blood-letting for tracking in the snow were advantageous.

8.3 Comparative Trends

The above synthesis and interpretation of trends identified within the datasets reviewed in this thesis highlights a remarkable degree of variability in the archaeological correlates of microlithic technology. After scrutinising internal archaeological variability within different instances of microlithic technology from prehistory, albeit through using select data samples, consideration may now turn to the possibility of broader universalisms. Although counterintuitive to the aim of the project, to more critically explore reductionist interpretations of microlith based hunting technology, Table 44 shows a generalised summary of other data examined in this investigation. With regards to non-technological data (i.e. characterisations of faunal and habitat reconstruction), it is difficult to satisfactorily convey more subtly nuanced trends. Table 45 complements these trends by surmising the extent to which the appearance and disappearance of these elements coordinated with substantial changes in material selection, ungulate economy and environmental conditions. The number of sites studied does not refer to any universalism in the support of trends, simply that these results were born from consideration of multiple assemblages.

	Number of study sites	Confirmed Projectile Delivery Mechanism	Raw Material Selection	Dominant Ungulate Economy	Associated Habitat
Cantabrian Backed Bladelets	7	Atlatl	Fine grained	Narrow economy, medium sized game focus	Varied
Howieson's Poort Geometric Pieces	3	?	Fine grained, non-local	Diverse economy, greater small-medium sized game focus	Varied
Interior Alaskan Microblades	6	Atlatl / Bow	Fine grained, non-local	Varied economy, medium-large sized game focus	Varied

Table 44: Comparison of Generalised Trends between Case Study Areas

	Number of study sites	Raw Material Selection	Prevailing Fauna	Significant Environmental Change
Cantabrian Backed Bladelets	7	Yes	No	No
Howieson's Poort Geometric Pieces	3	Yes	Yes	No
Interior Alaskan Microblades	6	Yes	No	No

Table 45: Correlation of Trends with Proliferation of Microlithic Technology

The appearance or proliferation of particular microlithic types in each of the cases included in this study are in fact just the most numerically distinct components of broader synchronous shifts in technology. The Magdalenian, Howieson's Poort and, for lack of a better handle, the Denali, are all primarily characterised by particular microlithic forms in association with a variety of changes in other lithic and non-lithic technological systems. Of these case-studies, only the Howieson's Poort sequences show the disappearance of this technological mode. In central Alaska, microblade use continued to varying degrees for a number of millennia after the period of focus, and in Cantabrian Spain, backed bladelets gave way in dominance to backed geometric forms in the Mesolithic.

8.3.1 **Delivery Mechanisms**

With the exception of extremely rare discoveries of equipment used to deliver projectiles (e.g. González Morales and Straus 2009) or circumstantial evidence of a compelling nature (e.g. Edwards 2007; Binneman 1994), it has remained an immensely frustrating challenge to archaeologists concerned with subsistence practices that it remains so difficult to differentiate between different methods and techniques (Cattelain 1997). Despite hopes that various use-wear assessments and particularly microwear analyses might be able to highlight diagnostic differences, there are still no testable criteria to confidently distinguish between hand-delivery, spear-throwing and bow and arrow delivery mechanisms. The ability to differentiate different weapon systems would understandably permit greater discussion over the sorts of hunting tactics that may have been preferred (Churchill 1993; Ellis 1997).

A further problem in the investigation of microlithic armatures has been the question of how they were hafted, whether as weapon tips or as laterally hafted cutting insets or barbs. Investigations into the patterning of archaeological residue traces (Lombard 2008a) and experimental reconstructions of micro-striations (Crombé et al. 2001; Ibánez Estevez and González Urquijo 1996) have enabled more enlightened discussion, but these methods have not been widely implemented and their reliability remains questionable. Consequently, questions of delivery mechanism and the specific function of different microlithic pieces remains dominated by discussions of morphological form relative to supposed weapon-designs. The bow and arrow remains a possible weapon-system in all three of the case-studies considered, but by far the greatest efforts to argue its presence has been among MSA archaeologists, where this argument is inextricably bound to research agendas concerned with demonstrating the behavioural capacity of peoples at this time (Lombard and Haidle 2012; Lombard 2012). The spear-thrower, as a somewhat less sophisticated technological ensemble is perhaps a less contentious possibility for MSA hunters, although equally lacking in unequivocal evidence. It has been shown that there is much greater evidence to support the use of this technology in both Cantabrian Spain and Interior Alaska.

8.3.2 **Raw Materials**

In cases where it has been possible to contrast raw material composition, it is clear that the adoption of microlithic technology is underwritten by change in selection towards more fine-grained types. While microlithic technology may have been a primary consideration in the selection of these materials, they are by no means the only assemblage components to be affected by it. At Klasies River, material selection preferences established during the Howieson's Poort appear to have begun prior to, and continued to some degree after, the technological mode itself. The pattern is more marked at Klasies River, as completely novel materials were utilised during this time. At Diepkloof and Sibudu the materials preferred in the HP were present in earlier and later assemblages, just in varying frequency. A similar pattern is apparent in Cantabrian Spain, where flint types were known and used prior to the proliferation of backed bladelets in the Magdalenian. Central Alaska is the least well-known area, with only materials from Dry Creek having been subjected to thorough assessment. At this site it seems that fine grained materials were obtained from sometimes distant (300 km) sources.

The attributes of material are emphasised rather than the distance from which it was procured, under the assumption that the mechanical properties were important for technological consideration. For the production of microliths, finer grained materials offer more regular and predictable fracture patterns, facilitating greater control over crude standardisation in the process of batch production. Microlithisation may represent a means of maximising material utility, while conserving material costs through economic manufacturing processes. While it can be said that there is a preference for fine-grained materials in assemblages characterised by microlithic technology, this does not always translate into substantial transport differences. Nevertheless, shifts in material preference are often interpreted as indicative of a change in group range, mobility, and/or network size. The tendency for microliths to numerically dominate in assemblages where they occur can inflate material representation in generalised assemblage characterisations. In this study, this is best evidenced in the discussion of raw material quantification at La Riera, where selection clearly correlates with peaks in backed bladelet representation. As already mentioned, changes in raw material selection and preference cannot always be equated with changes in territorial mobility and range, but the idea of microlithic technology facilitating flexibility in (not exclusively hunting) tool-kit design seems to fit well with suppositions of extended range and the encountering of potentially unknown habitats and prey. To make such suppositions, however, a clear understanding of material provenance is necessary (Minichillo 2006; Ambrose 2006).

8.3.3 **Ungulate Economy**

Microlithic pieces are most widely assumed to have functioned as weapon armatures in each of the contexts examined in this study (Straus 2002; Ambrose 2002; Yesner and Pearson 2002). Technologically, microlithisation is often thought to have been a response to the requirement of greater reliability in tool design (e.g. Bleed 2002). Different weapon systems are associated with the exploitation of specific prey types through the adoption of varying tactics (Churchill 1993). Consequently, it may be expected that the adoption of microlithic technology corresponds with changes in faunal economy. For the purposes of this thesis, only ungulate and other medium-large species have been considered as sources of prey. It is clear that the subsistence base of these groups was not limited to these taxa (Altuna 1986; Cuenca-Bescós et al. 2012; Clark and Plug 2008; Steele and Klein 2013; Yesner 2001), but it is not an unreasonable assumption to suggest that, at least for much of the year, prey of a more substantial size likely constituted a main food source.

In Cantabrian Spain, the ubiquitous dual economy of red deer and ibex was already established prior to the proliferation of backed bladelets in the Magdalenian. The presence of backed bladelets in the Solutrean suggests that they were more heavily invested in rather than a new innovation. This emphasis may have been accompanied by a shift in focus to different hunting strategies, but continued to target the aforementioned species. It has been argued that the exploitation of smaller temperate species was driven by the overexploitation of traditional sources of prey (Cuenca-Bescós et al. 2012). The faunal economy associated with the Howieson's Poort appears to vary across sites and is generally quite diverse. Poor resolution of data has inhibited comparison of Still Bay, HP and post-HP assemblages. The most notable corresponding change is a more specific focus upon bovids (and particularly smaller bovids) at Sibudu (Clark and Plug 2008) and Diepkloof (Steele and Klein 2013), although these changes may relate to the broader sweep of developments (such as the innovation of trapping equipment) associated with the HP rather than the geometric backed pieces specifically. By the same token, the continued presence of species such as Giant and Cape Buffalo in some assemblages indicate that hunters were still more than capable of successfully targeting large and potentially dangerous prey. From the limited data available from early central Alaskan assemblages, it seems that microblade armatures were important throughout the late Pleistocene and early Holocene to varying degrees (Wygal 2011), and may have been associated with a variety of fauna. As an alternative possibility to Potter's hypothesis of an association between microblade technology and larger lowland ungulates such as bison and wapiti (2011), I have tentatively suggested that they may have represented a highly flexible and generalised component of a broader variety of contemporary weapon-systems in which various lithic points and other less archaeologically visible hunting equipment constituted more niche specific adaptations. Ultimately it has proved difficult to effectively reconstruct faunal economy and observe any clear-cut associations with different technological systems.

In addition to assemblage composition, there are also questions regarding the association of different hunting tool-kits with the targeting of a particular prey demographic, which often relates to seasonal patterning of subsistence activities. Finding sufficient quality of data upon which to base these reconstructions is often difficult, and estimations are often inhibited by the extent to which we can account for the full composition of a site's faunal economy (Binford 1984; Altuna 1986c) and understand the extent to which these estimates are impacted by specific butchery practices and various taphonomic processes (Clark 2011).

It is a truism to claim that hunter-gather behaviour was heavily influenced by seasonal variation in subsistence, and although the use of trapping technology in the Howieson's Poort supports the emphasis of this factor (McCall and Thomas 2012), it has not been possible to contrast behaviour from different periods of the MSA. Recent research suggests a preference for juveniles of certain species in the Howieson's Poort of Sibudu, but this has been linked to resource stress rather than seasonal abundance (Clark 2011, 284). In Cantabrian Spain, juvenile mortality profiles at La Riera suggest a change at the end of the Solutrean from generalised year-round occupation to a more heavily summer oriented use of the cave (Figure 23), with a similar pattern documented at La Fragua (Arroyo and González Morales 2007). Remains from Magdalenian deposits at montane site Rascano confuse matters, however, by suggesting year-round occupation at times (Figure 26). Finally, regarding Interior Alaskan sites, changes in faunal composition over time at Broken Mammoth (Figure 113) and Dry Creek (Hoffecker et al. 1996) have been suggested as potentially indicative of varying seasonal occupation. Realistically, there is insufficient data to test this hypothesis at other sites and further examine how these changes related to different technological practices.

8.3.4 **Habitat Diversity**

A common perspective regarding microlithic technology among prehistorians of the Upper Palaeolithic and Mesolithic of Eurasia has been that they were primarily an adaptation to forest environments (Burdukiewicz 2005). This adaptation implicitly pertains to the idea that they were used as armatures for bow and arrow weaponry, regarded by many as the ideal tool-kit for small-medium game in densely forested environments (Rozoy 1989; Bergman 1993). The chronological and geographical range over which various forms of microlithic technology occur, an issue emphasised in the design of this investigation, seems likely to undermine any broader extrapolations of microliths in this manner. In each of the case studies addressed here, archaeological occurrences of microlithic technology seem suited to exploit a variety of habitats. The extent to which prehistorians are able to effectively reconstruct palaeoenvironments has, and will likely always be, a subject of considerable debate. From the sites considered here however, it seems that microliths were utilised in a variety of landscapes, and in both forested and open environments. If any loose association could be drawn from the narrow sample of assemblages examined in this study, it is that microlithic technology was evidently suitable for the exploitation of open and often cold landscapes.

Descriptors such as open and closed landscapes, cold and warm, dry and wet climates are clearly only very general and relative binary terms. Actual habitat reconstruction offers greater insight into the sort of habitat conditions hunters really operated in. Yet even at this poor resolution, there is seemingly considerable potential for variability. Microlithic technology in the Howieson’s Poort has been found at sites that occupied open fynbos and grassland environments as well as relatively dense forest. In Cantabrian Spain, backed bladelets are found at sites from both the coastal plain and from higher elevations with more mountainous terrain. In central Alaska, microblades were used at times when the landscape was very sparsely covered, but also in more densely wooded ecosystems. From a larger study sample, it has been argued that microblades were primarily associated with taxa more commonly associated with lowland habitat preferences, although this pattern is not exclusive (Potter 2011).

It is clear that even when limited to a crude resolution, the habitats of different locations within the landscape do change over time. If the use of microliths is primarily influenced by specific prey types and the effectiveness of their utility is not substantially altered by more minor variation in habitat, then archaeologists should be wary of hoping to observe narrow and restrictive correlations between the technology and associated habitats. Reflecting upon the results of this study shows that microlithic tool-kits were serviceable in a variety of environmental contexts. This does not mean that they were not designed with particular scenarios of use in mind, but rather at the resolution considered here it has been difficult to elicit clear trends. It appears that the potential flexibility in tool-kit design facilitated by microlithisation allowed for utility that was not strictly dictated by habitat conditions. These patterns also serve to remind of the many complexities involved in attempting to define restrictive associations and correlations between specific technological adaptations and environments.

8.4 General Issues

As well as the above regional comparison of the archaeological trends identified in the analysis section, engaging with different research discourses in the course of this investigation has raised a number of other issues that deserve consideration. The need to discuss these issues was recognised after experiencing the varying ways in which they posed problems for the different research traditions consulted in this investigation. These issues interrelate with one another in varying ways that require consideration.

8.4.1 Defining and Quantifying Microlithic Assemblages

The question of what constitutes a microlithic assemblage is one that has rarely necessitated extensive critical discussion. This is largely due to the broad acceptance of regional typological orders used to categorise various assemblages by type-fossils and the ability to discount stratigraphic mixing between deposits. When these two issues are not agreed upon, quantification may be referred to as a measure of significance. For example, in discussions of the Post-Howieson's Poort, geometric backed pieces similar to those found in the Howieson's Poort are occasionally noted, but because of the minor quantities in which they are found, even when they are not explained through processes of stratigraphic mixing they do not affect the overall characterisation of the assemblage they are found in. The regionally varying nature of site formation processes prevents generalised consideration of how microliths should be quantified, although the issue has been discussed in specific cases where disagreement has been raised (Crombé et al. 2009; Vanmontfort 2009).

As it is rare to find assemblages that entirely comprise microlithic pieces, it is more helpful to characterise assemblages as being part of a microlithic tradition, a chronologically and geographically discrete archaeological pattern in which microlithic technology is often (but not exclusively) emphasised as an important technological mode. The importance of the technology is assumed through the relative frequency of the microliths. It is expected that tool frequency may vary from assemblage to assemblage according to varying site function. Consequently, there may be Cantabrian assemblages in which backed bladelets are absent or comprise only a very small proportion, yet through either the association of other archaeologically distinct materials or through proxy of dating and geographic proximity, the assemblage may nevertheless be considered Magdalenian or Azilian. The Solutrean of Cantabria, by contrast, often contains assemblages of backed bladelets, but rarely in the same quantities. Although Solutrean bifacial points themselves are rarely recovered in large numbers, they are nevertheless emphasised as the most unique and defining technological tradition from this period. While it would be wrong to dismiss the backed bladelets recovered from many Solutrean assemblages, the phase is not characterised as microlithic or as having a strong emphasis on microlithic technology.

The situation is more clear-cut in the MSA of Southern Africa thanks largely due to the lack of sites with a continuous stratigraphic sequence throughout the Still Bay and Howieson's Poort, though at Diepkloof there are levels designated as Howieson's Poort with Still Bay bifaces and vice versa (Figure 99, Figure 100). In Interior Alaska, confusion over the chronological and technological distinction of different assemblage types has rendered the question of how assemblages are defined as microlithic more problematic. Inventories for many sites are unavailable and various revisions of interpretation have been necessary following the expansion of work at various sites. For example, Kelly Graf and Nancy Bigelow dismiss the microblades from Broken Mammoth CZ3 as there is as yet no evidence of their manufacture from the same assemblage (Graf and Bigelow 2011). I have disagreed with this position in my thesis, and in each case-study have accepted microlithic technology wherever instances of it have been documented and cases of stratigraphic mixing have been dismissed. I suspect one of the reasons the establishment of a clear chrono-cultural system in Interior Alaska has proved so problematic is because of the difficulties in disentangling microblades, a clear technological strategy in their own right, from the more typical modes by which assemblages are characterised based on the presence or absence of retouched forms. As discussed further below, the qualification of what can be considered a microlith varies greatly according to these criteria, and represents one of the biggest disparities in prehistoric research.

A final problem regarding the definition of microlithic assemblages is the question of how to meaningfully interpret fluctuations in quantity over time. Such assessments can only be given with a firm understanding of the changing habitat and function of the site over time. Unfortunately, such level of understanding is rarely permitted by the archaeological record. Although, as stated earlier, I have tried to at least note instances where microliths have been recorded, my own investigations have necessarily reflected the emphases of the scholars whose work I have depended upon. Consequently, although by no means a linear association, the tendency throughout this thesis has been to focus on the general proliferation and diminishment of microlithic forms rather than more curious appearances. Likewise, the investigation has focussed upon the forms traditionally regarded as of importance, despite advocating reconsideration of pieces (most notably unretouched bladelets from the MSA and Upper Palaeolithic of Cantabria) that are generally more marginalised.

8.4.2 **Microliths and Bifaces**

An interesting feature of each of the case-studies examined in this thesis is the relationship between microlithic and bifacial point technology. Assemblages characterised by microlithic types are all preceded by or overlap with assemblages characterised by bifacial technology. These pieces are often substantially larger, although a variety of smaller forms are also typical in both Interior Alaska and the Solutrean of Cantabria. As with microlithic pieces, bifacial points are most commonly assumed to have served for weaponry, probably for hunting, but may also have functioned in other capacities (Greaves 1997). These points, and especially the larger variants, are commonly assumed to have been singularly hafted on spears delivered by hand as thrusting spears, or thrown as projectiles. In central Alaska, it is likely that a number of them also tipped darts (Hare et al. 2004). It is difficult to compare bifacial and microlithic technology because it is hypothesised that only a single point would be utilised in a projectile in comparison to any number of microlithic pieces. While there are many hunting weapon-systems that may have utilised neither of these pieces, it is nevertheless interesting that there appears to be a precedent of the former preceding, co-existing with, and giving way to the latter. The association of these pieces with different weapon-designs and/or preferences in material selection means that they are often interpreted as reflective of markedly contrasting hunting strategies (Churchill 1993) and technological characteristics regarding reliability and maintainability (Straus 1993; Straus 2005; McCall 2006;

McCall and Thomas 2012; Dusseldorp 2012; Graf and Goebel 2009; Goebel 2011; Potter 2011).

8.4.3 **Spatial Patterning and Technological Variability**

A range of geographic areas is covered through the different study areas assessed in this thesis. Archaeologists commonly seek to understand how groups utilise different areas within the landscape for different activities. It is also recognised that archaeological residues and materials may cluster in zones according to differential use of space within the delineated site. Both the archaeological record of Cantabrian Spain and MSA of Southern Africa predominantly comprise cave and rockshelter sites. It is possible that a substantial amount of behavioural variability may be unquantifiable due to the loss of open landscape sites from the archaeological record. In Southern Africa, the large geographical area across which the Howieson's Poort occurred limits the effectiveness of attempts to characterise different systems of landscape use. Nevertheless, even from the three sites included here, it is clear that hunters exploited a variety of ecosystems. In Cantabrian Spain, researchers have sought to discuss landscape mobility (Arroyo and González Morales 2007; Arroyo 2009b; Arroyo 2009c; Cuenca-Bescós et al. 2012; Stanford and Bradley 2012; Straus 2014) whilst acknowledging the complications posed by archaeological variability and a lack of open air sites. Site function may be a key explanatory factor in the presence or absence of certain tool types and faunal assemblage patterns.

Similarly, in Interior Alaska, differential exploitation of the landscape has been discussed (Mason et al. 2001; Potter 2011), although limitations of the available data compounded by confusion over the distinction of different archaeological assemblages has rendered these discussions more speculative. While researchers continue to seek a pattern of technological variation across different site locations, research in the Alaskan interior has served to highlight the importance of intra-site spatial variability. Our understanding of several early Alaskan sites, including Dry Creek (Powers and Hoffecker 1989), Broken Mammoth (Krasinski and Yesner 2008), Gerstle River (Potter 2005) and Swan Point (Holmes 2011), has been significantly improved by expanding excavation areas and attempting to observe discrete associations of different materials. Through expanding sample sizes in this manner, microblades have been discovered in previously designated non-microblade components, both Swan Point CZ3 (Holmes 2008) and Broken Mammoth CZ3 (Krasinski and Yesner 2008). The caves and rockshelters of Cantabria and the Southern African MSA naturally restrict the extent of preservation afforded to the sites they contain, and excavation is often spatially restricted through concerns of safety or logistics. Consequently, it is generally more difficult to ascertain the extent to which an archaeological dataset can be considered representative of the broader site, and when excavations are confined to deep trenches of a small excavation area, questions of spatially patterned behaviours cannot be effectively investigated.

8.4.4 **The Importance of Retouch**

It is often assumed that microlithic armatures require backing in order to facilitate hafting. The backing of pieces is achieved through processes of retouch. Although not mutually exclusive, in many microlithic assemblages backing accounts for the majority of retouch. Consequently, in assemblages where the two are juxtaposed, it is easy to dichotomise retouched and backed pieces as functional, and unretouched pieces without backing are regarded as manufacturing blanks, spares or simply debitage. While it is reasonable to equate evidence of retouch and backing with the intention of use, I would caution against being uncritically dismissive of pieces lacking these traits. It is clear from the evidence of microblade technology in Alaska that backing retouch need not necessarily be a requisite of hafting. Furthermore, use-wear investigations have overwhelmingly focussed upon pieces that exhibit retouch in assemblages containing both retouched and unretouched elements. Analysis conducted on an assemblage of unretouched flakes has demonstrated that pieces may have sometimes been utilised, even if only opportunistically (Odell and Cowan 1986). I believe that the unretouched debitage bladelets that co-occur alongside backed-bladelets throughout the record of Upper Palaeolithic Cantabria, and smaller flake-blade / bladelet types of the MSA in Southern Africa, merit further investigation regarding the question of their use-potential. I see at present no substantial reason to preclude the possibility that these pieces may also have been hafted and utilised in some capacity.

8.4.5 **Reliability and Maintainability**

It is rare for archaeologists to find definitive proof of technology in action. With regards to hunting technology, this would constitute an embedded armature or similarly direct association of the sort unlikely to be deposited let alone preserved at most archaeological sites. This makes discussing specific hunting techniques in relation to specific prey behaviours difficult. As discussed in the introduction, it has seemed more profitable to conceptualise technological variability and its use through hypothesised scenarios of reliability, maintainability and, relative to these concepts, flexibility (Bleed 1986). In Bleed's initial argument (1986), he stresses that concepts of reliability and maintainability are not binary opposites, but rather the extremes of a spectrum.

Archaeologically, these concepts are most frequently used when discussed relative to costs associated through hypothesised risk (Bamforth and Bleed 1997). As most current hunter-gatherer groups survive in what would be considered at least relatively marginal environments where risks of a various nature may be high, it should perhaps be anticipated that certain aspects of their toolkits are designed with a strong emphasis upon reliability or maintainability. Furthermore, it has also become clear that it is difficult to assess the extent to which a toolkit may be considered reliable or maintainable without an appreciation of the broader technological systems of which it is a part. The success and advantages intended from some weapon designs are dependent upon strategised use in conjunction with other tools. Examples of this are perhaps most effectively demonstrated by Oswalt's description of the various designs that may be utilised in singular modes of arctic maritime subsistance (Oswalt 1976).

In ethnographic studies, observations relating to technology, use behaviours and outcomes, allows the formulation of interplay models such as Churchill's (1993). In archaeology, use behaviours are hypothesised and outcomes are inferred. It may be expected that substantial differences in technology may result in equally contrasting qualities of reliability and maintainability. The tendency towards this view further fuels the apparent dichotomy between large bifacial points and microlithic armatures that is so often identified. These concepts may also be discussed on more nuanced patterns of archaeological variability however, when the resolution of data permits it, as has been shown by Jelmer Eerkens' interpretation of less standardisation over time in the design of microliths during the British Mesolithic (1998). A lack of clarity over the particular component elements, specific designs of function, or overall weapon-system fitness may lead to varying interpretations of reliability or maintainability. This is exemplified by contradicting stances regarding the intended quality of Howieson’s Poort backed segments as maintainable (Dusseldorp 2012, 4) or reliable (McCall and Thomas 2012, 25). I disagree with McCall and Thomas’s interpretation of Dusseldorp’s work as inherently misunderstanding these concepts, but rather believe that disagreement stems from emphasising different aspects of the technological system under discussion. When toolkits are characterised as maintainable or reliable, the sense in which they are deemed as such needs to be made explicitly clear. The microlithic armature itself, even if not immediately readily replaceable, may represent a relatively maintainable design feature for a weapon that is overall characterised as reliable.

Often, our ability to understand archaeological variability is too limited to allow the effective delineation of relationships between different results and technological inputs (or “contents”, as advocated by Bleed (1997)), even when changes in technology appear to be considerable as in the dichotomy between large bifacial points and microliths. La Riera provides an excellent example of this. The dual economy of red deer and ibex may have encouraged the design of highly reliable weaponry for specialised niche exploitation. The proliferation of backed bladelets does not however appear to correlate with any obvious change in faunal economy. Indeed, for much of the later Solutrean it appears neither large bifacial points nor backed bladelets were common. Although I feel unable to effectively characterise the microlithic weapon systems assessed in this thesis as reliable or maintainable, I do believe that, following this investigation, I am able to tentatively offer a few remarks regarding general qualities inherent within microlithic armatures. These are presented alongside other final thoughts and reflections in the conclusion.

8.5 Overview

8.5.1 Summary

This section serves to draw together the regionally specific reviews of data detailed in the analysis section and reflect upon the significance of the contrasting variability that they document. It is shown that microliths served as part of an effective technological strategy for the exploitation of a variety of species from a range of environmental settings. This variability is documented both at an inter-regional level and at times intra-regionally. Advantageous qualities of microlithic technology were exploited to various effect in a range of scenarios. In addition to the results of the main study, a number of other trends and issues identified throughout the course of research are also discussed, along with their significance for our understanding of microlithic hunting assemblages.

8.5.2 **Areas for Future Consideration**

This investigation has focussed primarily upon the cross-examination of three broad categories of data: technological (quantity, use-wear and material selection), ungulate fauna (species composition, mortality data), and habitat environment (vegetation proxies, general climatic data, and faunal indicators). Various other modes of inquiry not fully explored in this thesis may offer further insight if pursued in further future investigation. These include more in-depth exploration of different technological modes of production, the scheduling of different technological practices, the behaviour of specific types of prey, and consideration of the impact of demographic reconstructions (Kuhn and Elston 2002, 3), stylistic concerns and the role that culturally specific aesthetics may have on aspects of weapon and armature design (Wiessner 1984; Gendel 1982; 1984; Blankholm 1990). By exploring these issues, it may be possible to elicit further trends or variability in cross-regional comparisons of microlithic technology, and better improve our understanding of both how these armatures functioned and why they were chosen and developed at different stages throughout the past.

9 Conclusion

In the analysis portion of this thesis, I sought to review investigations into a variety of contemporary sites from different regions to observe whether broad changes in faunal assemblage and palaeoenvironmental data correspond to developments in the use of microlithic technology as hunting weaponry armatures. The desire to do this was born out of curiosity regarding the extent to which generalisations may be made about microlithic technology and the sorts of archaeologically visible correlates that make them a desirable technological strategy. A second aim of the investigation has been to reflect upon the potential value of comparative analysis; the patterns and ideas that arise from comparing different regionally specific research discourses. In addressing both these aims in this manner, I am able to evaluate our ability to relate specific archaeological patterns of change through time to macroscale concepts. To my knowledge, this is the first attempt to assess microlithic based hunting strategies from such a broad scope in this manner.

As established at the outset of this investigation, microlithic technology is documented in a variety of forms throughout prehistory. These assemblages have been understood through regionally specific research frameworks, contextualised within local histories of technological development. Considering the broad chronological and geographical range across which this technology has been documented, I aimed to compare and contrast a broad cross-section of these regional traditions, to identify whether there are any key developments associated with shifts towards or away from microlithic technology. As a starting premise for the thesis, case-studies were chosen where there is reasonable consensus among the scholars who work in these areas that a primary function of the microliths was as armatures for hunting weaponry. Each case-study also happens to represent unique periods of history in which microlithic technology seems to have been involved in the success of the populations utilising them.

In Cantabrian Spain, backed bladelet technology seems to have been an important adaption to an LGM refugium landscape that may have imposed various constraints upon materials and resources. In Southern Africa, the Howieson’s Poort was, by many estimates, a chronologically discrete if geographically widespread expression of microlithisation most distinctly characterised by backed geometric pieces. This technology contrasts strongly with the Still Bay and MSA industries that preceded it, and along with a variety of accompanying archaeological traits, has garnered considerable interest as an early example of complex technological adaptation. The interior Alaskan sites that comprise the third case-study area show that microblade technology was important for the first colonists of the Americas, and continued to be of importance throughout the changing landscapes of the Younger Dryas and into the Holocene.

9.1 Preliminary Remarks

Before addressing the main conclusions, there are two other aspects of this research that deserve brief reflection. The first is my critique of the ability of use-wear and particularly microwear investigations to address key questions regarding the function of microliths in relation to hunting strategies. It is clear from the analysis chapter that the impact of these investigations has been great and that these studies have helped substantially to further interpretation and debate. The application of these analytical procedures should be welcomed. The purpose of my critique was to express concern for uncritical acceptance of the results that these analyses often generate. Such methods offer great potential when regarded critically and integrated sufficiently with other modes of investigation. I do believe that unfortunately a great deal of hunting armatures, and particularly pieces considered expendable or replaceable are not preserved in the archaeological record because of their loss during the act of hunting. It is such utilized hunting elements that would have the greatest potential for use-wear analysis.

The second aspect of research that merits review is the re-tabulation of data from Klasies River. One of the reasons I sought to review site data in the manner that I did was driven by a desire to understand the justifications of the original investigators in their own assessments and quantification of data. I believed an awareness of these considerations, along with other issues relating to site formation and stratigraphic integrity, would help facilitate a better understanding of how various datasets could be related to one another. As a matter of course, it was not uncommon to find occasional minor errors in the presentation of raw data, however notable inconsistencies were encountered in assessing the Klasies River Mouth report. After attempting to identify the source of the error and redress the discrepancy, I was able to determine that the impact of this re-tabulation of data did not substantially impact the basic trends upon which the original and subsequent investigators have based their interpretations. Nevertheless, I hope that this matter of clarification may be useful for future researchers, as there has seemingly been no prior acknowledgement of this issue (e.g. Villa et al. 2010).

9.2 Regional Trends and Variability

While not overall a primary aim of this investigation, the course of research has nevertheless allowed for remarks to be made about microlithic technology in each of these particular case-studies.

