

Debitage Analysis of 'Uyun al-Hammâm
The Reconstruction of Epipalaeolithic Reduction Sequences

by

Danielle Macdonald
B.A. Honours, University of Toronto, 2005

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Requirements for the Degree of

MASTER OF ARTS

In the Department of Anthropology

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University of Victoria

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ABSTRACT

The transition from a hunter-gatherer way of life to sedentary food-producing societies was a pivotal shift in human prehistory, affecting social, political, economic and ideological structures. The Epipalaeolithic in the Levant precedes the “origins of agriculture” and is the key to understanding the beginnings of social and economic phenomena seen in the later periods. Excavations at the site ‘Uyun al-Hammâm, located in northern Jordan, has uncovered a large amount of lithic material, faunal remains, and several human burials suggesting this site was a place of importance on the Epipalaeolithic landscape. This thesis explores the lithic debitage from ‘Uyun al-Hammâm to determine the stages of reduction that are represented in the assemblage. Debitage analysis, in conjunction with other site data, contributes to a robust understanding of the site’s unique function during the Epipalaeolithic.

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CHAPTER 1: INTRODUCTION

CONTEXT OF RESEARCH

The Epipalaeolithic Period in the Levant (~20,000-10,200 BP) has been the topic of numerous studies, debates and hypotheses in the archaeological community. These debates include interpretations of lithic variability and the emergence of behaviours that laid the groundwork for agricultural production in the Neolithic. These topics are integral to the study of the Epipalaeolithic and the discoveries made from these debates further the archaeological discipline by contributing to our understandings of the human condition. This thesis explores lithic reduction patterns at an Epipalaeolithic site in northern Jordan, 'Uyun al-Hammâm, as a means of contributing to the current debates of typological construction and technological production in the Epipalaeolithic.

The temporal context of the Epipalaeolithic guilds archaeological research as evidence of Neolithic origins is traced to preceding Epipalaeolithic groups. During the Upper Palaeolithic there is an increased trend towards microlithization in the tool assemblage, culminating in the following Epipalaeolithic period. The Epipalaeolithic leads into the Early Neolithic period where the origins of agriculture and sedentary villages are first seen across the archaeological record in the Levant. In contrast to the later Neolithic, the Epipalaeolithic landscape was populated by hunter-gatherers with varying degrees of nomadic behaviour and whose lithic assemblages were composed of microlith tools. These were people who interacted with and adapted to the fluctuations of the Terminal Pleistocene. Questions about this time period are prompted by our interest in the origins of agriculture; were the people of the Epipalaeolithic instrumental in laying the foundation for sedentism and agricultural production? The transition from a hunter-

gatherer way of life to sedentary food-producing societies was a pivotal shift in human prehistory, affecting social, political and economic structures. Features integral to the development of agriculture and social complexity have roots that can be traced back to earlier periods and are the result of slowly accumulating processes (Byrd 1998, Maher 2005). In other words, the domestication of plants and animals “was a long-term process, that is only revolutionary in hindsight” (Verhoeven 2004: 264). The Epipalaeolithic is the key to understanding the beginnings of social and economic phenomenon seen in the later periods.

The Middle Epipalaeolithic site of ‘Uyun al-Hammâm (15,280± 933 cal BP) is located in the al-Koura district of northern Jordan. Cultural accumulations of faunal and lithic material suggest intensive occupation of ‘Uyun al-Hammâm during the Middle Epipalaeolithic over many generations (Maher 2006). The presence of several burials at the site further suggests a special attachment to the site. The purpose of this thesis is to reconstruct the processes of flint knapping reduction that were taking place at ‘Uyun al-Hammâm through examination of the debitage assemblage. Debitage analysis allows for the reconstruction of the site occupants’ behaviour while moving away from a typological approach of lithic interpretation.

Reconstruction of stone tool production is achieved through the analysis of the debitage assemblage excavated during the 2005 field season. This analysis focuses on the dynamic nature of lithic reduction by looking at individual attributes of the production of flake and tool blanks to understand decisions made during the process and methods of manufacture. Reconstruction of flint knapping and tool making activities at ‘Uyun al-Hammâm will further our understanding of this site’s function and importance

on the Epipalaeolithic landscape. This contributes to the current debates by highlighting the importance of understanding long term trends during the Epipalaeolithic.

OUTLINE OF RESEARCH

'Uyun al-Hammâm is first placed in the wider regional and chronological context in order to understand the site's significance in the Levantine Epipalaeolithic. Chapter 1 outlines the background of the Epipalaeolithic, the palaeoclimatic record, and the different cultural entities that have been identified within the period. The cultural entities are described by site types and lithic typology to understand patterns of interpretation and identification currently proposed for the Epipalaeolithic. Cultures in the Epipalaeolithic are defined by their lithic technology and are delineated by the morphology of microliths within the assemblage. Variability in microlith form is seen across regional and chronological boundaries, creating a very complex cultural record. The cultural record of the Epipalaeolithic is described to highlight the current delineations. This chapter provides a framework, both cultural and geographical, within which to understand the questions posed in this thesis.

As mentioned above, the Epipalaeolithic is characterized by regional and temporal variability in microlith types, the most distinctive artifact category. Archaeologists have interpreted this lithic variation, both spatially and temporally, as indicative of ethnically-distinct culture groups (Bar-Yosef 1970, Goring-Morris and Belfer-Cohen 1998, Henry 1995). Recently, authors have reevaluated the validity of splitting the Epipalaeolithic into numerous distinct cultural groups and more emphasis has been placed on the continuity seen within assemblages than differences between

them (Maher et al. 2001, Pirie 2004). Highlighting the similarities between artifacts and accepting variability as a natural component in material culture “lumps” the current ethnic divisions, thereby allowing for realistic conditions of heterogeneity in artifact assemblages. Chapter 3 delves further into the typological debate which is central to understanding our current interpretations of the Epipalaeolithic. This places the thesis into a theoretical framework within which to understand the importance of further lithic study for the Epipalaeolithic, as well of the importance of transparent analysis methods used in this research.

The site of ‘Uyun al-Hammâm provides the ideal sample from which to address issues of long-lasting behaviours and trends in the Epipalaeolithic. The large accumulations of cultural material and burials suggest that this site was intensely used by its inhabitants and had special meaning on the landscape. Chapter 4 discusses features of ‘Uyun al-Hammâm, previous research that has been conducted at the site, and the details of the 2005 excavation season, on which this thesis is based. Also, the other Epipalaeolithic sites of Wadi Ziqlab are discussed briefly to place ‘Uyun al-Hammâm into its local context.

As mentioned above, this thesis focuses on debitage analysis of the ‘Uyun al-Hammâm lithic assemblage. Chapter 5 outlines the lithic research and methodology employed during the analysis. Previous Epipalaeolithic lithic studies are briefly outlined to provide a foundation upon which this work is building. Following this, different techniques and theoretical approaches of lithic reduction analysis are discussed. The *stage of reduction* analysis technique and the *chaîne opératoire* are two different yet complementary approaches for understanding removal processes of lithic material.

Debitage, the material produced during the reduction sequence that has not been turned into a formal tool upon discard, can illuminate patterns within the lithic assemblage through the reconstruction of flint knapping sequences.

Chapter 6 outlines statistical procedures used to examine patterns within thedebitage assemblage. Hypotheses about the relationship betweendebitage and behaviour were tested using a variety of statistical methods and refitting. Discussion centers around four aspects of thedebitage: the flakes and blades, the cores, the core trimming elements, chips and shatter. As discussed in Chapter 6 and 7, data obtained from thedebitage analysis demonstrates that on-site activities included raw material reduction into shaped cores, tool production and subsequent discard.

The site of 'Uyun al-Hammâm had a unique and important place on the Epipalaeolithic landscape of Northern Jordan. From thedebitage assemblage we can see that all stages of lithic reduction were taking place at the site including initial core reduction, preparation of microblade cores, tool production, tool maintenance, and tool discard. This suggests that the people of 'Uyun al-Hammâm used this site intensively for lithic activities, including all stages of stone tool production. The large quantity of stone tools implies that this site was intensively occupied for an extended period of time. As the only known large Geometric Kebaran site on this landscape, 'Uyun al-Hammâm would have been a prominent settlement during the Epipalaeolithic. The Epipalaeolithic's importance to the phenomena of sedentism and agriculture can be further understood by continued research at unique sites such as 'Uyun al-Hammâm.

CHAPTER 2: THE EPIPALAEOLITHIC PERIOD

INTRODUCTION

There have been many detailed reviews of the Epipalaeolithic that describe cultural entities and their regional variations (see Bar-Yosef 1970, Goring-Morris and Belfer-Cohen 1998, Henry 1995). The purpose of this chapter is to provide a brief outline of the Epipalaeolithic, situating cultural entities within a regional and chronological framework, not to provide detailed descriptions of them. It will outline the three broad chronological phases and the major cultural entities within them in order to provide the framework for understanding the major characteristics of the Levantine Epipalaeolithic.

BACKGROUND TO THE EPIPALAEOLITHIC PERIOD

The Epipalaeolithic period in the Levant (approximately 22,000-10,200 BP) is characterized in the archaeological literature by an image of nomadic hunter-gatherers hunting local fauna and harvesting wild cereals and grasses. The high percentage of microliths in the archaeological record represents a continued trend towards microlithization that begins in the Upper Palaeolithic and distinguishes this period from the following Neolithic. These microliths are variable in form (Figure 2.1) but have an increasing tendency towards geometric shapes, beginning in the Middle Epipalaeolithic with trapeze-rectangles and reaching an apex with Natufian lunates. Variability in microlith form is often defined by the perceived differences in assemblages between the arid and Mediterranean zones within the Levantine region. There have been numerous interpretations of microlith variability and most archaeologists have delineated different

cultural terms for the variation seen both spatially and temporally between microlith components of Mediterranean and arid-zone sites.

Traditional studies of the Epipalaeolithic delineate cultures, both temporally and spatially, based on the percentages as well as the presence or absence of different microlith forms. Heavy reliance on lithic assemblages for the creation of cultural distinctions is the result of preservation; lithics are the most common artifact class in Epipalaeolithic assemblages as they tend to survive post-depositional processes better than other artifacts of the period such as bone and shell. Scholars such as Bar-Yosef (1970) and Goring-Morris (1987) analyzed numerous sites within both the Mediterranean and the arid zones of the Levant creating the typologies on which most current research is based. These authors grouped lithics into discrete tool types based on the tool's final morphology. The typological categories are the foundation of current Epipalaeolithic typological construction and interpretation. From these initial typologies numerous others have been developed creating a plethora of cultural distinctions in the Epipalaeolithic (e.g. Henry 1995). Currently there are at least eighteen different named groups in the Southern Levant (Olszewski 2006). Although typological categorization does obscure the variability inherent to each individual piece, one does gain the advantage of comparability between assemblages (Pirie 2004). Thus, current studies based on these typological categories are inherently comparable but they continue to reproduce previous biases used to construct the original typology. Unfortunately the continued splitting of lithic variability into new typologies disconnects researchers, thereby obscuring general patterns and trends during the Epipalaeolithic.

Recently, authors have been reevaluating the validity of splitting the Epipalaeolithic into a multitude of distinct cultural groups (as will be outlined later) and more emphasis has been placed on the continuity seen within assemblages than the differences between them (Maher et al. 2001, Olszewski 2006, Pirie 2004). Despite the acceptance that the numerous cultural identities may be superfluous, these authors do not reject the notion that at least some of the cultural delineations are valid. For the purposes of this chapter, I will outline the major cultural groups identified in earlier studies, as the terminology is still prevalent in the literature and many authors still adhere to the identification of cultural groups within the Epipalaeolithic. However, Chapter 3 outlines the problems with typological construction and further explores concepts of Epipalaeolithic variability.

At its broadest distinction the Epipalaeolithic is divided into three temporal phases: Early, Middle and Late. The Early Epipalaeolithic, as will be discussed later, is characterized by backed bladelets and micropoints. The Middle Epipalaeolithic is dominated by geometric microlith forms such as trapeze-rectangles. Finally, within the Late Epipalaeolithic the intensified use of lunates is seen in the archaeological record (Figure 2.1).

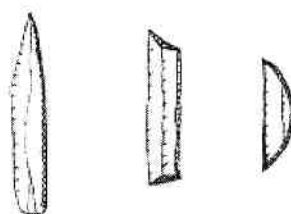


Figure 2.1 The Dominate Microlith Types during the Epipalaeolithic. From Left to Right: Micropoint, Trapeze-Rectangle, and Lunate (Adapted from Bar-Yosef 1970).

The transition of microlith morphology from one period to the next shows an increase in standardization to facilitate hafting (Belfer-Cohen and Goring-Morris 2002). Despite overall trends there is great variation within these three periods and, as mentioned above, scholars have further split these Epipalaeolithic categories into distinct cultural groups on the basis of the variability seen within the lithic assemblages. Table 1 outlines some of the more prominent cultural groups that have been identified within the Levantine Epipalaeolithic:

Dates B.P. (uncalibrated)	Period	Archaeological Entity	
		Mediterranean Zone	Steppe & Desert Zone
20 000 - 14 500 B.P.	Early Epipalaeolithic	Masraḡan	Masraḡan
			Nebekian
		Kebaran	Kebaran
		Nizzanan	Nizzanan
14 500 - 12 500 B.P.	Middle Epipalaeolithic	Geometric Kebaran	Geometric Kebaran
			Mushabian
			Ramonian
12 500 - 10 200 B.P.	Late Epipalaeolithic	Natufian	Natufian
			Harifian

Table 2.1 (adapted from Belfer-Cohen and Goring-Morris 2002, Maher 2005)

Further discussion of these different cultural groups later in this chapter will highlight their artifact assemblages, settlement patterns and subsistence strategies.

The delineation of cultures within the Epipalaeolithic has allowed scholars to develop models evaluating the relationship between hunter-gatherer populations, their landscape, and their environment. Thus a brief outline of the geography and palaeoclimate during the Epipalaeolithic is integral to understanding the changes seen in the archaeological record. Study of the Epipalaeolithic is often used to help understand the nature of hunter-gatherer territories and regional variability in response to dramatic climate change (Byrd 1998). New evidence of the nature of hunter-gatherer populations

in the Middle Epipalaeolithic will be explored through technological study of lithic debitage from the recently excavated site of 'Uyun al-Hammâm in Wadi Ziqlab, Jordan.

GEOGRAPHY OF THE LEVANT

The Levant ranges from modern day Syria and Lebanon in the north to Jordan, Palestine, Israel and the Sinai Peninsula in the south. It is believed that this region saw the first waves of migrations outside of the African continent at around 1.8 million years ago (Bar-Yosef and Belfer-Cohen 2001). Archaeological evidence indicates that the Levant has been inhabited for hundreds of thousands of years and has experienced many cultural revolutions, the most famous being the origins of agriculture and domestication.

Chronologically, the Epipalaeolithic follows the Upper Palaeolithic and precedes the Neolithic, famous for the development of agricultural and settled communities. Because the Epipalaeolithic precedes the Neolithic, studies of the Epipalaeolithic tend to focus on cultural traits that can be seen as the precursor to agricultural practices.

During the Pleistocene the landscape of the Southern Levant was dominated by many large lakes, including Lake Lisan. The only remaining evidence of this once large lake is the highly saline Dead Sea and its main tributary the Jordan River. Lake Lisan existed between 70,000 to 15,000 years ago, at which point it began to recede to modern levels (Bartov et al. 2002). Around 25,000 cal BP, Lake Lisan reached its maximum extent at over 164 m above sea level (Bartov et al. 2002), compared to modern levels of approximately 418 meters below sea level. Due to changing climate patterns, the lake receded to approximately 300 m below sea level by 15,000 cal BP indicating that the lake levels dropped substantially over 10,000 years. The lake itself was saline, although

this salinity varied over time, limiting the resources that could be found in its waters. However, along the edges of Lake Lisan were a series of freshwater springs and rivers that would have sustained other resources (Edwards 2001). The combination of freshwater and saltwater resources would have made the borders of Lake Lisan a very attractive place to live during the Late Pleistocene. However, the receding waters and shoreline of Lake Lisan would have drastically affected the subsistence strategies of populations living during the Late Epipalaeolithic.

PALAEOCLIMATE OF THE LEVANT

Palaeoclimatic studies in the Levant have been pursued through a variety of methods, including lacustrine sediments, palaeobotanical records, terrestrial geochemical records, and marine sediments, the results of which have provided detailed reconstructions of climate change during the Epipalaeolithic. Recently published research by Robinson et al. (2006) provides a summary of current data for dating Levantine palaeoclimatic events. Although the Levant experienced regionally-specific climate changes, there are global trends that dictated overall climatic conditions in the Pleistocene. Discussion of climate change is imperative to the study of the Epipalaeolithic as fluctuations in the natural environment affect the settlement patterns, subsistence strategies and other cultural elements.

The Epipalaeolithic coincides with the end of the Last Glacial Maximum, a period punctuated by intense and frequent climate changes (Burroughs 2005). This period was terminated at around 14,670 BP by an abrupt warming trend called the Bølling Transition (Severinghaus and Brook 1999). Following this transition in the

Levant is the Bølling-Allerød interstadial (~14,500-13,000 BP), characterized by warm and wet conditions. This ameliorated period coincides roughly with the Middle and beginnings of the Late Epipalaeolithic and was interrupted by the onset of cold and dry temperatures in the Younger Dryas (~12,700-11,500 cal BP). The aridity during this period was very pronounced, returning to rainfall levels similar to, or less than, the Last Glacial Maximum (Burroughs 2005, Robinson et al. 2006). The aridity of this period is further demonstrated by the lowering of Lake Lisan and the accumulation of salt deposits (Robinson et al. 2006). The Younger Dryas is thought to coincide with the Late Natufian and the Pre-Pottery Neolithic A. Following this period of cold temperatures and arid conditions is the Holocene (~10,000-7000 BP). The early phase of the Holocene had the highest average rainfall of any of the previous periods and was characterized by warm and wet conditions (Robinson et al. 2006).

Within the southern Levant are two distinct zones, the Mediterranean and the arid region (Goring-Morris and Belfer-Cohen 1998) (Figure 2.2). The Mediterranean zone is characterized by oak, pine and pistachio forests whereas the arid, or Irano-Turanian steppe, is a semi-desert environment (Bar-Yosef 1987). Although both these areas are affected by climatic trends, the Mediterranean zone has higher precipitation than the more marginal arid regions. These conditions would have been similar during the Terminal Pleistocene although the boundaries of the zones would have fluctuated with climate trends. The dichotomy between the Mediterranean and the arid zones forms the basis of many Epipalaeolithic typologies, as cultural entities are defined by the differences seen between sites in these two zones.

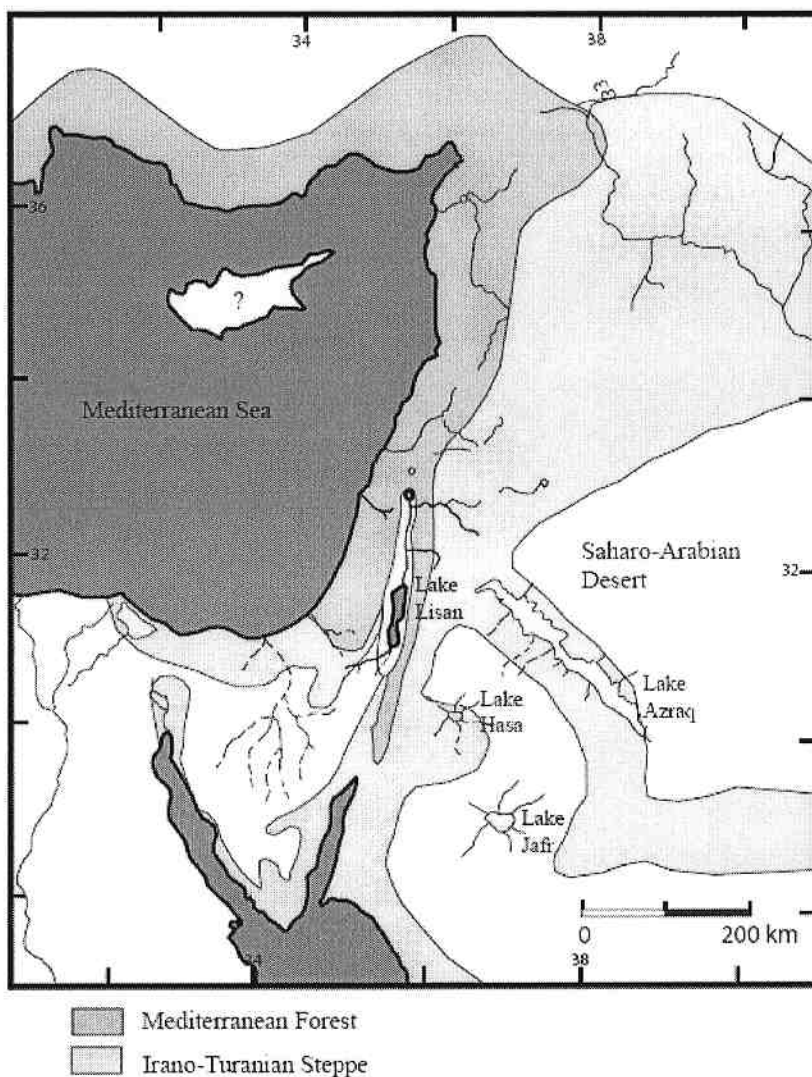


Figure 2.2 The Boundaries of the Mediterranean Zone and the Arid Steppe in the Levant during the Late Pleistocene (adapted from Bar-Yosef 1987)

The overall picture of Levantine climatic conditions during the Epipalaeolithic reflect cool conditions terminated by a rapidly ameliorated climate, with a subsequent return to cooler temperatures. Despite these general trends, each region experienced unique variations of larger climate change, affecting local site and cultural patterns. The changing climate of each period had a profound effect on human occupation in the Levant. The following is a description of the three major periods in the Epipalaeolithic

and the major cultural entities identified within each period. The sites mentioned in the text are shown in Figure 2.3.

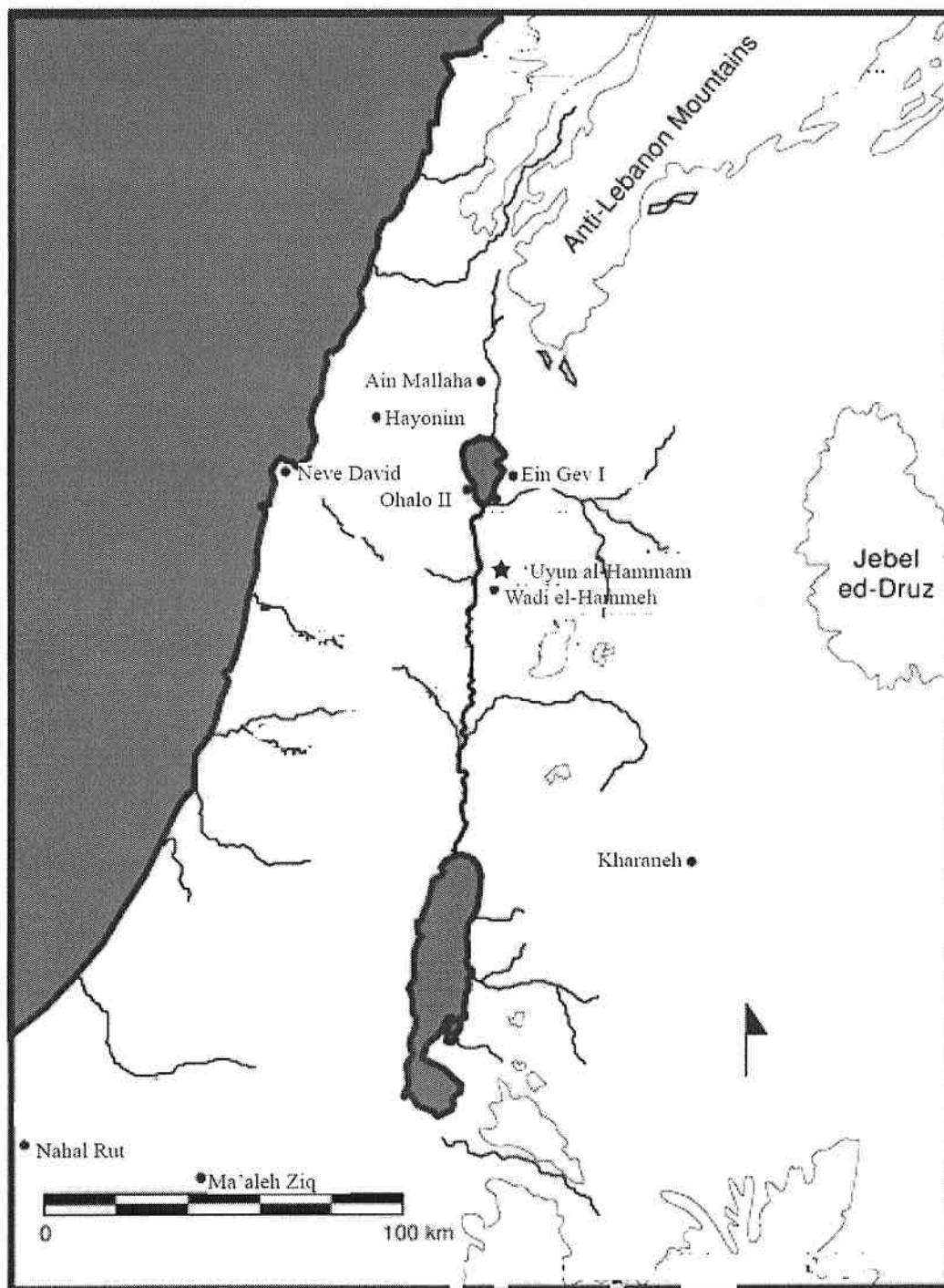


Figure 2.3 Epipalaeolithic Sites Mentioned in the Text (Adapted from Maher 2005)

EARLY EPIPALAEOLITHIC

The Early Epipalaeolithic period (Table 2.1) exhibits continuity with the preceding Upper Paleolithic through similar subsistence strategies and a derived microlith component in the archaeological assemblages (Goring-Morris and Belfer-Cohen 1998). Upper Paleolithic microliths revolve around two forms, the straight pointed bladelet and the twisted Dufour bladelet (Belfer-Cohen and Goring-Morris 2002). The blanks closely resemble the intended form with little retouch needed to obtain the desired tool. Similarly, the Dufour bladelets exhibit only small amounts of alternate or inverse retouch. In contrast, Early Epipalaeolithic microliths tend to be continuously backed with abrupt retouch thereby changing the form of the tool to facilitate hafting (Belfer-Cohen and Goring-Morris 2002). This trend of blank modification continues to increase over time during the Epipalaeolithic with increased manipulation of the blank's morphology for hafting into composite tools.

The most widespread cultural entity identified in the Early Epipalaeolithic period is the Kebaran. Because of its archaeological visibility the Kebaran has often become synonymous with the Early Epipalaeolithic in the literature (Goring-Morris and Belfer-Cohen 1998). However, numerous cultural entities have been identified beyond the Kebaran during the Early Epipalaeolithic based on variations in the lithic assemblages.

Kebaran sites are found primarily in the Mediterranean zone and generally have a small overall surface area, with an average of 200m² (Bar-Yosef 1970). The small size of Kebaran sites is thought to reflect site function. Kebaran sites are interpreted as ephemeral seasonal camps, suggesting that the occupants were highly mobile people moving seasonally across their landscape (Goring-Morris and Belfer-Cohen 1998).

These seasonal movements are expressed through the clustering of winter encampments in low lying areas, in contrast to summer camps concentrated at higher elevations. Choice of site location presumably reflected the yearly climate cycle, with low elevations being more hospitable during the colder winter months (Bar-Yosef 1970). The majority of Kebaran sites are situated within caves and rock shelters, however there is evidence of sites outside of this context. For example, the site of Ohalo II, which will be discussed later, is an open-air site.

The lithic assemblages of the Kebaran are dominated by microliths, primarily by backed bladelets and micropoints including a high proportion of non-geometric microliths, burins and scrapers (Bar-Yosef 1970). Other representations of Kebaran material culture, such as bone, are rare from most sites (Maher 2005). Some recovered faunal remains suggest that they were hunting a large range of medium-sized mammals as a primary diet source (Goring-Morris and Belfer-Cohen 1998).

Another Early Epipalaeolithic entity is the Masraqan, the sites of which are found along the western shores of Lake Lisan (Goring-Morris and Belfer-Cohen 1998). Masraqan lithic assemblages are dominated by bladelets with Ouchtata (very fine retouch) and steep retouch. It has been debated that this cultural entity is actually the Late Ahmarian, an Upper Palaeolithic culture.

It has been suggested that the Nebekian, another Early Epipalaeolithic variant, is contemporaneous with the Masraqan. This culture is found on the eastern margins of the Transjordanian plateau and is characterized by seasonal aggregation sites (Goring-Morris and Belfer-Cohen 1998). The microburin technique of lithic production is habitually used during the Nebekian to produce narrow curved bladelets, a technique that moves in

and out of popularity throughout the Epipalaeolithic (Belfer-Cohen and Goring-Morris 2002). The microburin technique is a means of controlling the location and direction of an oblique truncation on a bladelet through notching the edge and then snapping the proximal or distal end at this notch (Maher 2005, Tixier 1974). The use of this technique can be identified by the presence of a microburin scar on the truncated bladelet and a microburin, the snapped-off distal or proximal end.