In Cantabrian Spain, backed bladelets became a numerically dominant feature of many assemblages in the Magdalenian, although they are also documented in various Solutrean deposits. Bladelet blanks, lacking in retouch, are found in large quantities throughout the Upper Palaeolithic. It has been confirmed that from at least the Magdalenian if not prior, inhabitants of the region were using spear-throwing weapon systems. The main ungulate economy at this time comprised red deer and ibex, although it appears that the proliferation of backed bladelets has little impact on overall faunal assemblage variability. Although not an exclusive trend, it seems that backed bladelet technology was particularly popular at times when conditions were cold and the landscape relatively open. It is not clear how landscape variability influenced the use of bladelet based weapon systems. The shift in focus towards retouched bladelets is accompanied by a more general shift in technological forms, and a higher preference for fine-grained materials in contrast to the preceding Solutrean.

In the Southern African MSA, backed geometric forms (most commonly crescent segments and trapezes) became a defining feature of the Howieson’s Poort. Although it is widely accepted that this period was preceded by the Still Bay, an industry best known for large bifacial tools, sequences with continuous deposition from earlier periods through to the Howieson's Poort are unfortunately rare, leaving a degree of uncertainty over the nature of the phenomenon's origin. A variety of unretouched laminar forms, small enough to be considered bladelets, are found throughout these and other MSA assemblages. It is as yet unclear how sophisticated the weapon systems in which Howieson's Poort geometric pieces were utilised actually were. The composition of faunal assemblages vary, with bovids and particularly smaller species favoured at some sites. Broadly speaking, however, species composition remains relatively diverse. Equally, it appears that this technological system was utilised across a variety of habitats. There is generally a greater emphasis in the Howieson's Poort on fine-grained materials for geometric pieces, although materials such as quartz may have also had desirable properties. These preferred materials may have at times been sourced over relatively substantial distances.

Current wisdom suggests that microblade technology was important for the earliest occupants of Interior Alaska. These microblades are unretouched, unlike the pieces that form the main focus of research in Cantabria and Southern Africa. Evidence of advanced delivery systems from these early occupations is lacking, although it is believed that early inhabitants likely utilised atlatls if not more sophisticated weapons. Although conspicuously absent from some assemblages, microblades were used intermittently throughout much if not all of early Alaskan prehistory, as various vegetation communities re-established and diversified. No strict associations of prey and tool-type have yet been identified among these assemblages. While it seems that microblade weapon-systems may have been utilised for a variety of species, it has been suggested elsewhere that they may have been preferentially used in the exploitation of larger ungulates (particularly bison) in lowland settings (Potter 2011). Raw material selection for microblade technology seems to have favoured fine-grained materials including obsidian, which was likely sourced from a substantial distance (Cook 1995), although confirmation of this preference for selection requires further research.

9.3 Cross-Regional Assessment

From comparing the assessment of these specific case studies, it is possible to make several statements regarding generalised patterns of microlithic hunting use. Habitat reconstructions based upon palaeoenvironmental data collected from sites yielding microlithic assemblages show that this technology was likely utilised in a variety of settings. These include open steppe tundra, shrublands and grasslands, forested biomes, lowland river plains, rocky foothills and perhaps even in mountainous terrain. Indeed, many of the sites included for assessment may be considered ecotonal in nature. If it is assumed that particular weaponry designs are suited to different hunting strategies catered to different environmental contexts (Oswalt 1976; Churchill 1993; Bleed 1997), then the presence of microlithic pieces at sites where a variety of ecological niches were exploited suggests that the tool-kits they were intended for were themselves adaptable for a variety of scenarios and strategies.

Likewise, the association of microlithic assemblages with a variety of faunal types may be seen to imply a degree of flexibility. Moreover, it is clear from the results of this study that microlithic based hunting weaponry was a preferred technological adaptation at times when subsistence bases comprised both narrow and relatively diverse faunal economies. Again, this defies the idea that microlithic technology represents a specific adaptive trend with regards to diversity of subsistence economy. It also further enforces the idea that the various weapon systems that microlithic technology facilitated were capable of being designed or used to effectively target a variety of prey. Underlying all these interpretations, however, is the inescapable problem of rarely being able to directly associate specific lithic technologies with particular prey. For the purposes of this investigation, ungulates and other medium-large terrestrial species have been considered the main focus of microlithic based subsistence, although various other fauna (terrestrial and non-terrestrial) may have constituted economically important resources on at least a seasonal basis.

As has been shown throughout the investigation, extrapolating the true significance of fluctuations in the proportional representation of a particular lithic type within assemblages over time is problematic for various reasons. Nevertheless, it seems reasonable to assume that microliths were a main technological focus in assemblages where they comprise a major component, and were at least part of the technological repertoire of assemblages where they comprise a less dominant portion. Many of the microlithic assemblages examined in this thesis have demonstrated a preference for fine-grained materials. Although in some cases these materials were transported over substantial distances, they were also preferentially sought when procured from more local sources. It is likely that their fracturing properties afforded greater control, making them ideal for the manufacture and standardisation of shape and form, with the added bonus of maximising material utility in cases where it was considered valuable. Fine grained materials may also be more brittle and therefore perhaps more likely to fracture upon or after impact, a property demonstrated in various experimental reconstructions (Pargeter 2007; Chesnaux 2008; Crombé et al. 2001) and potentially a desired outcome of their use (Ellis 1997).

It is clear from surmising the above conclusions that microlithic technology represented a suitably versatile option for effective hunting strategies catered for a variety of scenarios. From the selection of sites used for this study, it would seem that the appropriation of this technology, or particular variant forms of it (i.e. the retouched pieces from the Howieson's Poort and Cantabrian Upper Palaeolithic) was not always related to archaeologically visible changes in ungulate faunal economy or shifting environmental conditions. It is possible that changes relating to the selection of this technology were simply too nuanced to be clearly visible with the restrictive archaeological resolution from periods of this antiquity, but it is also likely that the flexibility of design facilitated by microlithic armatures along with the various strategies that could be developed around these weapon systems facilitated a flexible hunting technology. In cases where shifts in subsistence economy does change in a way that appears approximately synchronous with the increased importance of particular microlithic forms, it may relate more closely to broader cultural and technological developments of which microliths merely comprise a particularly visible component.

9.4 The Microlith as a Global Phenomenon

It is widely assumed, and reasonably so, that most microlithic forms by virtue of their size required and were therefore designed with the intention of being hafted for effective utility. It is also widely assumed, although less so, that microlithic pieces were most commonly utilised as hunting armatures. Since David Clarke roundly challenged this notion (1976), various researchers have continued to question the complacency with which it is accepted (Finlayson and Mithen 1997; Kuhn and Elston

2002, 3; Torrence 2002, 181; Igreja and Porraz 2013). While it is clear that this normative position could benefit from greater scrutiny, it remains popular in many cases thanks to various fortuitous finds attesting to the use of microliths in this capacity (e.g. Noe-Nygaard 1974; Ackerman 1996; Hare et al. 2004; Edwards 2007; Larsson and Sjöström 2011; Leduc 2014), and further support from various use-wear investigations, as demonstrated throughout the examples used in this investigation.

The ubiquity of microlithic technology throughout the prehistoric archaeological record being such that it is, it should perhaps be unsurprising that a cross-examination of geographically and chronologically distinct periods and research traditions favours interpretations of versatility. For the purposes of this thesis, microliths are regarded as small (refraining from a metric definition in acknowledgement of the relativity of this term) cutting implements created to a basic template i.e. excluding opportunistically utilised flakes. Although similar forms and modes appear across wide expanses of time and space, this is largely a result of the limitations of technological equifinality. While the advantages of microlithic technology may have been commonly appreciated by different people, their cultural meaning and value must be treated as a regionally specific phenomenon.

The qualities of a particular tool-type can only be assessed with specific stresses and risks in mind (Nelson 1991, 66) and relative to other technological options known to have been available (Bamforth and Bleed 1997; Elston and Brantingham 2002). As microliths are most commonly assumed to have functioned as insets in composite weaponry, there remains a great deal of variability both in design and use strategy that is difficult to estimate due to the limited nature of the archaeological data available. A microlith may be hafted in a number of different arrangements and configurations to function as a cutting edge or tip in a variety of weapon-systems or toolkits. A variety of microlithic designs, potentially intended for different contingencies, might have been equipped contemporaneously. Further still, these designs may have been utilised alongside various other non-microlithic food-getting toolkits, to reduce the dependence or stress upon these particular weapon systems. Consequently, statements regarding the advantages of microlithic technology may not necessarily be amplified in the toolkits in which they were used. Without effective reconstruction of the toolkits for which they were intended or the broader technological systems of which they were a part, a substantial amount of potential variability remains unaccountable. Although this seems pessimistic, it is in itself a revealing statement, and although firm evidence may be lacking archaeologically, the design and use of various weapon-systems may at least be hypothesised with the aid of ethnographic data.

9.5 General Characteristics

As a global phenomenon, microlithic technology may be conceptualised as highly versatile due to the wide variety of circumstances in which it appears to have been selected. This apparent versatility, in the sense defined by Margaret Nelson as meaning that a variety of needs may be met through the maintenance of a generalised form (Nelson 1991, 70), in part results from the hugely generalised definition of microlithic technology. While the versatility of this technology may have been an appeal to various different groups, it must be assumed that culturally specific ideas regarding their use-potential existed, rather than that they represented a universal armature / tool for all occasions. The tool-kits they were utilised for represent the broader system of which they were a constituent technology, and it is at this level that their effectiveness in hunting should be considered. Too often, these concepts are conflated, and assumptions are made regarding microlithic technology and the sorts of tool-kits they were utilised within. This is reasonably understandable: it is difficult to imagine a microlithic armature having the sheer stopping power of a large biface tipped spear for example.

The versatility of the microlith in its basic form, as considered within the broader cultural and technological operating parameters of specific groups, allows for potential flexibility in weapon design through modularity, wherein the toolkit for which the microliths are utilised may be adapted in design for varying requirements. This explains the desire for archaeologists to reconstruct specific weapon-systems (e.g. Cattelain 1997; Lombard and Haidle 2012; González Morales and Straus 2009; Ackerman 2007), as understanding the context of the system within which microliths were co-opted facilitates more developed understanding of the overall significance in these shifts in modes of lithic production (Rozoy 1990; Bergman 1993; Maschner and Mason 2013).

Trends towards microlithisation may be interpreted as a selection of expedience in armature manufacture. Batch production results in a stockpile of pieces that could be relatively regular in size and form, and may also be both conservative in material costs and cheap in terms of energy and time in their production. This may equally facilitate weapon-designs considered to be maintainable or expedient, or offset costs incurred elsewhere in the design or scheduling of more reliable weapon systems. Technological designs that incorporate multiple hafted elements are often characterised as reliable due to the idea that multiple armatures mitigate the cost of failure in any specific one. While overall the weapon design may be considered a significant investment in terms of the time, energy or material costs involved in creation and/or curation, it may be compensated somewhat through replaceable and maintainable component elements. Thus microlithic technology may simultaneously reflect complex and considered implementation of multiple qualities in the overall design of a weapon.

9.6 Final Conclusion

Microliths come in a variety of morphological forms, and the importance of retouch in defining these pieces, at least as functionally significant, varies according to different traditions of research (Kuhn and Elston 2002, 2) with little critical justification. Furthermore, there are numerous different methods of manufacture that may result in what in essence is the same final product in all appearances (Chen 2007). Microlithic technology is generally assumed to be indicative of complex, multi-component, composite tool-designs. The versatility of a small haftable cutting-edge allows them to vary in functional significance according to the needs and demands of specific regional groups using them. This allows them to be utilised effectively as components of toolkits designed for various scenarios. While general qualities may be assessed at this macroscale resolution, their fitness as part of a context specific technological strategy, or relative to the merits of other alternative or contemporary adaptations, remains locally and historically contingent. Cross comparison of datasets and interpretive theories offers fertile potential for further developing an appreciation of the reasons behind the selection of microlithic technology in response to particular circumstances. By the same token however, sweeping statements regarding the advantages or motivations behind the selection of microlithic technology cannot be made without archaeological substantiation. The strengths and weaknesses of microlithic armatures must be approached from a consideration of the specific toolkits they were designed for and the scenarios for which these were intended.

10 Bibliography

Ackerman, R. E. 1996. “Cave 1, Lime Hills.” In *American Beginnings: The Prehistory and Paleoecology of Beringia,* edited by F. H. West. University of Chicago: 470-477.

Ackerman, R. E. 2007. “The Microblade Complexes of Alaska and the Yukon: Early Interior and Coastal Adaptations.” In *Origin and Spread of Microblade Technology in Northern Asia and North America,* edited by I͡A V . Kuzmin, S.G. Keates, and C. Shen. Archaeology Press, Simon Fraser University, British Columbia. 147-170.

Alfimov, A. V. and D. I. Berman. 2001. “Beringian Climate during the Late Pleistocene and Holocene.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 127–34.

Allott, L. F. 2004. “Changing Environments in Oxygen Isotope Stage 3: Reconstructions Using Archaeological Charcoal from Sibudu Cave.” *South African Journal of Science* 100 (3-4): 179–84.

Allott, L. F. 2005. “*Palaeoenvironments of the Middle Stone Age at Sibudu Cave, KwaZulu-Natal, South Africa: An Analysis of Archaeological Charcoal.*” Unpublished PhD Thesis. Faculty of Science, University of the Witwatersrand.

Allott, L. F. 2006. “Archaeological Charcoal as a Window on Palaeovegetation and Wood-Use during the Middle Stone Age at Sibudu Cave.” *Southern African Humanities* 18 (1): 173–201.

Altuna, J. 1981. “Restos Óseos Del Yacimiento Prehistórico Del Rascaño.” In *El Paleolítico Superior de La Cueva Del Rascaño (Santander),* edited by J. González Echegaray and Ignacio Barandiarán Maestu, 3. Monographias No 3. Centro de Investigacion y Museo de Altamira: 223-269.

Altuna, J. 1986a. “Appendix A: Inventory of the Bone and Antler Industry from the 1976-1979 Excavations at La Riera Cave.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain,* edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 385-420.

Altuna, J. 1986b. “Appendix B: The Mammalian Faunas of La Riera Cave: MNI, NR, Body Part Representation, Breakage Patterns; Age, Sex and Metrical Data by Level.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain,* edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 421-480.

Altuna, J. 1986c. “The Mammalian Faunas from the Prehistoric Site of La Riera.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain,* edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 237-274.

Altuna, J. 1995. “Faunas de Mamíferos Y Cambios Ambientales Durante El Tardiclacial Cantábrico.” In *El Final Del Paleolítico Cantábrico.*

Transformaciones Ambientales Y Culturales Durante El Tardiglacial Y Comienzos Del Holoceno En La Región Cantábrica, edited by R. A. Moure, S. C. Gonzalez, J. Altuna and Seminario Internacional Transformaciones Ambientales y Culturales Durante el Tardiglacial y Comienzos del Holoceno en la Region Cantabrica. Universidad de Cantabria, Santander: 77-118.

Ambrose, S. H. 2002. "Small Things Remembered: Origins of Early Microlithic Industries in Sub-Saharan Africa." *Archeological Papers of the American Anthropological Association* 12 (1): 9–29.

Ambrose, S. H. 2006. "Howieson's Poort Lithic Raw Material Procurement Patterns and the Evolution of Modern Human Behavior: A Response to Minichillo (2006)." *Journal of Human Evolution* 50 (3): 365–69.

Ambrose, S. H. and K. G. Lorenz. 1990. "Social and Ecological Models for the Middle Stone Age in Southern Africa." In *The Emergence of Modern Humans: An Archaeological Perspective,* edited by P. Mellars. Edinburgh University Press: 3-33.

Anderson, D. D. 1970. "Microblade Traditions in Northwestern Alaska." *Arctic Anthropology* 7 (2): 2–16.

Andrefsky, W. 2005. *Lithics: Macroscopic Approaches to Analysis*. Cambridge University Press.

Arroyo, A. B. M. 2009a. "Assessing What Lies Beneath the Spatial Distribution of a Zooarchaeological Record: The Use of Gis and Spatial Correlations at El Mirón Cave (spain)*." *Archaeometry* 51 (3): 506–24.

Arroyo, A. B. M. 2009b. "Exploitation of the Montane Zone of Cantabrian Spain during the Late Glacial: Faunal Evidence from El Mirón Cave." *Journal of Anthropological Research* 65 (1): 69–102.

Arroyo, A. B. M. 2009c. "The Use of Optimal Foraging Theory to Estimate Late Glacial Site Catchment Areas from a Central Place: The Case of Eastern Cantabria, Spain." *Journal of Anthropological Archaeology* 28 (1): 27–36.

Arroyo, A. B. M. and M. R. González Morales. 2007. "La Fragua Cave, a Seasonal Hunting Camp in the Lower Asón Valley (Cantabria, Spain) at the Pleistocene-Holocene Transition." *Anthropozoologica* 41 (320): 61–84.

Ashton, N. and A. David. (eds.) 1994. *Stories in Stone: Lithic Studies Society Occasional Paper* 4. Lithic Studies Society.

Aura, J. E., M. Tiffagom, J. F. J. Pardo, E. Duarte, J. F. de la Vega, D. Santamaria, M. de la Rasilla, M. Vadillo, and M. P. Ripoll. 2012. "The Solutrean–Magdalenian Transition: A View from Iberia." *Quaternary International*, The Magdalenian Settlement of Europe, 272–273 (September): 75–87.

Avery, D. M. 1987. "Late Pleistocene Coastal Environment of the Southern Cape Province of South Africa: Micromammals from Klasies River Mouth." *Journal of Archaeological Science* 14 (4): 405–21.

Backwell, L., F. d' Errico, and L. Wadley. 2008. "Middle Stone Age Bone Tools from the Howieson's Poort Layers, Sibudu Cave, South Africa." *Journal of Archaeological Science* 35 (6): 1566-80.

Bailey, G. 1983. Economic Change in Late Pleistocene Cantabria. In "*Hunter-Gatherer Economy in Prehistory: A European Perspective*", edited by G. N. Bailey. Cambridge University Press: 149-164.

Bamforth, D. B. 1986. "Technological Efficiency and Tool Curation." *American Antiquity* 51 (1): 38–50.

Bamforth, D. B. 1988. "Investigating Microwear Polishes with Blind Tests: The Institute Results in Context." *Journal of Archaeological Science* 15 (1): 11–23.

Bamforth, D. B. and P. Bleed. 1997. "Technology, Flaked Stone Technology, and Risk." *Archeological Papers of the American Anthropological Association* 7 (1): 109–39.

Bamforth, D. B., G. R. Burns, and C. Woodman. 1990. "Ambiguous Use Traces and Blind Test Results: New Data." *Journal of Archaeological Science* 17 (4): 413–30.

Barham, L. and P. Mitchell. 2008. *The First Africans: African Archaeology from the Earliest Tool Makers to Most Recent Foragers*. Cambridge World Archaeology, Cambridge University Press.

Begét, J. E. 2001. "Continuous Late Quaternary Proxy Climate Records from Loess in Beringia." *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 499–507.

Bergman, C. A. 1993. "The Development of the Bow in Western Europe: A Technological and Functional Perspective." *Archeological Papers of the American Anthropological Association* 4 (1): 95–105.

Bever, M. R. 2001. "An Overview of Alaskan Late Pleistocene Archaeology: Historical Themes and Current Perspectives." *Journal of World Prehistory* 15 (2): 125–91.

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.

Bever, M. R. 2008. "Distinguishing Holocene Microblades from a Paleoindian Component at the Mesa Site, Alaska." *Journal of Field Archaeology* 33 (2): 133–50.

Bigelow, N. H. and W. R. Powers. 1994. "New AMS Dates from the Dry Creek Paleoindian Site, Central Alaska." *Current Research in the Pleistocene* 11: 114–16.

Bigelow, N. H. and W. R. Powers. 2001. "Climate, Vegetation, and Archaeology 14,000–9000 Cal Yr B.P. in Central Alaska." *Arctic Anthropology* 38 (2): 171–95.

Bigelow, N. H. and M. E. Edwards. 2001. “A 14,000 Yr Paleoenvironmental Record from Windmill Lake, Central Alaska: Lateglacial and Holocene Vegetation in the Alaska Range.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 203–15.

Binford, L. R. 1979. “Organization and Formation Processes: Looking at Curated Technologies.” *Journal of Anthropological Research*, 255–73.

Binford, L. R. 1984. *Faunal Remains from Klasies River Mouth*. Academic Press, Orlando.

Binneman, J. N. F. 1994. “A Unique Stone Tipped Arrowhead from Adam’s Kranz Cave, Eastern Cape.” *Southern African Field Archaeology* 3: 58–60.

Blalock, H. M. 1972. *Social Statistics*. 2nd edition. McGraw-Hill Series in Sociology. McGraw-Hill, New York.

Blankholm, H. P. 1990. “Stylistic Analysis of Maglemosian Microlithic Armatures in Southern Scandinavia: An Essay.” In *Contributions to the Mesolithic in Europe: Papers Presented at the Fourth International Symposium, The Mesolithic in Europe, Leuven, 1990, 5* edited by P. M. Vermeersch and P. Van Peer. Leuven University Press, Belgium: 239-258.

Bleed, P. 1986. “The Optimal Design of Hunting Weapons: Maintainability or Reliability.” *American Antiquity* 51 (4): 737.

Bleed, P. 1996. “Risk and Cost in Japanese Microcore Technology.” *Lithic Technology* 21 (2): 95–107.

Bleed, P. 1997. “Content as Variability, Result as Selection: Toward a Behavioral Definition of Technology.” *Archeological Papers of the American Anthropological Association* 7 (1): 95–104.

Bleed, P. 2002. “Cheap, Regular, and Reliable: Implications of Design Variation in Late Pleistocene Japanese Microblade Technology.” *Archeological Papers of the American Anthropological Association* 12 (1): 95–102.

Bonnichsen, R. and K. L. Turnmire, eds. 1999. *Ice Age Peoples of North America: Environments, Origins and Adaptations of the First Americans*. Oregon State University Press.

Bordaz, J. 1971. *Tools of the Old and New Stone Age*. David and Charles Publishers, Newton Abbot, Devon, UK.

Bousman, C. B. 1993. “Hunter-Gatherer Adaptations, Economic Risk and Tool Design.” *Lithic Technology* 18 (1/2): 59–86.

Boyer-Klein, A. 1981. “Análisis Palinológico Del Rascaño.” In *El Paleolítico Superior de La Cueva Del Rascaño (Santander)*, edited by J. González Echegaray and I. B. Maestu. Monographias No 3. Centro de Investigacion y Museo de Altamira, Spain: 215-220.

Brain, C. K. 1974. *Some Suggested Procedures in the Analysis of Bone Accumulations from Southern African Quaternary Sites*. Transvaal Museum, Pretoria.

Brigham-Grette, J. 2001. “New Perspectives on Beringian Quaternary Paleogeography, Stratigraphy, and Glacial History.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 15–24.

Brown, K. S., C. W. Marean, Z. Jacobs, B. J. Schoville, S. Oestmo, E. C. Fisher, J. Bernatchez, P. Karkanas, and T. Matthews. 2012. “An Early and Enduring Advanced Technology Originating 71,000 Years Ago in South Africa.” *Nature* 491 (7425): 590–93.

Burdukiewicz, J. M. 2005. “Microlithic Technology in the Stone Age.” *Journal of the Israel Prehistoric Society* 35: 337–51.

Butzer, K. W. 1978. “Sediment Stratigraphy of the Middle Stone Age Sequence at Klasies River Mouth, Tsitsikama Coast, South Africa.” *The South African Archaeological Bulletin* 33 (128): 141.

Butzer, K. W. 1981. “Cave Sediments, Upper Pleistocene Stratigraphy and Mousterian Facies in Cantabrian Spain.” *Journal of Archaeological Science* 8 (2): 133–83.

Butzer, K. W. 1982. “Geomorphology and Sediment Stratigraphy.” In *The Middle Stone Age at Klasies River Mouth in South Africa*. The University of Chicago Press: 33-42.

Cartwright, C. R. 2013. “Identifying the Woody Resources of Diepkloof Rock Shelter (South Africa) Using Scanning Electron Microscopy of the MSA Wood Charcoal Assemblages.” *Journal of Archaeological Science* 40 (9): 3463–74.

Cattaneo, C., K. Gelsthorpe, J. Gale, P. Phillips, and R. J. Sokol. 1994. “Erratic Survival: Blood on Stones.” In *Stories in Stone: Lithic Studies Society Occasional Paper*, edited by N. Ashton and A. David. Lithic Studies Society: 24-27.

Cattaneo, C., K. Gelsthorpe, P. Phillips, and R. J. Sokol. 1993. “Blood Residues on Stone Tools: Indoor and Outdoor Experiments.” *World Archaeology* 25 (1): 29–43.

Cattelain, P. 1997. “Hunting during the Upper Paleolithic: Bow, Spearthrower, or Both.” In *Projectile Technology*, edited by H. Knecht. Plenum Press, New York and London: 213-240.

Charrié-Duhaut, A., G. Porraz, C. R. Cartwright, M. Igreja, J. Connan, C. Poggenpoel, and P-J. Texier. 2013. “First Molecular Identification of a Hafting Adhesive in the Late Howieson’s Poort at Diepkloof Rock Shelter (Western Cape, South Africa).” *Journal of Archaeological Science* 40 (9): 3506–18.

Chase, B. M. 2010. “South African Palaeoenvironments during Marine Oxygen Isotope Stage 4: A Context for the Howieson’s Poort and Still Bay Industries.” *Journal of Archaeological Science* 37 (6): 1359–66.

Chen, C. 2007. “Techno-Typological Comparison of Microblade Cores from East Asia and North America.” In *Origin and Spread of Microblade Technology in Northern Asia and North America, Archaeology Press, Simon Fraser University, Burnaby, BC*, edited by I͡A. V. Kuzmin, S. G. Keates, and C. Shen. Archaeology Press, Simon Fraser University, British Columbia: 7-38.

Chesnaux, L. 2008. “Sauveterrian Microliths: Evidence of the Hunting Weapons of the Last Hunter-Gatherers of the Northern Alps.” In *Projectile Weapon Elements from the Upper Palaeolithic to the Neolithic, Proceedings of Session C83, XVth World Congress UISPP, Lisbon, September 4-9* edited by J-M. Pétillon, M-H. Dias-Meirinho, P. Cattelain, M. Honneger, C. Normand, and N. Valdeyron. International Union For Prehistoric and Protohistoric Sciences: 133-146 www.palethnologie.org

Churchill, S. E. 1993. “Weapon Technology, Prey Size Selection, and Hunting Methods in Modern Hunter-Gatherers: Implications for Hunting in the Palaeolithic and Mesolithic.” *Archeological Papers of the American Anthropological Association* 4 (1): 11–24.

Cinq-Mars, J. and R. E. Morlan. 1999. “Bluefish Caves and Old Crow Basin: A New Rapport.” In *Ice Age Peoples of North America. Environments, Origins, and Adaptations of the First Americans*, edited by R. Bonnichsen and K. L. Turnmire. Oregon State University Press: 200-212

Clark, D. W. 2001. “Microblade-Culture Systematics in the Far Interior Northwest.” *Arctic Anthropology* 38 (2): 64–80.

Clark, G. A. 1983a. “Boreal Phase Settlement/subsistence Models for Cantabrian Spain.” In *Hunter-Gatherer Economy in Prehistory*, edited by G. N. Bailey, Cambridge University Press: 96–110.

Clark, G. A. 1983b. *The Asturian of Cantabria: Early Holocene Hunter-Gatherers in Northern Spain*. 41. Tucson, University of Arizona Press.

Clark, G. A. 1989. “Romancing the Stones: Biases, Style and Lithics at La Riera.” *Archeological Papers of the American Anthropological Association* 1 (1): 27–50.

Clark, G. A., D. Young, L. G. Straus, and R. Jewett. 1986. “Multivariate Analysis of La Riera Industries and Fauna.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 325-50.

Clark, G. A. and L. R. Richards. 1978. “Late and Post-Pleistocene Industries and Fauna from the Cave Site of La Riera (Province of Asturias, Spain).” In *Views of the Past: Essays in Old World Prehistory and Paleanthropology*, edited by L. G. Freeman. World Anthropology, Walter de Gruyter & Co, Berlin: 117-152.

Clark, J. L. 2011. “The Evolution of Human Culture during the Later Pleistocene: Using Fauna to Test Models on the Emergence and Nature of ‘modern’ Human Behavior.” *Journal of Anthropological Archaeology* 30 (3): 273–91.

Clark, J. L. and I. Plug. 2008. “Animal Exploitation Strategies during the South African Middle Stone Age: Howieson’s Poort and Post-Howieson’s Poort Fauna from Sibudu Cave.” *Journal of Human Evolution* 54 (6): 886–98.

Clarke, D. L. 1976. “Mesolithic Europe: The Economic Basis.” In *Problems in Economic and Social Archaeology*, edited by G. de G. Sieveking, I. H. Longworth, and K. Wilson. Duckworth London: 449-481.

Close, A. E. 2002. “Backed Bladelets Are a Foreign Country.” *Archeological Papers of the American Anthropological Association* 12 (1): 31–44.

Close, A. E. and C. Garth Sampson. 1998. “Recent Backed Microlith Production in Central South Africa.” *Lithic Technology* 23 (1): 5–19.

Cochrane, G. W. G. 2006. “An Analysis of Lithic Artefacts from The ~ 60 Ka Layers of Sibudu Cave.” *Southern African Humanities* 18 (1): 69–88.

Cochrane, G. W. G. 2008. “The Transition from Howieson’s Poort to Post-Howieson’s Poort Industries in Southern Africa.” *Goodwin Series* 10 (December): 157–67.

Cook, J. P. 1995. “Characterization and Distribution of Obsidian in Alaska.” *Arctic Anthropology* 32 (1): 92–100.

Cook, J. P. 1996. “Healy Lake.” In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West. University of Chicago Press: 323-327.

Coutouly, Y. A. G. 2012. “Pressure Microblade Industries in Pleistocene-Holocene Interior Alaska: Current Data and Discussions.” In *The Emergence of Pressure Blade Making*, edited by P. M. Desrosiers. Springer US: 347-374.

Craighead, A. 1999. “Climate Change and Patterns in the Exploitation of Economic Resources (marine Mollusca and Ungulate Fauna) in Cantabrian Spain at the End of the Pleistocene, Ca. 21-6.5 Kyr BP.” In *Zooarchaeology of the Pleistocene/Holocene Boundary*, edited by J. C. Driver. Vol. 800. BAR International Series, Archaeopress, Oxford: 9-21.

Crass, B. A., B. L. Kedrowski, J. Baus, and J. A. Behm. 2011. “Residue Analysis of Bone-Fueled Pleistocene Hearths.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 192-198.

Crombé, P. J. Sergant, and E. Robinson. 2009. “Counting Microliths: A Reliable Method to Assess Mesolithic Land Use?” *Antiquity* 83 (321): 821–26.