The Nizzanan is another Early Epipalaeolithic variant, dating to 16,500-15,500 BP making it contemporaneous with some Kebaran assemblages (Goring-Morris and Belfer-Cohen 1998). These sites are located primarily to the east and the south of Lake Lisan and include small camps and larger aggregation sites (Goring-Morris and Belfer-Cohen 1998). The lithic assemblage is similar to the Nebekian with the habitual use of the microburin technique.

The well-studied Early Epipalaeolithic site of Ohalo II is radiocarbon dated to c. 19,500 BP (Nadel 2001). Discovered in the late 1970s on the shore of the Lake Tiberius in northern Israel, the site had been submerged for thousands of years preserving the archaeological remains. Included in the finds from this remarkable site is evidence of organic structures, minute flint debitage, and mortuary activity.

While cave sites are commonly seen in the Early Epipalaeolithic, Ohalo II is an open air site. Evidence of six brush huts and numerous hearths were found at Ohalo II providing the best preserved evidence of organic settlement during the Epipalaeolithic (Nadel 2001). These huts are oval in shape, built from oak and tamarisk branches with a covering composed of leaves, branches, shrubs and weeds (Nadel 2001). Preservation of floral material from the Epipalaeolithic is exceptionally rare, thus the finds at Ohalo II

greatly contribute to our understanding of this period. The brush huts provide important information regarding use of local organic materials and the composition of architectural forms.

The most outstanding find at this site was a burial found on the periphery of the occupation area. The burial is of a robust adult male and exhibits some signs of physical deformation (Nadel 2001). The body was placed in a shallow pit lying on his back in a flexed position with his arms crossed over his chest (Nadel and Hershkovitz 1991). Other Early Epipalaeolithic burials have been found at the sites of Ein Gev I and Kharaneh IV. The burial at Ein Gev I was found in association with several grinding tools. The practice of groundstone burial goods is continued in later periods and may represent evidence of cultural continuity over time (Bar-Yosef 1970).

In summary, the Early Epipalaeolithic is characterized by non-geometric microlith assemblages that have been minimally altered from the original blank to facilitate hafting. The primary identified culture is the Kebaran which is thought to represent a nomadic hunter-gather population moving between seasonal camps in high and low elevations. Many of the other cultural variants show habitual use of the microburin technique in lithic production. These cultures, the Masraqa, Nebekian, and Nizzanan, are characterized by the aggregation and dispersal of small groups.

MIDDLE EPIPALAEOLITHIC

The Middle Epipalaeolithic exhibits the greatest variability within and between defined cultures of the Epipalaeolithic. The most prominent of these cultures is the Geometric Kebaran. Unlike the Early Epipalaeolithic Kebaran culture, Geometric Kebaran sites

spread beyond the Mediterranean zone, moving further into more the arid regions to the south and east (Maher 2005). The expansion of sites into new regions is attributed, in part, to climate amelioration during the Middle Epipalaeolithic. As the climate became more hospitable, people were able to move further into regions that were previously uninhabitable.

As mentioned above, the Geometric Kebaran is the most prominently represented cultural group in Middle Epipalaeolithic assemblages. The lithic assemblage for the Geometric Kebaran exhibits a range of microliths that are considered 'geometric' due to their morphology; trapeze-rectangles being the most common tool type. These microliths are named for their shape which exhibits a continuum between a trapezoidal and rectangular form. The homogeneity of the trapeze-rectangle microliths facilitates their hafting into a variety of housings. Although the full range of hafting forms are not known, it is hypothesized that the microliths would have been used for blades in sickles and as barbs for projectiles, among other composite tool categories.

Evidence of material culture beyond the lithic component is often found at Geometric Kebaran sites. The cluster of sites around Nahal Rut (sites: Nahal Rut 48A-48D) in the Negev Desert shows evidence of incised ostrich shell and stone ornamentation (Gilead and Marder 1989). Artistic expression is rare from both Kebaran and Geometric Kebaran sites so the incised ostrich shell fragments represent some of the earliest forms of art found in this region (Gilead and Marder 1989).

Ranging between 50-800 m², Geometric Kebaran sites are larger than Kebaran occupations but they are still relatively small in size when compared to sites from later periods. This small site size has led to the interpretation that the people of the Geometric

Kebaran still practiced a nomadic hunter-gathering existence continuing from the previous period (Edwards 2001, Goring-Morris and Belfer-Cohen 1998). The widespread production of standardized trapeze-rectangles suggests that there was some form of cultural contact across the whole region (Maher 2005) although the nature of this contact, whether friendly or antagonistic is not known.

Settlement patterns in the Geometric Kebaran exhibit a dichotomy of small ephemeral sites and larger sites with deep cultural deposits. One example of a large site, thought to represent a location of aggregation, is Neve David located in modern Haifa, Israel. This site, as well as being a place of aggregation, may also represent evidence for longer occupation. This is further supported by the two human burials that were found on site, one of which contained a broken and breached mortar (Kaufman 1987). The multiple burials found at Neve David suggest symbolic attachment to this particular place on the landscape.

Smaller sites are often found in the arid regions of the Levant, including Wadi Sayakh and Ma'aleh Ziq. The site of Ma'aleh Ziq is located in the Central Negev, a small assemblage at only 150m² (Goring-Morris 1978). Wadi Sayah is located in the Southern Sinai and contains both a hearth and a shallow ash-filled depression (Bar-Yosef and Killebrew 1984). The assemblage from this site can be related to sites in the Negev and Northern Sinai when comparing the lithic assemblage (Bar-Yosef and Killebrew 1984). Wadi Sayakh is also one of the southernmost Geometric Kebaran sites representing the vast expansion of occupation during the Middle Epipalaeolithic.

The highly variable Middle Epipalaeolithic period has been divided into numerous distinct cultures beyond the Geometric Kebaran. One of these is the

Mushabian, first identified at Gebel Maghara in northern Sinai (Bar-Yosef and Phillips 1977). This industry is characterized and differentiated from the Geometric Kebaran by the intensive use of the microburin technique. This technique was used to produce La Mouillah points making their presence in the lithic assemblage, along with arched backed bladelets, characteristic of this culture (Bar-Yosef and Phillips 1977). Mushabian sites are located in arid regions of the Negev and Sinai, coinciding temporally in the archaeological record with Geometric Kebaran sites in the same region.

Other Middle Epipalaeolithic entities not mentioned include the Middle and Late Hamran (Henry 1995), the Ramonian (Goring-Morris and Belfer-Cohen 1998), and the Geometric Kebaran A and B (Bar-Yosef 1970). I have outlined the most prominent Middle Epipalaeolithic cultures, the Geometric Kebaran and the Mushabian, characterized by geometric microliths and the use of the microburin technique respectively. The climatic amelioration of this period drastically affected the southern Levantine regions, causing rapid expansion into previously unoccupied areas. Homogeneity within Geometric Kebaran assemblages suggests that there was interaction and exchange of ideas between groups across the Levant.

LATE EPIPALAEOLITHIC

As with the other Epipalaeolithic periods, the Late Epipalaeolithic is divided into many distinct entities. The Natufian is the most extensively studied period of the entire Epipalaeolithic. This period precedes the Pre-Pottery Neolithic A. Because of the interest in agricultural origins and the position of the Natufian immediately preceding the advent

of farming villages, the majority of Epipalaeolithic research has been focused on the Natufian to better comprehend the shift from a hunter-gatherer to agricultural practices.

Settlement patterns during the Natufian show a shift to sedentary settlements coupled with less evidence of sites on the Coastal Plain (Goring-Morris and Belfer-Cohen 1998). This may represent a move away from the coast, or these sites may be submerged under the modern coastline. Large sedentary settlements, both open-air and cave sites, are located primarily in the Mediterranean zone and contain semi-subterranean dwellings (Bar-Yosef 1998). Some of these houses show evidence of unique features such as plaster use and built-up hearths (Goring-Morris and Belfer-Cohen 1998). There is little evidence of storage, except for a paved bin at Hayonim Terrace and plastered pits at Ain Mallaha which may have served as storage areas (Bar-Yosef 1998). The household features of the Natufian are common in the following Pre-Pottery Neolithic periods and may represent cultural continuity from the Natufian. Evidence for both permanent habitation and storage facilities suggests a move toward a classic complex hunter-gatherer pattern; a pattern which is linked to increasing social complexity (Bettinger 1987).

The lithic assemblage from the Natufian period is characterized by the production of lunates, often using the microburin technique. These miniature half-moon shaped lithics were hafted together to create larger composite tools. Bone sickle hafts have been recovered in Natufian archaeological assemblages (e.g., Wadi el-Hammeh 27) suggesting that lunates were, at least in part, used for harvesting plant material.

Groundstone artifacts are common at Natufian sites, where they increase in diversity and abundance compared to earlier Epipalaeolithic sites. These include tools

that show continuity with the previous Geometric Kebaran groundstone. Some of the groundstone includes bedrock mortars that are permanently fixed on the landscape (Bar-Yosef 1998). Natufian groundstone artifacts include mortars, pestles, and also fishing weights, buttons and 'stone pipes' associated with mortuary contexts (Bar-Yosef 1970).

Art objects that represent abstract and natural forms depicting human and animal representations become much more prevalent at Natufian sites (Bar-Yosef 1970).

Ornamentation is also commonly found during the Natufian in the form of dentalium shell beads, bone and tooth pendants. The bone tool industry is very rich with hooks, gorgets, needles and even some recovered sickle-hafts (Bar-Yosef 1970). Widespread use of symbolic and decorative artifacts such as figurines and beads represents increasing symbolic behaviour relative to preceding periods. Although this may be related, in part, to preservation issues, symbolic representation is a noticeable phenomenon in the Natufian.

In summary, the beginning of the Natufian coincided with warm climates followed by a period of climate deterioration during the Late Natufian. Definitive evidence of semi-sedentism to sedentism is seen in storage pits, large quantities of groundstone, and burials. The material culture shows evidence of mounting symbolic behaviour that may be tied to increasing social complexity characteristic of complex hunter-gatherers. The cultural patterns witnessed in the Early Natufian represent patterns seen continued on during the later Neolithic.

SUMMARY

The Epipalaeolithic is divided into three broad phases: the Early, Middle and Late, within which numerous cultures have been identified based on lithic variability. The unifying feature of the Epipalaeolithic is the microlithization of lithic technologies with an increase in geometric forms over time. The technology suggests an increase towards standardization of microlith form, probably to facilitate hafting.

Traditionally, steps towards sedentism and the rise of farming villages are believed to begin in the Natufian period, solidifying during the early Neolithic (~10,500-6,000 BP) in the Levant. Recently, researchers have argued that several features integral to the development of sedentism and social complexity have roots that can be traced back to earlier in the Epipalaeolithic and are the result of slowly accumulating processes (Byrd 1998, Maher 2005, Maher 2006). Although there is pronounced evidence of continuity between the Natufian and the Neolithic, the beginnings of these trends can be seen at Middle Epipalaeolithic sites. The following chapter will evaluate typological construction to understand how long term trends can be seen in the Epipalaeolithic by critically evaluating the interpretation of lithic variability. This is the first step in understanding diachronic trends of the Epipalaeolithic.

CHAPTER 3: TYPOLOGICAL CONSTRUCTION OF THE EPIPALAEOLITHIC

INTRODUCTION

Variability in Epipalaeolithic lithic toolkits has been interpreted as evidence of distinct ethnic groups (Bar-Yosef 1970, Bar-Yosef 1991c, Goring-Morris 1987, Henry 1995, Henry 1998). Critical research into the creation of typologies is important to Epipalaeolithic studies as current cultural distinctions based on lithic morphology are still prevalent within the literature and many authors still adhere to the identification of cultural groups. This chapter outlines archaeological typology debates in the context of the Epipalaeolithic with special attention paid to division of variability across time and space. Furthermore, interpretations of ethnic affiliation based on variability during the Epipalaeolithic are examined.

Certain characteristics have become entrenched in the literature on the Epipalaeolithic as a result of earlier studies and the delineations authors created with their typologies. These characteristics are a) the existence of distinct cultures, with long lasting traditions, b) separate ethnic trajectories linked to two separate environmental zones, and c) change that is triggered by climate (Pirie 2004: 700). Through understanding the typologies currently used, new typologies can be created allowing archaeologists to reflect on the nature of our adherence to the current Epipalaeolithic characteristics.

Archaeologists focus on categorization and the classification of the archaeological record into typologies to facilitate the organization of material culture (Adams and Adams 1991). These typologies help to order material culture into bounded groups; each type compartmentalizes material culture into units, such as site types,

technological sequences, or artistic styles, allowing for diachronic and regional comparisons of archaeological material.

Lithic typologies have been the focus of considerable debate in archaeology, where the methodology, assumptions and interpretations of typologies have been questioned. Critical exploration of the construction of Epipalaeolithic lithic typologies and the ensuing critiques is essential to further our understanding of this period. The Epipalaeolithic is characterized and defined by the considerable amount of lithic variability, which has been classified into formal typologies. From these typologies, inferences regarding ethnic affiliation have been created and widely adopted by researchers. The association of ethnic affiliation with particular artifact types is based on the desire to create bounded entities of time and space. It is my belief that typologies are useful for the exploration of variability in relation to long term diachronic trends, but the classification of lithic technologies are not useful for understanding ethnic affiliations. Rather, the goal of Epipalaeolithic research should be to explore long-term processes to better comprehend the shift between hunter-gatherer subsistence patterns that characterize the region before 10,000 BP and agricultural production that typifies the region afterwards through the use of lithic typologies. Technological differences combined with multiple lines of evidence such as faunal information, use-wear and morphology can create a more robust typology which focuses on trends of change rather than form.

TYPOLOGIES

Typologies, defined as the processes of sorting entities into mutually exclusive categories (Adams and Adams 1991), are integral to archaeology as a discipline. The classification of artifacts into types¹ allows for material to be compared across the artifact assemblage and between sites, facilitating the tracking of diachronic and regional trends. Often, artifact types are created through the selection and grouping of (primarily) morphological attributes of an artifact. These artifact types are then compiled to create a typology of the artifact assemblage. However, since each individual piece has a multitude of qualitative attributes (the descriptions of which can be very subjective) only a select few are chosen to include in the creation of a typology. Thus the creation of typologies is such that certain attributes are favoured over others in the definition and delineation of a 'type'. Attributes that are seen as important or desirable by the archaeologist are given more weight and importance within the archaeological assemblage.

There has been considerable debate within archaeology as to the meaning of the types created by archaeologists. The meaning and significance of typologies was first prominently debated in the classic dialogue between Ford (1954) and Spaulding (1953, 1954) regarding variability seen in typological classifications. This debate evaluated the meaning of typologies, whether there are emic types to be 'discovered', or if typologies are a reflection of the archaeologist's research questions and biases (i.e. etic types). Spaulding's statistical techniques based on morphology were critiqued by Ford for

¹ Type: a particular kind of class, which is mutually exclusive and does not overlap with other types, and is a member of a typology.