Crombé, P., Y. Perdaen, J. Sergant, and J-P. Caspar. 2001. “Wear Analysis on Early Mesolithic Microliths from the Verrebroek Site, East Flanders, Belgium.” *Journal of Field Archaeology* 28 (3-4): 253–69.

Cuenca-Bescós, G., A. B. M. Arroyo, I. Martínez, M. R. González Morales, and L. G. Straus. 2012. “Relationship between Magdalenian Subsistence and

Environmental Change: The Mammalian Evidence from El Mirón (Spain).” *Quaternary International*, The Magdalenian Settlement of Europe, 272–273 (September): 125–37.

Cuenca-Bescós, G., L. G. Straus, M. R. González Morales, and J. C. G. Pimienta. 2009. “The Reconstruction of Past Environments through Small Mammals: From the Mousterian to the Bronze Age in El Mirón Cave (Cantabria, Spain).” *Journal of Archaeological Science* 36 (4): 947–55.

Cushman, K. 1986. “Macrobotanical Remains from La Riera Cave.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark, 65–66. Anthropological Research Papers 36. Tempe: Arizona State University.

D’ Errico, F. and Backwell, L. 2008. *From Tools to Symbols: From Early Hominids to Modern Humans*. Witwatersrand University Press.

D’ Errico, F., M. Vanhaeren, and L. Wadley. 2008. “Possible Shell Beads from the Middle Stone Age Layers of Sibudu Cave, South Africa.” *Journal of Archaeological Science* 35 (10): 2675–85.

De Sonneville-Bordes, D. and J. Perrot. 1953. “Essai D’adaptation Des Méthodes Statistiques Au Paléolithique Supérieur. Premiers Résultats.” *Bulletin de La Société Préhistorique de France*: 323–33.

Deacon, H. J. 1985. “Faunal Remains from Klasies River Mouth by L.R. Binford.” *The South African Archaeological Bulletin* 40 (141): 59.

Deacon, H. J. 1989. “Late Pleistocene Palaeoecology and Archaeology in the Southern Cape, South Africa.” In *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans* edited by P. Mellars and C. Stringer. Edinburgh University Press: 547–64.

Deacon, H. J. and V. B. Geleijnse. 1988. “The Stratigraphy and Sedimentology of the Main Site Sequence, Klasies River, South Africa.” *The South African Archaeological Bulletin* 43 (147): 5-14.

Delagnes, A., L. Wadley, P. Villa, and M. Lombard. 2006. “Crystal Quartz Backed Tools from the Howieson’s Poort at Sibudu Cave.” *Southern African Humanities* 18 (1): 43–56.

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

Dixon, J. E. 2011. “Arrows, Atlatls, and Cultural-Historical Conundrums.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 362-72.

Dockall, J. E. 1997. “Wear Traces and Projectile Impact: A Review of the Experimental and Archaeological Evidence.” *Journal of Field Archaeology* 24 (3): 321-331.

Donahue, R. E. 1994. “The Current State of Lithic Microwear Research.” In *Stories in Stone: Lithic Studies Society Occasional Paper*, edited by N. Ashton and A. David, 4: 156–67.

Dumond, D. E. 2001. “The Archaeology of Eastern Beringia: Some Contrasts and Connections.” *Arctic Anthropology* 38 (2): 196–205.

Dumond, D. E. 2011. “Technology, Typology, and Subsistence: A Partly Contrarian Look at the Peopling of Beringia.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 345-361.

Dumont, J. V. 1988. *A Microwear Analysis of Selected Artefact Types from the Mesolithic Sites of Star Carr and Mount Sandel.* BAR British Archaeological Report, British Series , Oxford.

Dusseldorp, G. L. 2012. “Tracking the Influence of Technological Change on Middle Stone Age Hunting Strategies in South Africa.” *Quaternary International* 270 (August): 70–79.

Eastham, A. 1986. “The La Riera Avifaunas.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark, 275–84. Anthropological Research Papers 36. Tempe, Arizona State University.

Echegaray, J. G. 1981. “Industria Litica.” In *El Paleolítico Superior de La Cueva Del Rascaño (Santander)*, edited by J. González Echegaray and I. B. Maestu. Monographias No 3.Centro de Investigacion y Museo de Altamira, Spain: 55-94.

Echegaray, J. G. and I. B. Maestu. 1981. *El Paleolítico Superior de La Cueva Del Rascaño (Santander)*. Monographias No 3.Centro de Investigacion y Museo de Altamira, Spain.

Edwards, M. E. and E. D. Barker Jr. 1994. “Climate and Vegetation in Northeastern Alaska 18,000 Yr B.P.–present.” *Palaeogeography, Palaeoclimatology, Palaeoecology*, Pollen and Climate, 109 (2–4): 127–35.

Edwards, P. C. 2007. “A 14000 Year-Old Hunter-Gatherer’s Toolkit.” *Antiquity* 81 (314): 865–76.

Eerkens, J. W. 1998. “Reliable and Maintainable Technologies: Artifact Standardization and the Early to Later Mesolithic Transition in Northern England.” *Lithic Technology* 23 (1): 42–53.

Ellis, C. J. 1997. “Factors Influencing the Use of Stone Projectile Tips.” In *Projectile Technology,* edited by H. Knecht. Plenum Press, New York and London: 37-74.

Elston, R. G. and P. J. Brantingham. 2002. “Microlithic Technology in Northern Asia: A Risk-Minimizing Strategy of the Late Paleolithic and Early Holocene.” *Archeological Papers of the American Anthropological Association* 12 (1): 103–16.

Elston, R. G. and S. L. Kuhn. 2002. *Thinking Small: Global Perspectives on Microlithization*. Archeological Papers of the American Anthropological Association 12. American Anthropological Association.

Erlandson, J., R. Walser, H. Maxwell, N. H. Bigelow, J. Cook, R. Lively, C. Adkins, D. Dodson, A. Higgs, and J. Wilber. 1991. "Two Early Sites of Eastern Beringia: Context and Chronology in Alaskan Interior Archaeology." *Radiocarbon* 33 (1): 35–50.

Evans, A. A. 2009. "*Microwear Analysis and the Role of the Microlith in Mesolithic Britain*". Unpublished PhD Thesis, University of Bradford.

Evans, A. A. 2014. "On the Importance of Blind Testing in Archaeological Science: The Example from Lithic Functional Studies." *Journal of Archaeological Science* 48: 5-14.

Evans, A. A., H. Lerner, D. A. Macdonald, W. J. Stemp, and P. C. Anderson. 2014a. "Standardisation, Calibration and Innovation: A Special Issue on Lithic Microwear Method." *Journal of Archaeological Science* 48.

Evans, A. A., H. Lerner, D. A. Macdonald, W. J. Stemp, and P. C. Anderson. 2014b. "Standardization, Calibration and Innovation: A Special Issue on Lithic Microwear Method." *Journal of Archaeological Science*, Lithic Microwear Method: Standardisation, Calibration and Innovation, 48: 1–4.

Evans, A A. and R. E. Donahue. 2008. "Laser Scanning Confocal Microscopy: A Potential Technique for the Study of Lithic Microwear." *Journal of Archaeological Science* 35 (8): 2223–30.

Feathers, J. K. 2002. "Luminescence Dating in Less Than Ideal Conditions: Case Studies from Klasies River Main Site and Duinefontein, South Africa." *Journal of Archaeological Science* 29 (2): 177–94.

Finlayson, B. and S. Mithen. 1997. "The Microwear and Morphology of Microliths from Gleann Mor." In *Projectile Technology*, edited by H. Knecht. Plenum Press, New York and London: 107-129.

Finlayson, B. and S. Mithen. 2000. "The Morphology and Microwear of Microliths from Bolsay Farm and Gleann Mor: A Comparative Study." In *Hunter-Gatherer Landscape Archaeology. McDonald Institute: Cambridge*, edited by S. Mithen. Cambridge University Press: 589-598.

Fischer, A. 1990. "Hunting with Flint-Tipped Arrows: Results and Experiences from Practical Experiments." In *Contributions to the Mesolithic in Europe: Papers Presented at the Fourth International Symposium, 3, The Mesolithic in Europe, Leuven, 1990, 5* edited by P. M. Vermeersch and P. Van Peer. Leuven University Press, Belgium: 29-39.

Fischer, A., P. V. Hansen, and P. Rasmussen. 1984. "Macro and Micro Wear Traces on Lithic Projectile Points: Experimental Results and Prehistoric Examples." *Journal of Danish Archaeology* 3 (1): 19–46.

Fitzhugh, B. 2001. “Risk and Invention in Human Technological Evolution.” *Journal of Anthropological Archaeology* 20 (2): 125–67.

Flenniken, J. J. 1987. “The Paleolithic Dyuktai Pressure Blade Technique of Siberia.” *Arctic Anthropology* 24 (2): 117–32.

Freeman, L. G. 1973. “The Significance of Mammalian Faunas from Paleolithic Occupations in Cantabrian Spain.” *American Antiquity* 38 (1): 3–44.

Friis-Hansen, J. 1990. “Mesolithic Cutting Arrows: Functional Analysis of Arrows Used in the Hunting of Large Game.” *Antiquity* 64 (244): 494–504.

Gendel, P. A. 1982. “An Analysis of Stylistic Variation in Some Late Mesolithic Assemblages from Northwestern Europe.” *Bulletin de La Société Royale Belge d’Anthropologie et de Préhistoire Bruxelles,* no. 93: 51–62.

Gendel, P. A. 1984. *Mesolithic Social Territories in Northwestern Europe*. Vol. 218. BAR International Series. Archaeopress, Oxford.

Gibson, N. E., L. Wadley, and B. S. Williamson. 2004. “Microscopic Residues as Evidence of Hafting on Backed Tools from the 60 000 to 68 000 Year-Old Howieson’s Poort Layers of Rose Cottage Cave, South Africa.” *Southern African Humanities* 16: 1–11.

Glenny, W. 2006. “Report on the Micromammal Assemblage Analysis from Sibudu Cave.” *Southern African Humanities* 18 (1): 279–88.

Goebel, T. 2011. “What Is the Nenana Complex? Raw Material Procurement and Technological Organization at Walker Road, Central Alaska.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia,* edited by T. Goebel and I. Buvit. Texas A&M University Press: 199-214.

Goebel, T. and I. Buvit. 2011. “Introducing the Archaeological Record of Beringia.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia,* edited by T. Goebel and I. Buvit. Texas A&M University Press: 1-32.

Goebel, T. and I. Buvit, eds. 2011. *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*. Texas A&M University Press.

Goebel, T. and N. H. Bigelow. 1992. “The Denali Complex at Panguingue Creek, Central Alaska.” *Current Research in the Pleistocene* 9: 15–18.

Goebel, T. and N. H. Bigelow. 1996. “Panguingue Creek.” In *American Beginnings: The Prehistory and Palaeoecology of Beringia,* edited by F. H. West. University of Chicago Press: 366-371.

Goebel, T., W. R. Powers, and N. H. Bigelow. 1991. “The Nenana Complex of Alaska and Clovis Origins.” In *Clovis Origins and Adaptations,* edited by R. Bonnischen and K. Turnmire. Oregon State University: 49–79.

González Morales, M. R. 1986. “La Riera Bone and Antler Artifact Assemblages.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 209-218.

González Morales, M. R. 2000. “La Prehistoria de Las Marismas: Excavaciones En La Cueva de La Fragua, Santoña. Campañas de 1990, 1991, 1993, 1994 Y 1996.” In *Actuaciones Arquelogicas En Cantabria 1984-1999*. Conserjeria de Cultura, Turismo y Deporte, Gobierno de Cantabria, Spain: 177-180.

González Morales, M. R. and L. Straus. 2009. “Extraordinary Early Magdalenian Finds from El Mirón Cave, Cantabria (Spain).” *Antiquity* 83: 267–81.

González Morales, M. R. and M. A. Fano Martinez. 2005. “The Mesolithic of Cantabrian Spain: A Critical Review.” In *Mesolithic Studies at the Beginning of the 21st Century*, edited by Nicky Milner and Peter Woodman. Oxbow Books, Oxford: 14-29.

Goodwin, A. J. H. 1929. *The Stone Age Cultures of South Africa*. Annals of the South African Museum v.27. South African Museum, Cape Town.

Grace, R., I. D. G. Graham, and M. H. Newcomer. 1985. “The Quantification of Microwear Polishes.” *World Archaeology* 17 (1): 112–20.

Graf, K. E. and N. H. Bigelow. 2011. “Human Response to Climate during the Younger Dryas Chronozone in Central Alaska.” *Quaternary International*, Humans and Younger Dryas: Dead End, Short Detour, or Open Road to the Holocene?, 242 (2): 434–51.

Graf, K. E. and T. Goebel. 2009. “Upper Paleolithic Toolstone Procurement and Selection across Beringia.” In *Lithic Materials and Paleolithic Societies*, edited by B. Adams and B. S. Blades. Wiley-Blackwell, Oxford: 55-77.

Greaves, R. D. 1997. “Hunting and Multifunctional Use of Bows and Arrows.” In *Projectile Technology*, edited by H. Knecht, 287–320. Plenum Press, New York and London.

Grimaldi, S. 2008. “Experimental Observations of Early Mesolithic Points in North-East Italy.” In *Projectile Weapon Elements from the Upper Palaeolithic to the Neolithic, Proceedings of Session C83, XVth World Congress UISPP, Lisbon, September 4-9* edited by J-M. Pétillon, M-H. Dias-Meirinho, P. Cattelain, M. Honneger, C. Normand, and N. Valdeyron. International Union For Prehistoric and Protohistoric Sciences: 147-160. www.palethnologie.org.

Guthrie, D. R. 2001. “Origin and Causes of the Mammoth Steppe: A Story of Cloud Cover, Woolly Mammal Tooth Pits, Buckles, and inside-out Beringia.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 549–74.

Guthrie, D. R. 2003. “Rapid Body Size Decline in Alaskan Pleistocene Horses before Extinction.” *Nature* 426 (6963): 169–71.

Guthrie, D. R. 2006. “New Carbon Dates Link Climatic Change with Human Colonization and Pleistocene Extinctions.” *Nature* 441 (7090): 207–9.

Hamilton, T. D. and T. Goebel. 1999. “Late Pleistocene Peopling of Alaska.” In *Ice Age Peoples of North America: Environments, Origins, and Adaptations of the First Americans*, edited by R. Bonnichsen and K. L. Turnmire, 156–99. Oregon State University Press.

Hardy, B. and J. Svoboda. 2009. “Mesolithic Stone Tool Function and Site Types in Northern Bohemia, Czech Republic.” In *Archaeological Science under a Microscope: Studies in Residue and Ancient DNA Analysis in Honour of Thomas H. Loy*, edited by M. Haslam, G. Robertson, A. Crowther, S. Nugent, and L. Kirkwood. Australian National University Press, Canberra: 159-174.

Hare, P. G., S. Greer, R. Gotthardt, R. Farnell, V. Bowyer, C. Schweger, and D. Strand. 2004. “Ethnographic and Archaeological Investigations of Alpine Ice Patches in Southwest Yukon, Canada.” *Arctic* 57 (3): 260–72.

Haynes, G. and K. E. Krasinski. 2010. “Taphonomic Fieldwork in Southern Africa and its Application in Studies of the Earliest Peopling of North America.” *Journal of Taphonomy* 8 (2-3): 181–202.

Hendey, Q. B. and T. P. Volman. 1986. “Last Interglacial Sea Levels and Coastal Caves in the Cape Province, South Africa.” *Quaternary Research* 25 (2): 189–98.

Henshilwood, C. S. 2012. “Late Pleistocene Techno-Traditions in Southern Africa: A Review of the Still Bay and Howieson’s Poort, C. 75–59 Ka.” *Journal of World Prehistory* 25 (3-4): 205–37.

Henshilwood, C. S. and B. Dubreuil. 2011. “The Still Bay and Howieson’s Poort, 77–59 Ka: Symbolic Material Culture and the Evolution of the Mind during the African Middle Stone Age.” *Current Anthropology* 52 (3): 361–400.

Herries, A. I. R. 2006. “Archaeomagnetic Evidence for Climate Change at Sibudu Cave.” *Southern African Humanities* 18 (1): 131–47.

Hiscock, P., C. Clarkson, and A. Mackay. 2011. “Big Debates over Little Tools: Ongoing Disputes over Microliths on Three Continents.” *World Archaeology* 43 (4): 653–64.

Hoffecker, J. F. 2001. “Late Pleistocene and Early Holocene Sites in the Nenana River Valley, Central Alaska.” *Arctic Anthropology* 38 (2): 139–53.

Hoffecker, J. F. 2011. “Assemblage Variability in Beringia: The Mesa Factor.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 165-178.

Hoffecker, J. F. and S. A. Elias. 2003. “Environment and Archeology in Beringia.” *Evolutionary Anthropology: Issues, News, and Reviews* 12 (1): 34–49.

Hoffecker, J. F. and S. A. Elias. 2007. *Human Ecology of Beringia*. Columbia University Press, New York.

Hoffecker, J. F. and W. R. Powers. 1996. "Little Panguingue Creek." In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. University of Chicago Press: 371-374.

Hoffecker, J. F., W. R. Powers, and N. H. Bigelow. 1996. "Dry Creek." In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West, 343–52. University of Chicago Press.

Hoffecker, J. F., W. R. Powers, and P. G. Phippen. 1996. "Owl Ridge." In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. University of Chicago Press: 353-356.

Hoffecker, J. F., W. R. Powers, and T. Goebel. 1993. "The Colonization of Beringia and the Peopling of the New World." *Science* 259: 1.

Holmes, C. E. 1996. "Broken Mammoth." In *American Beginnings: The Prehistory and Paleoecology of Beringia*, edited by F. H. West. University of Chicago Press: 312-318.

Holmes, C. E. 2001. "Tanana River Valley Archaeology circa 14,000 to 9000 B.P." *Arctic Anthropology* 38 (2): 154–70.

Holmes, C. E. 2008. "The Taiga Period: Holocene Archaeology of the Northern Boreal Forest, Alaska." *Alaska Journal of Anthropology* 6 (1–2): 69-81.

Holmes, C. E. 2011. "The Beringian and Transitional Periods in Alaska: Technology of the East Beringian Tradition as Viewed from Swan Point." In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 179-191.

Holmes, C. E., R. VanderHoek, and T. E. Dilley. 1996. "Swan Point." In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. University of Chicago Press: 319-323.

Hurcombe, L. 1988. "Some Criticisms and Suggestions in Response to Newcomer et al. (1986)." *Journal of Archaeological Science* 15 (1): 1–10.

Ibáñez Estevez, J. J. and J. E. González Urquijo. 1996. *From Tool Use to Site Function: A New Methodological Strategy Applied to Upper Paleolithic Sites in the Basque Country*. BAR International Series 658. Tempus Reparatum, Oxford.

Ibáñez Estevez, J. J. and J. E. González Urquijo. 1998. "The Production and Use of Lithic Tools at the End of the Upper Palaeolithic in the Basque Country." In *The Organization of Lithic Technology in Late Glacial and Early Post-Glacial Europe*, edited by S. Milliken. BAR International Series. Oxford: Archaeopress, Oxford: 17-34.

Ibáñez Estevez, J. J. and J. E. González Urquijo. 2003. “Use-Wear in the 1990s in Western Europe: Potential and Limitations of a Method.” In *Lithic Analysis at the Millennium*, edited by Norah Moloney and Michael J. Shott. Left Coast Press, California: 163–68.

Igreja, M. and G. Porraz. 2013. “Functional Insights into the Innovative Early Howieson’s Poort Technology at Diepkloof Rock Shelter (Western Cape, South Africa).” *Journal of Archaeological Science* 40 (9): 3475–91.

Jacobs, Z. and R. G. Roberts. 2008. “Testing Times: Old And New Chronologies For The Howieson’s Poort And Still Bay Industries In Environmental Context.” *Goodwin Series* 10 (December): 9–34.

Jacobs, Z., A. G. Wintle, G. A. T. Duller, R. G. Roberts, and L. Wadley. 2008. “New Ages for the Post-Howieson’s Poort, Late and Final Middle Stone Age at Sibudu, South Africa.” *Journal of Archaeological Science* 35 (7): 1790–1807.

Jacobs, Z., R. G. Roberts, R. F. Galbraith, H. J. Deacon, R. Grün, A. Mackay, P. Mitchell, R. Vogelsang, and L. Wadley. 2008. “Ages for the Middle Stone Age of Southern Africa: Implications for Human Behavior and Dispersal.” *Science* 322 (5902): 733–35.

Jerardino, A. and C. W. Marean. 2010. “Shellfish Gathering, Marine Paleoecology and Modern Human Behavior: Perspectives from Cave PP13B, Pinnacle Point, South Africa.” *Journal of Human Evolution* 59 (3–4): 412–24.

Jochim, M. 1987. “Late Pleistocene Refugia in Europe.” In *The Pleistocene Old World*, edited by Olga Soffer, 317–31. Interdisciplinary Contributions to Archaeology. Springer US.

Kaufman, D. 1986. “A Proposed Method for Distinguishing Between Blades and Bladelets.” *Lithic Technology* 15 (1): 34–40.

Keeley, L. H. 1980. *Experimental Determination of Stone Tool Uses: A Microwear Analysis*. University of Chicago Press.

Keeley, L. H. 1988. “Lithic Economy, Style and Use: A Comparison of Three Late Magdalenian Sites.” *Lithic Technology* 17 (1): 19–25.

Klein, R. G. 1975. “Middle Stone Age Man-Animal Relationships in Southern Africa: Evidence from Die Kelders and Klasies River Mouth.” *Science* 190 (4211): 265–67.

Klein, R. G. 1976. “The Mammalian Fauna of the Klasies River Mouth Sites, Southern Cape Province, South Africa.” *The South African Archaeological Bulletin* 31 (123/124): 75–98.

Klein, R. G. 1977. “The Mammalian Fauna from the Middle and Later Stone Age (Later Pleistocene) Levels of Border Cave, Natal Province, South Africa.” *The South African Archaeological Bulletin* 32 (125): 14–27.

Knecht, H. ed. 1997. *Projectile Technology*. Plenum Press, New York and London.

Krasinski, K. and D. R. Yesner. 2008. “Late Pleistocene/Early Holocene Site Structure in Beringia: A Case Study from the Broken Mammoth Site, Interior Alaska.” *Alaska Journal of Anthropology* 6: 27–41.

Kuhn, S. L. 2002. “Pioneers of Microlithization: The ‘Proto-Aurignacian’ of Southern Europe.” *Archeological Papers of the American Anthropological Association* 12 (1): 83–93.

Kuhn, S. L. and R. G. Elston. 2002. “Introduction: Thinking Small Globally.” *Archeological Papers of the American Anthropological Association* 12 (1): 1–7.

Kuzmin, I͡A. V., S. G. Keates, and C. Shen. 2007. “Introduction: Microblades and Beyond.” In *Origin and Spread of Microblade Technology in Northern Asia and North America*, edited by I͡A V. Kuzmin, S. G. Keates, and C. Shen. Archaeology Press, Simon Fraser University, British Columbia: 1-6.

Kuzmin, I͡A. V., S. G. Keates, and C. Shen, eds. 2007. *Origin and Spread of Microblade Technology in Northern Asia and North America*. Archaeology Press, Simon Fraser University, British Columbia.

Larsson, L. and A. Sjöström. 2011. “Early Mesolithic Flint-Tipped Arrows from Sweden.” *Antiquity* 85 (330).

Laughlin, W. S. 1968. “Hunting: An Integrating Biobehavior System and Its Evolutionary Importance.” In *Man the Hunter*, edited by R. B. Lee and I. de Vore. Aldine Transaction, New Brunswick and London: 304-320.

Laville, H. 1986. “Stratigraphy, Sedimentology and Chronology of the La Riera Cave Deposits.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark, 25–56. Anthropological Research Papers 36. Tempe: Arizona State University.

Laville, H. and M. Hoyos. 1981. “Estudio Geológico de La Cueva de Rascaño.” In González Echagaray Y Barandiarán, I, *El Paleolítico Superior de La Cueva Del Rascaño*. Monographias No 3.Centro de Investigacion y Museo de Altamira, Spain: 191-210.

Leduc, C. 2014. “New Mesolithic Hunting Evidence from Bone Injuries at Danish Maglemosian Sites: Lundby Mose and Mullerup (Sjælland).” *International Journal of Osteoarchaeology* 24 (4): 476–91.

Leroi-Gourhan, A. 1986. “The Palynology of La Riera Cave.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 59-64.

Lively, R. A. 1996. “Chugwater.” In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. University of Chicago Press: 308-311.

Lombard, M. 2004. “Distribution Patterns of Organic Residues on Middle Stone Age Points from Sibudu Cave, KwaZulu-Natal, South Africa.” *The South African Archaeological Bulletin* 59 (180): 37–44.

Lombard, M. 2005a. “A Method for Identifying Stone Age Hunting Tools.” *The South African Archaeological Bulletin* 60 (182): 115–20.

Lombard, M. 2005b. “Evidence of Hunting and Hafting during the Middle Stone Age at Sibudu Cave, KwaZulu-Natal, South Africa: A Multianalytical Approach.” *Journal of Human Evolution* 48 (3): 279–300.

Lombard, M. 2006a. “Direct Evidence for the Use of Ochre in the Hafting Technology of Middle Stone Age Tools from Sibudu Cave.” *Southern African Humanities* 18: 57–67.

Lombard, M. 2006b. “First Impressions of the Functions and Hafting Technology of Still Bay Pointed Artefacts from Sibudu Cave.” *Southern African Humanities* 18: 27–41.

Lombard, M. 2006c. “The Howieson’s Poort of South Africa: What We Know, What We Think We Know, What We Need to Know.” *Southern African Humanities* 17: 33–55.

Lombard. M. 2007. “*Archaeological Use-Trace Analyses of Stone Tools from South Africa.*” Unpublished PhD Thesis. University of Witwatersrand.

Lombard, M. 2008a. “Finding Resolution for the Howieson’s Poort through the Microscope: Micro-Residue Analysis of Segments from Sibudu Cave, South Africa.” *Journal of Archaeological Science* 35 (1): 26–41.

Lombard, M. 2008b. “From Testing Time to High Resolution: The Late Pleistocene Middle Stone Age of South Africa and Beyond.” *Goodwin Series* 10 (December): 180–88.

Lombard, M. 2009. “The Howieson’s Poort of South Africa Amplified.” *The South African Archaeological Bulletin*, 4–12.

Lombard, M. 2011. “Quartz-Tipped Arrows Older than 60 Ka: Further Use-Trace Evidence from Sibudu, KwaZulu-Natal, South Africa.” *Journal of Archaeological Science* 38 (8): 1918–30.

Lombard, M. 2012. “Thinking through the Middle Stone Age of Sub-Saharan Africa.” *Quaternary International* 270 (August): 140–55.

Lombard, M. and J. Pargeter. 2008. “Hunting with Howieson’s Poort Segments: Pilot Experimental Study and the Functional Interpretation of Archaeological Tools.” *Journal of Archaeological Science* 35 (9): 2523–31.

Lombard, M. and L. Phillipson. 2010. “Indications of Bow and Stone-Tipped Arrow Use 64 000 Years Ago in KwaZulu-Natal, South Africa.” *Antiquity* 84 (325): 635–48.

Lombard, M. and L. Wadley. 2009. “The Impact Of Micro-Residue Studies On South African Middle Stone Age Research.” In *Archaeological Science Under a Microscope: Studies in Residue and Ancient DNA Analysis in Honour of Thomas H. Loy*, edited by M. Haslam, G. Robertson, A. Crowther, S. Nugent and L. Kirkwood. ANU E Press, Canberra: 11-28.

Lombard, M. and M. N. Haidle. 2012. “Thinking a Bow-and-Arrow Set: Cognitive Implications of Middle Stone Age Bow and Stone-Tipped Arrow Technology.” *Cambridge Archaeological Journal* 22 (02): 237–64.

Ludt, C. J., W. Schroeder, O. Rottmann, and R. Kuehn. 2004. “Mitochondrial DNA Phylogeography of Red Deer (Cervus Elaphus).” *Molecular Phylogenetics and Evolution* 31 (3): 1064–83.

Macdonald, D. 2010. “Interpreting Variability through Multiple Methodologies: Form, Function and Technology of Microliths.” *Vis-À-Vis: Explorations in Anthropology* 10 (2).

Mackay, A. 2008. “On the Production of Blades and Its Relationship to Backed Artefacts in the Howieson’s Poort at Diepkloof, South Africa.” *Lithic Technology* 33 (1): 87–99.

Maestu, I. B. and J. G. Echegaray. 1981. “Interpretación Cultural Y Ambiental Del Depósito Arqueológico Del Rascaño.” In El Paleolítico Superior de La Cueva Del Rascaño (Santander), edited by J. E. González and I. B. Maestu. Monographias No 3.Centro de Investigacion y Museo de Altamira, Spain: 323-355.

Magne, M. and D. Fedje. 2007. “The Spread of Microblade Technology in Northwestern North America.” In *Origin and Spread of Microblade Technology in Northern Asia and North America*, edited by IA. V. Kuzmin, S. G. Keates, and C. Shen. Archaeology Press, Simon Fraser University, British Columbia: 171-188.

Marean, C. W., M. Bar-Matthews, J. Bernatchez, E. Fisher, P. Goldberg, A.I.R. Herries, Z. Jacobs, et al. 2007. “Early Human Use of Marine Resources and Pigment in South Africa during the Middle Pleistocene.” *Nature* 449 (7164): 905–8.

Mariezkurrena, C. 1990. “Dataciones Absolutas Para La Arquelogia Vasca.” *Munibe Antropologia Arkeologia* 42: 287–304.

Maschner, H. and O. K. Mason. 2013. “The Bow and Arrow in Northern North America.” *Evolutionary Anthropology: Issues, News, and Reviews* 22 (3): 133–38.

Mason, O. K., P. M. Bowers, and D. M. Hopkins. 2001. “The Early Holocene Milankovitch Thermal Maximum and Humans: Adverse Conditions for the Denali Complex of Eastern Beringia.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 525–48.

McBrearty, S. and A. S. Brooks. 2000. “The Revolution That Wasn’t: A New Interpretation of the Origin of Modern Human Behavior.” *Journal of Human Evolution* 39 (5): 453–563.

McCall, G. S. 2006. “Multivariate Perspectives on Change and Continuity in the Middle Stone Age Lithics from Klasies River Mouth, South Africa.” *Journal of Human Evolution* 51 (4): 429–39.

McCall, G. S. 2007. “Behavioral Ecological Models of Lithic Technological Change during the Later Middle Stone Age of South Africa.” *Journal of Archaeological Science* 34 (10): 1738–51.

McCall, G. S. and J. T. Thomas. 2012. “Still Bay and Howieson’s Poort Foraging Strategies: Recent Research and Models of Culture Change.” *African Archaeological Review* 29 (1): 7–50.

Mellars, P. 2006. “Why Did Modern Human Populations Disperse from Africa Ca. 60,000 Years Ago? A New Model.” *Proceedings of the National Academy of Sciences* 103 (25): 9381–86.

Merino, J. M. 1984. “Estudio de Los Materiales Líticos de La Cueva de Ekain.” In *El Yacimiento Prehistórico de La Cueva de Ekain* edited by J. M. Merino. Deba, Guipúzcoa, Spain: 65–175.

Miller, C. E., P. Goldberg, and F. Berna. 2013. “Geoarchaeological Investigations at Diepkloof Rock Shelter, Western Cape, South Africa.” *Journal of Archaeological Science* 40 (9): 3432–52.

Milo, R. G. 1998. “Evidence for Hominid Predation at Klasies River Mouth, South Africa, and Its Implications for the Behaviour of Early Modern Humans.” *Journal of Archaeological Science* 25 (2): 99–133.

Minichillo, T. 2006. “Raw Material Use and Behavioral Modernity: Howieson’s Poort Lithic Foraging Strategies.” *Journal of Human Evolution* 50 (3): 359–64.

Mohapi, M. 2008. “*A New Angle on Middle Stone Age Hunting Technology in South Africa*”. Unpublished PhD Thesis. University of Witwatersrand.

Morlan, R. E. 1970. “Wedge-Shaped Core Technology in Northern North America.” *Arctic Anthropology* 7 (2): 17–37.

Morlan, R. E. 2003. “Current Perspectives on the Pleistocene Archaeology of Eastern Beringia.” *Quaternary Research,* Special Issue Dedicated to Troy Pewe, 60 (1): 123–32.

Moss, E. H. 1987. “A Review of ‘Investigating Microwear Polishes with Blind Tests.’” *Journal of Archaeological Science* 14 (5): 473–81.

Muhs, D. R, T. A. Ager, and J. E. Begét. 2001. “Vegetation and Paleoclimate of the Last Interglacial Period, Central Alaska.” *Quaternary Science Reviews,* Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 41–61.

Murray, M. S. 2002. ed. *Archaeology and Human Paleoecology in the Holarctic: Papers in Honor of Professor William Roger Powers*. Anthropological Papers, University of Alaska (New Series). Dept. of Anthropology, University of Alaska, Fairbanks.

Nelson, N. C. 1935. "Early migration of man to America." *Natural History* 35(4): 356.

Nelson, M. C. 1991. "The Study of Technological Organization." *Archaeological Method and Theory* 3 (January): 57–100.

Nelson, M. C. 1997. "Projectile Points: Form, Function and Design." In *Projectile Technology*, edited by H. Knecht. Interdisciplinary Contributions to Archaeology. New York and London: Plenum Press, New York and London: 371-384.

Newcomer, M., R. Grace, and R. Unger-Hamilton. 1986. "Investigating Microwear Polishes with Blind Tests." *Journal of Archaeological Science* 13 (3): 203–17.

Newcomer, M. H., R. Grace, and R. Unger-Hamilton. 1988. "Microwear Methodology: A Reply to Moss, Hurcombe and Bamforth." *Journal of Archaeological Science* 15 (1): 25–33.

Noe-Nygaard, N. 1974. "Mesolithic Hunting in Denmark Illustrated by Bone Injuries Caused by Human Weapons." *Journal of Archaeological Science* 1 (3): 217–48.

Nuzhnyi, D. 1990. "Projectile Damage on Upper Paleolithic Microliths: Use of Bow and Arrow among Pleistocene Hunters in the Ukraine." In *Proceedings of the International Conference on Lithic Use-Wear Analysis. Uppsala, Sweden, 15*, edited by Bo Gräslund. Societas Archaeologica Uppsaliensis, Uppsala, Sweden: 113-124.

Odell, G. H. 1980. "Toward a More Behavioral Approach to Archaeological Lithic Concentrations." *American Antiquity* 45 (3): 404–31.

Odell, G. H. 1981. "The Morphological Express at Function Junction: Searching for Meaning in Lithic Tool Types." *Journal of Anthropological Research* 37 (4): 319–42.

Odell, G. H. and F. Cowan. 1986. "Experiments with Spears and Arrows on Animal Targets." *Journal of Field Archaeology* 13 (2): 195–212.

Olausson, D. S. 1980. "Starting from Scratch: The History of Edge-Wear Research From 1838-1978." *Lithic Technology* 9 (2): 48–60.

Oswalt, W. H. 1973. *Habitat and Technology: The Evolution of Hunting*. Holt, Rinehart and Winston, New York.

Oswalt, W. H. 1976. *An Anthropological Analysis of Food-Getting Technology*. New York: John Wiley & Sons.

Panter-Brick, C., R. Layton, and P. Rowley-Conwy, eds. 2001. *Hunter-Gatherers: An Interdisciplinary Perspective*. Cambridge University Press.

Pargeter, J. 2007. “Howieson’s Poort Segments as Hunting Weapons: Experiments with Replicated Projectiles.” *The South African Archaeological Bulletin* 62 (186): 147–53.

Parkington, J. E. 1990. “A Critique of the Consensus View on the Age of Howieson’s Poort Assemblages in South Africa.” In *The Emergence of Modern Humans: An Archaeological Perspective,* edited by P. Mellars. Edinburgh University Press: 34-55.

Parkington, J. E. and C. Poggenpoel. 1987. Diepkloof Rock Shelter. In “*Papers in the Prehistory of the Western Cape, South Africa.*” BAR International Series 332, Oxford: 269-293.

Parkington, J. E., J-Ph. Rigaud, C. Poggenpoel, G. Porraz, and P-J. Texier. 2013. “Introduction to the Project and Excavation of Diepkloof Rock Shelter (Western Cape, South Africa): A View on the Middle Stone Age.” *Journal of Archaeological Science* 40 (9): 3369–75.

Parry, W. J. and R. L. Kelly. 1987. “Expedient Core Technology and Sedentism.” In *The Organization of Core Technology*, edited by J. K. Johnson and C. A. Morrow. Westview Press, Boulder, Colorado: 285-304.

Pearson, G. A. 1999. “Early Occupations and Cultural Sequence at Moose Creek: A Late Pleistocene Site in Central Alaska.” *Arctic* 52 (4): 332–45.

Pearson, G. A. and W. R. Powers. 2001. “The Campus Site Re-Excavation: New Efforts to Unravel Its Ancient and Recent Past.” *Arctic Anthropology* 38 (1): 100–119.

Pétillon, J-M. 2008. “What Are These Barbs for? Preliminary Study on the Function of the Upper Magdalenian Barbed Weapon Tips.” In *Projectile Weapon Elements from the Upper Palaeolithic to the Neolithic, Proceedings of Session C83, XVth World Congress UISPP, Lisbon, September 4-9* edited by J-M. Pétillon, M-H. Dias-Meirinho, P. Cattelain, M. Honneger, C. Normand, and N. Valdeyron. International Union For Prehistoric and Protohistoric Sciences: 66-97. www.palethnologie.org

Pétillon, J.-M., M-H. Dias-Meirinho, P. Cattelain, M. Honneger, C. Normand, and N. Valdeyron, eds. 2008. *Projectile Weapon Elements from the Upper Palaeolithic to the Neolithic, Proceedings of Session C83, XVth World Congress UISPP, Lisbon, September 4-9*. International Union For Prehistoric and Protohistoric Sciences. www.palethnologie.org.

Pétillon, J-M., O. Bignon, P. Bodu, P. Cattelain, G. Debout, M. Langlais, V. Laroulandie, H. Plisson, and B. Valentin. 2011. “Hard Core and Cutting Edge: Experimental Manufacture and Use of Magdalenian Composite Projectile Tips.” *Journal of Archaeological Science* 38 (6): 1266–83.

Pickering, R. 2006. “Regional Geology, Setting and Sedimentology of Sibudu Cave.” *Southern African Humanities* 18 (1): 123–29.

Plug, I. 2004. “Resource Exploitation: Animal Use during the Middle Stone Age at Sibudu Cave, KwaZulu-Natal.” *South African Journal of Science* 100 (3-4): 151–58.

Plug, I. 2006. “Aquatic Animals and Their Associates from the Middle Stone Age Levels at Sibudu.” *Southern African Humanities* 18 (1): 289–99.

Plug, I. and J. L. Clark. 2008. “In the Air: A Preliminary Report on the Birds from Sibudu Cave, Kwazulu-Natal, South Africa.” *Goodwin Series* 10 (December): 133–42.

Pokines, J. T. 1998. “Experimental Replication and Use of Cantabrian Lower Magdalenian Antler Projectile Points.” *Journal of Archaeological Science* 25 (9): 875–86.

Pokines, J. T. 2000. “Microfaunal Research Design in the Cantabrian Spanish Paleolithic.” *Journal of Anthropological Research* 56 (1): 95–112.

Porraz, G., J. E. Parkington, J-P. Rigaud, C. E. Miller, C. Poggenpoel, C. Tribolo, W. Archer. 2013. “The MSA Sequence of Diepkloof and the History of Southern African Late Pleistocene Populations.” *Journal of Archaeological Science* 40 (9): 3542–52.

Porraz, G., P-J. Texier, J-P. Rigaud, J. E. Parkington, C. Poggenpoel, and D. L. Roberts. 2008. “Preliminary Characterization of a Middle Stone Age Lithic Assemblage Preceding the ‘Classic’ Howieson’s Poort Complex at Diepkloof Rock Shelter, Western Cape Province, South Africa.” *Goodwin Series* 10 (December): 105–21.

Porraz, G., P-J. Texier, W. Archer, M. Piboule, J-P. Rigaud, and C. Tribolo. 2013. “Technological Successions in the Middle Stone Age Sequence of Diepkloof Rock Shelter, Western Cape, South Africa.” *Journal of Archaeological Science* 40 (9): 3376–3400.

Potter, B. A. 2001. “Recent Investigations at the Gerstle River Site, a Multicomponent Site in Central Alaska.” *Current Research in the Pleistocene* 18: 52–54.

Potter, B. A. 2002. “A Provisional Correlation of Stratigraphy, Radiocarbon Dates, and Archaeological Components at the Gerstle River Site, Central Alaska.” In *Archaeology and Human Paleoecology in the Holarctic: Papers in Honor of Professor William R. Powers*, edited by M. S. Murray. Anthropological Papers, University of Alaska (New Series). Dept. of Anthropology, University of Alaska, Fairbanks: 73-93.

Potter, B. A. 2005. “*Site Structure and Organization in Central Alaska: Archaeological Investigations at Gerstle River.*” Unpublished PhD Thesis. University of Alaska, Fairbanks.

Potter, B. A. 2007. “Models of Faunal Processing and Economy in Early Holocene Interior Alaska.” *Environmental Archaeology* 12 (1): 3–23.

Potter, B. A. 2008a. “Exploratory Models of Intersite Variability in Mid to Late Holocene Central Alaska.” *Arctic* 61 (4): 407–25.

Potter, B. A. 2008b. “Radiocarbon Chronology of Central Alaska: Technological Continuity and Economic Change.” *Radiocarbon* 50 (2): 181-204.

Potter, B. A. 2011. “Late Pleistocene and Early Holocene Assemblage Variability in Central Alaska.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas: Texas A&M University Press: 215-233.

Potter, B. A., P. M. Bowers, J. D. Reuther, and O. K. Mason. 2007. “Holocene Assemblage Variability in the Tanana Basin: NLUR Archaeological Research, 1994–2004.” *Alaska Journal of Archaeology* 5 (1): 23–42.

Powers, W. R. and J. F. Hoffecker. 1989. “Late Pleistocene Settlement in the Nenana Valley, Central Alaska.” *American Antiquity* 54 (2): 263–87.

Pyne, L. V. 2008. “*The Life History of Klasies River Mouth: A Case Study of Archaeology and the History and Philosophy of Science*. ” Unpublished PhD thesis. Arizona State University.

Reynolds, S. C. 2006. “Temporal Changes in Vegetation and Mammalian Communities during Oxygen Isotope Stage 3 at Sibudu Cave.” *Southern African Humanities* 18 (1): 301–14.

Rigaud, J-P., P-J. Texier, J. Parkington, and C. Poggenpoel. 2006. “Le Mobilier Stillbay et Howieson’s Poort de L’abri Diepkloof. La Chronologie Du Middle Stone Age Sud-Africain et Ses Implications.” *Comptes Rendus Palevol* 5 (6): 839–49.

Rots, V. and B. S. Williamson. 2004. “Microwear and Residue Analyses in Perspective: The Contribution of Ethnoarchaeological Evidence.” *Journal of Archaeological Science* 31 (9): 1287–99.

Rots, V. and H. Plisson. 2014. “Projectiles and the Abuse of the Use-Wear Method in a Search for Impact.” *Journal of Archaeological Science* 48: 154-116.

Rozoy, J-G. 1989. “The Revolution of the Bowmen in Europe.” In *The Mesolithic in Europe. International Symposium. 3,* edited by C. Bonsall. John Donald, Edinburgh: 13-28.

Sattler, R., D. M. Vinson, and T. E. Gillispie. 2001. “Calibrated Radiocarbon Ages and Taphonomic Factors in Beringian Cave Faunas at the End of the Pleistocene.” In *People and Wildlife in Northern North America: Essays in Honor of R. Dale Guthrie,* edited by S. C. Gerlach and M. S. Murray, S944. BAR International Series. Archaeopress, Oxford: 112-123.

Semenov, S. A. 1964. *Prehistoric Technology : An Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*. Cory, Adams & Mackay, London.

Shackleton, N. J. 1982. “Stratigraphy and Chronology of the Klasies River Mouth Deposits: Oxygen Isotope Evidence.” In *The Middle Stone Age at Klasies River Mouth in South Africa* by R. Singer and J. Wymer. University of Chicago Press: 194–99.

Shea, J. J. 2006. “The Origins of Lithic Projectile Point Technology: Evidence from Africa, the Levant, and Europe.” *Journal of Archaeological Science* 33 (6): 823–46.

Shott, M. J. 1986. “Technological Organization and Settlement Mobility: An Ethnographic Examination.” *Journal of Anthropological Research* 42 (1): 15–51.

Shott, M. J. 1996. “An Exegesis of the Curation Concept.” *Journal of Anthropological Research* 52 (3): 259–80.

Shott, M. J. 1997. “Stones and Shafts Redux: The Metric Discrimination of Chipped-Stone Dart and Arrow Points.” *American Antiquity* 62 (1): 86–101.

Sievers, C. 2006. “Seeds from the Middle Stone Age Layers at Sibudu Cave.” *Southern African Humanities* 18 (1): 203–22.

Singer, R. and J. Wymer. 1982. *The Middle Stone Age at Klasies River Mouth in South Africa*. University of Chicago Press.

Singer, R., J. Wymer, and L. R. Binford. 1986. “On Binford on Klasies River Mouth: Response of the Excavators.” *Current Anthropology* 27 (1): 56–62.

Speakman, R. J., C. E. Holmes, and M. D. Glascock. 2007. “Source Determination of Obsidian Artifacts from Swan Point (XBD-156), Alaska.” *Current Research in the Pleistocene* 24: 143–45.

Stanford, D. J. and B. A. Bradley. 2012. *Across Atlantic Ice: The Origin of America’s Clovis Culture*. University of California Press, Berkley, California.

Steele, T. E. and R. G. Klein. 2013. “The Middle and Later Stone Age Faunal Remains from Diepkloof Rock Shelter, Western Cape, South Africa.” *Journal of Archaeological Science* 40 (9): 3453–62.

Straus, L. G. 1986a. “A Comparison of La Riera Assemblages with Those from Contemporary Sites in Cantabrian Spain.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 219-236.

Straus, L. G. 1986b. “An Overview of the La Riera Chronology.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 19-24.

Straus, L. G. 1986c. “La Riera and the Terminal Pleistocene Environments of Cantabrian Spain.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 67-74.

Straus, L. G. 1987. “Upper Paleolithic Ibex Hunting in Southwest Europe.” *Journal of Archaeological Science* 14 (2): 163–78.

Straus, L G. 1990. “Underground Archaeology: Perspectives on Caves and Rockshelters.” *Archaeological Method and Theory* 2 (January): 255–304.

Straus, L. G. 1991. “Southwestern Europe at the Last Glacial Maximum.” *Current Anthropology* 32 (2): 189–99.

Straus, L. G. 1992. *Iberia Before the Iberians: The Stone Age Prehistory of Cantabrian Spain*. University of New Mexico Press.

Straus, L. G. 1993. “Upper Paleolithic Hunting Tactics and Weapons in Western Europe.” *Archeological Papers of the American Anthropological Association* 4 (1): 83–93.

Straus, L. G. 1996. “The Use of Quartzite in the Upper Paleolithic of Cantabrian Spain.” In *Non-Flint Stone Tools and the Palaeolithic Occupation of the Iberian Peninsula*, edited by N. Moloney, L. Raposo, and M. Santonja. Archaeopress, Oxford: 37-41.

Straus, L. G. 1999. “High Resolution Archeofaunal Records across the Pleistocene Holocene Transition on a Transect between 43 and 51 Degrees North Latitude in Western Europe.” In *Zooarchaeology of the Pleistocene/Holocene Boundary*, edited by J. C. Driver. BAR International Series. Archaeopress, Oxford: 21-29.

Straus, L. G. 2000. “A Quarter-Century of Research on the Solutrean of Vasco-Cantabria, Iberia and beyond.” *Journal of Anthropological Research* 56 (1): 39–58.

Straus, L. G. 2002. “Selecting Small: Microlithic Musings for the Upper Paleolithic and Mesolithic of Western Europe.” *Archeological Papers of the American Anthropological Association* 12 (1): 69–81.

Straus, L. G. 2005. “The Upper Paleolithic of Cantabrian Spain.” *Evolutionary Anthropology: Issues, News, and Reviews* 14 (4): 145–58.

Straus, L. G. 2008. “The Mesolithic of Atlantic Iberia.” In *Mesolithic Europe*, edited by P. Spikins and G. N. Bailey. Cambridge University Press: 302-327.

Straus, L. G. 2011. “Were There Human Responses to Younger Dryas in Cantabrian Spain?” *Quaternary International*, Humans and Younger Dryas: Dead End, Short Detour, or Open Road to the Holocene?, 242 (2): 328–35.

Straus, L. G. 2012. “The Magdalenian Settlement of the Cantabrian Region (Northern Spain): The View from El Miron Cave.” *Quaternary International* 272: 111–24.

Straus, L. G. 2013. “After the Deep Freeze: Confronting ‘Magdalenian’ Realities in Cantabrian Spain And Beyond.” *Journal of Archaeological Method and Theory* 20 (2): 236–55.

Straus, L. G. 2014. “Recent Developments in the Study of the Upper Paleolithic of Vasco-Cantabrian Spain.” *Quaternary International* 364: 255-271.

Straus, L. G. and G. A. Clark. 1978. “Prehistoric Investigations in Cantabrian Spain.” *Journal of Field Archaeology* 5 (3): 289–317.

Straus, L. G. and G. A. Clark. 1986a. “Introduction: Research Design, Site Location and Setting, History of Earlier Excavations and Methodology.” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain,* edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 1-18.

Straus, L. G. and G. A. Clark. 1986b. “La Riera: Archaeological Remains - Level Contents and Characteristics.” In *La Riera Cave. Stone Age Hunther-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 75-187.

Straus, L. G. and G. A. Clark, eds. 1986c. *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain*. Anthropological Research Papers 36. Tempe, Arizona State University.

Straus, L. G. and G. A. Clark. 1986d. “Synthesis and Conclusions-Part II: The La Riera Excavation, Chronostratigraphy, Paleoenvironments and Cultural Sequence in Perspective.” In *La Riera Cave. Stone Age Hunter-Gatherer Adaptations in Northern Spain*, edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 367-383.

Straus, L. G. and M. R. González Morales. 2003. “El Mirón Cave and The ^{14}C Chronology of Cantabrian Spain.” *Radiocarbon* 45 (1): 41–58.

Straus, L. G. and M. R. González Morales. 2009. “A Preliminary Description of Solutrean Occupations in El Mirón Cave (Ramales de La Victoria, Cantabria).” *Munibe Antropologia-Arkeologia* 60: 117–37.

Straus, L. G., J. Altuna, G. A. Clark, M. R. González Morales, H. Laville, A. Leroi-Gourhan, M. Menendez de la Hoz, et al. 1981. “Paleoecology at La Riera (Asturias, Spain) [and Comments and Reply].” *Current Anthropology* 22 (6): 655–82.

Straus, L. G., G. A. Clark, J. Ordaz, L. Suarez, and R. Esbert. 1986. “Patterns of Lithic Raw Material Variation at La Riera,” In *La Riera Cave: Stone Age Hunter-Gatherer Adaptations in Northern Spain,* edited by L. G. Straus and G. A. Clark. Anthropological Research Papers 36. Tempe, Arizona State University: 189-208.

Straus, L. G. and M. R. González Morales, eds. 2012. *El Mirón Cave, Cantabrian Spain: The Site and Its Holocene Archaeological Record*. University of New Mexico Press, Alberquerque.

Straus, L. G., M. R. González Morales, W. R. Farrand, and W. J. Hubbard. 2001. “Sedimentological and Stratigraphic Observations in El Mirón, a Late Quaternary Cave Site in the Cantabrian Cordillera, Northern Spain.” *Geoarchaeology* 16 (5): 603–30.

Straus, L. G., M. R. González Morales , M. Á. Fano Martínez , and M. P. García-Gelabert. 2002. "Last Glacial Human Settlement in Eastern Cantabria (Northern Spain)." *Journal of Archaeological Science* 29 (12): 1403–14.

Straus, L. G., M. R. González Morales, and E. B. Stewart. 2008. "Early Magdalenian Variability: New Evidence from El Mirón Cave, Cantabria, Spain." *Journal of Field Archaeology* 33 (2): 197–218.

Straus, L. G., M. R. Gonzalez Morales, I. Gutierrez Zugasti, and M. J. Iriarte. 2011. "Further Solutrean Evidence in El Mirón Cave (Ramales de La Victoria, Cantabria)" *Munibe Antropologia Arkeologia* 62: 117–33.

Texier, P-J., G. Porraz, J. Parkington, J-P. Rigaud, C. Poggenpoel, and C. Tribolo. 2013. "The Context, Form and Significance of the MSA Engraved Ostrich Eggshell Collection from Diepkloof Rock Shelter, Western Cape, South Africa." *Journal of Archaeological Science* 40 (9): 3412–31.

Thackeray, A. I. 1992. "The Middle Stone Age South of the Limpopo River." *Journal of World Prehistory* 6 (4): 385–440.

Thackeray, A. I. and A. J. Kelly. 1988. "A Technological and Typological Analysis of Middle Stone Age Assemblages Antecedent to the Howieson's Poort at Klasies River Main Site." *The South African Archaeological Bulletin* 43 (147): 15.

Thorson, R. M. and T. D. Hamilton. 1977. "Geology of the Dry Creek Site; a Stratified Early Man Site in Interior Alaska." *Quaternary Research* 7 (2): 149–76.

Torrence, R. 1983. "Time Budgeting and Hunter-Gatherer Technology." In *Hunter-Gatherer Economy in Prehistory*, edited by G. N. Bailey, 11–22. Cambridge University Press.

Torrence, R. 1989a. *Time, Energy and Stone Tools*. Cambridge University Press.

Torrence, R. 1989b. "Tools as Optimal Solutions." In *Time, Energy and Stone Tools*, edited by R. Torrence. Cambridge University Press: 1-6.

Torrence, R. 2001. "Hunter–gatherer Technology: Macro-and Microscale Approaches." In *Hunter–gatherers: An Interdisciplinary Perspective*, edited by C. Panter-Brick, R. Layton, and P. Rowley-Conwy. Cambridge University Press: 73-98.

Torrence, R. 2002. "Thinking Big about Small Tools." *Archeological Papers of the American Anthropological Association* 12 (1): 179–89.

Tribolo, C., N. Mercier, E. Douville, J.-L. Joron, J.-L. Reyss, D. Rufer, N. Cantin, et al. 2013. "OSL and TL Dating of the Middle Stone Age Sequence at Diepkloof Rock Shelter (South Africa): A Clarification." *Journal of Archaeological Science* 40 (9): 3401–11.

Tribolo, C., N. Mercier, and H. Valladas. 2005. "Chronology of the Howieson's Poort and Still Bay Techno-Complexes: Assessment and New Data from Luminescence." In *From Tools to Symbols: From Early Hominids to Modern*

Humans, edited by L. Backwell and F. D'Errico. Witwatersrand University Press: 493-511.

Tribolo, C., N. Mercier, H. Valladas, J.L. Joron, P. Guibert, Y. Lefrais, M. Selo, et al. 2009. "Thermoluminescence Dating of a Stillbay–Howieson's Poort Sequence at Diepkloof Rock Shelter (Western Cape, South Africa)." *Journal of Archaeological Science* 36 (3): 730–39.

Van Andel, T. H. 1989. "Late Pleistocene Sea Levels and the Human Exploitation of the Shore and Shelf of Southern South Africa." *Journal of Field Archaeology* 16 (2): 133–55.

Van Gijn, A. L. 2014. "Science and Interpretation in Microwear Studies." *Journal of Archaeological Science*, Lithic Microwear Method: Standardisation, Calibration and Innovation, 48 (August): 166–69.

Vanmontfort, B. 2009. "Taking Microliths into Account." *Antiquity* 83 (321): 827–30.

Vasil'ev, S. A. 2011. "The Earliest Alaskan Archaeological Record: A View from Siberia." In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 119-127.

Villa, P., A. Delagnes, and L. Wadley. 2005. "A Late Middle Stone Age Artifact Assemblage from Sibudu (KwaZulu-Natal): Comparisons with the European Middle Paleolithic." *Journal of Archaeological Science* 32 (3): 399–422.

Villa, P., S. Soriano, N. Teyssandier, and S. Wurz. 2010. "The Howieson's Poort and MSA III at Klasies River Main Site, Cave 1A." *Journal of Archaeological Science* 37 (3): 630–55.

Villa, P. and W. Roebroeks. 2014. "Neandertal Demise: An Archaeological Analysis of the Modern Human Superiority Complex." *PLoS ONE* 9 (4): 1-10

Vogel, J. C. 2001. "Radiometric Dates for the Middle Stone Age in South Africa." In *Humanity from African Naissance to Coming Millennia*, edited by P. V. Tobias, M. A. Raath, J. Moggi-Cecchi and G. A. Doyle. Firenze University Press, Italy: 261–68.

Wadley, L. 2001. "What Is Cultural Modernity? A General View and a South African Perspective from Rose Cottage Cave." *Cambridge Archaeological Journal* 11 (2): 201–21.

Wadley, L. 2004. "Vegetation Changes between 61 500 and 26 000 Years Ago: The Evidence from Seeds in Sibudu Cave, KwaZulu-Natal." *South African Journal of Science* 100 (3-4): 167–73.

Wadley, L. 2005. "A Typological Study of the Final Middle Stone Age Stone Tools from Sibudu Cave, KwaZulu-Natal." *The South African Archaeological Bulletin* 60 (182): 51–63.

Wadley, L. 2006. “Partners in Grime: Results of Multi-Disciplinary Archaeology at Sibudu Cave.” *Southern African Humanities* 18 (1): 315–41.

Wadley, L. 2007. “Announcing a Still Bay Industry at Sibudu Cave, South Africa.” *Journal of Human Evolution* 52 (6): 681–89.

Wadley, L. 2010. “Were Snares and Traps Used in the Middle Stone Age and Does It Matter? A Review and a Case Study from Sibudu, South Africa.” *Journal of Human Evolution* 58 (2): 179–92.

Wadley, L. and Z. Jacobs. 2004. “Sibudu Cave, KwaZulu-Natal: Background to the Excavations of Middle Stone Age and Iron Age Occupations.” *South African Journal of Science* 100 (March): 145–51.

Wadley, L. and M. Mohapi. 2008. “A Segment Is Not a Monolith: Evidence from the Howieson’s Poort of Sibudu, South Africa.” *Journal of Archaeological Science* 35 (9): 2594–2605.

Wadley, L. and Z. Jacobs. 2006. “Sibudu Cave: Background to the Excavations, Stratigraphy and Dating.” *Southern African Humanities* 18 (1): 1–26.

Wadley, L., T. Hodgskiss, and M. Grant. 2009. “Implications for Complex Cognition from the Hafting of Tools with Compound Adhesives in the Middle Stone Age, South Africa.” *Proceedings of the National Academy of Sciences of the United States of America* 106 (24): 9590–94.

Wells, C. R. 2006. “A Sample Integrity Analysis of Faunal Remains from the RSp Layer at Sibudu Cave.” *Southern African Humanities* 18 (1): 261–77.

West, F. H. 1967. “The Donnelly Ridge Site and the Definition of an Early Core and Blade Complex in Central Alaska.” *American Antiquity* 32 (3): 360–82.

West, F. H. ed. 1996a. *American Beginnings: The Prehistory and Palaeoecology of Beringia*. University of Chicago Press.

West, F. H. 1996b. “Donnelly Ridge.” In *American Beginnings: The Prehistory and Palaeoecology of Beringia*, edited by F. H. West. University of Chicago Press: 302-307.

Wiessner, P. 1984. “Reconsidering the Behavioral Basis for Style: A Case Study among the Kalahari San.” *Journal of Anthropological Archaeology* 3 (3): 190–234.

Williamson, B. S. 2005. “Subsistence Strategies in the Middle Stone Age at Sibudu Cave: The Microscopic Evidence from Stone Tool Residues.” In *From Tools to Symbols: From Early Hominids to Modern Humans. Witwatersrand University Press, Johannesburg*, edited by F. d'Errico and L. Backwell. Witwatersrand University Press: 493-511.

Winterhalder, B. 1981. “Optimal Foraging Strategies and Hunter-Gatherer Research in Anthropology: Theory and Models.” In *Hunter-Gatherer Foraging Strategies:*

Ethnographic and Archaeological Analyses, edited by B. Winterhalder and E. A. Smith. University of Chicago Press: 13-35.

Wurz, S. 1999. “The Howieson’s Poort Backed Artefacts from Klasies River: An Argument for Symbolic Behaviour.” *The South African Archaeological Bulletin* 54 (169): 38–50.

Wurz, S. 2000. “*The Middle Stone Age At Klasies River, South Africa.*” Unpublished PhD thesis, University of Stellenbosch.

Wurz, S. 2002. “Variability in the Middle Stone Age Lithic Sequence, 115,000–60,000 Years Ago at Klasies River, South Africa.” *Journal of Archaeological Science* 29 (9): 1001–15.

Wurz, S. 2005. “Exploring and Quantifying Technological Differences between the MSA I, MSA II and Howieson’s Poort at Klasies River.” In *From Tools to Symbols: From Early Hominids to Modern Humans. Witwatersrand University Press, Johannesburg*, edited by F. d'Errico and L. Backwell. Witwatersrand University Press: 418-440.

Wurz, S. 2008. “Modern Behaviour At Klasies River.” *Goodwin Series* 10 (December): 150–56.

Wurz, S. 2012. “The Significance of MIS 5 Shell Middens on the Cape Coast: A Lithic Perspective from Klasies River and Ysterfontein 1.” *Quaternary International* 270 (9): 61–69.