Adams, W., and E. Adams. 1991. *Archaeological Typology and Practical Reality: A Dialectical Approach to Artifact Classification and Sorting*. Cambridge: Cambridge University Press.

assuming the existence of 'real' types. Ford suggested instead that changes in 'types' are fluid and that the construction of typologies places an etic classification system on the archaeological record. Ford's position is supported by post-processual critiques of typological construction (Shanks and Tilley 1992:11) that suggest typologies are unable to capture the multi-faceted identities of the past and that there may be no emic types to discover. Furthermore, different individuals and social groups have different views and interpretations of the past. This creates multiple and competing conceptions of prehistory affecting the way that typologies are constructed and interpreted (Conkey and Spector 1998). This polyvocal interpretation suggests that in fact 'types' are etic constructs that convey meaning for the group or individual employing the typology and are not a reflection of emic classification and intrinsic lithic organization.

Despite the debates associated with the construction of typologies, there are many excellent reasons for the use of classification systems in an archaeological context. For example, typologies are useful as an organizational tool in analysis, helping archaeologists to recognize and understand patterns in the data that are directed at specific research questions. Thus, typologies should not be viewed as a tool to understand emic classification systems of material culture but instead should be viewed as a method of ordering archaeological material for archaeologists (Banning 2000:55). Typologies can still be meaningful without adhering to the concept of emic significance; they are meaningful in that they order the archaeological record in a way that facilitates easy analysis of material towards a certain goal. As advocated by Adams and Adams (1991) there is no right or wrong way to classify an assemblage, but there are certain methods of classification that are better at achieving different purposes. Thus

archaeologists must be explicit in their research questions and objectives while creating and defining a typology since it will be inherently biased towards their research goals. Also, when choosing a typology that was created by other researchers, the same questions must be asked: what question drove their delineation of types?

TPOLOGY AND INTERPRETATION

Traditionally, typologies are used to order assemblages both spatially and temporally (Adams and Adams 1991, Odell 1981). There are many ways of constructing and interpreting typologies that achieve this goal of organization. Seriation of artifact assemblages creates relative chronological sequences between artifact types to identify chronological processes. Likewise contemporary typologies are compared to each other on a regional scale. These are often created relative to perceived environmental zones and ordering the landscape into cultural units.

Beyond the interpretation of typologies as a means of classification, archaeologists interpret spatial and temporal variation through the use of typologies. Cultural identities (Bordes 1961, Henry 1995), tool functions (Beyries 1988, Binford and Binford 1969), and cognitive development (Chazan 1997) have all been inferred from the typological categorization of lithics. It is the former, cultural identity, which is pertinent to the typologies created for the Epipalaeolithic and will be discussed later.

A common critique of typologies is the tendency for archaeologists to assume stasis or homogeneity of lithics. This assumption negates the comprehensive life history of the artifacts, ignoring that "tool manufacture was a dynamic, not static, part of prehistoric cultural systems. The artifacts that we discover often served as portions of

larger implements, and their forms and working edges were occasionally sharpened and shaped during their use-lives” (Odell 2001: 47). The artifacts that are present in the archaeological record may not represent their ideal or intentional type, but instead reflect a stage in the life-history of the tool, including exhausted and discarded forms (Dibble and Rolland 1992, Noble and Davidson 1991). Typologies based on morphology may simply represent a single stage in the life history of an artifact. This creates a distinct problem for the use of typologies in the identification of emic categories such as ethnicity. If the variation that we witness in lithic assemblages is, in part, a product of the tool’s ‘stage of life’ then we cannot assume this same variability would have been meaningful in prehistory.

One possible way to gain improved comprehension of archaeological assemblages is to construct the *chaîne opératoire* of the tools. By reconstructing the processes by which a tool was mentally conceived, enacted through production, used, modified and finally discarded, a more thorough understanding of tools in their cultural context can be developed (Shott 2003). It has also been suggested that the construction of the *chaîne opératoire* can identify people who belonged to the same prehistoric social group (Bar-Yosef 1991b). However, inferred meaning from typological classification is problematic because, like all archaeological inference, it is an etic construct of the archaeologist based on the archaeologist’s cultural and theoretical affiliation (Charles 1992). Thus, the interpretations that we make from our typologies should be focused on the fluidity between tool types and dynamic processes associated with tool variability instead of on bounded etic types. New methods need to be developed that highlight

continuity in form and the process of construction, instead of the bounded units that we create to understand the archaeological record.

THE TEMPORALITY OF TYPOLOGIES

As previously mentioned, typologies are used to structure time in order to understand temporal change. The types that we create are often used to demonstrate the passage of time and the evolution of form. These typologies show diachronic change to construct meaning out of the archaeological record. Each distinct form is allocated a temporal placement, dividing history (or prehistory) into units. For example, we infer the transition of time from Early to Middle to Late Epipalaeolithic based on the introduction of new lithic 'types' in the form of differing retouched edges. Although these interpretations are often corroborated with absolute dating methods, such as radiocarbon dating, transitions in lithic style and morphology often do not follow a linear progression. From these interpretations human culture and ethnic affiliation are assumed to be bounded into typological entities based on artifact morphology, despite the fact that there is variability in their technological and stylistic production. Defining ethnicity from typologies is inherently problematic because it ignores the dynamic processes of human interaction that create diversity in material culture. This is not to say that none of the variability seen in the archaeological record is due to ethnicity, but that these interpretations are too bounded. New interpretations of variability suggests that it is to reaffirm identity *within* a social group, not between groups (Close 2002). As archaeologists we should be highlighting the variability in the archaeological record to

examine long term processes instead of ethnic affiliation that looks at group attachment and affiliation.

The ordering of typologies can create artifact seriations that are used as a method of relative dating. Relative dating measures time in terms of internal change but without a calendar scale (O'Brien and Lyman 1999). This dating creates bounded units of time based on artifact assemblages which do not address the fact that "time is not packaged, but rather infinitely divisible" (Ramenofsky 1998:75). The use of typologies for dating packages time into units, divisions which are not inherent to time itself. As previously discussed, these typologies are reflective of modern bias and the researcher's agenda creating arbitrary units within time. The way that we see the past, the way it is structured, is not a reflection of prehistoric reality but of the bounded nature of our contemporary time. Dwelling in a Western culture our desire to compartmentalize time into arbitrary units has increased and diverged from a task-oriented time scale (Ingold 1995). This need for the categorization of time is reflected in the way that we organize our chronology of the archaeological record. Typologies help to maintain the bounded entities that we seem to desire in order to understand space and chronological scale. Thus, change over time should be viewed as a continuum, not as structured events of archaeological typological change.

In contrast to this typologically ordered time is 'lived' time which unites the past, future, and present (Gell 1994). Traditional units of time, which are often bounded in Western thought, become integrated with each other creating a fluid experience in the world. All time is relative because "to be perceived it must be *related* to scale" (O'Brien and Lyman 1999:8). Is it possible to create a phenomenological clock, to understand how

prehistoric people experienced time? Whether the complete details of experience are entirely lost to modern ears, there are some assumptions about our organization of prehistoric time that can be revisited. The continued use of bounded chronological groups as representative of past systems is counter to the phenomenological view of prehistoric time, especially if we are in keeping with the idea that clock-time is a uniquely contemporary phenomenon (Ingold 1995). We need to address the fluidity of time, its inherent unbounded nature, as an alternative form of interpretation. Research focused on the continuum of diachronic change instead of rigid typological constructions may remove some of our contemporary bias from our archaeological interpretations.

ETHNICITY AND SPACE

Assigning ethnic affiliation to artifact assemblages is a method of dividing and creating meaning within space. As mentioned above, typologies are often constructed to create meaning out of chronological variability, a variability that is also seen across space. Spatial variability (and the subsequent typologies) has been explained through a variety of formats, such as functional differences of sites and structures (e.g. Binford and Binford 1969). However, the identification of unique cultural or ethnic groups is still present in the literature (Bordes 1961, Henry 1995). This approach was commonly used during the culture-historic period, where prehistory was divided into a series of 'cultures' based on artifact types and geographical location (Jones 1997). These cultures were considered bounded types within the vast spans of prehistory. Even after the culture-historic approach fell out of fashion, the use of ethnic affiliation to explain the variability witnessed in the archaeological record remained widespread.

The term 'ethnic group' is defined as "any group of people who set themselves apart and/or are set apart from others with whom they interact or co-exist on the basis of their perceptions of cultural differentiation and/or common descent" (Jones 1997:xiii). This suggests that cultural transmission is mediated through and within ethnic barriers. Archaeologically one might assume that ethnic affiliation can be delineated through homogenous artifact assemblages suggesting lines of cultural transmission. In actuality artifact assemblages are characterized by the diversity of material culture and the variability in artifact form. This variability within archaeological assemblages necessitates the creation of typologies to order the data. From this typologically ordered data ethnicity is inferred. This means that as archaeologists we are creating artificial homogeneity, which is then inferred to represent ethnic affiliation.

One of the assumptions of ethnic identity in relation to typologies is that they are static and bounded. However, culture and ethnicity can be fluid and dynamic. Internal variation within typologies are regarded as 'noise' resulting from imperfect manufacture and expression (Dunnell 1986). By ignoring this 'noise' typologies remove individuals from the archaeological record thereby neglecting the interaction between individuals and influence of groups across the landscape. Likewise, if our typologies are etic constructs, as discussed previously, then they cannot be indicative of prehistoric ethnic groups.

As can be seen from my outline of the major Epipalaeolithic culture groups, there are numerous typologies that have been created out of the variability in microliths from this period. Archaeologists who identify themselves as "splitters" (in contrast to the "lumpers") have identified more than eighteen different groups in the Epipalaeolithic

(Goring-Morris and Belfer-Cohen 1998, Olszewski 2006). From these typologies cultural and ethnic groups have been defined. In the *Epipalaeolithic of Southern Jordan* Henry (1995: 434) writes that “real cultures can be identified on the basis of patterned variability in artifacts”. He further discusses that ethnicity can be inferred from the identification of this patterning and that these ethnic groups remained distinct through the habitual use of different environmental zones.

The continuum of technology and the evolution of morphology in microlith forms are often obscured by the practice of ‘splitting’ Epipalaeolithic variability into ethnically distinct groups. Beginning in the Early Epipalaeolithic and ending with the Late Epipalaeolithic there is increasingly invasive retouch and modification of the microlith types (Belfer-Cohen and Goring-Morris 2002). This can be seen in the transition from Ouchtata retouched non-geometric microliths to trapeze-rectangles to lunates, at the most generalized level. Although there are stylistic changes over time, these seemingly chronologically sensitive microliths are not absent from the other ‘cultures’, for example there are distinct transitional pieces within the assemblages. Bar-Yosef (1970) originally identified proto-rectangles, proto-trapezes, and proto-lunates as distinct types within Epipalaeolithic assemblages. These ‘preform’ artifacts highlight continuity within and between assemblages and blur the boundaries between the cultures (Pirie 2004). Later authors removed these transitional types in order to reaffirm the boundaries between the identified cultures (Pirie 2004).

Some authors argue for a view of Epipalaeolithic variability that represents continuous forms. Neeley and Barton (1994: 227) reexamined Epipalaeolithic typologies using one particular microlith feature, the microburin technique, suggesting that

“differences in microburin abundance and variation in microlith form are better viewed within a technological continuum of microlith manufacture, use and discard than as discrete, predetermined types”. Through their study of the microburin technique they suggest that microlith types and the mechanisms of manufacture are indicative of raw material abundance or scarcity and not of ethnicity. They observe that the primary morphological difference between microlith types is located on the hafting portion of the lithic. Therefore any ethnic affiliation associated with microlith types would not be visible when the tool was in use. Neeley and Barton’s research methodology has been heavily critiqued by others who study the Epipalaeolithic (Clark 1996, Goring-Morris 1996, Henry 1996, Phillips 1996). For example, Neeley and Barton used other people’s data sets and never examined the material themselves. Despite the flawed final results of their study, the theoretical position behind their research embraces alternative approaches to understanding the archaeological record inviting continued interpretation of lithic variability and they fully defend their approach which critically examines ethnic divisions of the Epipalaeolithic (Barton and Neeley 1996).

At the level of the artifact, continuity and transition in lithic form is also seen within the category of geometric microliths. In early studies, the Geometric Kebaran was divided into two distinct groups, the Geometric Kebaran A and B with the distinction between the two groups based on the average width of the trapeze-rectangles in an assemblage. The former group encompasses sites with averages between 4.5-6.5 mm in width while the Geometric Kebaran B sites exhibit microliths that are 6.5 mm and wider (Maher 2005). However, the scheme of dividing the Geometric Kebaran A and B into distinct variations has recently been abandoned in favour of a more unified approach that

highlights the similarities between Geometric Kebaran sites (Maher 2005). Recent studies suggest that the distinction between the Geometric Kebaran A and B is arbitrary and that the width of microliths within an assemblage is continuous (Maher 2005); there is no clear distinction between thin and thick geometric microliths in any spatially or temporally meaningful way. The bounded types that were created were not meaningful because they did not adequately represent the continuity within the geometric microlith class.

SUMMARY

Interpretation of the archaeological record is inherently influenced by contemporary bias, which structures the way that we view the past. The current methods of viewing time through a structured and bounded lens are projected onto the archaeological record obscuring variability within artifact assemblages. The creation of typologies is a method of structuring the past that places etic concepts of time and space onto archaeological entities. This can be useful for ordering data for specific research purposes; however emic types are still inferred from the typologies that we create. For example, the identification of ethnicity in the archaeological record suggests that the typologies we create are reflective of emic types. The Epipalaeolithic provides an example of archaeological interpretation that uses constructed typologies to interpret ethnic affiliation between sites in diverse environmental regions. These interpretations ignore the dynamic and interactive nature of human culture. An approach that focuses on examining the technological sequence of artifact creation, in this case lithic manufacturing, offers the opportunity to embrace long-term, dynamic processes that

Epipalaeolithic scholars ignore in favour of continued debate regarding ethnic affiliation. Taking a phenomenological stance on the structuring of time we need to embrace a fluid and continuous process of human culture to help remove contemporary bias from the interpretation of the archaeological record.

CHAPTER 4: 'UYUN AL-HAMMÂM AND EXCAVATION METHODOLOGY

INTRODUCTION

Excavations at 'Uyun al-Hammâm have yielded a wealth of information about the Middle Epipalaeolithic of the eastern Jordan Valley. This chapter outlines other sites found in the vicinity of 'Uyun al-Hammâm in order to contextualize the site in the landscape, and the results of excavations at the site.

EPIPALAEOLITHIC SITES OF WADI ZIQLAB

Wadi Ziqlab, in the Mediterranean zone of the southern Levant, is located in the al-Koura district of Northern Jordan. The river valley and its main tributaries have been extensively surveyed and excavated by the Wadi Ziqlab Project, directed by Dr. E.B. Banning, University of Toronto. The results of these archaeological explorations have yielded sites dating from Lower Palaeolithic to modern Islamic contexts (see Maher 2005 for a summary of sites). Within this diverse archaeological landscape fourteen Epipalaeolithic sites, ranging from the Early to Middle Epipalaeolithic, have been identified. Included in these sites is 'Uyun al-Hammâm, a Geometric Kebaran site with deep cultural deposits. This site is unique in the landscape because of the density and depth of cultural materials and the presence of human burials. 'Uyun al-Hammâm has been excavated over multiple field seasons (2000-2005), however this thesis focuses on the lithic material excavated from 'Uyun al-Hammâm during the 2005 field season.

Only seven of the fourteen identified Epipalaeolithic sites within Wadi Ziqlab have been the subject of archaeological excavation. The following is a brief description

of these excavated Epipalaeolithic sites, taken from Maher (2005). The sites are listed from east to west, starting with those that are closest to Lake Lisan (Figure 4.1).

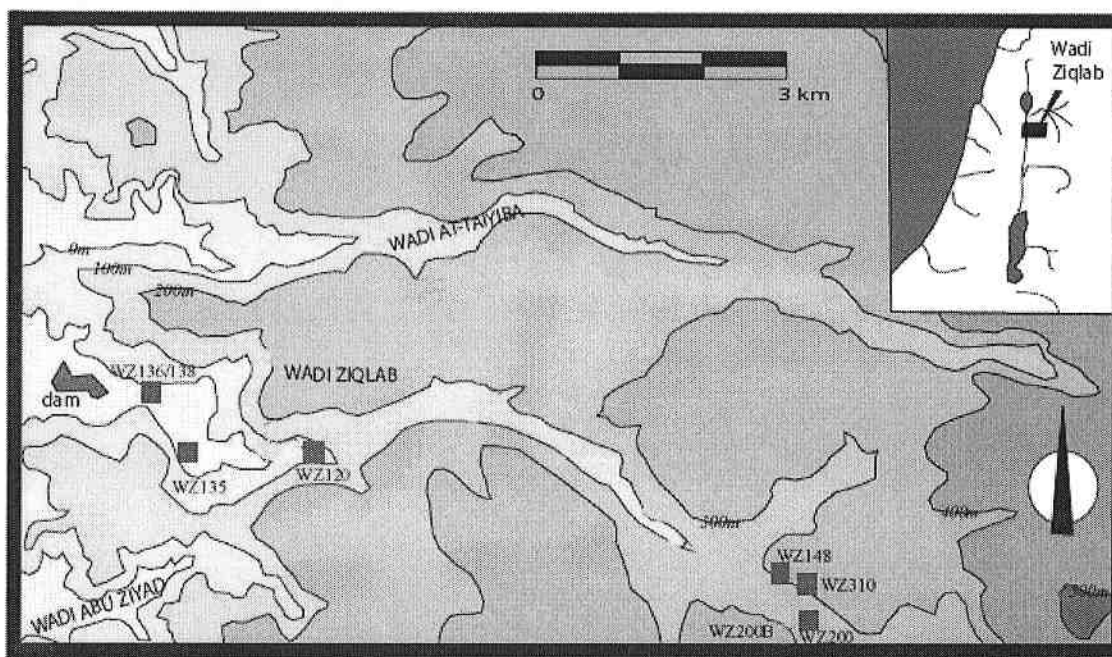


Figure 4.1 Map of the Sites in Wadi Ziqlab with Epipalaeolithic Components (Maher 2005)

The sites of al-Qasa' I (WZ136) and II (WZ138) were identified eroding from a river terrace in 2000-2001 and the lithic assemblage was collected from the eroding deposits. The microlith assemblages from al-Qasa' I and II are extremely variable suggesting a mixture of Early and Middle Epipalaeolithic deposits. The cultural affiliation of this site is further confused by possible Upper Paleolithic and intrusive Neolithic elements.

Al-Basafin (WZ135) was originally excavated to investigate the Late Neolithic component identified at the site. However, at the lower portion of the Neolithic component a highly disturbed Epipalaeolithic occupation was discovered (Maher 2005). Included in the recovered Epipalaeolithic artifacts are some backed bladelets and

microlith cores. Trapeze-rectangles are among the retouched tools suggesting that the occupation dates to the Middle Epipalaeolithic.

The Epipalaeolithic component of Tell Rakan I (WZ120) is located in a red palaeosol horizon similar to the soil found at 'Uyun al-Hammâm. The site's stratigraphy and the small number of bladelet fragments and cores suggest the presence of an Epipalaeolithic occupation under the Neolithic occupations. As a result little is known about the Epipalaeolithic occupation of this site.

Al-'Aqaba (WZ310) is a neighboring site to 'Uyun al-Hammâm and stands in stark contrast to it because only a small lithic assemblage was recovered. It has been suggested that this site might represent a continuation of its larger neighbor, 'Uyun al-Hammâm (Maher 2005). Currently it is unknown if this site should be treated as a separate occupation.

Tabaqat al-Bûma (WZ200) is one of the few excavated Epipalaeolithic sites in Wadi Ziqlab. The lithic assemblage represents an industry based in the production of narrow and gracile microliths. Bladelets were modified through truncation and backing, however their morphology does not resemble classic geometric microliths. Despite the fact that radiocarbon samples place the site firmly in the Middle Epipalaeolithic there are no diagnostic lithics firmly associating the site with the Geometric Kebaran. Tabaqat al-Bûma is a much smaller site than 'Uyun al-Hammâm, with a less diverse tool assemblage. It has been interpreted that the differences seen between Tabaqat al-Bûma and 'Uyun al-Hammâm may represent chronological separation, with the former site representing a slightly earlier occupation in Wadi Ziqlab (Maher 2005).

‘UYUN AL-HAMMÂM

The site of ‘Uyun al-Hammâm (WZ148) dates to $15,280 \pm 933$ cal BP (Maher 2006). Both the temporal placement (based on a radiocarbon date) and the lithic typology situates the site clearly in the Geometric Kebaran period. In comparison to other Epipalaeolithic sites in the region, ‘Uyun al-Hammâm has extremely deep cultural deposits which include large accumulations of lithic and faunal material. The site is located on an ancient river terrace indicating its proximity to permanent water during occupation (Maher 2005). Raw materials are also abundant in the region with several outcrops of high-quality flint available in the immediate vicinity. The abundance of raw materials and rich subsistence opportunities within the surrounding area would have made ‘Uyun al-Hammâm an attractive habitation site during the Terminal Pleistocene.

Middle Epipalaeolithic sites in Wadi Ziqlab are located in a distinct red palaeosol. These deposits are distinguishable in their pronounced structure and high carbonate levels (Maher et al. 2001). The soil is red in colour due to the deterioration of rich iron-bearing minerals in the soil, a process that requires a high moisture level in the environment (Maher 2005). Therefore, in the Levant, red soils are created only during periods of increased rainfall and warm temperatures. High temperatures and wet conditions also create deep soil accumulations (Goldberg and Macphail 2006), such as those seen at ‘Uyun al-Hammâm. Current conditions in Jordan are too arid to facilitate this process. The red palaeosol found at ‘Uyun al-Hammâm is attributed to the Bølling-Allerød interstadial and formed as a result of pedogenic processes which would have been pronounced during the climate amelioration of this period (Maher 2005).

The uppermost stratum at 'Uyun al-Hammâm is Holocene colluvium. The Holocene colluvium and Pleistocene palaeosol are separated by an erosional event probably dating to the Younger Dryas. As a result, any potential later Epipalaeolithic occupations were destroyed by erosional events during this arid climatic phase. Although the upper stratum is reworked from upslope, the lower deposits of the red palaeosol represent undisturbed contexts of Middle Epipalaeolithic material. There is a minimal amount of disturbance in this stratigraphic level related to later occupations, including a Byzantine field wall that crosses the excavation units in the overlying Holocene colluvium (the wall foundations are in the top of the reworked portion of the palaeosol). Also, three sherds of pottery, possibly attributed to the Neolithic, were discovered in the reworked portion of the palaeosol. This pottery was not associated with any Neolithic features or diagnostic lithics and their significance remains unknown. However, there is a Neolithic component at the neighboring site of al-'Aqaba suggesting they may have been residual from this nearby, heavy disturbed site. Despite their presence on site neither of these two components are intrusive into the *in situ* Epipalaeolithic deposits. Because of the wealth of archaeological material recovered from undisturbed contexts the material analyzed for this thesis comes mainly from primary contexts.

The retouched lithic assemblage of 'Uyun al-Hammâm consists primarily of geometric microliths and endscrapers. Other identified Geometric Kebaran tool types include asymmetrical trapezes, notches, denticulates, and obliquely truncated and backed bladelets (Figure 4.2). The majority of these tools were knapped on locally available

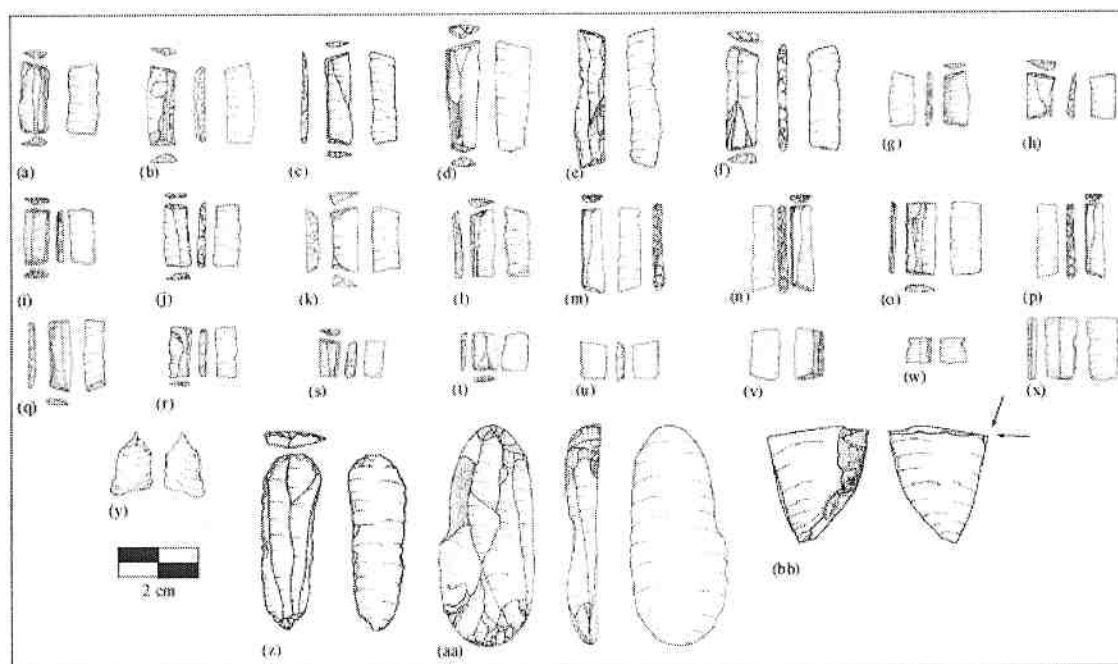


Figure 4.2 Selected Tools from 'Uyun al-Hammâm. Complete trapeze rectangles (a-k), incomplete trapeze rectangles (l-t), backed bladelet fragments (u-x), perforator (y), endscrapers (z,aa), and burin (bb) (Maher 2005).

light-brown flint (Maher 2006 *per. comm.*). There is, however, very-fine dark-coloured flint, pink flint, purple flint and other high quality flints present within the assemblage (Maher 2005). These flints are not local to the site but are found at sources within walking distance. For example, very-fine, dark-brown flint outcrops have been noted both in Wadi Ziqlab and in chalk strata near 'Ain Beidha in Wadi Abu Ziyad, towards the Jordan valley. Although the Wadi Ziqlab Project has conducted informal raw material surveys, there are currently no publications on the distribution of chert sources on the eastern side of the Jordan Valley.

Unretouched debitage represents the largest amount of lithic material present at the site. Included in the debitage are a high number of cores, primarily single-platform

subpyramidal bladelet cores from which geometric microliths appear to have been produced. The combination of cores and the high percentage of debitage suggest that a large portion of tool production was undertaken on-site. Analysis of the lithic debitage will confirm whether the full range of knapping activities were undertaken at 'Uyun al-Hammâm or if some core preparation, tool production, use or maintenance was completed elsewhere.

Groundstone objects are among the other artifacts found at this site. These include complete and broken pestles, handstones and pounding stones made from basalt and limestone. A few fragmentary beads of bone were also unearthed (Maher 2005). Further cultural remains include red and orange ochre collected from various deposits on-site, including from burials. The ochre may relate to ceremonial or decorative function.

Preliminary faunal analysis suggests that the inhabitants of 'Uyun al-Hammâm hunted a wide variety of local fauna including deer (*Cervidae* sp.), gazelle (*Gazella* sp.), hartebeast (*Alcephalus* sp.) and dog (*Canis* sp.) (Humphrey 2003). All of the identified species found at the site could have been hunted in the surrounding forest-steppe (Maher and Banning 2003). The diverse subsistence base suggests the possibility of multi-seasonal occupation which is strengthened by the large accumulation of both faunal and lithic deposits (Maher 2005). The bones on site represent a combination of both high and low utility items. This suggests that the whole animal carcass was butchered on site, rather than being butchered at another location (Humphrey 2003). Despite the wide array of bones, it is unlikely that 'Uyun al-Hammâm was a specialized 'kill site' due to the amount of lithic, groundstone and other material on-site.

The most unique feature of 'Uyun al-Hammâm is the presence of multiple human burials. At least ten individuals have been identified (Maher 2006). There is a diverse range of burial practices seen in the internments; primary extended burials, primary partially-flexed burials, secondary internments, and internments associated with animal remains and grave goods have all been excavated (Maher 2006). Human remains from Geometric Kebaran sites are extremely rare and the discovery of several burials at one site is unparalleled for this time period. Other human remains have been found at the sites of Neve David, Qadish Valley and Wadi Matah within the Mediterranean zone, totaling four individuals (Maher 2006). The discovery of these burials at 'Uyun al-Hammâm contributes greatly to our understanding of Geometric Kebaran burial and ideological practices. Current research by Dr. Lisa Maher of the University of Toronto and Dr. Jay Stock of Cambridge University is underway to give insight into the palaeoanthropological data provided by these skeletons, including their morphology, health, and diet.