Wurz, S. and M. Lombard. 2007. “70 000-Year-Old Geometric Backed Tools from the Howieson’s Poort at Klasies River, South Africa: Were They Used for Hunting.” *Southern African Humanities* 19: 1–16.

Wygal, B. T. 2011. “The Microblade/Non-Microblade Dichotomy: Climatic Implications, Toolkit Variability, and the Role of Tiny Tools in Eastern Beringia.” In *From the Yenisei to the Yukon: Interpreting Lithic Assemblage Variability in Late Pleistocene/Early Holocene Beringia*, edited by T. Goebel and I. Buvit. Texas A&M University Press: 234-254.

Yaroshevich, A., D. Kaufman, D. Nuzhnyy, O. Bar-Yosef, and M. Weinstein-Evron. 2010. “Design and Performance of Microlith Implemented Projectiles during the Middle and the Late Epipaleolithic of the Levant: Experimental and Archaeological Evidence.” *Journal of Archaeological Science* 37 (2): 368–88.

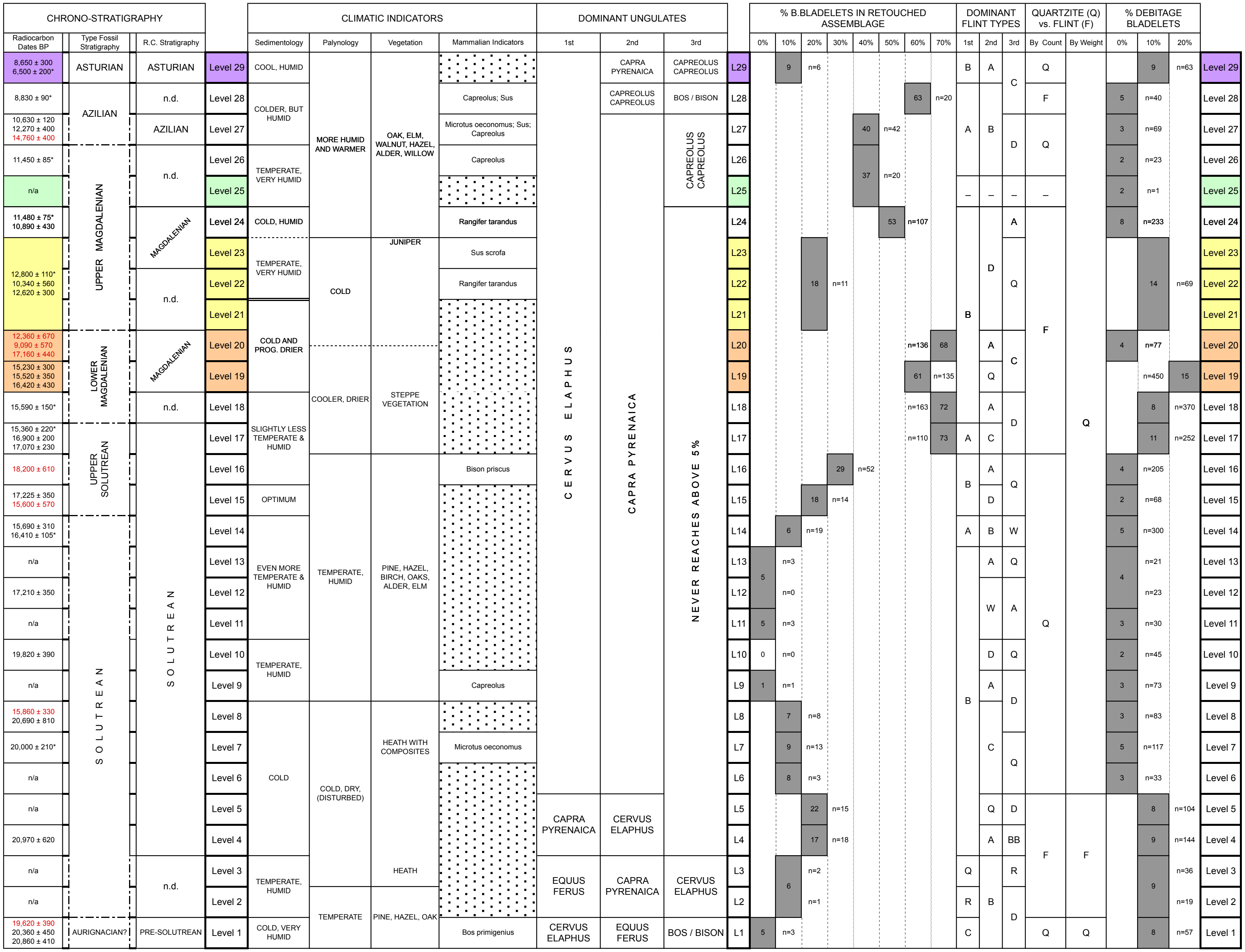
Yesner, D. R. 1996. “Human Adaptation at the Pleistocene—Holocene Boundary (circa 13,000 to 8,000 Bp) in Eastern Beringia.” In *Humans at the End of the Ice Age*, edited by L. G. Straus, B. V. Eriksen, J. M. Erlandson and D. R. Yesner. Springer, US: 255–76.

Yesner, D. R. 2001. “Human Dispersal into Interior Alaska: Antecedent Conditions, Mode of Colonization, and Adaptations.” *Quaternary Science Reviews*, Beringian Paleoenvironments - Festschrift in Honour of D.M. Hopkins, 20 (1–3): 315–27.

Yesner, D. R. and G. Pearson. 2002. “Microblades and Migrations: Ethnic and Economic Models in the Peopling of the Americas.” *Archeological Papers of the American Anthropological Association* 12 (1): 133–61.

Zvelebil, M. 1984. “Archaeology: Clues to Recent Human Evolution from Specialized Technologies?” *Nature* 307: 314–15.

Zvelebil, M. 1986. “Postglacial Foraging in the Forests of Europe.” *Scientific American* 254 (5): 104–6.



CHRONO-STRATIGRAPHY				CLIMATIC INDICATORS				DOMINANT UNGULATES				% B.BLADELETS IN RETOUCHED ASSEMBLAGE		DOMINANT FLINT TYPES			QUARTZITE (Q) vs. FLINT (F)		% DEBITAGE BLADELETS		
Radiocarbon Dates BP	Type Fossil Stratigraphy	R.C. Stratigraphy		Sedimentology	Palynology	Vegetation	Mammalian Indicators	1st	2nd	3rd		%	n	1st	2nd	3rd	By Count	By Weight	%	n	
8,650 ± 300 6,500 ± 200*	ASTURIAN	ASTURIAN	Level 29	COOL, HUMID	MORE HUMID AND WARMER	OAK, ELM, WALNUT, HAZEL, ALDER, WILLOW		C E R V U S E L A P H U S	CAPRA PYRENAICA	CAPREOLUS CAPREOLUS	L29	9	n=6	B	A	C	Q	Q	9	n=63	Level 29
8,830 ± 90*	AZILIAN	n.d.	Level 28	COLDER, BUT HUMID			Capreolus; Sus		CAPREOLUS CAPREOLUS	BOS / BISON	L28	63	n=20	A	B		F		5	n=40	Level 28
10,630 ± 120 12,270 ± 400 14,760 ± 400		AZILIAN	Level 27				Microtus oeconomus; Sus; Capreolus		C A P R A P Y R E N A I C A	CAPREOLUS CAPREOLUS	L27	40	n=42			D	Q		3	n=69	Level 27
11,450 ± 85*	UPPER MAGDALENIAN	n.d.	Level 26	TEMPERATE, VERY HUMID			Capreolus				L26	37	n=20						2	n=23	Level 26
n/a			Level 25								L25			–	–	–	–		2	n=1	Level 25
11,480 ± 75* 10,890 ± 430		MAGDALENIAN	Level 24	COLD, HUMID			**Rangifer tarandus**			N E V E R R E A C H E S A B O V E 5 %	L24	53	n=107	B	D	A	F		8	n=233	Level 24
12,800 ± 110* 10,340 ± 560 12,620 ± 300			Level 23	TEMPERATE, VERY HUMID	COLD	JUNIPER	Sus scrofa				L23	18	n=11			Q			14	n=69	Level 23
		n.d.	Level 22				Rangifer tarandus				L22										Level 22
			Level 21	COLD AND PROG. DRIER							L21										Level 21
12,360 ± 670 9,090 ± 570 17,160 ± 440	LOWER MAGDALENIAN	MAGDALENIAN	Level 20								L20	68	n=136		A	C			4	n=77	Level 20
15,230 ± 300 15,520 ± 350 16,420 ± 430			Level 19		COOLER, DRIER	STEPPE VEGETATION					L19	61	n=135		Q				15	n=450	Level 19
15,590 ± 150*		n.d.	Level 18	SLIGHTLY LESS TEMPERATE & HUMID							L18	72	n=163		A	D			8	n=370	Level 18
15,360 ± 220* 16,900 ± 200 17,070 ± 230	UPPER SOLUTREAN	S O L U T R E A N	Level 17								L17	73	n=110	A	C				11	n=252	Level 17
18,200 ± 610			Level 16		TEMPERATE, HUMID	PINE, HAZEL, BIRCH, OAKS, ALDER, ELM	Bison priscus				L16	29	n=52	B	A	Q	Q		4	n=205	Level 16
17,225 ± 350 15,600 ± 570			Level 15	OPTIMUM							L15	18	n=14		D				2	n=68	Level 15
15,690 ± 310 16,410 ± 105*	S O L U T R E A N		Level 14	EVEN MORE TEMPERATE & HUMID							L14	6	n=19	A	B	W			5	n=300	Level 14
n/a			Level 13								L13	5	n=3	B	A	Q			4	n=21	Level 13
17,210 ± 350			Level 12								L12		n=0		W	A				n=23	Level 12
n/a			Level 11								L11	5	n=3						3	n=30	Level 11
19,820 ± 390			Level 10	TEMPERATE, HUMID							L10	0	n=0		D	Q			2	n=45	Level 10
n/a			Level 9				Capreolus				L9	1	n=1		A	D			3	n=73	Level 9
15,860 ± 330 20,690 ± 810			Level 8	COLD	COLD, DRY, (DISTURBED)	HEATH WITH COMPOSITES					L8	7	n=8		C				3	n=83	Level 8
20,000 ± 210*			Level 7				Microtus oeconomus				L7	9	n=13			Q			5	n=117	Level 7
n/a			Level 6								L6	8	n=3						3	n=33	Level 6
n/a			Level 5					CAPRA PYRENAICA	CERVUS ELAPHUS		L5	22	n=15		Q	D	F	F	8	n=104	Level 5
20,970 ± 620			Level 4								L4	17	n=18		A	BB			9	n=144	Level 4
n/a		n.d.	Level 3	TEMPERATE, HUMID		HEATH		EQUUS FERUS	CAPRA PYRENAICA	CERVUS ELAPHUS	L3	6	n=2	Q	B	R			9	n=36	Level 3
n/a			Level 2		TEMPERATE	PINE, HAZEL, OAK					L2		n=1	R		D				n=19	Level 2
19,620 ± 390 20,360 ± 450 20,860 ± 410	AURIGNACIAN?	PRE-SOLUTREAN	Level 1	COLD, VERY HUMID			Bos primigenius	CERVUS ELAPHUS	EQUUS FERUS	BOS / BISON	L1	5	n=3	C			Q	Q	8	n=57	Level 1

NISP of species at Rascano

Levels	5	4b	4a	3	2	1	Total
Equus ferus	5	3	1	4	7	3	23
Capra pyrenaica	1313	1319	673	510	557	577	4980
Rupicapra rupicapra				2	7	6	16
Bos / Bison	2		1	1			6
Cervus elaphus	113	173	63	26	67	82	530
Sus scrofa					2	4	6
Total Ungulados	1433	1495	738	543	640	672	5561

NISP (%) of species at Rascano

Levels	5	4b	4a	3	2	1
Equus ferus	0.3	0.2	0.1	0.7	1.1	0.4
Capra pyrenaica	91.7	88.2	91.3	93.9	87	85.9
Rupicapra rupicapra				0.4	1.1	0.9
Bos / Bison	0.1		0.1	0.2		
Cervus elaphus	7.9	11.6	8.5	4.8	10.5	12.2
Sus scrofa					0.3	0.6

MNI of species at Rascano

Levels	5	4b	4a	3	2	1	Total
Equus ferus	2	1	1	1	1	1	7
Capra pyrenaica	34	36	23	20	15	26	161
Rupicapra rupicapra				1	1	3	6
Bos / Bison	1		1	1			5
Cervus elaphus	4	8	4	4	4	9	36
Sus scrofa					1	1	2
Total Ungulados	41	45	29	27	22	40	217

Appendix 5 Klasies River MSA III Lithics Retotaled

	Level	Cores	Core Prep + Rejuv flakes*	Flake-Blades	Pointed Flake-Blades	Broken Blade Segments	Worked Flakes	Worked Points	Flakes	Non-local flakes including flake-blades and segments	Crescents*	Total (+8 Crescents)	Total As Recorded in Singer & Wymer Table 7.2
1968 + Initial Cutting	1												
	2												
	3	4										4	
	1 - 3	7		23	4	15	20	8	156	11		244	
	4	2		23	1	6	7	4	47	1		91	
	5	5		35	4	22	8	3	141	2		220	
	6	24	16	280	10	229	51	8	2221	95		2934	
	7	10	9	92	5	356	16	6	1478	23		1995	
	8	3		11			0		105	18		137	
	9	9		23	1		5	1	219	75		333	
	7 - 9	26	12	90	3		3	4	452	21		611	
	Total	90	37	577	28	628	110	34	4819	246	8	6577	
Initial Cutting	1			1					7	3		11	11
	2								1	2		3	3
	3	2		8	1		5	3	16	1		36	36
	4			14		2	3	2	20			41	41
	5	2		19	4	6	4		2	2		39	39
	6	5	2	60	8	56	12	5	291	10		449	449
	7 - 9	13	6	94	3	100	2	7	452	22		699	699
	Total	22	8	196	16	164	26	17	789	40	0	1278	1278
1968 Total (Initial Cutting Subtracted From Combined Total)		68	29	381	12	464	84	17	4030	206	8	5299	
1968 Total As Recorded in Singer & Wymer Table 7.1		68	29	186	15	464	84	18	4030	206	8	5108	

* No crescents are detailed for individual levels of the combined 1968 and Initial Cutting, as their exact provenance is unknown.

MSA III Totals As According To Singer & Wymer 1982	
1968 Excavation (1982: Table 7.1)	5108
Initial Cutting (1982: Table 7.2)	1278
Total	6386

MSA III Revised Totals	
1968 Excavation	5299
Initial Cutting	1278
Total	6577

Appendix 6 Klasies River Howieson's Poort Lithics Retotaled

	Level	Cores	Core Prep + Rejuv flakes*	Flake-Blades	Pointed Flake-Blades	Broken Blade Segments	Worked Flakes	Worked Points	Flakes	Non-local flakes including flake-blades and segments	Crescents	Handaxes*	Total	Total As Recorded in Singer & Wymer Table 7.2
1968 Excavation	10	85	15	296	3	553	41		390	2198	197		3778	
	11	54	21	332	1	502	22		6264	2180	183		9559	
	12	50	7	266		432	26		3929	2831	144		7685	
	13	67	1	25		47	5		1178	1169	33		2525	
	14	136	0	42	3	50	7		1302	4722	29		6291	
	15	23	2	31		45	10		440	907	19		1477	
	16	56	26	259		594	54		2506	2279	46		5820	
	17	130	85	731	3	1433	108	1	11370	5738	166		19765	
	18	49	17	214		550	44		4786	1909	87		7656	
	19	62	32	368	5	847	27		7877	873	113		10204	
	20	142	18	522	6	825	88	5	12324	2495	194		16619	
	21	21	6	109		202	31		1613	67	34		2083	
	Total	875	230	3195	21	6080	463	6	53979	27368	1245	0	93462	
1968 Total As Recorded in Singer & Wymer Table 7.1		887	230	3195	21	5880	463	6	53979	27370	1245	1	93277	
Initial Cutting	10 - 12	60		85	7	56	7	7	778	75	11		1086	1086
	13 - 16	70		58	4	36	5		657	338	12		1180	1180
	17 - 21	57	15	372		501	31		8219	552	59		9806	9806
	Total	187	15	515	11	593	43	7	9654	965	82	0	12072	12072

* The exact provenance of the handaxe (Singer & Wymer, 1982: 83) is unknown.

HP Totals As According To Singer & Wymer 1982	
1968 Excavation (1982: Table 7.1)	93277
Initial Cutting (1982: Table 7.2)	12072
Total	105349

HP Revised Totals	
1968 Excavation	93462
Initial Cutting	12072
Total	105534

Appendix 7 Klasies River Crescents and allied forms Retotaled

Raw Material Selection in Crescents & Allied Forms (KR1A)

Level	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	Sub-total
Local Qtzite	170	161	117	22	11	7	4	59	48	87	87	31	804
Fine Silcrete	9	3	6	1	1	9	27	68	20	5	88		237
Coarse Silcrete	13	3	4	1	7		1	3	10	17	11	2	72
Indurated shale	3	4	1	3	3	1	13	22	3	1		1	55
Qtz inc. qtz crystal	1	9	15	4	7	2		11	2	3	8		62
Chalcedony	1	3	1	1			1	2	4				13
Chert				1				1					2
Total of Non-Local Rocks	27	22	27	11	18	12	42	107	39	26	107	3	441
Total of all rocks	197	183	144	33	29	19	46	166	87	113	194	34	1245

Numbers highlighted in red have been reduced by 10 in order to match figures with the actual artefact count

Crescents and Allied Forms (KR1A)

Crescents: completely blunted	64	55	48	21	14	1	4	23	20	43	92	9	394
Crescents: partially blunted	19	29	12	1	1			15	10	12	19	7	125
Trapezes	1					7	16	21	3	24	9	1	82
Triangles		3							2		1	1	7
Obliquely blunted points: forming angle	15			1	1	2	2	19	5	3	16	4	68
Obliquely blunted points: forming arc	24	45	43	4	5	7	5	25	14	10	18	2	202
Broken indeterminate	69	44	31	5	7	2	19	63	30	19	39	6	334
Unfinished or aberrant forms	3	2	2		1				3			4	15
Notched and snapped rejects	2	5	8	1						2			18
Total	197	183	144	33	29	19	46	166	87	113	194	34	1245

Appendix 8 Klasies River MSA II Lithics Retotaled

	Level	Cores	Core Prep + Rejuv flakes*	Flake-Blades	Pointed Flake-Blades	Broken Blade Segments	Worked Flakes	Worked Points	Flakes	Non-local flakes including flake-blades	Crescents*	Handaxes	Obliquely Blunted Point	Total ** (+12 Crescents)	Total As Recorded in Singer & Wymer Table 7.2
1968 + Initial Cutting	22	43	10	130	14	152	9		783	71	12			1212	
	23	-	-	40	2	29	8	1	391	38				509	
	23-24	73	23	346	13	296	29	24	3088	16				3908	
	24	-	-	92	9	121	14	14	1415	4				1669	
	25	20	15	99	55	70	9	3	1714	4				1989	
	26	31	2	33	29	14	6	1	494	2				612	
	27	71	50	356	66	147	12	1	3762	9				4474	
	28	-	-	405	89	102	7	1	2093	2				2699	
	28-29	116	83	155	79	60	0	1	2404	8				2906	
	29	-		93	64	52	5	1	926	6				1147	
	30	2	2	138	25	136	8	2	831	7				1151	
	31	3	1	46	12	38	3		829	5				937	
	32	-	-	135	58	49	0		932	48				1222	
	32-33	51	104	95	82	59	14	-	1636	24				2065	
	33	-	-	25	13	31	2	1	-	13				85	
	34	52	26	294	45	122	10	4	1764	9				2326	
	35	1	1	-	-		0		16	1				19	
	36	71	19	760	123	389	53	19	1998	51		1	1	3485	
	Total	534	336	3242	778	1867	189	73	25076	318	12	1		32427	
Initial Cutting	22	19	4	109	7	111	8		625	59	7			949	292
	23 - 24	23	3	361	13	296	25	26	3088	16	1			3852	3854
	25	6	3	48	34	26	3		1257	2				1379	1380
	26	15	1	25	29	9	6	1	458	2				546	546
	27	20	10	57	66	14	3		1420	2				1592	1593
	28 - 29	40	14	155	79	60		1	2425	8				2782	2783
	30	1		6	2	4			70	2				85	85
	31			2	1	2			74					79	79
	32 - 33	14	42	95	82	59	14		1603	27				1936	1936
	34	25	13	294	45	122	10	3	1754	9				2275	2276
	Total	163	90	1152	358	703	69	31	12774	127	8	0		15475	14824
1968 Total (Initial Cutting Subtracted From Combined Total)		371	246	2090	420	1164	120	42	12302	191	4	1	1	16952	
1968 Total As Recorded in Singer & Wymer Table 7.1		295	246	2090	75	1164	121	42	12853	191	6	1		17084	

* No crescents are detailed for individual level totals for the combined 1968 and Initial Cutting, as their exact provenance is uncertain.

** A thick backed asymmetrical crescent, possibly a thick-backed scraper or aberrant worked point was also recorded with unknown provenance.

MSA II Totals Singer & Wymer 1982	
1968 Excavation (1982: Table 7.1)	17084
Initial Cutting (1982: Table 7.2)	14824
Total	31908

MSA II Revised Totals	
1968 Excavation	16952
Initial Cutting	15475
Total	32427

Appendix 9 Klasies River MSA II Lithics Retotaled (Leve

	Level	Cores	Core Prep + Rejuv flakes*	Flake-Blades	Pointed Flake-Blades	Broken Blade Segments	Worked Flakes	Worked Points	Flakes	Non-local flakes including flake-blades	Crescents*	Handaxes	Total (+12 Crescents)	Total As Recorded in Singer & Wymer Table 7.2
1968 + Initial Cutting	22	43	10	130	14	152	9		783	71	12		1212	
	23	-	-	40	2	29	8	1	391	38			509	
	23-24	73	23	361	13	296	29	24	3088	16			3923	
	24	-	-	92	9	121	14	14	1415	4			1669	
	25	20	15	99	55	70	9	3	1714	4			1989	
	26	31	2	58	29	14	6	1	494	2			637	
	27	71	50	326	66	147	12	1	3762	9			4444	
	28	-	-	405	89	102	7	1	2093	2			2699	
	28-29	116	83	155	79	60	0	1	2404	8			2906	
	29	-		93	64	52	5	1	926	6			1147	
	30	2	2	138	25	136	8	2	831	7			1151	
	31	3	1	46	12	38	3		829	5			937	
	32	-	-	135	58	49	0		932	48			1222	
	32-33	51	104	95	82	59	14	-	1636	24			2065	
	33	-	-	25	13	31	2	1	-	13			85	
	Total	410	290	2198	610	1356	126	50	21298	257	12	0	26607	
Initial Cutting	22	19	4	109	7	111	8		625	59	7		949	292
	23 - 24	23	3	361	13	296	25	26	3088	16	1		3852	3854
	25	6	3	48	34	26	3		1257	2			1379	1380
	26	15	1	25	29	9	6	1	458	2			546	546
	27	20	10	57	66	14	3		1420	2			1592	1593
	28 - 29	40	14	155	79	60		1	2425	8			2782	2783
	30	1		6	2	4			70	2			85	85
	31			2	1	2			74				79	79
	32 - 33	14	42	95	82	59	14		1603	27			1936	1936
	Total	138	77	858	313	581	59	28	11020	118	8	0	13200	12548
1968 Total (Initial Cutting Subtracted From Combined Total)		262	213	1340	297	775	67	22	10278	139	4	0	13407	
1968 Total As Recorded in Singer & Wymer Table 7.1		295	246	2090	75	1164	121	42	12853	191	6	1	17084	

* No crescents are detailed for individual level totals for the combined 1968 and Initial Cutting, as their exact provenance is uncertain.

MSA II Totals As According To Singer & Wymer 1982	
1968 Excavation (1982: Table 7.1)	17084
Initial Cutting (1982: Table 7.1)	14824
Total	31908

MSA II Revised Totals	
1968 Excavation	13397
Initial Cutting	13200
Total	26597

Appendix 10 Klasies River Initial Cutting Lithics Retotaled. Categories amalgamated in Singer & Wymer's table 7.1 are colour coordinated.

	Initial Cutting Table 7.2						Flake Blade Segments				Worked Flakes Total: 43								Quartz				Other Non-Local Rock				
	Layers As Published	Cores	Core Prep + Rejuv.	Flakes	Flake Blades	Pointed Flake Blades	Bulbous	Mid Segments	Nonbulbous	Total	Worked Points	Denticulates	Scrapers	Gravers?	Borers	Unspecialised	Crescents	Trapezes	Cores	Flakes	Crescents	Worked Flakes	Cores	Flakes	Crescents	Worked Flakes	Red Ochre
MSA III	1			7	1															3							
	2			1																2							
	3	2		16	8	1					3	1	2			2								1			
	4			20	14		2			2	2	2	1														
	5	2		2	19	4	3		3	6			1			3								2			
	6	5	2	291	60	8	32	12	12	56	5	1	2			9				2				8			
	7 - 9	13	6	452	94	3	36	28	36	100	7	1				1				9				13			1
	Total	22	8	789	196	16	73	40	51	164	17	5	6	0	0	15	0	0	0	16	0	0	0	24	0	0	1
	Table 7.1 Total	22	8	789	391	13				164	16	26								40							
HP	10 - 12	37		778	85	7	27	16	13	56	7					7	9		12	50	1		11	25	1		
	13 - 16	18		657	58	4	16	11	9	36			1				8		32	245	1		20	93	3	4	
	17 - 21	23	15	8219	372		218	197	86	501			1			15	31	12	7	140			27	412	16	15	
	Total	187	15	9654	515	11	261	224	108	593	7	0	2	0	0	22	48	12	51	435	2	0	58	530	20	19	0
	Table 7.1 Total	187	15	9654	515	11				593	0	43					82			965							
MSA II	22	7	4	625	109	7	53	40	18	111		1	3			3	5		11	43		1	1	16	2		1
	23 - 24	23	3	3088	361	13	128	116	52	296	26	8	3		1	13	1			5				11			1
	25	6	3	1257	48	34	12	8	6	26		1	1			1				1				1			1
	26	15	1	458	25	29	5	4		9	1		2			4				1				1			
	27	20	10	1420	57	66	11	3		14		1	2							1				1			1
	28 - 29	40	14	2425	155	79	24	31	5	60	1									5				3			
	30	1		70	6	2	3	1		4														2			
	31			74	2	1	2			2																	
	32 - 33	14	42	1603	95	82	42	11	6	59		3		2		9								27			
	34	24	13	1754	294	45	77	28	17	122	3					10				4			1	5			1
	Total	163	90	12774	1152	358	357	242	104	703	31	14	11	2	1	40	6	0	11	60	0	1	2	67	2	0	5
	Table 7.1 Total	150	90	12708	1057	358				703	31	68 (actual total is 69)					6 (should be 8)			127							

MSA III	1278
HP	12072
MSA II	15475

	Actual Total	Table 7.2	Table 7.1
MSA III	1278	1278	1469
HP	12072	12072	12065
MSA II	15475	14824	15298
Total	28825	28174	28832

Appendix 11 Klasies River HP Lithic Assemblages From 1968 Excavations a

									Flake Blades (Non Local)					Segments (Non Local)					
Level	Cores, Core Prep, Rejuv Flakes Local Rock	Cores, Core Prep, Rejuv Flakes Nonlocal	Flake Blades	Segments	Pointed Flake Blades	Flakes (Raw Mat Undifferentiated)	Crescents, Trapezes and Allied Forms	Worked Flakes	Fine Silcrete	Coarse Silcrete	Indurated Shale	Qtz, other crystal and rock	Sub-Total	Fine Silcrete	Coarse Silcrete	Indurated Shale	Qtz, other crystal and rock	Sub-Total	Total
10	59	41	296	553	3	2550	197	41	11	12	4	2		5	4				3778
11	56	19	332	502	1	8398	183	22	32	10				2	2				9559
12	39	18	266	432		6735	144	26	4	13	6				2				7685
13	17	51	25	47		2341	33	5			4	2							2525
14	15	121	42	50	3	5968	29	7	20	20	7	8			1				6291
15	6	19	31	45		1139	19	10	114	3	41			50					1477
16	34	48	259	594		4343	46	54	192	2	72	6		148		18	4		5820
17	118	97	731	1433	3	16251	166	109	336	2	58	4		455	1		1		19765
18	42	24	214	550		6501	87	44	36	23				111	24				7656
19	72	22	368	847	5	8613	113	27	20	35		9		24	48		1		10204
20	70	90	522	825	6	14548	194	93	122	3		4		130	4		8		16619
21	24	3	109	202		1667	34	31		7					6				2083
Actual Total	552	553	3195	6080	21	79054	1245	469	887	130	192	35	1244	925	92	18	14	1049	93462
Total (Singer & Wymer chapter 6)	554	563	3195	5880	21	79054	1245	469	889	130	192	35	1246					1049	93276

Appendix 12 Klasies River Singer & Wymer’s Table 7.1 (1982, 110).