There is no evidence of burial pits for the burials at 'Uyun al-Hammâm, perhaps indicating that they were dug into shallow earthen pits (Maher 2006). This parallels the evidence of burying the dead in shallow pits at Ohalo II and Ein Gev I (Nadel and Hershkovitz 1991). All of the burials were found in reworked artifact bearing contexts, indicating they were interned after the artifacts were deposited (Maher 2006). This suggests that 'Uyun al-Hammâm already had a special place on the Epipalaeolithic landscape and the presence of the burials further ties the Epipalaeolithic people to the land. This site may mark the beginning of burial grounds that are seen in the later

Natufian period, suggesting the continuation of long term trends in mortuary patterns from the Middle Epipalaeolithic to the Neolithic (Maher 2006).

The large amount of lithic material, including cores and debitage, as well as the faunal remains and human burials suggests that 'Uyun al-Hammâm had an important place on the Epipalaeolithic landscape. Cultural accumulation to this extent suggests repeated use of this terrace. The presence of groundstone artifacts, such as those found on site, is often interpreted as secondary evidence of sedentism because these objects are difficult and cumbersome to transport (Belfer-Cohen and Bar-Yosef 2000). Coupled with the amount of cultural material recovered during excavations of 'Uyun al-Hammâm, this can be interpreted as a place of intensive use. Furthermore, burials suggest an attachment to the landscape and a sense of place. Ideological significance in conjunction with the plethora of functional artifacts could represent a move towards sedentism. New research also suggests that burial evidence may not represent sedentism but instead may represent a continual return to an "ancestral" place on the landscape (Boyd 2006). Are the people of 'Uyun al-Hammâm living at the site on a permanent basis or does this site represent an ideological aggregation point on the landscape? Whether the site was an aggregation point for smaller nomadic groups or a larger community growing due to the wealth of resources found in the local area, 'Uyun al-Hammâm is a unique and important place on the Epipalaeolithic landscape.

EXCAVATIONS AT 'UYUN AL-HAMMÂM

The lithic material analyzed for this thesis was excavated at 'Uyun al-Hammâm during the 2005 field season. This field season's material was chosen because these excavations concentrated on *in situ* deposits. By focusing on *in situ* deposits, inferences regarding behaviour drawn from the lithic assemblage can be combined with other data from the site to create a robust interpretation of activity.

Excavations during the 2005 season were initially concentrated around unit H16. In the previous season, evidence of human remains were found eroding out of the terrace wall in this area, but due to time limitations the remains were left unexcavated. The focus of the 2005 season was to investigate and remove the remains, both for preservation issues and for further insight into Geometric Kebaran burial practices. Three other units contiguous to H16 were excavated to understand the burial's context at the site. Within these units three other burials were discovered and systematically excavated by Dr. Stock. Other units to the east of these four areas also yielded Epipalaeolithic internments. The debitage analysis for this thesis is concentrated on units H16 (the unit with the original burial), H15, and G15 (Figure 4.2). These units were chosen because they yielded the greatest density of lithic material and they are adjacent to each other. Through this close proximity refitting can be attempted and larger activity areas may be defined.

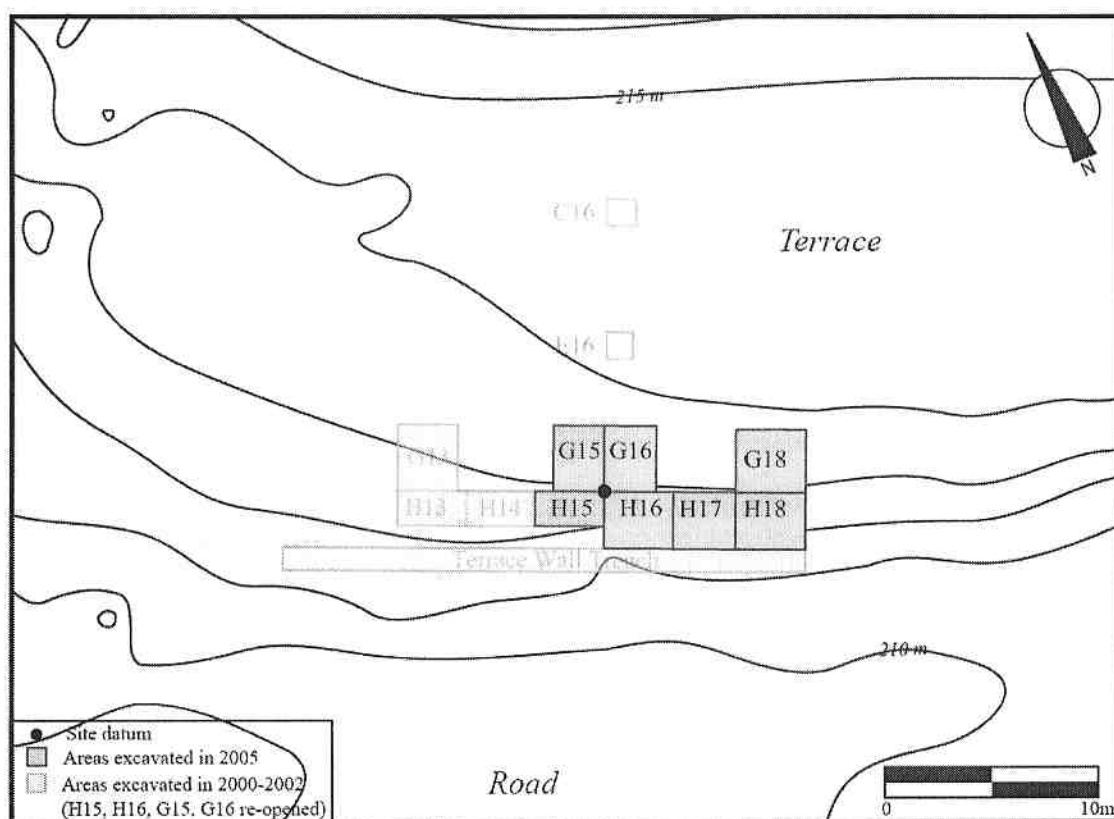


Figure 4.3 Map of 'Uyun al-Hammâm Excavation Units (drawn by L. Maher)

SUMMARY

The site of 'Uyun al-Hammâm is a classic Geometric Kebaran site. It occupies a unique place on the Epipalaeolithic landscape because of the vast accumulation of lithic and faunal material recovered during excavations. Furthermore, numerous burials were found on the site making 'Uyun al-Hammâm to-date the only Geometric Kebaran occupation in the Levant with this many internments. This site may have functioned as a semi-sedentary habitation area with functional and ideological significance. The presence of burials and deep cultural accumulation at 'Uyun al-Hammâm shows a more gradual

development of sedentism and social complexity, challenging the current notion that these phenomena began abruptly in the Natufian.

CHAPTER 5: METHODOLOGY

INTRODUCTION

Epipalaeolithic assemblages are usually characterized by the large quantity of lithic material, which outnumbers all other artifact classes combined. Because lithics are the most prevalent Epipalaeolithic artifact, this material has been subjected to intensive analysis and investigation by archaeological researchers. Although many Epipalaeolithic typologies contain a multitude of lithic types, microliths predominate. There is extensive microlith variation throughout the region and the majority of archaeological studies have focused on the interpretation of microlith variation in the Epipalaeolithic (see Bar-Yosef 1970, Goring-Morris 1987, Henry 1998). Few researchers have evaluated lithic reduction sequences for the Epipalaeolithic (see Bar-Yosef 1991a, Bar-Yosef 1991b, Davidzon and Goring-Morris 2003). Further exploration into Epipalaeolithic reduction sequences and debitage analysis will greatly expand our current knowledge of this period. This study conducts systematic debitage analysis from a Middle Epipalaeolithic site in northern Jordan in order to reconstruct the *chaîne opératoire* of lithic production at 'Uyun al-Hammâm.

HISTORY OF DEBITAGE ANALYSIS

Debitage analysis looks at the material produced during flint knapping that is not retouched or used as a tool. Debitage results from the process of tool manufacture and although this archaeological material may not be relevant in a cultural-historical context, as debitage does not take on typologically unique forms, it provides the opportunity to evaluate cognitive processes of prehistoric peoples through reconstructing past actions.

Prehistoric cognition can be accessed through debitage because it allows the researcher to reconstruct patterns of behaviour and decision making processes. Furthermore, debitage analysis allows the researcher to move beyond bounded typologies when interpreting the archaeological record, focusing on process rather than product. Thus, we can view the decisions and choices made by individual flint knappers, and understand the transmission of knowledge across time. This has increased the popularity of debitage studies in archaeological discourse as interest moves towards understanding meaning and ideas within the past, resulting in numerous publications and edited volumes dedicated to debitage studies (see Andrefsky 2001, Hall and Larson 2004).

There are numerous definitions and ideas around the meaning and the purpose of debitage. For some scholars, debitage is the “detached piece that is discarded during the reduction sequence” (Andrefsky 2001: xi). This definition implies that the pieces are waste products that were not intended to be used. Furthermore, it suggests that the archaeologist is witnessing the process of reduction at its final stage, with each piece discovered in its final form. Other scholars identify a dichotomy between debitage types produced during core reduction versus debitage produced during tool manufacture (Sullivan and Rozen 1985). This dichotomy further propagates the idea that debitage is only a byproduct of something more desirable. Although many pieces of debitage are removed for the purposes of forming and shaping the core for other removals or for the production of tools, other pieces may have been intended for retouch or for use. For example experimental research has shown the utility of expedient flakes as cutting tools (Jones 1980). Use-wear studies of Middle Palaeolithic assemblages have further shown that unretouched debitage exhibits wear associated with a wide diversity of tasks

including woodworking and butchering (Beyries 1988). Therefore, it can be inferred that some debitage are not waste products but tools in their earliest form. Based on this understanding I define debitage as unretouched pieces detached during reduction which highlight the *process* of tool making. Thus the intended function of the debitage is not inferred but rather the dynamic nature of lithic reduction is focused upon.

There are numerous ways of approaching the study of debitage. Traditionally, debitage was categorized through a typological approach. A popular debitage typology used in reduction analysis involves the division of flakes into three categories: primary, secondary and tertiary flakes (Sullivan and Rozen 1985). These flakes are identified by decreasing amounts of cortex, with the primary flakes having the highest percentage of preserved cortex. A debitage assemblage can then be divided based on these categories and from the resulting analysis inferences regarding lithic reduction are made. This typological approach is problematic because it assumes a linear reduction sequence with the full removal of cortex before the manufacturing of tools. This is further complicated by the use of only one variable when placing the debitage into the typology; the natural variability found in each flake is not acknowledged and an *a priori* assumption is made that cortex is the most reliable feature on debitage for stage of reduction analysis.

To guard against the problems of typological debitage analysis a method of “interpretation-free” analysis was developed by Sullivan and Rozen (1985). This hierarchical method identifies debitage based on the presence or absence of attributes such as an interior surface and an intact platform. It also looks at the portion of the artifact that is preserved and at the degree of breakage (Odell 2004). From this study four categories of debitage were discerned: complete flake, broken flake, flake fragment, and

debris. A complete flake is characterized by an interior surface (the ventral surface), a platform and a termination, a broken flake has a ventral surface and a platform, a flake fragment has a ventral surface but no platform, and debris has no ventral surface (often called shatter or “chunks”) (Sullivan and Rozen 1985). These categories have been tested and revised over the past two decades through the inclusion of other variables such as flake size (e.g. Prentiss 2001), however this hierarchical model of debitage analysis is still influential in many contemporary studies.

Another popular type of debitage analysis is aggregate mass analysis. This type of analysis subdivides the debitage assemblage into size categories, usually through the use of screens or other quick-sorting methods (Ahler 1989, Larson 2004). Each size category is then sorted for cortical elements. This method focuses on the complete debitage assemblage rather than placing each piece into a reduction stage (Bradbury and Carr 2004b). The results of this analysis can be used to understand the technological production of the debitage, how much is being produced on site, in a very expedient manner. Aggregate mass analysis is particularly useful for very large assemblages that need to be analyzed in a short period of time. This technique has become popular in cultural resource management settings where a description of the debitage assemblage is often needed on short deadlines. However, this method of analysis is problematic because it ignores the variability within the lithic assemblage by classifying reduction stages only by size. This creates a crude and superficial understanding of a debitage assemblage.

The advantage to a debitage-focused analysis is that interpretations can be made regarding the behaviour and intent of prehistoric peoples. A well known method of

behavioural interpretation of lithic assemblages is the the *chaîne opératoire* approach. This technique was first developed by Andre Leroi-Gourhan in *Le Geste et la Parole* (1964) and focused on the dynamic process of movement and morphological changes that occur during the life of an object, the operational sequence (Graves 1994, Trigger 2006). This technique was modified and applied to lithic studies describing the “technological operations that bring a raw material from a natural state to a manufactured one” (Bleed 2001: 105). This process incorporates both cognitive and technical aspects of stone tool production, from raw material procurement to final discard of a tool at the end of its use-life. This process however does not have the ability to evaluate post-depositional processes that affect and modify lithics prior to their discovery in an archaeological context (Bleed 2001). Despite its limitations, the *chaîne opératoire* gives the archaeologist a rare glimpse into prehistoric cognition by highlighting the dynamic nature of lithic reduction and human agency.

Another popular sequential archaeological model is the reduction sequence. Emerging from processual archaeology and the desire to understand processes, lithic reduction sequences focus on systematic stages of reduction in the production of primarily bifacial artifacts (Bleed 2001). This approach is very common in North American lithic studies where the technique has been applied to numerous collections to understand flint knapping patterns.

It has been argued by some scholars that the *chaîne opératoire* differs quite substantially from North American models of reduction sequences (Bleed 2001, Odell 2001). Other authors argue that these two methods are inherently similar, that both are processual approaches that emphasize the process of lithic production and the subsequent

tools determined by context (Shott 2003). It is my belief that these two techniques differ in that the *chaîne opératoire* allows for the tool to be fully contextualized in space and time. The *chaîne opératoire* identifies different choices made in the process of lithic manufacture, including the distances traveled for raw material, the way in which a tool was used, re-sharpened, and the manner and reason for abandonment. Stage of reduction analysis has the capacity to evaluate the same process however it primarily focuses on the linear sequence of flake removals to achieve a desired and preconceived resulting tool. The *chaîne opératoire*'s focus on the full sequence of a tool's life including the raw material procurement, processes of manufacture, use, and discard presents a nonlinear, holistic approach to lithic analysis that is not incorporated in stage of reduction analysis. It further supposes that the resulting material culture is both a technological and a social expression (Darville 2002:78).

One method used to reconstruct both the *chaîne opératoire* and the reduction sequence of lithic assemblages is refitting. Refitting identifies a set of conjoining lithics that were knapped during the same reduction sequence (Inizan et al. 1999: 151). This undertaking reconstructs the knapping sequence by placing each individual piece of debitage into the reduction sequence. Refitting can help to identify the patterns of reduction, raw material choice, individual flint knappers, and cognitive choices of prehistoric peoples (Bleed 2004). It can also show how activities are situated across a landscape as the pieces are rejoined between various activity areas within or between sites. Refitting of a lithic assemblage creates an understanding of the individual components in relation to the whole assemblage, thus situating each piece in a wider

context (Bleed 2004). This allows the archaeologist to reconstruct the dynamic processes involved in flint knapping from the static context of debitage.