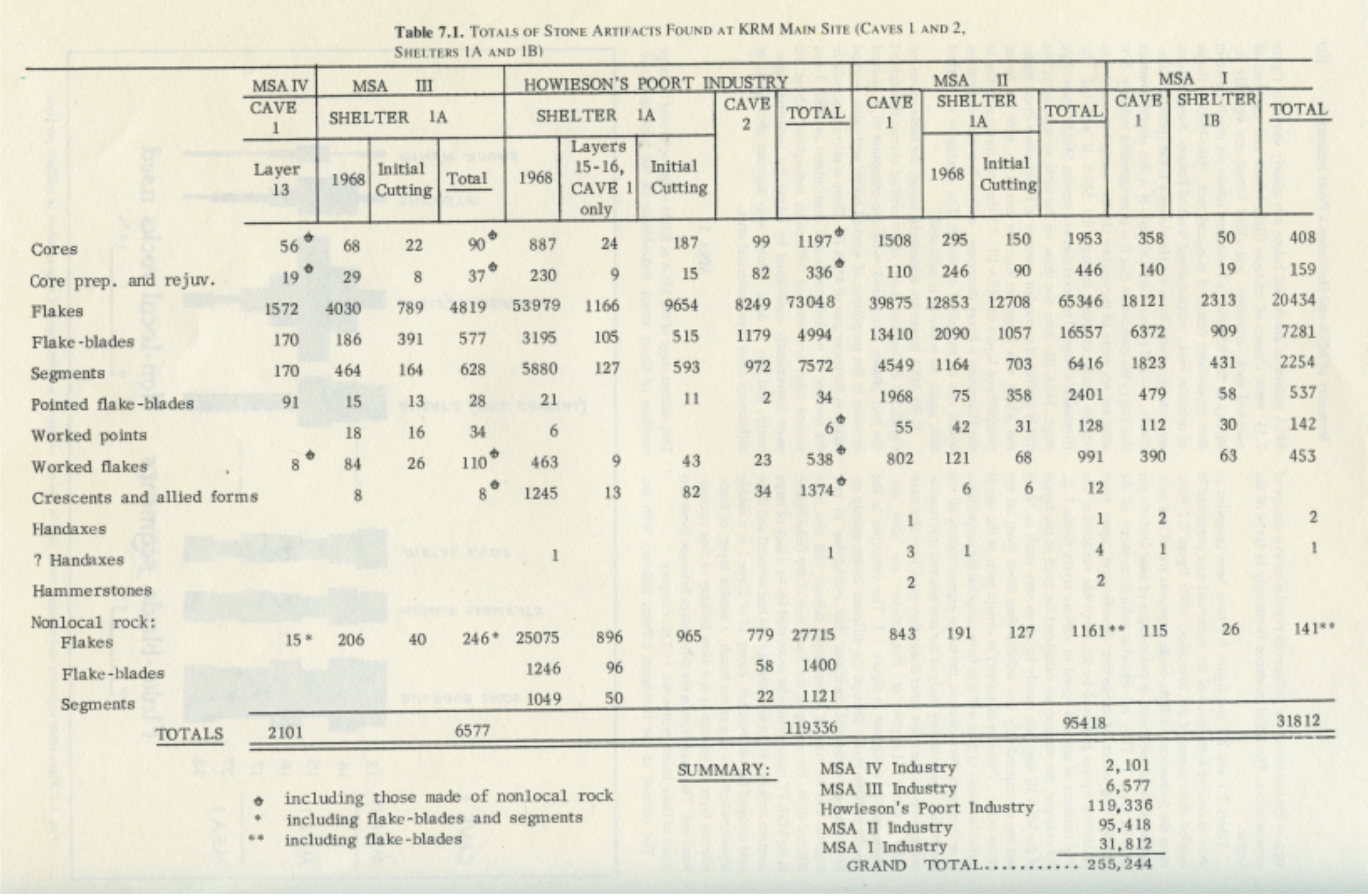


Table 7.1. TOTALS OF STONE ARTIFACTS FOUND AT KRM MAIN SITE (CAVES 1 AND 2, SHELTERS 1A AND 1B)

	MSA IV	MSA III			HOWIESON'S POORT INDUSTRY					MSA II				MSA I		
	CAVE 1	SHELTER 1A			SHELTER 1A			CAVE 2	TOTAL	CAVE 1	SHELTER 1A		TOTAL	CAVE 1	SHELTER 1B	TOTAL
	Layer 13	1968	Initial Cutting	Total	1968	Layers 15-16, CAVE 1 only	Initial Cutting				1968	Initial Cutting				
Cores	56◆	68	22	90◆	887	24	187	99	1197◆	1508	295	150	1953	358	50	408
Core prep. and rejuv.	19◆	29	8	37◆	230	9	15	82	336◆	110	246	90	446	140	19	159
Flakes	1572	4030	789	4819	53979	1166	9654	8249	73048	39875	12853	12708	65346	18121	2313	20434
Flake-blades	170	186	391	577	3195	105	515	1179	4994	13410	2090	1057	16557	6372	909	7281
Segments	170	464	164	628	5880	127	593	972	7572	4549	1164	703	6416	1823	431	2254
Pointed flake-blades	91	15	13	28	21		11	2	34	1968	75	358	2401	479	58	537
Worked points		18	16	34	6				6◆	55	42	31	128	112	30	142
Worked flakes	8◆	84	26	110◆	463	9	43	23	538◆	802	121	68	991	390	63	453
Crescents and allied forms		8		8◆	1245	13	82	34	1374◆		6	6	12			
Handaxes										1			1	2		2
? Handaxes					1				1	3	1		4	1		1
Hammerstones										2			2			
Nonlocal rock:																
Flakes	15*	206	40	246*	25075	896	965	779	27715	843	191	127	1161**	115	26	141**
Flake-blades					1246	96		58	1400							
Segments					1049	50		22	1121							
TOTALS	2101			6577					119336				95418			31812

◆ including those made of nonlocal rock
* including flake-blades and segments
** including flake-blades

SUMMARY:

MSA IV Industry	2,101
MSA III Industry	6,577
Howieson's Poort Industry	119,336
MSA II Industry	95,418
MSA I Industry	31,812
GRAND TOTAL...........	255,244

Appendix 13 Klasies River Singer & Wymer's Table 7.2 (1982, 111).

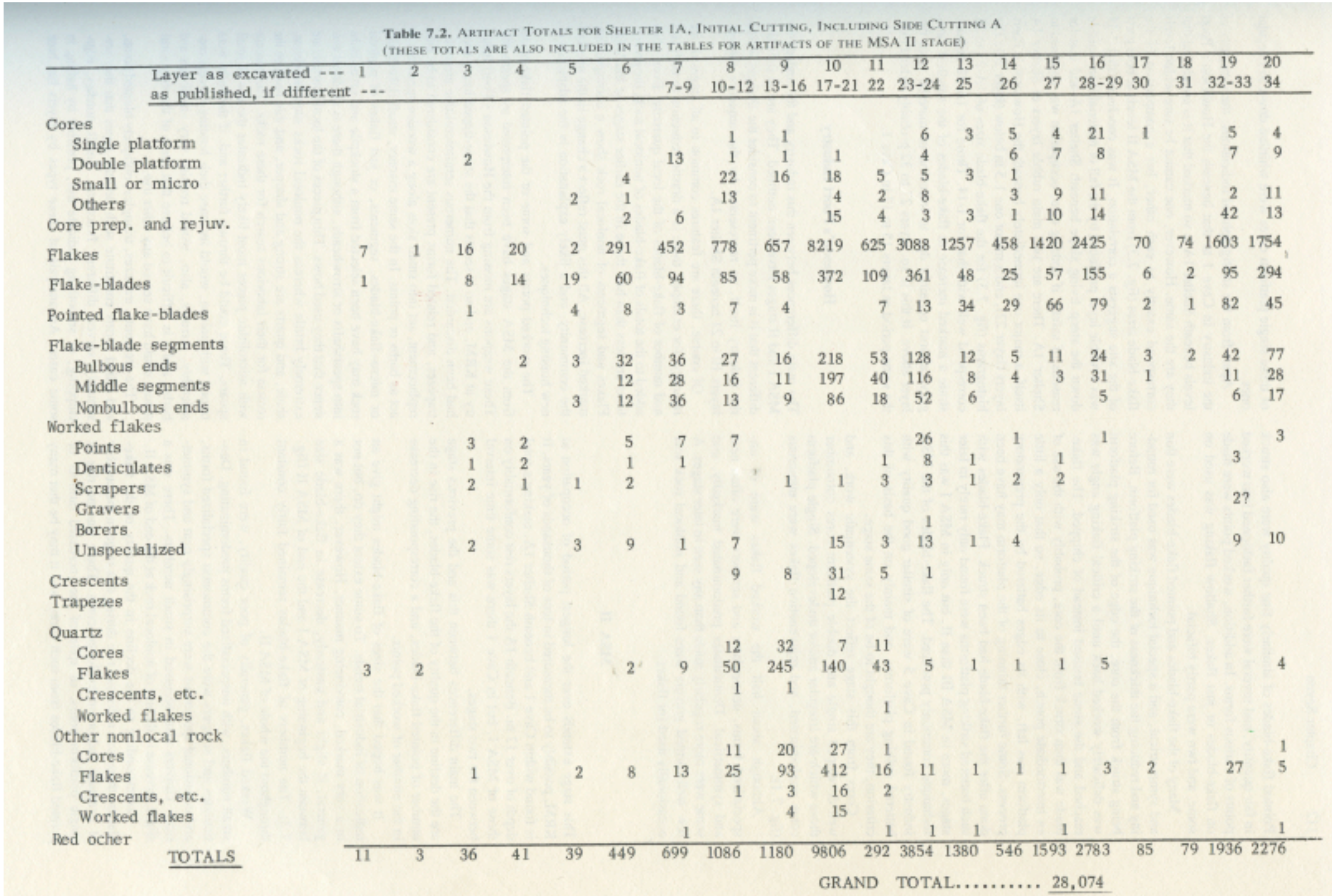


Table 7.2. ARTIFACT TOTALS FOR SHELTER 1A, INITIAL CUTTING, INCLUDING SIDE CUTTING A
(THESE TOTALS ARE ALSO INCLUDED IN THE TABLES FOR ARTIFACTS OF THE MSA II STAGE)

Layer as excavated ---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
as published, if different ---							7-9	10-12	13-16	17-21	22	23-24	25	26	27	28-29	30	31	32-33	34
Cores																				
Single platform								1	1			6	3	5	4	21	1		5	4
Double platform			2				13	1	1	1		4		6	7	8			7	9
Small or micro						4		22	16	18	5	5	3	1						
Others					2	1		13		4	2	8		3	9	11			2	11
Core prep. and rejuv.						2	6			15	4	3	3	1	10	14			42	13
Flakes	7	1	16	20	2	291	452	778	657	8219	625	3088	1257	458	1420	2425	70	74	1603	1754
Flake-blades	1		8	14	19	60	94	85	58	372	109	361	48	25	57	155	6	2	95	294
Pointed flake-blades			1		4	8	3	7	4		7	13	34	29	66	79	2	1	82	45
Flake-blade segments																				
Bulbous ends				2	3	32	36	27	16	218	53	128	12	5	11	24	3	2	42	77
Middle segments						12	28	16	11	197	40	116	8	4	3	31	1		11	28
Nonbulbous ends					3	12	36	13	9	86	18	52	6			5			6	17
Worked flakes																				
Points			3	2		5	7	7				26		1		1				3
Denticulates			1	2		1	1				1	8	1		1				3	
Scrapers			2	1	1	2			1	1	3	3	1	2	2					
Gravers																			2?	
Borers												1								
Unspecialized			2		3	9	1	7		15	3	13	1	4					9	10
Crescents								9	8	31	5	1								
Trapezes										12										
Quartz																				
Cores								12	32	7	11									
Flakes	3	2				2	9	50	245	140	43	5	1	1	1	5				4
Crescents, etc.								1	1											
Worked flakes											1									
Other nonlocal rock																				
Cores								11	20	27	1									1
Flakes			1		2	8	13	25	93	412	16	11	1	1	1	3	2		27	5
Crescents, etc.								1	3	16	2									
Worked flakes									4	15										
Red ocher							1				1	1	1		1					1
TOTALS	11	3	36	41	39	449	699	1086	1180	9806	292	3854	1380	546	1593	2783	85	79	1936	2276

GRAND TOTAL.......... 28,074

KRM SHELTER 1A

SEQUENCE								PALAEOENVIRONMENT	
OIS Correlation	Dating - Years (ka)				Stratigraphic Unit	Chrono-Stratigraphy	Level	Microfauna	Sedimentology
	U-Series	TL	OSL	Luminescence					
					UPPER MEMBER	MSA III	1	Denser Thicket Vegetation and Graminoids. Possible decrease in shrubs. Greater Seasonal Rainfall Variation.	Cave Dry, Sea Level Near Present And Falling
							2		
							3		
							4		
							5		
							6		
							7		
							8		
			57.9 ± 2.3	ca. 50			9		
							7 - 9		
						HOWIESONS POORT	10	Generally Open, Cooler, Decrease in Dense Vegetation Coverage. Irregular rainfall (less seasonal). Increased biodiversity may indicate amelioration.	Cave Dry, Sea Cool, Major Frost Weathering (Nelson Bay Cave)
OIS 3							11		
							12		
							13		
	65						14		
		56 ± 3		60-55			15		
							16		
							17		
							18		
OIS 4							19		
			64.1 ± 2.6				20		
							21		
			72.1 ± 3.4	70-80	ROCKFALL	MSA II	22	Denser Vegetation Decreasing shrub coverage. Occasional periods of grass coverage. Less marked seasonal variation.	Cave Dry, Sea Near Present at End (No info for earlier segments)
					SAS MEMBER		23		
							24		
OIS 5a							25		
							27		
							28		
							29		
	77-82						30		
							31		
OIS 5b							32		
							33		

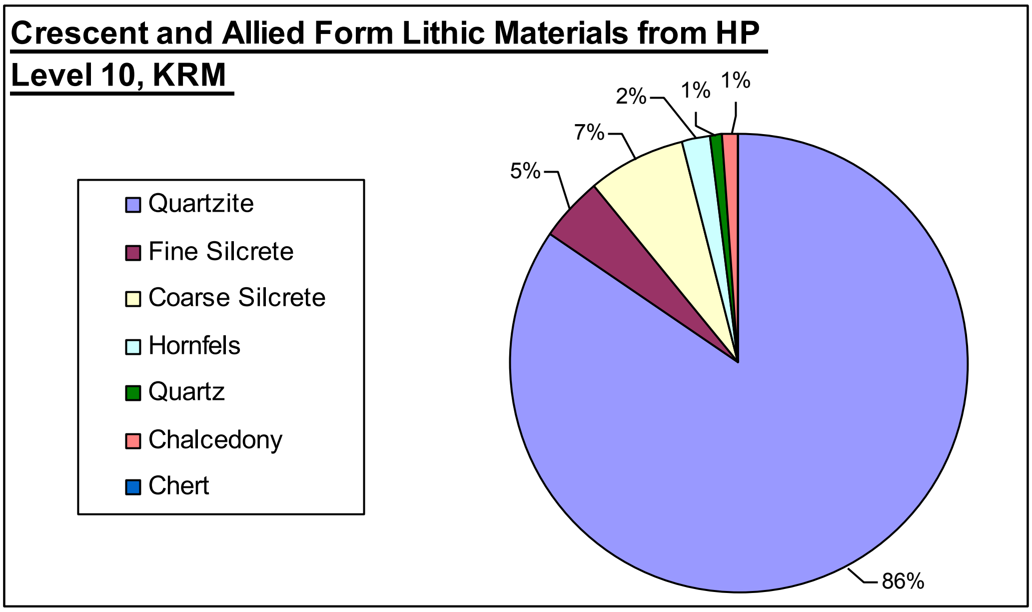
L	DOMINANT UNGULATES (MNI)		
	1st	2nd	3rd
1 - 3	-	-	-
4	-	-	-
5	T. ORYX (3)	-	-
6	S. CAFFER (4)	-	-
7	TAUROTRAGUS ORYX (3)	-	-
8			
9			
7 - 9			
10	SYNCERUS CAFFER (7)	PELOROVIS ANTIQUUS (5)	- (3)
11			
12			
13	RAPHICERUS MELANOTIS (6)	HIPPOTRAGUS LEUCOPHAEUS (5)	EQUUS cf. QUAGGA (3)
14			
15			
16			
17	TAUROTRAGUS ORYX (7)	EQUUS cf. QUAGGA (6)	SYNCERUS CAFFER (4)
18			
19			
20			
21			
22	-	-	-
23	S. CAFFER (3)	-	-
24			
25	T. STREPSICEROS (2)	-	-
27	-	-	-
28	T. ORYX (6)	H. LEUCOPHAEUS (2)	-
29			
30	-	-	-
31	-	-	-
32	T. ORYX (3)	H. LEUCOPHAEUS (2)	-
33			

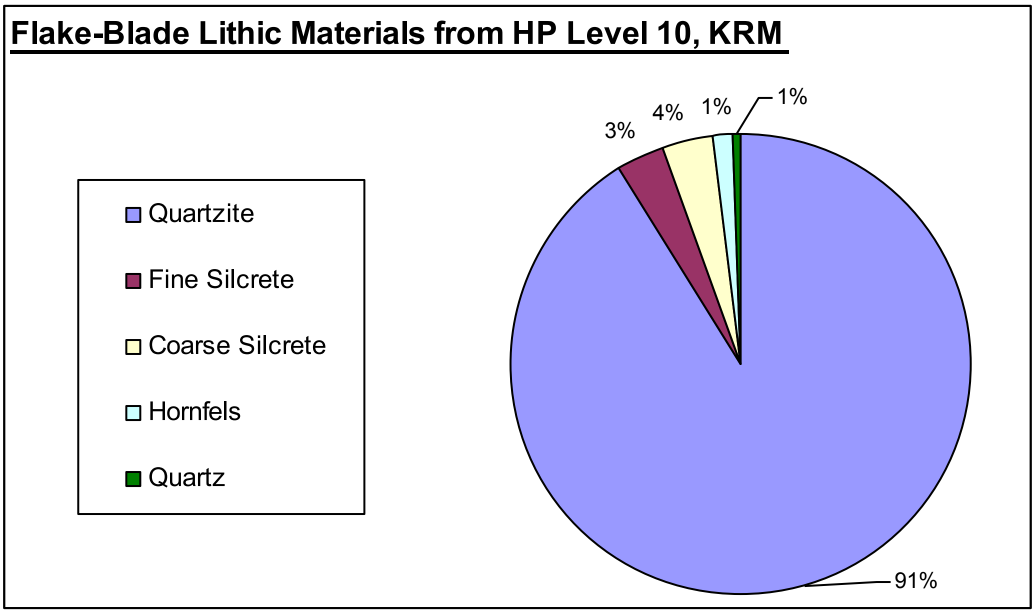
% MICROLITHS IN ASSEMBLAGE (excluding flakes)

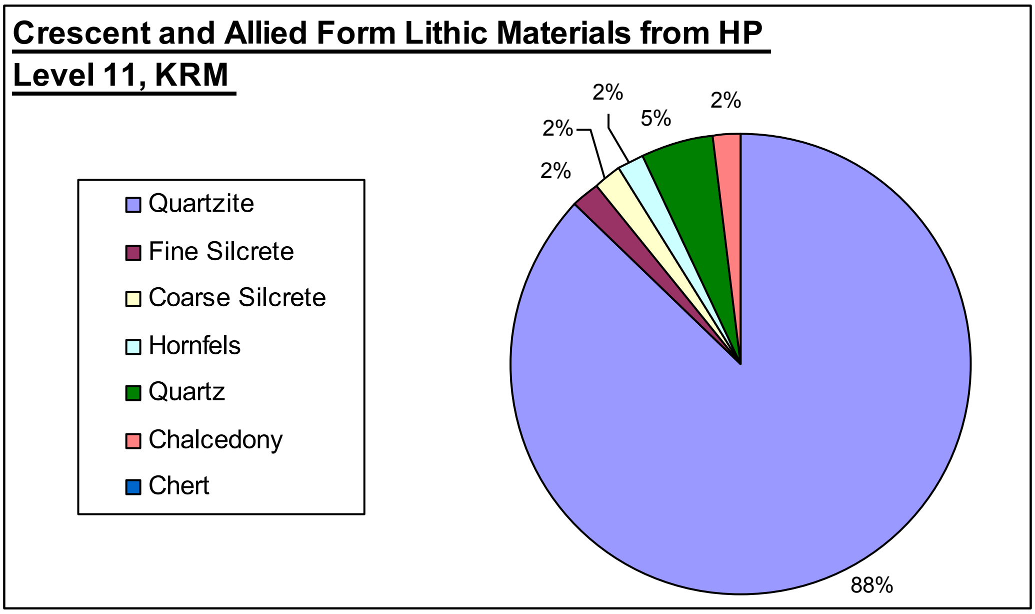
L	Crescents & Allied Forms						Raw Materials ≥5%			Local Qtzite / Exotic Rock
	0%	5%	10%	15%	20%	Mean%	1st	2nd	3rd	
1 - 3										
4										
5										
6										
7										
8										
9										
7 - 9										
10				16	n=197	16	A	C	B	LQ
11				16	n=183			E		
12				15	n=144					
13				18	n-33	12			D	
14		9	n=29					C/E	D	ER
15		6	n=19				B	A	E	
16	3	n=46						D	A	
17		5	n=166			8		A	D	
18		8	n=87				A	B	C	LQ
19		7	n=113					C		
20		9	n=194				A/B			ER
21		8	n=34				A			LQ
22										
23										
24										
25										
27										
28										
29										
30										
31										
32										
33										

L	Flake Blades <4cm (Local Quartzite)						Raw Materials ≥5% (All Flake Blades)			Local Qtzite / Exotic Rock
	0%	5%	10%	15%	20%	Mean%	1st	2nd	3rd	
1 - 3	1	n=3								
4	1	n=1								
5	1	n=3								
6	3	n=94								
7	2	n=41				2				
8	3	n=4								
9	2	n=7								
7 - 9	5	n=90								
10			12	n=142		17	A			LQ
11				19	n-217			B		
12				n=198	21					
13		9	n=17			11		D	E	
14		8	n=26					B/C		ER
15	4	n=13					B	D	A	
16		9	n=132				A	B	D	
17		9	n=330			12				LQ
18		8	n=98						C	
19			11	n=174				C	B	
20			12	n=258				B		
21			10	n=41				C		
22	4	n=9								
23	1	n=7				1				
24	1	n=15								
25	2	n=9								
27	3	n=87								
28	2	n=64				2				
29	1	n=12								
30	2	n=21								
31	1	n=6								
32	2	n=27				2				
33	2	n=2								

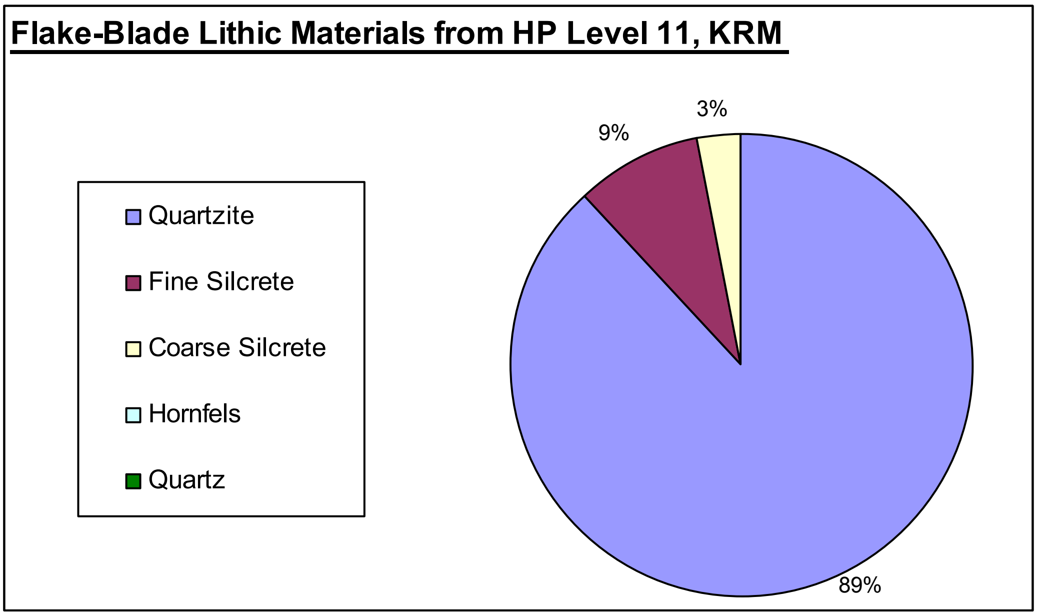
L	OTHER SMALL LITHICS			
	Pointed Flake Blades	Mid Segments		
	Total	Total	% of Segs	Ave. %
1 - 3	4	2	13	31% of 464
4	1	1	25	
5	4	5	31	
6	10	65	38	
7	5	73	29	
8		-		
9	1	-		
7 - 9	3	-		
10	3	173	31	33% of 6080
11	1	122	24	
12		102	24	
13		12	26	
14	3	13	26	
15		19	42	
16		211	36	
17	3	637	44	
18		167	30	
19	5	268	32	
20	6	215	26	
21		66	33	
22	14	7	17	23% of 775
23	2	7	24	
24	9	45	37	
25	55	6	14	
27	66	29	22	
28	89	16	16	
29	64	9	17	
30	25	38	29	
31	12	10	28	
32	58	4	8	
33	13	6	19	


Crescent and Allied Form Lithic Materials from HP Level 10, KRM

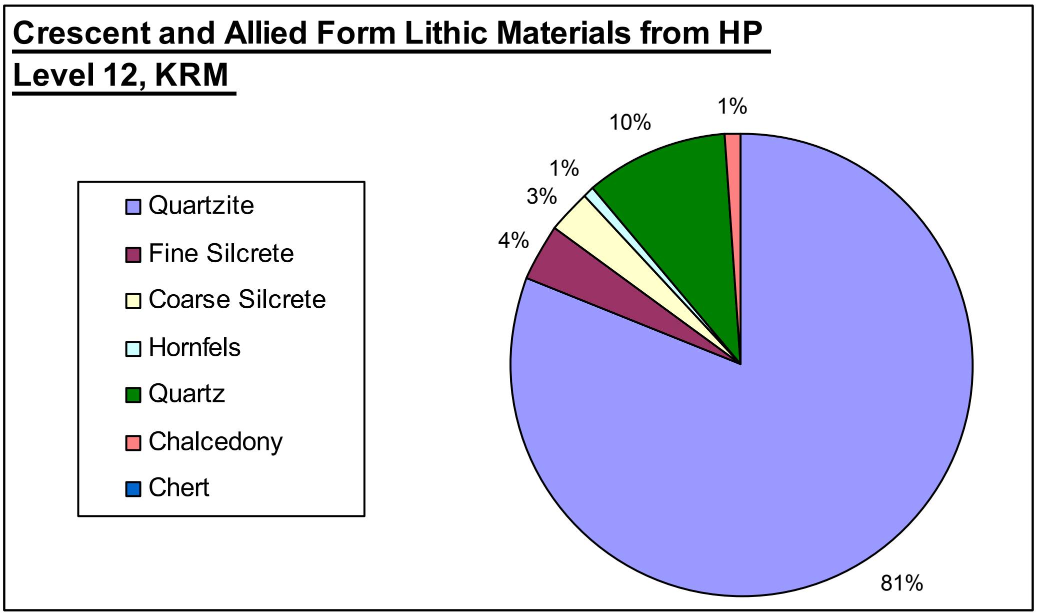

Flake-Blade Lithic Materials from HP Level 10, KRM

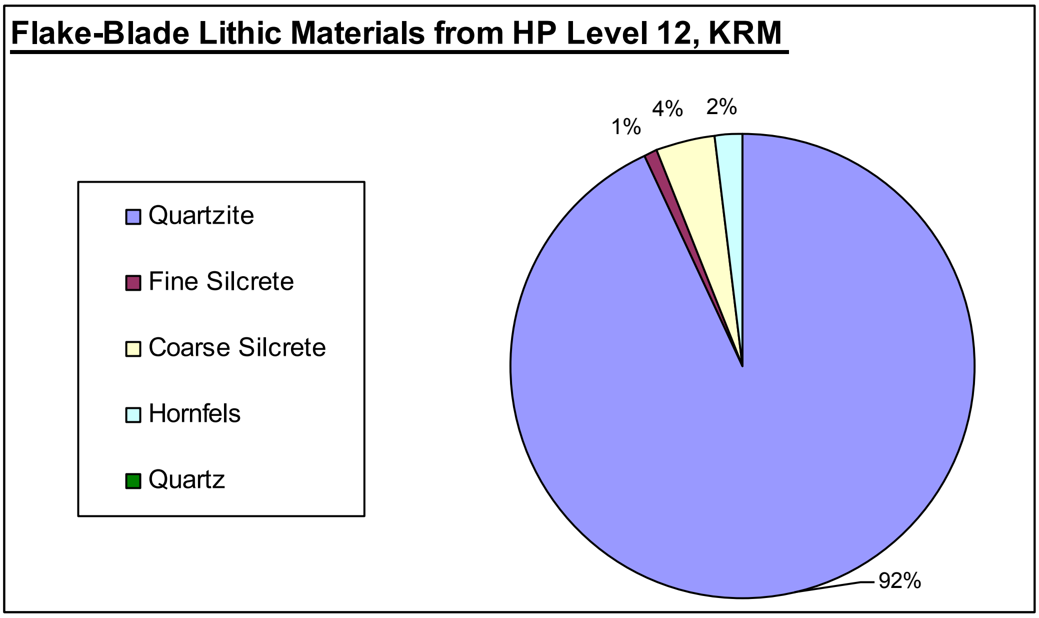


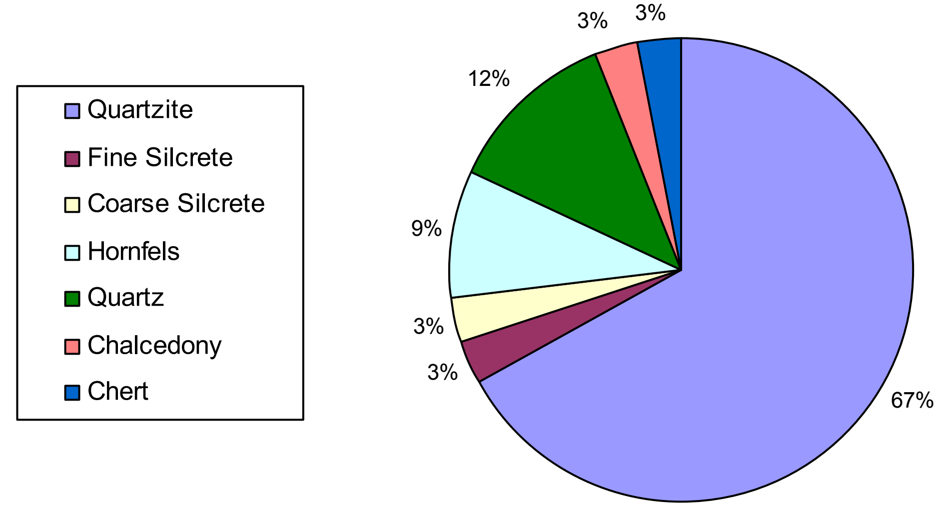
Crescent and Allied Form Lithic Materials from HP Level 11, KRM



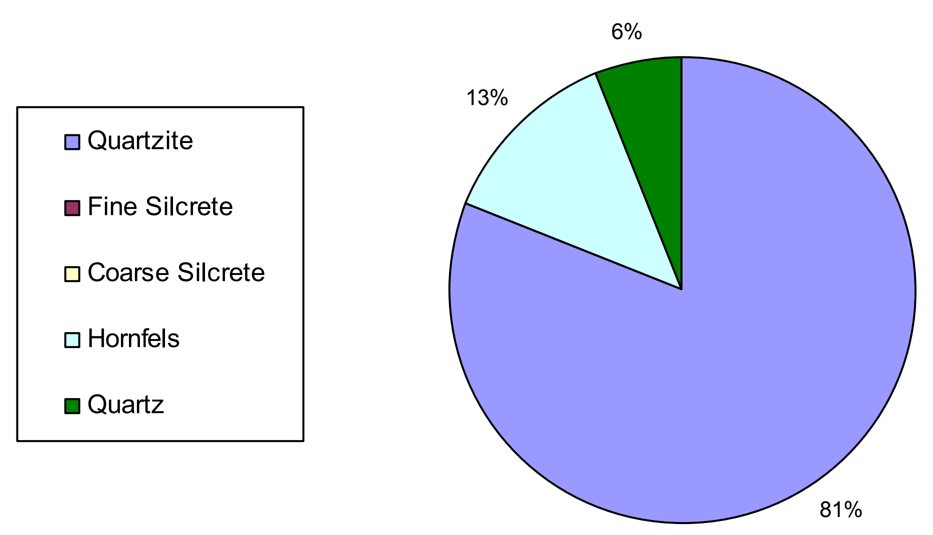
Flake-Blade Lithic Materials from HP Level 11, KRM


Crescent and Allied Form Lithic Materials from HP Level 12, KRM
Quartzite
Fine Silcrete
Coarse Silcrete
Hornfels
Quartz
Chalcedony
Chert
1%
10%
1%
3%
4%
81%

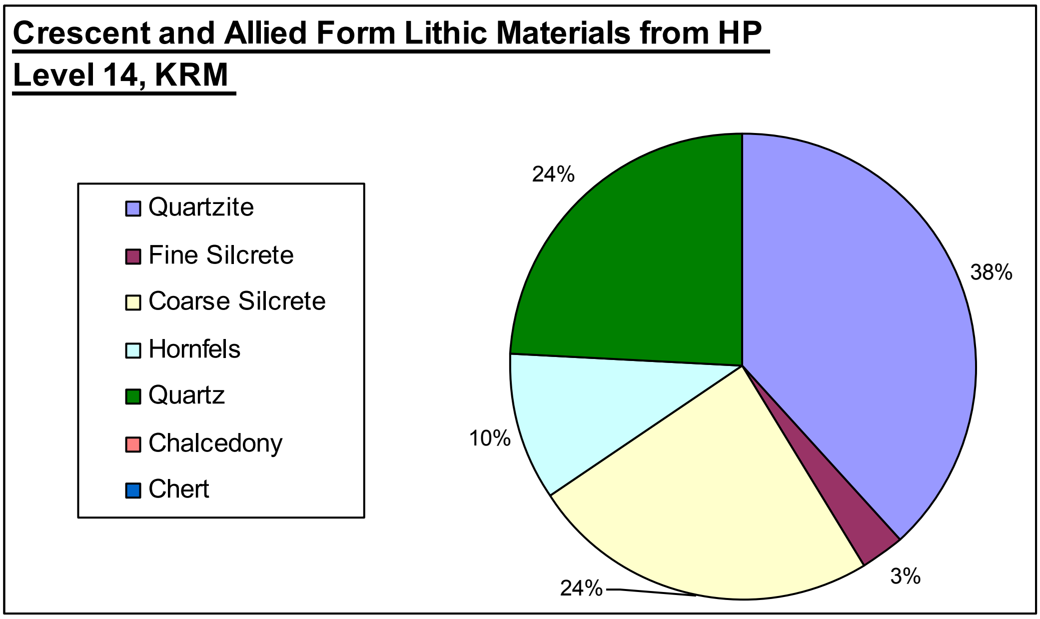

Flake-Blade Lithic Materials from HP Level 12, KRM
Quartzite
Fine Silcrete
Coarse Silcrete
Hornfels
Quartz
1%
4%
2%
92%

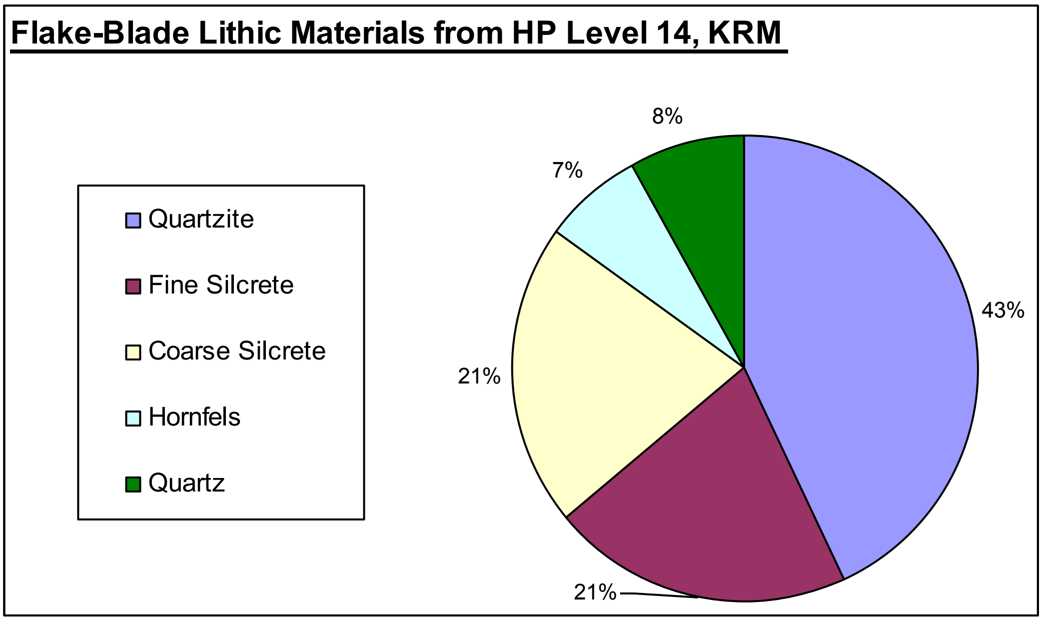


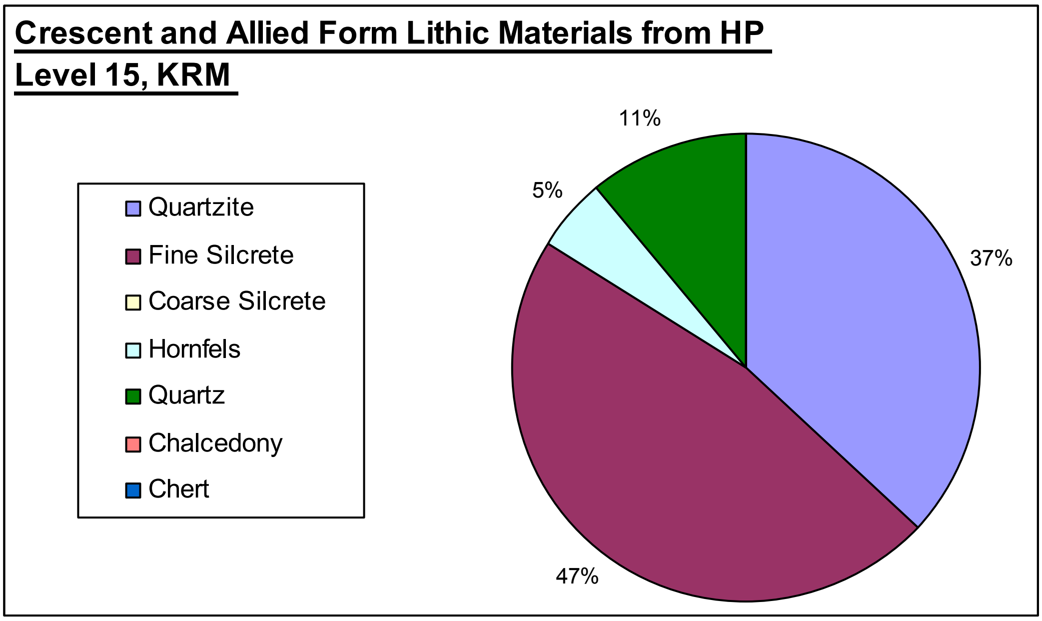
Crescent and Allied Form Lithic Materials from HP Level 13, KRM

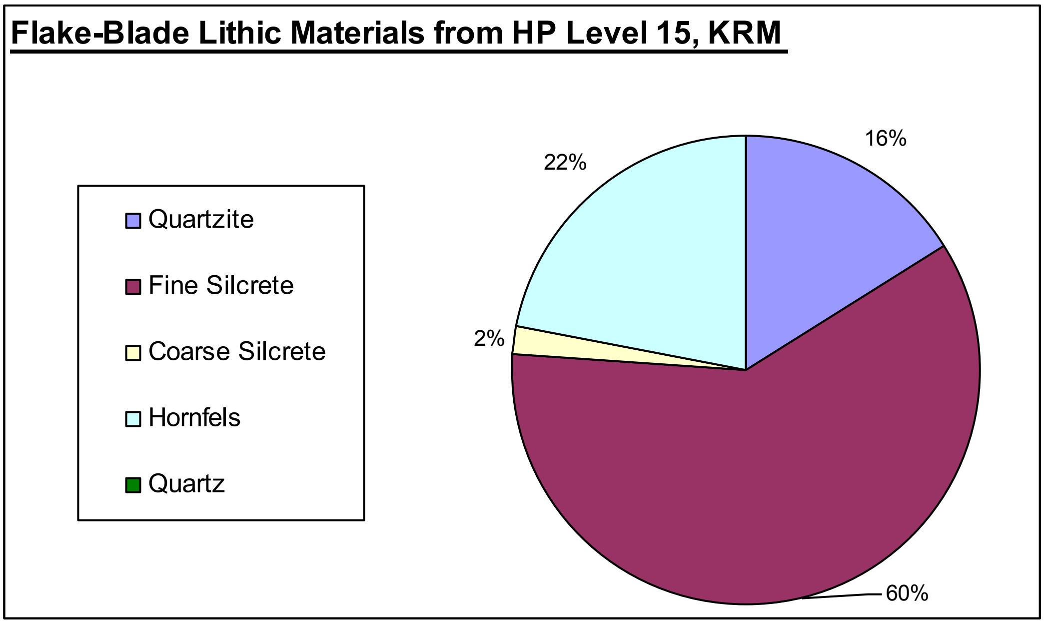


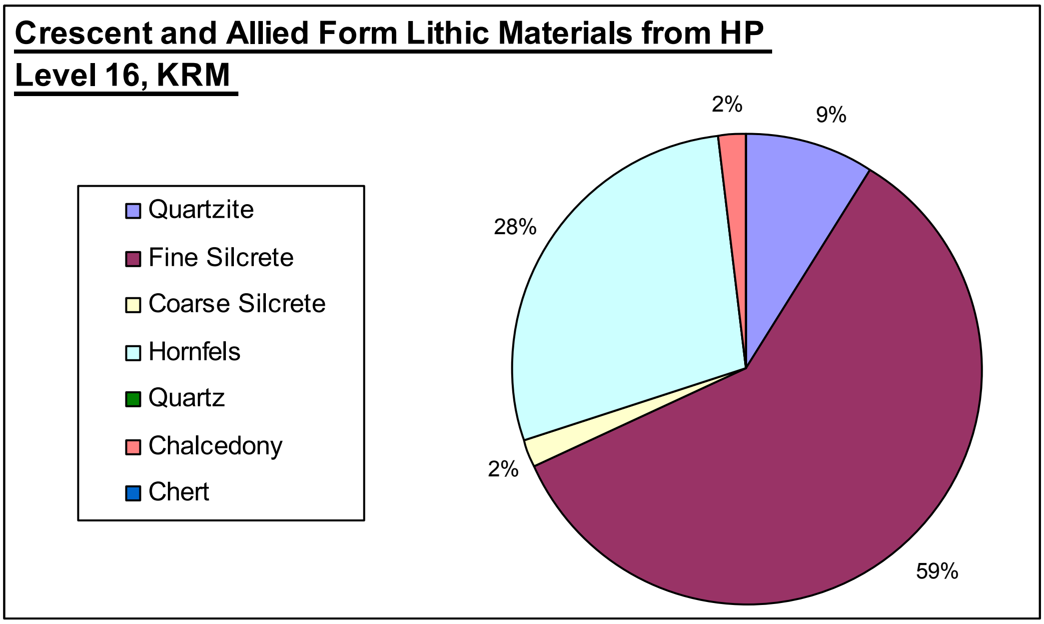
Flake-Blade Lithic Materials from HP Level 13, KRM

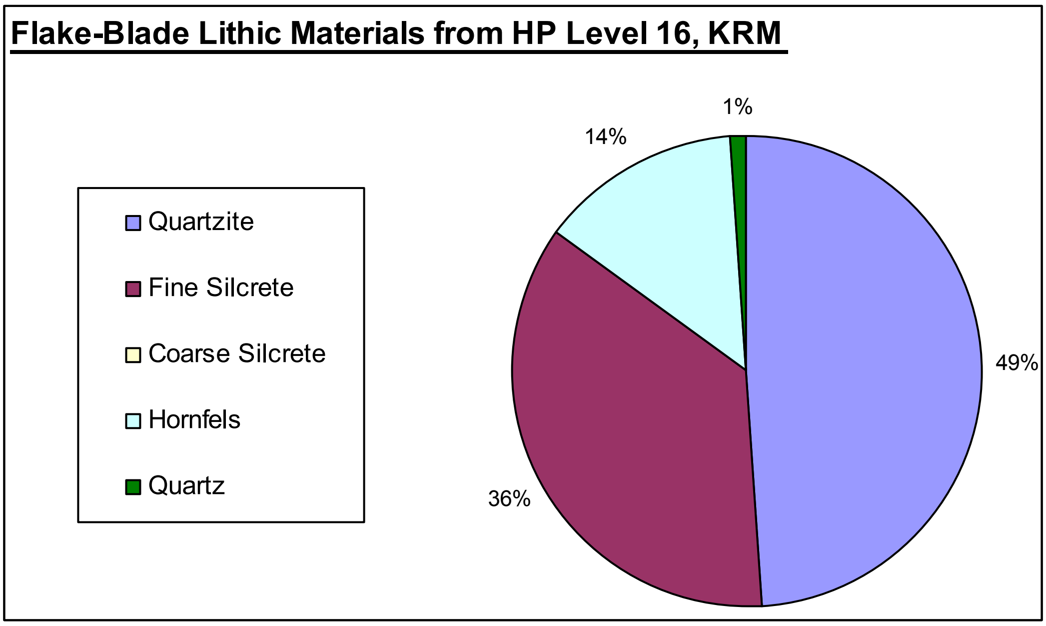

Crescent and Allied Form Lithic Materials from HP Level 14, KRM

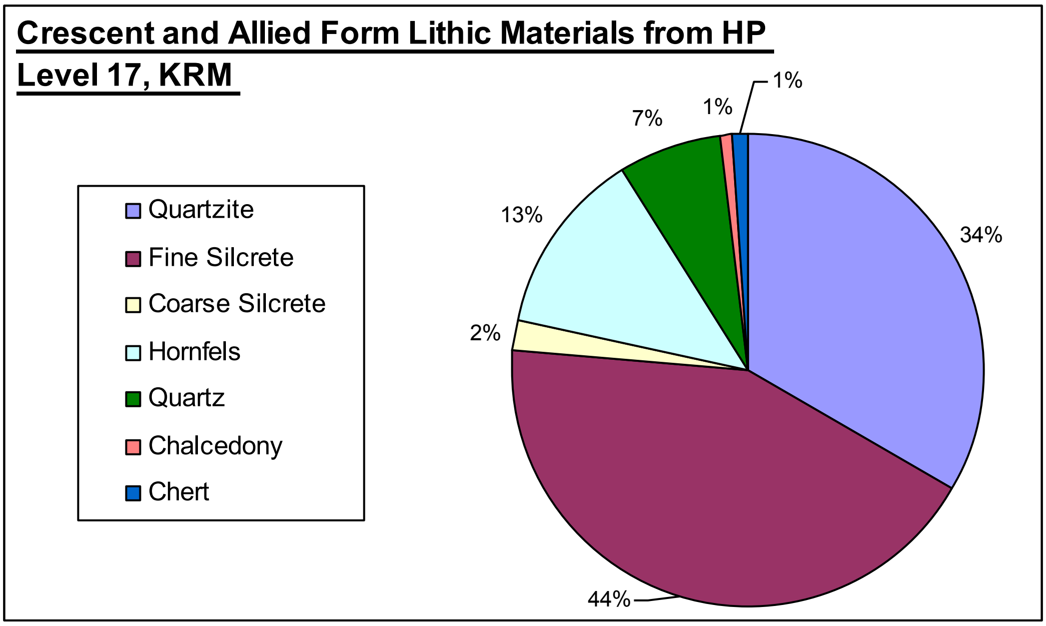

Flake-Blade Lithic Materials from HP Level 14, KRM


Crescent and Allied Form Lithic Materials from HP Level 15, KRM

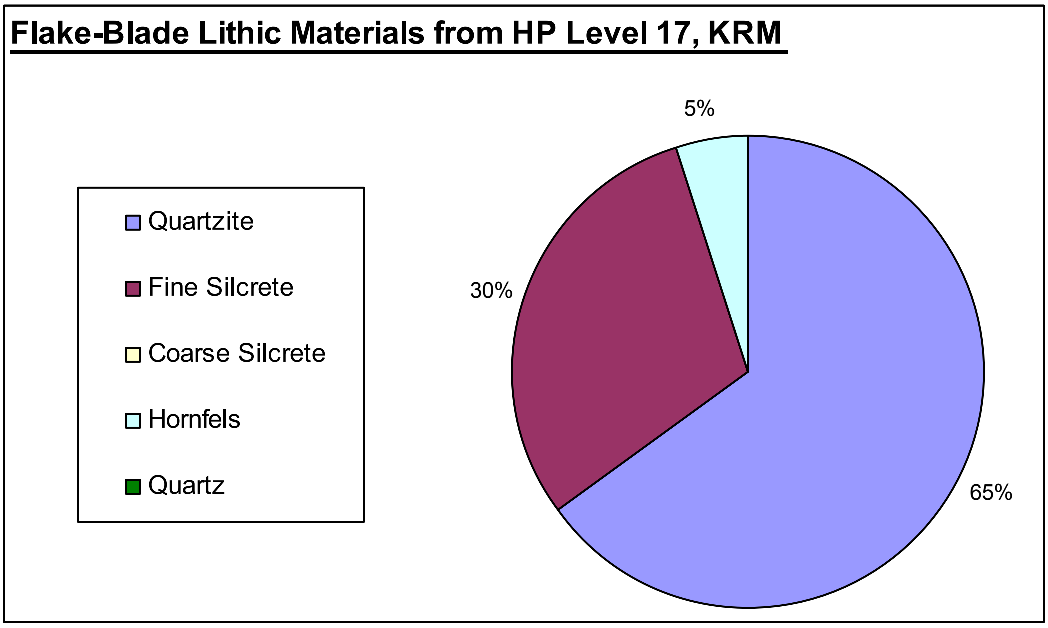

Flake-Blade Lithic Materials from HP Level 15, KRM


Crescent and Allied Form Lithic Materials from HP Level 16, KRM

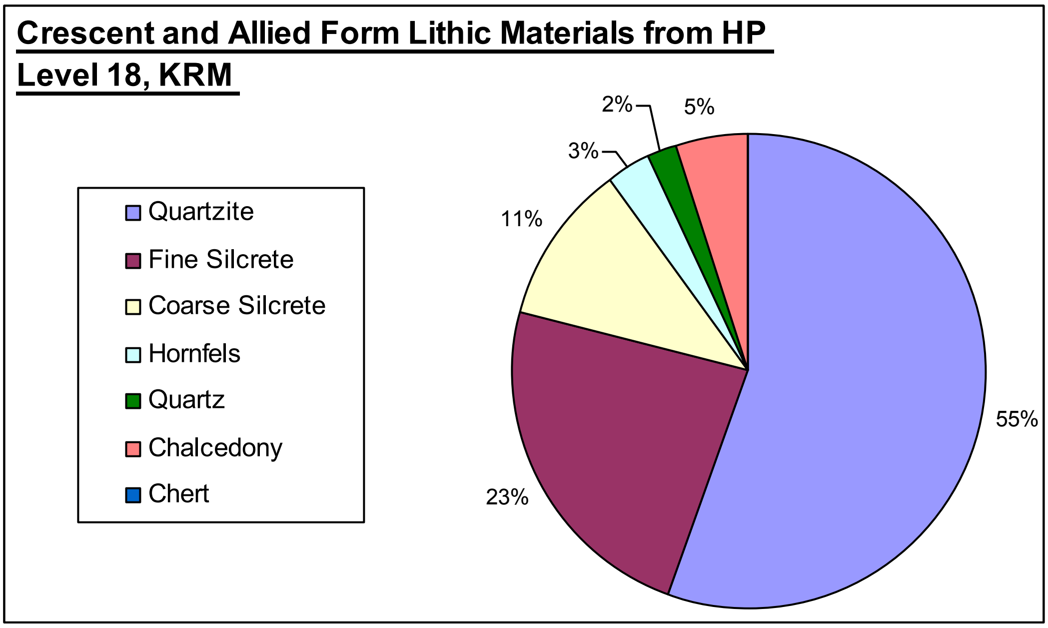

Flake-Blade Lithic Materials from HP Level 16, KRM

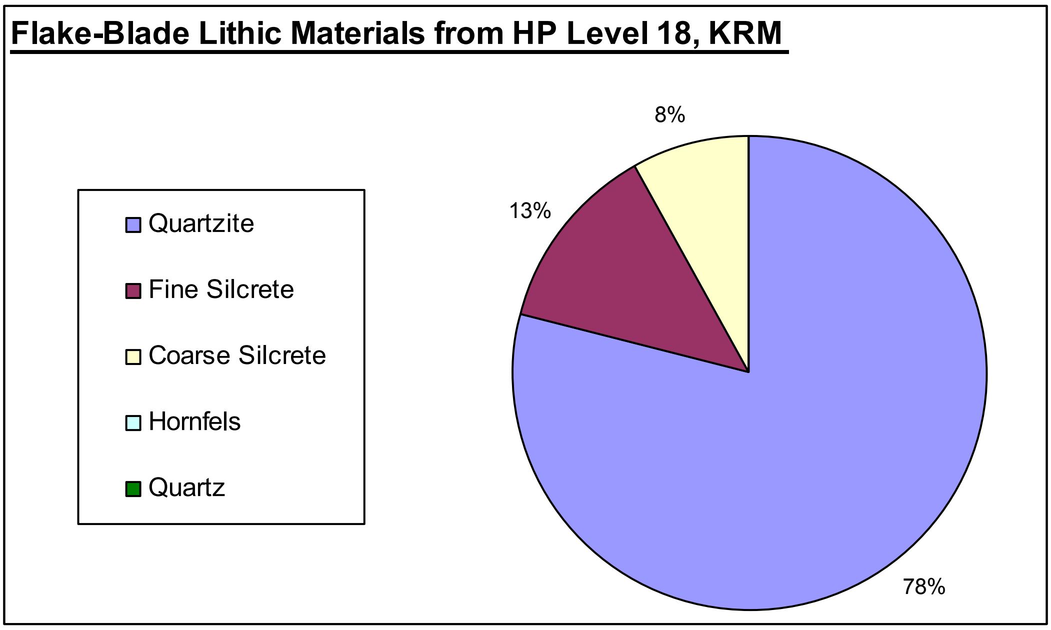


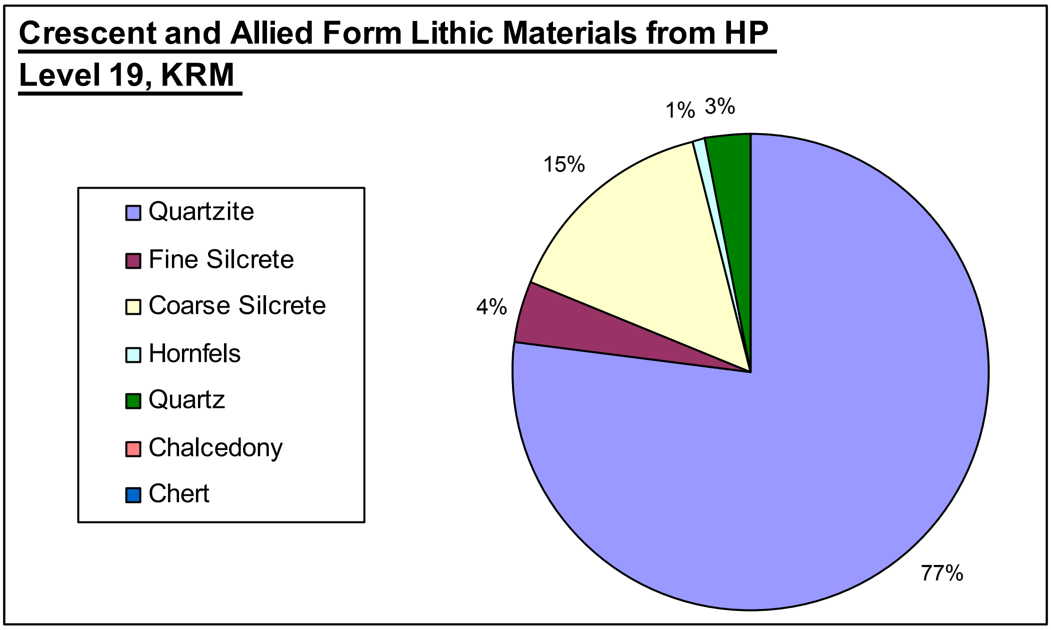
Crescent and Allied Form Lithic Materials from HP Level 17, KRM

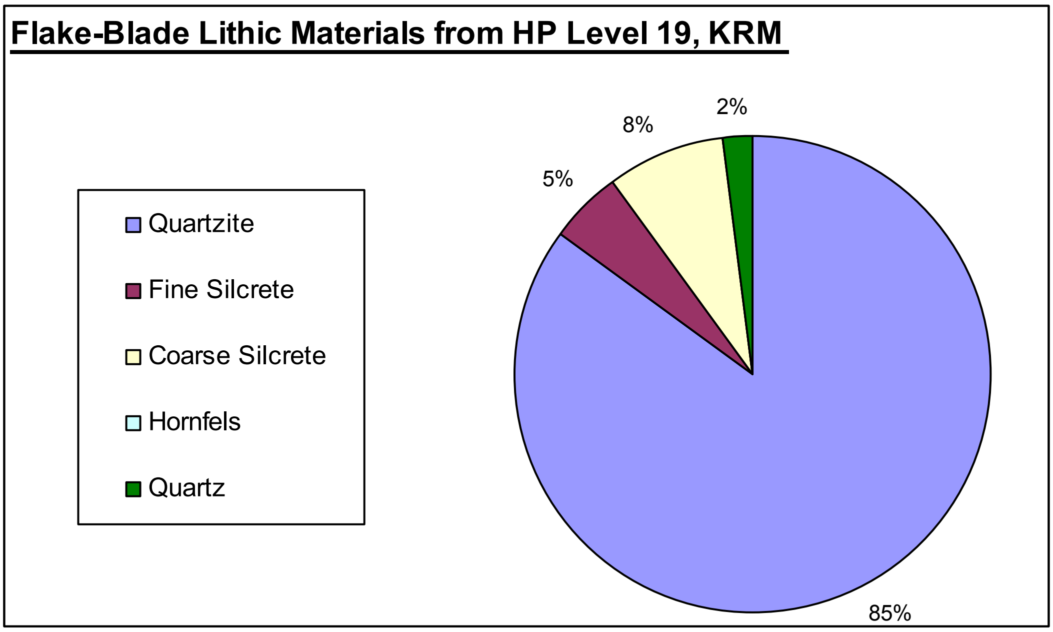


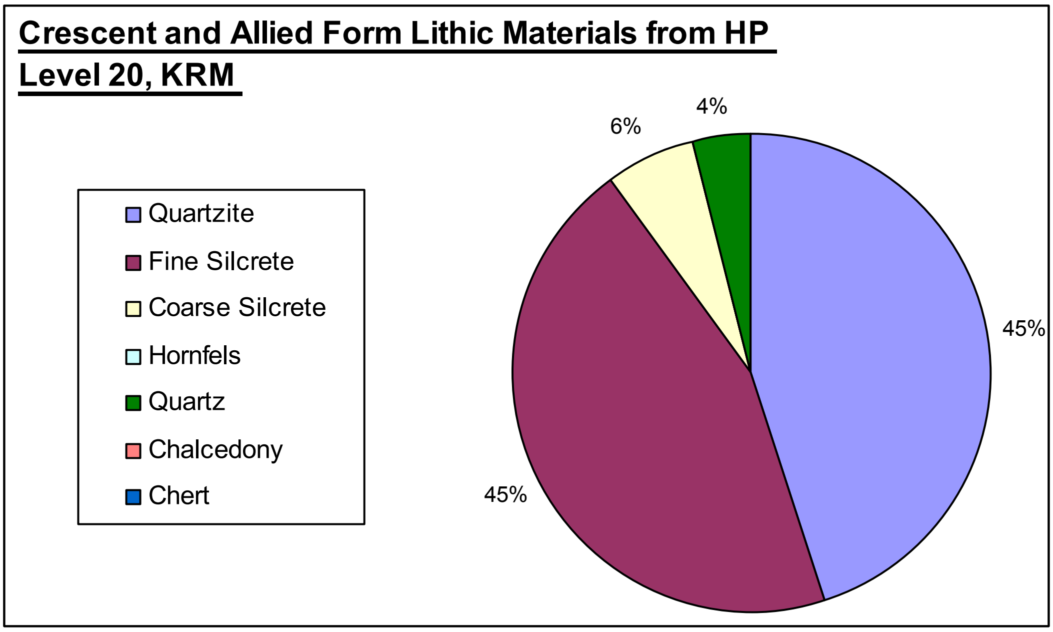
Flake-Blade Lithic Materials from HP Level 17, KRM