RESEARCH QUESTIONS

A large amount of debitage was recovered from the excavations at 'Uyun al-Hammâm. The debitage assemblage from the 2002 field season was analyzed using an aggregated mass analysis methodology. Although this method provides an understanding of the material composing the assemblage, it provides poor resolution of the individual pieces in the collection. For the present study, I use a method of individual debitage analysis which provides a detailed analysis of the assemblage (Bradbury and Carr 2004a).

Although time-consuming, this approach increases the level of detail captured, as more attributes are examined for each piece of debitage (Bradbury and Carr 2004a).

Furthermore, it tests the levels of variability within the assemblage and highlights patterns, thereby removing the individual pieces from a predetermined typology.

The wealth of debitage data in the 2005 'Uyun al-Hammâm collection allows for the detailed exploration of the Epipalaeolithic *chaîne opératoire*. The reconstruction of the *chaîne opératoire* is approached through the framework of a series of hypotheses.

The hypotheses I am testing in the present study are as follows:

1. Not all stages of lithic reduction were taking place on site at 'Uyyun al-Hammâm.
2. Large blade tools, such as endscrapers, and bladelet tools, such as trapezorectangles, have different reduction strategies.

3. Different stages of reduction were taking place on site for different raw material types. Local raw material will show more complete reduction stages while non-local raw material will exhibit only later stages of reduction.

Through the exploration and testing of these hypotheses the choices and patterns of Epipalaeolithic flint knapping will be uncovered. This will give an insight into the decision-making processes of the people of 'Uyun al-Hammâm. These behaviours include the choices of activities performed on the site, differences in core reduction and tool production. Debitage analysis highlights the processes enacted by the people living in the past.

THE COLLECTION

The debitage assemblage from 'Uyun al-Hammâm is currently housed at the Wadi Ziqlab Project Laboratory, Department of Anthropology, University of Toronto, by permission of the Department of Antiquities of Jordan. As mentioned above, the analysis that I am undertaking for this research is focused on the unretouched debitage from this site. Simultaneously at the Leverhulme Center for Human Evolutionary Studies, University of Cambridge, Dr. Lisa Maher is analyzing the tool assemblage, Dr. Jay Stock is analyzing the human internments, Dr. Tamsin O'Connell and James Haywood are analyzing samples of the human and faunal bones for stable isotopes, and Dr. Preston Miracle and James Haywood are analyzing the faunal assemblage. All of these analyses will contribute to a more holistic picture of human activity at 'Uyun al-Hammâm. The use of multiple lines of evidence is very important in lithic analysis to help gain a full understanding of the assemblage (Bradbury and Carr 1999, Bradbury and

Carr 2004a). Therefore, for the purposes of this study, the data obtained by Dr. Maher will be combined with the debitage analysis to understand the complete lithic assemblage.

The first stage of my research was to prioritize the material based on its stratigraphic context. The decision of what and how many contexts to sample was based on the chosen method of analysis as measuring several attributes on individual pieces of debitage is a lengthy and time-consuming process. Furthermore, because the debitage assemblage is very substantial, disturbed contexts were ruled out of analysis in order to focus on *in situ* contexts. Therefore each stratigraphic layer (or locus) from the excavation unit was ranked according to several factors. From the list, twelve high priority contexts were chosen for analysis (Table 5.1). The excavation units chosen for analysis are all adjacent to one another which is very important for refitting studies.

Excavation Sediments Analyzed for Debitage			
Unit Number	Locus Number	Bag Number	Description
G16	013	38, 46-47, 52, 54, 61	compact red soil within a rock feature
G16	014	56	sediment surrounding the human burial
G16	016	64-66, 68-69	compact red soil with soft patches
G16	017	70	patchy layer of cobbles within the red soil
G16	018	71-73	compact red soil
G16	019	74-78	compact red soil, slightly sandy
G16	020	81	hard red soil from the middle of feature 009
H15	005	91-92	soil beneath red soil, less artifact density
H15	015	82-84, 86-87	soil surrounding burial and the burial
H16	013	73, 75	burial (extended)
H16	005	81-82, 84, 86, 87, 90, 92, 93	red soil below cobbles, in situ
H16	006	83, 85, 88-89, 91, 94-95	burial (flexed)

Table 5.1 Analyzed Loci

TEST VARIABLES

The attributes chosen for analysis are primarily based on the attribute's usefulness at discerning the reduction stage for each piece of debitage. Through the combination of multiple lines of evidence for this reconstruction, anomalies and biases in the data collection can be minimized. These include the lumping of debitage into stages of reduction based on one attribute (such as aggregate analysis). The individual flake analysis is combined with refitting data in order to fully understand the knapping process and the *chaîne opératoire*. The following tables outline the attributes tested and their implications in interpretation. Screenshots of the database forms are included in Appendix A.

Flakes and Blades	
Attributes	Implications
Portion: Complete, Proximal, Medial/Distal	Percentage preserved impacts debitage size
Size; <2cm 2-3cm, 3-5cm, >5cm	Overall size trends show decrease of size during reduction stages (Andrefsky 2005).
Weight	Weight correlates with debitage size
Raw Material	Identified based on raw material quality and colour. Implicates preference of raw material type and movement for raw material acquisition.
Percent of Cortex and Location	Places each flake into reduction stage based on percent of cortex
Striking Platform Type	Identification of platform types to understand removal preparations
Striking Platform Dimensions	Places each flake into reduction stage (Odell 1989) and shows evidence of platform preparation
Burning	Process that gives insight into behaviours of heat treatment and proximity to hearths.
Post-depositional alterations	Post-depositional processes that might obscure or change results
Utilized	Macroscopic evidence of use-wear is recorded for future studies

Table 5.2 Attributes Analyzed for Flakes and Blades

Core and Core Fragments	
Attributes	Implications
Core Shape	Suggests kind of debitage that was produced
Core Type	Flake or blade
Core Platform Orientation	Type of technology employed; multidirectional, unidirectional etc.
Core Platform Type	Correlate with platform type of debitage
Core Maximum Facet	Suggests size of final debitage removed

Dimension	
Core Platform Dimensions	Identifies whether more debitage could have been removed
Core Dimensions	Size of final debitage removed
Raw Material	Identified based on raw material quality and colour. Implicates preference of raw material type and movement for raw material acquisition.
Weight	Weight correlates to core size
Reason for Abandonment	Shows why the core was abandoned; hinged terminations, wrong angle, exhausted etc.
Percent of Cortex	Possible indicator of original size of flint nodule
Burning	Process that gives insight into behaviours of heat treatment and proximity to hearths.
Post-depositional Alterations	Post-depositional processes that might obscure or change results

Table 5.3 Attributes Analyzed for Cores and Core Fragments

Shatter and Chips	
Attributes	Implications
Count	Count of all pieces (either shatter or chips)
Weight	Weight of full assemblage
Raw Material	Identified based on raw material quality and colour. Implicates preference of raw material type and movement for raw material acquisition.
Burning	Process that gives insight into behaviours of heat treatment and proximity to hearths.
Post-depositional alterations	Post-depositional processes that might obscure or change results

Table 5.4 Attributes Analyzed for Shatter and Chips

For each piece, additional comments were also recorded so that unique characteristics not anticipated on the forms could be recorded.

LABORATORY METHODOLOGY

The first stage of analysis involved sorting the debitage into raw material classes. This sorting facilitates refitting as individual pieces from similar raw material types are likely to belong to the same original core (Davidzon and Goring-Morris 2003). Raw material categories were devised from visual observation of the chert's colour and quality. The majority of the raw material present in the assemblage is chert, which is commonly used by Epipalaeolithic flint knappers (Bar-Yosef 1991a). Materials that exhibit patina,

burning, or other post-depositional alterations that obscure the raw material's attributes are noted in the database.

Following Sullivan and Rozen's (1985) debitage analysis and classification system, the flake debitage is analyzed and categorized in a hierarchical manner. The first step is to locate the interior, ventral surface. If no ventral surface is present the debitage is classified as *shatter*. This is defined as "flaking debris that does not show the usual features of flakes" (Whittaker 1994: 21), meaning that there is no discernable ventral or dorsal surface. This class of debitage is assumed to be the result of unintentional pieces breaking off the core during reduction in non-conchoidal pattern.

If there is a ventral surface present then the debitage is either a *flake* or a *blade* (Figure 5.1-5.2). Blades are distinguished from flakes in that they are twice as long as they are wide (Inizan et al. 1999, Tixier 1974). Furthermore, because of the regularity of the microblade production at the site, only debitage pieces that display very regular characteristics such as parallel sides, axis of percussion situated down the middle of blade, and final termination opposite the platform are classified as blades. Irregular pieces of debitage (such as those that do not have parallel sides) are placed in the flake category.

Once the piece of debitage is identified as a flake or a blade, it is sorted by the preserved portion. Pieces that exhibit both a platform and a termination are identified as *complete*. Debitage with a platform but no termination are labeled *proximal* and finally, pieces with no platform are labeled *medial/distal*. The final category of debitage is *chips*. This is defined as any piece of debitage that is less than 1cm in size (Bar-Yosef 1991a).

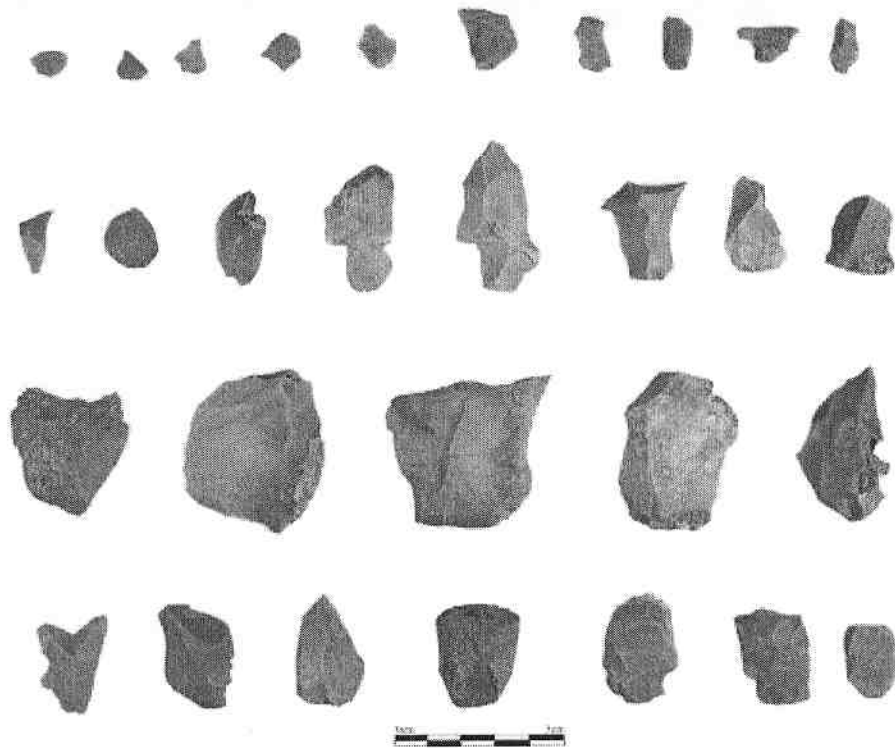


Figure 5.1 Selection of Complete Flakes



Figure 5.2 Selection of Complete Blades

The platform attributes of debitage pieces identified as complete or proximal are analyzed for platform type, length, and width. All measurements are taken with sliding calipers (precision at 0.1 mm). Platform types include *single* (a platform with only one surface), *faceted* (a platform with prior removal scars), *abraded* (platforms that have been ground as a preparation technique for further removals), and *cortical* (platforms with cortex).

The presence or absence of cortex is also recorded. This is done in an ordinal scale of 0%, 1-5%, 6-25%, 26-50%, 51-75%, 76-99%, and 100%. The presence of cortex refers to the cortex over the whole piece of debitage; therefore pieces with 100% cortex would be considered hammerstones or cobbles. This allows for the consistent recording of cortex between debitage and cores, which may have more than 50% cortex.

As mentioned previously, each individual piece of debitage is analyzed and catalogued for the highest resolution of variability within the assemblage. The individual cataloguing also allows for refitting across bags without losing original context and provenience for the debitage. Each piece of debitage is measured on an ordinal scale of <2cm, 2-3cm, 3-5cm, and >5cm. The use of a nominal scale versus interval scale allows for more reliability within the measurements; there is a greater chance of inter-observer error when measuring each artifact with calipers and it expedites the analysis. Furthermore, the debitage from the 2002 field season was analyzed using these size categories (Maher 2005:49) therefore there is continuity between the debitage analyzed for this thesis and the debitage previously analyzed. To compare length and width ratios, the complete blades from locus 005 were measured with sliding calipers to a precision of

01.mm. Each piece of debitage is also weighted on an electronic scale (precision at 0.1 grams).

SUMMARY

The method for the analysis of the 'Uyun al-Hammâm debitage takes an individual flake analysis approach (Bradbury and Carr 2004a) based on each piece's attributes combined with the hierarchical approach developed by Sullivan and Rozen (1985). The use of these two techniques allows for the highest resolution in data collection while still embracing the classifications seen in the hierarchical approach. This allows for the acceptance of distinct types within the assemblage, such as cores, flakes, blades, and shatter, while recording the variability seen within each piece. The attributes chosen for analysis relate to the production of the debitage; each attribute analyzed will help to develop the *chaîne opératoire* for 'Uyun al-Hammâm to better understand how stone tools were being produced at the site.

CHAPTER 6: ANALYSIS

THE DATA SET

The debitage assemblage from 'Uyun al-Hammâm was analyzed from January 2006-January 2007. Throughout the analysis the variability of the assemblage was tested and highlighted by analyzing each piece of debitage as an individual unit. Each of the recorded variables was analyzed to understand their relationship within the full assemblage. From this analysis, assemblage level patterns can be discerned. As outlined in Chapter 5, the purpose of the analysis is to develop an understanding of the *chaîne opératoire* for the 'Uyun al-Hammâm debitage assemblage. In order to understand the process of flint knapping at the site, numerous univariate statistical tests were run on the data set. The patterns and trends documented within the debitage assemblage offer a robust interpretation of the activities that were carried out at 'Uyun al-Hammâm.

The lithic variables tested included nominal, ordinal, and ratio values. Nominal and ordinal values were analyzed using chi-square tests and bar-graphs. Chi-square tests are able to show significance in relationships between variables measured at nominal and ordinal scales (Shennan 1988). Therefore this test was chosen to understand relationships between categorical data. Ratio values were analyzed using histograms, t-tests and regression analysis to understand relationships between variables. Histograms were used with continuous variables to enable the visual representation of the data. T-tests allow for the comparison of means between two samples, instead of populations (Madrigal 1998). Regression analysis shows the line of best fit in the sample to understand relationship between two variables (Drennan 1996).