Crescent and Allied Form Lithic Materials from HP Level 18, KRM

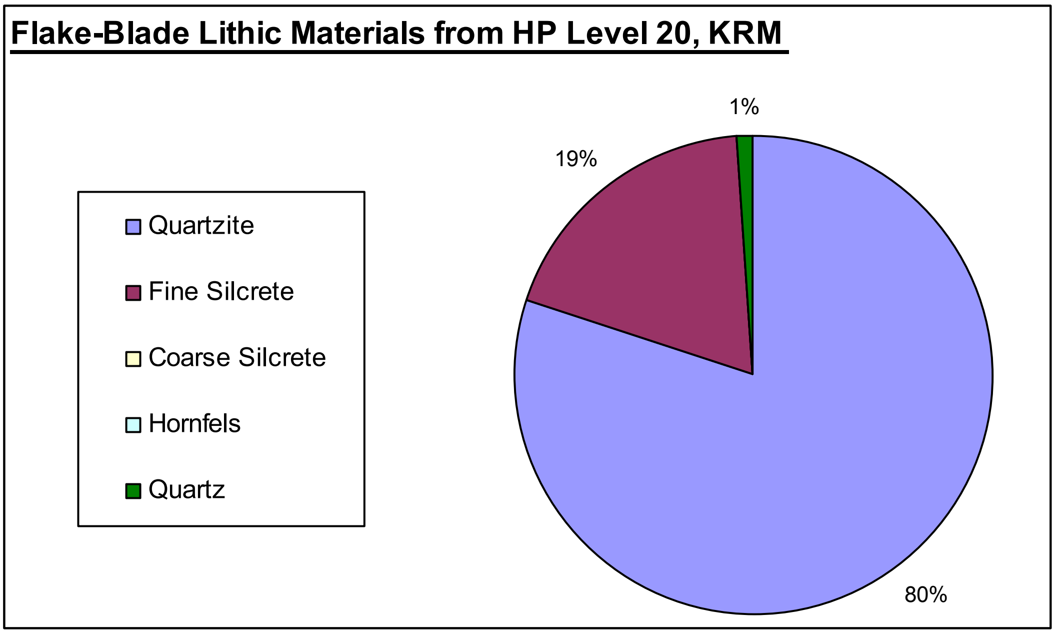

Flake-Blade Lithic Materials from HP Level 18, KRM


Crescent and Allied Form Lithic Materials from HP Level 19, KRM

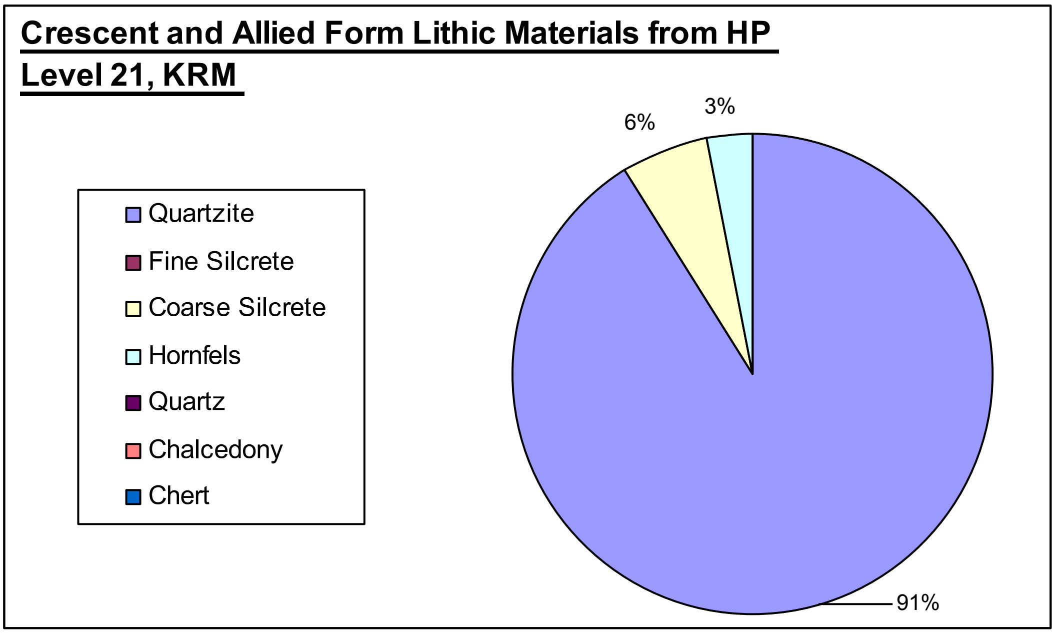

Flake-Blade Lithic Materials from HP Level 19, KRM

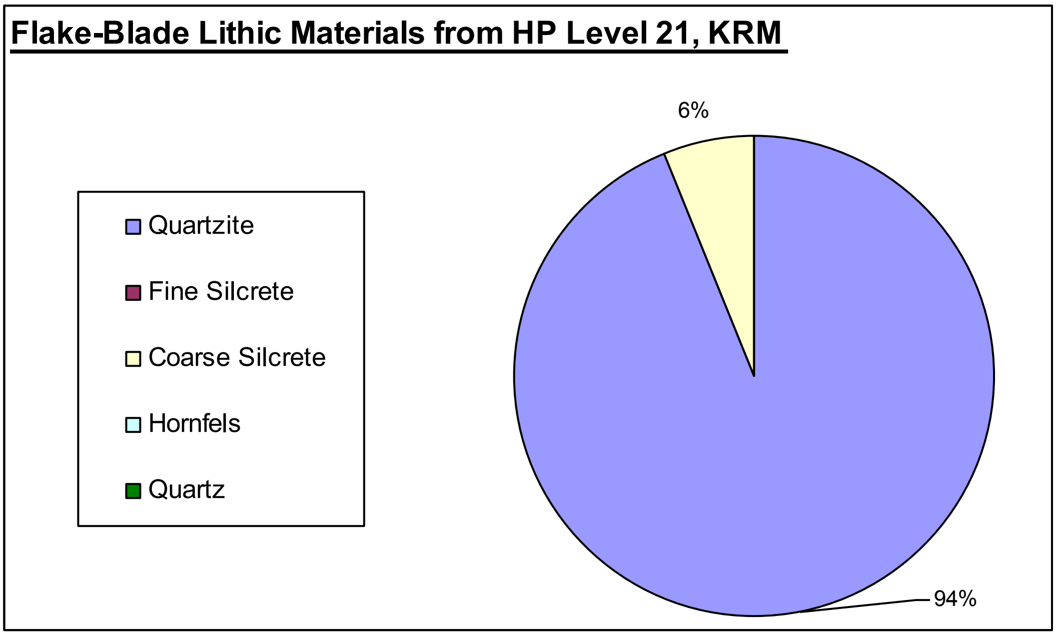


Crescent and Allied Form Lithic Materials from HP Level 20, KRM



Flake-Blade Lithic Materials from HP Level 20, KRM


Crescent and Allied Form Lithic Materials from HP Level 21, KRM


Flake-Blade Lithic Materials from HP Level 21, KRM

Appendix 27. Klasies River Spearman's Rank for fine silcrete pieces and trapezes

Fine silcrete		trapezes		d	d squared
0%	12	3%	6.5	5.5	30.25
2%	11	0%	10.5	0.5	0.25
3%	9.5	0%	10.5	-1	1
3%	9.5	0%	10.5	-1	1
4%	7.5	0%	10.5	-3	9
4%	7.5	21%	3	4.5	20.25
5%	6	1%	8	-2	4
23%	5	3%	6.5	-1.5	2.25
44%	4	13%	4	0	0
45%	3	5%	5	-2	4
47%	2	24%	2	0	0
59%	1	35%	1	0	0
				Total	72

0.748251748 Accepted at 10 degrees freedom under 5% and near 1%

Appendix 28. Klasies River Spearman's Rank for quartz and completely blunted crescents

	Qtz	Completely Blunted Crescents			(d)	d squared
21	0%	11.5	9%	12	-0.5	0
20	0%	11.5	26%	9	2.5	6
19	1%	10	32%	7	3	9
18	2%	9	23%	10	-1	1
17	3%	8	38%	4.5	3.5	12
16	4%	7	47%	3	4	16
15	5%	6	30%	8	-2	4
14	7%	5	14%	11	-6	36
13	10%	4	33%	6	-2	4
12	11%	3	38%	4.5	-1.5	2
11	12%	2	64%	1	1	1
10	24%	1	48%	2	-1	1
					Total	93

0.6748252 Accepted under 5% at 10 deg freedom

Appendix 29. Klasies River Spearman's rank for hornfels and trapezes

hornfels		trapezes		(d) difference	d squared
0%	12	5%	5	7	49
1%	10.5	0%	10.5	0	0
1%	10.5	21%	3	7.5	56.25
2%	8.5	0%	10.5	-2	4
2%	8.5	1%	8	0.5	0.25
3%	6.5	3%	6.5	0	0
3%	6.5	3%	6.5	0	0
5%	5	24%	2	3	9
9%	4	0%	10.5	-6.5	42.25
10%	3	0%	10.5	-7.5	56.25
13%	2	13%	4	-2	4
28%	1	35%	1	0	0
				Total	221

0.2272727 rejected at 10 degrees of freedom

Appendix 30. Klasies River Spearman's Rank for local quartzite pieces and completely blunted crescents

	Quartzite		Crescents (blunts)		(d) difference	d squared
21	9%	12	9%	12	0	0
20	34%	11	23%	11	0	0
19	37%	10	38%	9	1	1
18	38%	9	52%	3	6	36
17	45%	8	57%	2	6	36
16	55%	7	34%	10	-3	9
15	67%	6	67%	1	5	25
14	77%	5	49%	4	1	1
13	81%	4	42%	7.5	-3.5	12.25
12	86%	3	42%	7.5	-4.5	20.25
11	88%	2	46%	6	-4	16
10	91%	1	47%	5	-4	16
					Total	172.5

0.3968531 Reject significant correlation.

Appendix 31. Sibudu Complete Fauna Data

	Post HP MSA 1			Post HP MSA 2			HP		
	NISP	NISP %	MNI	NISP	NISP %	MNI	NISP	NISP %	MNI
Equus quagga Plains Zebra	25	4.6	2	-	-	-	2	0.1	1
Equus capensis extinct Cape Horse	3	0.6	1	1	0.3	1	-	-	-
Equus sp	16	3	2	2	0.6	1	-	-	-
Potamochoerus larvatus Bushpig	1	0.2	1	13	4	1	201	8.3	4
cf. Potamochoerus larvatus	-	-	-	-	-	-	4	0.2	-
Phacochoerus africanus Common warthog	4	0.7	1	1	0.3	1	-	-	-
Suid	7	1.3	1	9	2.3	3	16	0.7	2
cf. Giraffa camelopardalis giraffe	2	0.4	1	1	0.3	1	-	-	-
Pelorovis antiquus Giant Buffalo	5	0.9	1	-	-	-	-	-	-
cf. Pelorovis antiquus	12	2.2	1	-	-	-	-	-	-
Syncerus caffer African Buffalo	14	2.6	2	-	-	-	12	0.5	2
cf. Syncerus caffer	9	1.7	-	1	0.3	1	-	-	-
Tragelaphus strepsiceros Kudu	10	1.8	2	-	-	-	-	-	-
cf. Tragelaphus strepsiceros	3	0.6	-	-	-	-	-	-	-
Tragelaphus scriptus Bushbuck	-	-	-	2	0.6	1	5	0.2	2
cf. Tragelaphus scriptus	1	0.2	1	1	0.3	0	-	-	-
Tragelaphus oryx Eland	2	0.4	1	1	0.3	1	3	0.1	1
cf. Tragelaphus oryx	-	-	-	2	0.6	0	-	-	-
Tragelaphus sp.	1	0.2	1	-	-	-	-	-	-
Megalotragus priscus Giant Hartebeest	-	-	-	-	-	-	4	0.2	1
cf. Megalotragus priscus	2	0.4	1	-	-	-	-	-	-
Connochaetes taurinus Blue wildebeest	5	0.9	1	1	0.3	1	3	0.1	2
cf. Connochaetes taurinus	5	0.9	-	2	0.6	0	-	-	-
Alcelaphus buselaphus Red hartebeest	2	0.4	1	-	-	-	-	-	-
cf. Alcelaphus buselaphus	1	0.2	1	-	-	-	-	-	-
Damaliscus pygargus Blesbok	1	0.2	1	-	-	-	-	-	-
Alcelaphine large	14	2.6	2	-	-	-	3	0.1	1
Hippotragus equinus Roan antelope	-	-	-	-	-	-	5	0.2	2
Hippotragus/Tragelaphus oryx	1	0.2	1	-	-	-	4	0.2	1
Philantoba monticola Blue duiker	2	0.4	1	11	3.4	2	810	33.6	17
Cephalophus natalensis Red duiker	-	-	-	-	-		3	0.1	1
cf. Cephalophus natalensis	-	-	-	-	-	-	1	0	-
Sylvicapra grimmia Common duiker	-	-	-	-	-	-	2	0.1	2
Cephalophus/Sylvicapra	-	-	-	-	-	-	5	0.2	1
Redunca fulvorufula Mountain reedbuck	1	0.2	1	-	-	-	-	-	-
Redunca sp.	2	0.4	2	-	-	-	1	<0.1	1
Kobus ellipsiprymnus Waterbuck	1	0.2	1	-	-	-	-	-	-
cf. Kobus ellipsiprymnus	1	0.2	1	-	-	-	-	-	-
Pelea capreolus Grey rhebok	-	-	-	-	-	-	3	0.1	2
cf. Pelea capreolus	-	-	-	-	-	-	2	0.1	-
Pelea/Redunca	1	0.2	1	-	-	-	-	-	-
Raphicerus campestris Steenbock	-	-	-	-	-	-	21	0.9	3
cf. Raphicerus campestris	-	-	-	-	-	-	2	0.1	-
Raphicerus/Oreotragus	-	-	-	-	-	-	2	0.1	1
Aepyceros melampus Impala	-	-	-	1	0.3	1	4	0.2	1
cf. Aepyceros melampus	1	0.2	1	-	-	-	-	-	-
Oreotragus oreotragus Klipspringer	2	0.4	1	2	0.6	1	-	-	-
cf. Oreotragus oreotragus	-	-	-	2	0.6	-	-	-	-
Bov I	19	3.5	2	35	10.9	1	300	12.5	9
Bov I/II	2	0.4	1	8	2.5	1	6	0.2	1
Bov II	96	17.7	3	118	36.6	3	461	19.1	5
Bov II/III	1	0.2	1	9	2.8	1	4	0.2	1
Bov III	216	39.9	4	61	18.9	2	221	9.2	4
Bov III/IV	7	1.3	1	8	2.5	1	4	0.2	1
Bov IV	24	4.4	3	19	5.9	1	19	0.8	2
Bov IV/V	1	0.2	1	1	0.3	1	1	<0.1	1
Bov V	3	0.6	1	-	-	-	-	-	-
Grand Total	526	97.6	52	312	96.1	27	2134	88.6	72
Total Including Other Species	542	100	60	322	100	31	2408	100	122

Size Class: 1 2 3 4 5

Appendix 32. Diepkloof Lithics by Technology Type

	% Tool Types (Excluding Fragments & Manuports)										
	Post HP	Late HP		Interm. HP		MSA-Jack	Early HP		Still Bay	Pre-SB	MSA-Mike
	PHP Claude	LHP Eric	LHP Frans	IHP Fiona	IHP Jeff	MSA Jack	EHP Kate	EHP Kerry	SB Larry	PreSB Lynn	MSA Mike
Flakes	65.5	50.8	51.6	47.5	46.7	68.1	60.4	45.2	43.5	68.5	65.4
Triangular Flakes	3.2	0.7	0.7	0.4	0.4	1.7	0.4	0.3	0.9	5.2	17.2
Blades	19.3	25.3	29.9	30	32.1	22.5	22.6	22.5	8.4	12.6	13
Bladelets	7.6	18.1	11.1	15.9	19	5.2	11.2	18.8	3.1	2	1.1
Cores	4.4	5.1	6.7	6.2	1.8	2.5	3.4	4.2	0.7	1.5	3.3
Shaping Flakes	0	0	0	0	0	0	1.7	8	38.2	9.3	0
Bifacial Pieces	0	0	0	0	0	0	0.3	1	5.3	0.9	0
Subtotal	1216	1827	757	1103	2250	717	724	946	1381	460	1549
Raw Material Subtotal	1289	1946	839	1263	2645	892	888	1048	1285	496	1742
Difference	73	119	82	160	395	175	164	102	-91	36	193

* Red values indicate those that do not correspond to the number of fragments and manuports excluded

Appendix 33. Diepkloof Lithics by Raw Material Type

	% Pieces > 20mm										
	Post HP	Late HP		Interm. HP		MSA-Jack	Early HP		Still Bay	Pre-SB	MSA-Mike
	PHP Claude	LHP Eric	LHP Frans	IHP Fiona	IHP Jeff	MSA Jack	EHP Kate	EHP Kerry	SB Larry	PreSB Lynn	MSA Mike
Quartzite	19.5	7.8	12.3	10.3	20	45.4	34.6	25.3	68.9	64.5	86.3
Quartz	19.9	40.6	22.5	19	10.7	32.9	29.7	11.7	7	11.9	7.6
YB Silcrete	12.1	6.1	1.9	4.9	19.1	2.1	2.2	5.5	7.6	5.8	2
Silcrete	43.5	39.1	48.8	60.7	47.1	10.3	28.2	53.6	14.7	15.4	1.9
Hornfels	4	4.3	10.8	3.1	2.5	8.3	4.4	3.2	1.7	2.2	2
Others	1	2.1	3.7	2	0.6	1	0.9	0.7	0.1	0.2	0.2
Number of Pieces	1289	1946	839	1263	2645	892	888	1048	1285	496	1742

Appendix 34. Diepkloof Raw Material Classification

Local	Coarse-grained Quartzite	Coarse Quartzite
	Quartz	Quartz
Sub-Local	Fine-grained Quartzite	Fine Quartzite
	Medium to coarse-grained yellowish-brown Silcrete	Y.B. Silcrete
Exotic	Fine to medium-grained Silcrete	Fine Silcrete
	Hornfels	Hornfels
	Others (inc. Chert)	Others

Appendix 35. Diepkloof NISP Data

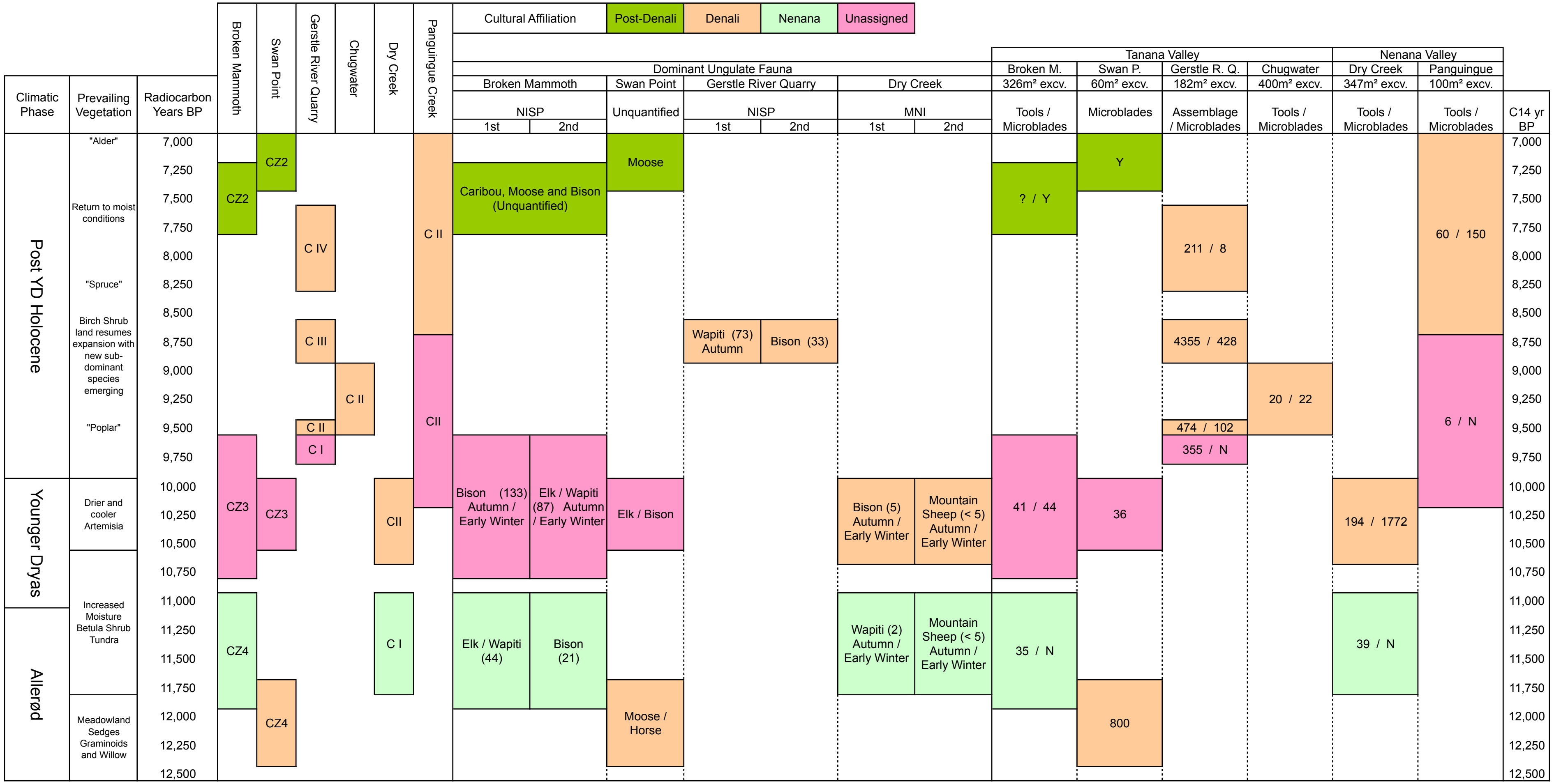
		NISP								
		Post-HP	Late HP	Intermediate HP	MSA-Jack	Early HP	Still Bay	Pre-SB Lynn	MSA-Mike	Total
Equus capensis	Cape zebra	10	5	1	0	0	6	1	1	24
Equus spp.	Equids	26	8	3	1	0	7	1	1	47
Rhinocerotidae gen. et sp. Indet	Rhinoceros(es)	7	9	10	1	2	8	1	1	39
Hippopotamus amphibious	Hippopotamus	1	3	1	1	2	10	0	0	18
Taurotragus oryx	Eland	4	5	3	0	4	6	0	3	25
Hippotragus leucophaeus	Blue antelope	3	1	2	1	1	1	1	1	11
Connochaetegnou and/or Alcelaphus buselaphus	Black wildebeest and/or Cape hartebeest	6	4	2	0	0	0	0	0	12
Pelea capreolus	Vaalribbok	0	3	1	0	0	0	0	0	4
Redunca arundinum	Southern reedbuck	3	4	1	0	3	0	0	0	11
Oreotragus oreotragus	Klipspringer	3	5	4	0	1	0	0	0	13
Raphicerus campestris	Steenbock	1	2	1	0	2	0	0	0	6
Raphicerus melanotis	Grysbock	0	0	1	0	0	0	0	0	1
Raphicerus sp(p.)	Grysbock/steenbock	13	14	20	5	11	7	2	0	72
Antidorcas sp.	Springbok	1	0	0	0	0	0	0	0	1
Pelorovis antiquus	Long-horned buffalo	3	1	0	0	1	0	0	0	5
	Small bovids	100	319	339	31	108	43	11	13	964
	Small-medium bovids	53	110	39	4	9	2	2	2	221
	Large-medium bovids	88	112	50	11	24	15	2	1	303
	Large bovids	34	61	27	11	27	11	2	5	178
Total		356	666	505	66	195	116	23	28	1955

Appendix 36. Diepkloof MNI Data

		MNI								
		Post-HP	Late HP	Intermediate HP	MSA-Jack	Early HP	Still Bay	Pre-SB Lynn	MSA-Mike	Total
Equus capensis	Cape zebra	2	1	1	0	0	1	1	1	7
Equus zebra / E. quagga	Mountain zebra and/or quagga	0	0	0	0	0	0	0	0	0
Equus spp.	Equids	2	1	1	1	0	1	1	1	8
Rhinocerotidae gen. et sp. Indet	Rhinoceros(es)	1	1	1	1	0	1	1	1	7
Hippopotamus amphibious	Hippopotamus	1	1	1	1	1	1	0	0	6
Taurotragus oryx	Eland	1	1	1	0	2	1	0	1	7
Hippotragus leucophaeus	Blue antelope	1	1	1	1	1	1	1	1	8
Connochaetegnou and/or Alcelaphus buselaphus	Black wildebeest and/or Cape hartebeest	2	1	1	0	0	0	0	0	4
Pelea capreolus	Vaalribbok	0	0	1	1	0	0	0	0	2
Redunca arundinum	Southern reedbuck	1	1	1	0	1	0	0	0	4
Oreotragus oreotragus	Klipspringer	1	1	1	0	1	0	0	0	4
Raphicerus campestris	Steenbock	1	2	1	0	1	0	0	0	5
Raphicerus melanotis	Grysbock	0	0	1	0	0	0	0	0	1
Raphicerus sp(p.)	Grysbock/steenbock	2	3	3	2	3	2	1	0	16
Antidorcas sp.	Springbok	0	1	0	0	0	0	0	0	1
Ovis aries	Sheep	0	0	0	0	0	0	0	0	0
Pelorovis antiquus	Long-horned buffalo	1	1	0	0	1	0	0	0	3
	Small bovids	3	7	9	2	4	2	1	2	30
	Small-medium bovids	2	3	2	1	1	1	1	1	12
	Large-medium bovids	3	3	2	1	1	1	1	1	13
	Large bovids	2	2	1	1	2	1	1	1	11
Total		26	31	29	12	19	13	9	10	149

Appendix 37. Diepkloof %NISP Data

		% NISP								
		Post-HP	Late HP	Intermediate HP	MSA-Jack	Early HP	Still Bay	Pre-SB Lynn	MSA-Mike	Total
Equus capensis	Cape zebra	3	1	0	0	0	5	4	4	17
Equus spp.	Equids	7	1	1	2	0	6	4	4	25
Rhinocerotidae gen. et sp. Indet	Rhinoceros(es)	2	1	2	2	1	7	4	4	23
Hippopotamus amphibious	Hippopotamus	0	0	0	2	1	9	0	0	12
Taurotragus oryx	Eland	1	1	1	0	2	5	0	11	20
Hippotragus leucophaeus	Blue antelope	1	0	0	2	1	1	4	4	12
Connochaetegnou and/or Alcelaphus buselaphus	Black wildebeest and/or Cape hartebeest	2	1	0	0	0	0	0	0	3
Pelea capreolus	Vaalribbok	0	0	0	0	0	0	0	0	1
Redunca arundinum	Southern reedbuck	1	1	0	0	2	0	0	0	3
Oreotragus oreotragus	Klipspringer	1	1	1	0	1	0	0	0	3
Raphicerus campestris	Steenbock	0	0	0	0	1	0	0	0	2
Raphicerus melanotis	Grysbock	0	0	0	0	0	0	0	0	0
Raphicerus sp(p.)	Grysbock/steenbock	4	2	4	8	6	6	9	0	38
Antidorcas sp.	Springbok	0	0	0	0	0	0	0	0	0
Pelorovis antiquus	Long-horned buffalo	1	0	0	0	1	0	0	0	2
	Small bovids	28	48	67	47	55	37	48	46	377
	Small-medium bovids	15	17	8	6	5	2	9	7	67
	Large-medium bovids	25	17	10	17	12	13	9	4	106
	Large bovids	10	9	5	17	14	9	9	18	91
Total		100	100	100	100	100	100	100	100	


Cultural Affiliation
Post-Denali
Denali
Nenana
Unassigned
Broken Mammoth
Swan Point
Gerstle River Quarry
Chugwater
Dry Creek
Panguingue Creek
Tanana Valley
Nenana Valley
Dominant Ungulate Fauna
Broken Mammoth
Swan Point
Gerstle River Quarry
Dry Creek
NISP
Unquantified
NISP
MNI
1st
2nd
1st
2nd
1st
2nd
Broken M.
326m² excv.
Tools / Microblades
Swan P.
60m² excv.
Microblades
Gerstle R. Q.
182m² excv.
Assemblage / Microblades
Chugwater
400m² excv.
Tools / Microblades
Dry Creek
347m² excv.
Tools / Microblades
Panguingue
100m² excv.
Tools / Microblades
Climatic Phase
Prevailing Vegetation
Radiocarbon Years BP
C14 yr BP
Post YD Holocene
Younger Dryas
Allerød
"Alder"
Return to moist conditions
"Spruce"
Birch Shrub land resumes expansion with new sub-dominant species emerging
"Poplar"
Drier and cooler Artemisia
Increased Moisture Betula Shrub Tundra
Meadowland Sedges Graminoids and Willow
7,000
7,250
7,500
7,750
8,000
8,250
8,500
8,750
9,000
9,250
9,500
9,750
10,000
10,250
10,500
10,750
11,000
11,250
11,500
11,750
12,000
12,250
12,500
CZ2
CZ2
C II
Caribou, Moose and Bison (Unquantified)
Moose
? / Y
Y
60 / 150
C IV
211 / 8
C III
Wapiti (73) Autumn
Bison (33)
4355 / 428
C II
CII
20 / 22
6 / N
C II
474 / 102
C I
355 / N
CZ3
CZ3
CII
Bison (133) Autumn / Early Winter
Elk / Wapiti (87) Autumn / Early Winter
Elk / Bison
Bison (5) Autumn / Early Winter
Mountain Sheep (< 5) Autumn / Early Winter
41 / 44
36
194 / 1772
CZ4
C I
Elk / Wapiti (44)
Bison (21)
Wapiti (2) Autumn / Early Winter
Mountain Sheep (< 5) Autumn / Early Winter
35 / N
39 / N
CZ4
Moose / Horse
800

Appendix 39. Broken Mammoth Non-Ungulate Fauna NISP

	Species		Cultural Zone 3	CZ3 % subtotal	Cultural Zone 4	CZ4 % subtotal
Carnivores	Bear	*Ursus sp*	1	5	1	4
	Wolf	*Canis sp*	1	5	1	4
	Arctic Fox	*Aloxpex lagopus*	13	62	18	69
	River Otter	*Lutra canadensis*	6	29	6	23
	Subtotal		21		26	
Small Mammals	Hare	Lepus sp	33	75	44	25
	Hoary marmot	*Marmota flavescens*	8	18	5	3
	Collared pika	*Ochotoma collaris*	3	7	3	2
	Subtotal		44		173	
	Unidentified		108		225	
Rodents	Arctic Ground Squirrel	*Spermophilus parryi*	298		305	
	Arctic Shrew	*Sorex arcticus*	9		11	
	Microtine Rodents		165		151	
Unidentified Mammals			203		111	
Birds	Tundra Swan	*Cygnus columbianus*	41		525	
	Canada Goose	*Branta canadensis*	2		22	
	White-fronted Goose	*Anser albifrons*	12		54	
	Snow Goose	*Chen hypoborea*	5		35	
	Mallard	*Anas platyrhynchos*	6		24	
	Pintail	*Anas actua*	2		36	
	Gadwall	*Anas strepera*	4		4	
	Widgeon	*Anas americana*	2		2	
	Green-winged teal	*Anas caroliensis*	6		22	
	Willow ptarmigan	*Lagopus lagopus*	23		77	
	Subtotal		103		801	
	Unidentified		117		363	
Fish	Cycloid/salmonid fish		28		28	
Unidentified Fragments			1067		976	

Appendix 40. Broken Mammoth Ungulate NISP

Species		Cultural Zone 3	CZ3 % subtotal	Cultural Zone 4	CZ4 % subtotal
Super Bison	Bison priscus	133	55	21	24
Elk/Wapiti	Cervus canadensis	87	36	44	51
Caribou	Rangifer tarandus	6	2	6	7
Moose	Alces alces	4	2	4	5
Mountain Sheep	Ovis dalli	11	5	11	13
Ungulate Fauna subtotal		241		86	
Unidentified large/medium fauna*		639		329	

* Not exclusively ungulate fauna

Appendix 41. Dry Creek Original Lithics Tabulation after Hoffecker et al. (1996)

Retouched Pieces	Component 1	Component 2
Flakes and Fragments	3474	28,529
Projectile Points / Point bases	3	9
Bifacial Points	2	
Bifacial Knives	3	
Endscrapers	9	
Endscraper / Burins	1	
Double Endscrapers	1	
Transverse Scrapers	3	
Side Scrapers	2	
Anvil Stones	2	3
Planes (quadrilateral unifaces)	2	
Miscellaneous Items	11	
Burins		29
Core/burins		8
Bifaces		44
Heavy Bifaces		47
Scrapers		21
Retouched Flakes	6	21
Blade-like retouched flakes		18
Hammerstones		3
Total (excluding flakes & fragments)	45	194