This chapter discusses the debitage assemblage and the questions asked of the assemblage. It outlines each test that was performed to answer these specific questions and the results of analysis. Statistical analysis of lithic assemblages highlights patterns within data. These patterns can be interpreted as resulting from the actions of the people who inhabited 'Uyun al-Hammâm.

This chapter is divided into four main sections, *Flakes and Blades*, *Cores*, *Core Trimming Elements*, and *Chips and Shatter*. These sections were chosen to better facilitate an understanding of relationships within the data set. Following these sections is a discussion of the results from the combined statistical tests of each section.

Each of the sections contains a series of statistical tests analyzing the significance of relationships between variables and the frequency of types using SPSS 15.0. Each test begins with a question, followed by the initial hypothesis where appropriate, the variables chosen to address the question, the test used, and the result of the analysis. I chose to include the output for SPSS for each question, creating transparent research methods and allowing for further interpretation of the results by the reader.

THE DEBITAGE ASSEMBLAGE

The analyzed debitage assemblage consisted of 11,788 individual pieces of debitage including flakes, blades, cores, core trimming elements (CTE), chips and shatter. One burin spall was identified and classified as "Other". Table 6.1 provides the frequency of each debitage type.

Debitage Type	Frequency	Percent
Blade	3748	31.8
Chips	219	1.9
Core	116	1.0
Core Fragment	23	0.2
CTE	68	0.6
Flake	7372	62.5
Other	1	0.0
Shatter	241	2.0
Total	11788	100.0

Table 6.1 Frequency of Debitage Types

As mentioned in Chapter 5, each piece ofdebitage was identified through the hierarchical method developed by Sullivan and Rozen (1985) and analyzed following a set of criteria. These criteria were chosen specifically for each type ofdebitage. The criterion by which the assemblage was analyzed is outlined in Chapter 5 (Tables 5.2-5.4). As can be seen from the frequencies in table 6.1, flakes represent 62.5% of the overalldebitage assemblage with blades following at 31.8%. Because these two categories represent 94.3% of the completedebitage assemblage most of the questions asked in this chapter focus on understanding the variability and relationships within these categories.

FLAKES AND BLADES

FLAKE AND BLADE PORTION

Question: Is there a relationship betweendebitage type (flakes and blades) and thedebitage portion? It is my hypothesis that if tool production is taking place on site then there will be a significantly higher percentage of proximal blades in the assemblage than proximal flakes. This is because proximal ends of blades were being snapped off to

create the trapeze-rectangles. To investigate this question a cross-tabulation table was created for debitage type as the independent variable and flake/blade portion as the dependent variable (Table 6.2).

			Flake/Blade Portion			Total
			Complete	Medial/Distal	Proximal	Complete
Debitage Type	Blade	Count	510	2286	952	3748
		% within Debitage Type	13.6%	61.0%	25.4%	100.0%
	Flake	Count	1902	4492	977	7371
		% within Debitage Type	25.8%	60.9%	13.3%	100.0%
Total	Count	2412	6778	1929	11119	
	% within Debitage Type	21.7%	61.0%	17.3%	100.0%	

Table 6.2 Debitage Type (Flakes or Blades) and Portion

The null hypothesis is that there is no significant relationship between the debitage type (flake or blade) and the percent of debitage portion recovered in the archaeological record. A chi-square test was then run on the data to identify if there is a significant relationship. The results of the test suggests that there is a significant relationship between flakes, blades and their preserved portions at a p value of <0.001 (Table 6.3).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	381.649	2	<0.001
Likelihood Ratio	384.424	2	0.000
N of Valid Cases	11119		

Table 6.3 Chi-square for Debitage Type (Flakes and Blades) by Portion

The chi-square rejects the null hypothesis. This means that portion is dependent on the debitage type. As seen in the cross-tabulation table, there is a significantly higher percentage of proximal blades than flakes. This suggests that blade snapping was taking place on site for the production of tools. Also, there is a significantly lower percent of complete blades than flakes. This could also be the result of snapping for tool making.

These results coincide with the conclusions of Sullivan and Rozan (1985) that complete flakes are the result of core reduction while broken flakes are the result of tool production. This theory can be applied to the flake and blade categories. Flakes have a higher percent of complete pieces at 25.8%. In contrast, complete blades only make up 13.6% of the blade assemblage. Thus, I suggest that at 'Uyun al-Hammâm, flakes can be interpreted as the result of core reduction and blades the result of tool production.

FLAKE AND BLADE SIZE CATEGORY

Question: Is there is relationship between debitage type (complete flakes and blades) and size categories? It is my hypothesis that there will be greater variability in complete flake size than in complete blade size. This is based on the assumption that blades were produced as blanks for tool production, suggesting the need for standardization in size, while flakes are largely the result of core reduction. To test this hypothesis a cross-tabulation table was created with complete debitage type (flake or blade) as the independent variable and size category as the dependent variable (Table 6.4).

			Size Category				Total
			<2cm	2-3cm	3-5cm	>5cm	<2cm
Debitage Type	Blade	Count	89	148	223	50	510
		% within Debitage Type	17.5%	29.0%	43.7%	9.8%	100.0%
	Flake	Count	952	543	349	58	1902
		% within Debitage Type	50.1%	28.5%	18.3%	3.0%	100.0%
Total	Count		1041	691	572	108	2412
	% within Debitage Type		43.2%	28.6%	23.7%	4.5%	100.0%

Table 6.4 Complete Debitage Type (Flakes and Blades) and Size Category

The null hypothesis is that there is no significant relationship between the type of debitage and the size category. A chi-square test was done to test the null hypothesis (Table 6.5).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	249.253	3	<0.001
Likelihood Ratio	248.622	3	0.000
N of Valid Cases	2412		

Table 6.5 Chi-square of Complete Debitage Type (Flakes and Blades) by Size Category

The results of the chi-square test show that there is a significant relationship between debitage type and the size category thus falsifying the null hypothesis. Flakes show a higher percent of <2cm debitage. This small debitage would be produced during the knapping process as the result of core reduction, possibly as trimming flakes for core platform preparation (Whittaker 1994) or for other core modification. Also, they may have been flakes removed during the retouching of larger tools although small debitage is produced in very large quantities during flint knapping. The largest quantities of blades are 3-5cm in length, slightly above the size of microlith tools suggesting that the blades are being produced for tool blanks. Thus, flakes are primarily being produced during core reduction activities while blades are being produced primarily as blanks.

BLADE AND FLAKE PERCENT OF CORTEX

Question: Is there a difference between the percent of cortex between flakes and blades?

It was my hypothesis the blades would show less cortex than the flakes, indicating that, on average, the flakes were initially removed in core preparation followed by blade removal. To investigate this question a cross-tabulation table was developed with

“debitage type” (flakes and blades) as the independent variable and “percent of cortex” as the dependent variable (Table 6.6).

			Percent of Cortex					Total
			0%	1-5%	6-25%	26-50%	51-75%	
Debitage Type	Blade	Count	3354	129	181	82	2	3748
		% within Debitage Type	89.5%	3.4%	4.8%	2.2%	0.1%	100.0%
	Flake	Count	6420	291	381	273	7	7372
		% within Debitage Type	87.1%	3.9%	5.2%	3.7%	0.1%	100.0%
Total		Count	9774	420	562	355	9	11120
		% within Debitage Type	87.9%	3.8%	5.1%	3.2%	0.1%	100.0%

Table 6.6 Flakes and Blades by Percent of Cortex

The null hypothesis is that there is no significant difference between the percent of cortex found on a flake versus the percent of cortex found on a blade. A chi-square test was then run on the data to identify if there is a significant relationship between the percentage of preserved cortex on flakes and blades. The results of the test suggest that there is a significant relationship between the amount of cortex on flakes and blades with a p value of <0.001 (Table 6.7).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.280	4	<0.001
Likelihood Ratio	23.533	4	0.000
N of Valid Cases	11120		

Table 6.7 Chi-square of Flakes and Blades by Percent of Cortex

The chi-square rejects the null hypothesis. This means that the percent of cortex on debitage is dependent on the debitage type. When evaluating the frequency of each cortical category (0%, 1-5%, 6-25%, 26-50%, and 51-75%) between the flakes and the blades we witness that the frequency of cortex is consistently higher on flakes than on blades. Likewise blades have a higher frequency in the 0% category. This suggests that flakes are removed during the initial knapping stages more frequently than blades therefore showing larger percents of cortex. However, when evaluating the percents, the

strength of this relationship is not strong. During analysis I noted that the cortex on many of the blades is located on one lateral dorsal scar. This suggests that initial flakes were removed to prepare blade cores, and then subsequent blades were removed in around the core face. The blades removed from the edge still have preserved cortex as the removal surface widens around the platform.

FLAKE SIZE AND CORTEX

Question: Is there a relationship between the percent of cortex and flake size categories?

It was my hypothesis that larger flake sizes would show higher percents of cortex relative to the smaller flake sizes. This is based on the assumption that reduction follows a diminishing pattern with pieces getting progressively smaller further through the knapping sequence. To investigate this question a cross-tabulation table was developed with "size category" as the independent variable and "percent of cortex" as the dependent variable (Tables 6.8).

			Percent of Cortex					Total
			0%	1-5%	6-25%	26-50%	51-75%	0%
Size Category	<2cm	Count	4413	146	153	108	1	4821
		% within Size Category	91.5%	3.0%	3.2%	2.2%	0.0%	100.0%
	2-3cm	Count	1396	78	112	95	3	1684
		% within Size Category	82.9%	4.6%	6.7%	5.6%	0.2%	100.0%
	3-5cm	Count	546	61	99	57	3	766
		% within Size Category	71.3%	8.0%	12.9%	7.4%	0.4%	100.0%
	>5cm	Count	65	6	17	13	0	101
		% within Size Category	64.4%	5.9%	16.8%	12.9%	0.0%	100.0%
Total		Count	6420	291	381	273	7	7372
		% within Size Category	87.1%	3.9%	5.2%	3.7%	0.1%	100.0%

Table 6.8 Flake Size by Percent of Cortex

The null hypothesis is that there is no significant difference between flake size and the percent of cortex. A chi-square test was then run on the table test this significance. The results of the test suggest that there is a significant relationship between the flake size and the percent of cortex with a p value of <0.001 (Table 6.9).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	354.969	12	<0.001
Likelihood Ratio	303.846	12	0.000
N of Valid Cases	7372		

Table 6.9 Chi-square of Flake Size by Percent of Cortex

The chi-square rejects the null hypothesis. This means that the percent of cortex on flakes is dependent on the size of the flake, with table 6.8 showing an increase in the percentage of cortex as the size of the flake increases. The $<2\text{cm}$ size category has 8.4% of the pieces with observed with cortex, 2-3cm has 17.1% cortex, 3-5cm has 28.7% cortex, and $>5\text{cm}$ has 35.6% cortex. Through this observation it can be inferred that larger flakes are initially removed during core preparation followed by smaller flakes with continued core reduction.

BLADE SIZE AND CORTEX

Question: Is there a relationship between the percent of preserved cortex and blade size?

It was my hypothesis that the larger blade sizes would show higher percents of preserved cortex relative to the smaller ones based on the same assumption as the flakes. To investigate this question a cross-tabulation table was developed with "size category" as the independent variable and "percent of cortex" as the dependent variable (Table 6.10).

			Percent of Cortex					Total
			0%	1-5%	6-25%	26-50%	51-75%	0%
Size Category	<2cm	Count	1999	40	76	32	1	2148
		% within Size Category	93.1%	1.9%	3.5%	1.5%	0.0%	100.0%
	2-3cm	Count	817	42	40	24	0	923
		% within Size Category	88.5%	4.6%	4.3%	2.6%	0.0%	100.0%
	3-5cm	Count	474	44	55	21	1	595
		% within Size Category	79.7%	7.4%	9.2%	3.5%	0.2%	100.0%
	>5cm	Count	64	3	10	5	0	82
		% within Size Category	78.0%	3.7%	12.2%	6.1%	0.0%	100.0%
Total		Count	3354	129	181	82	2	3748
		% within Size Category	89.5%	3.4%	4.8%	2.2%	0.1%	100.0%

Table 6.10 Blade Size by Percent of Cortex

The null hypothesis is that there is no significant difference between blade size and the percent of cortex. A chi-square test demonstrates that there is a significant relationship between the blade size and the percent of cortex (Table 6.11).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	115.930(a)	12	<0 .001
Likelihood Ratio	103.077	12	0.000
N of Valid Cases	3748		

Table 6.11 Chi-square of Blade Size by Percent of Cortex

The chi-square suggests that the null hypothesis is false. The percent of cortex on blades is dependent on the size of the blade with an increase in the amount of cortex as the size of the blade gets bigger (Table 6.12). Of the pieces observed with cortex, the <2cm category has 6.9% of pieces with cortex, 2-3cm has 11.5% cortex, 3-5cm has 20.3% cortex, and >5cm has 22.0% of pieces with cortex. Similar to flakes, I infer that initially

larger blades are removed followed by smaller blades as the reduction continued. Thus larger blades are removed to create the initial core shape, with blades at the edge of the removal face having some cortex. The decreasing size of the removals reflects the decreasing size of the core, at which point more of the cortex would be removed.

FLAKE RAW MATERIAL

Question: What is the distribution of raw material type within the flake debitage category? To investigate this question a frequency table was developed to illustrate the percentage of flake raw material type (Table 6.12).

Raw Material	Frequency	Percent
Coarse, tan	120	1.6
Coarse, white	95	1.3
Fine, dark-brown	93	1.3
Fine, light-brown	2541	34.5
Fine, light grey-tan	103	1.4
Fine, medium-brown	1236	16.8
Fine, medium-grey	168	2.3
Fine, red-brown	165	2.2
Fine, tan	126	1.7
Very-fine, dark-brown	152	2.1
Very-fine, medium-brown	150	2.0
Very-fine, orange	73	1.0
Very-fine, red-brown	214	2.9
Very-fine, red	46	0.6
Other	789	10.7
Unknown	1301	17.6
Total	7372	100.0

Table 6.12 Flake Raw Material Distribution

As can be seen in Appendix B, Table 3 there is a great deal of variability in raw material types. The range of raw material use is extremely varied, suggesting that numerous types

of materials were used for flint knapping activities. However, this variability obscures the patterns seen in the more frequently used raw material categories. Thus, every raw material category that represents less than 1% of the overall flake assemblage was lumped into the “Other” category. The “Unknown” category consists of pieces whose raw material identification is obscured by post-depositional alterations or burning. The information in the frequency table is displayed in a bar graph to illustrate the percent of raw material in flakes (Figure 6.1).

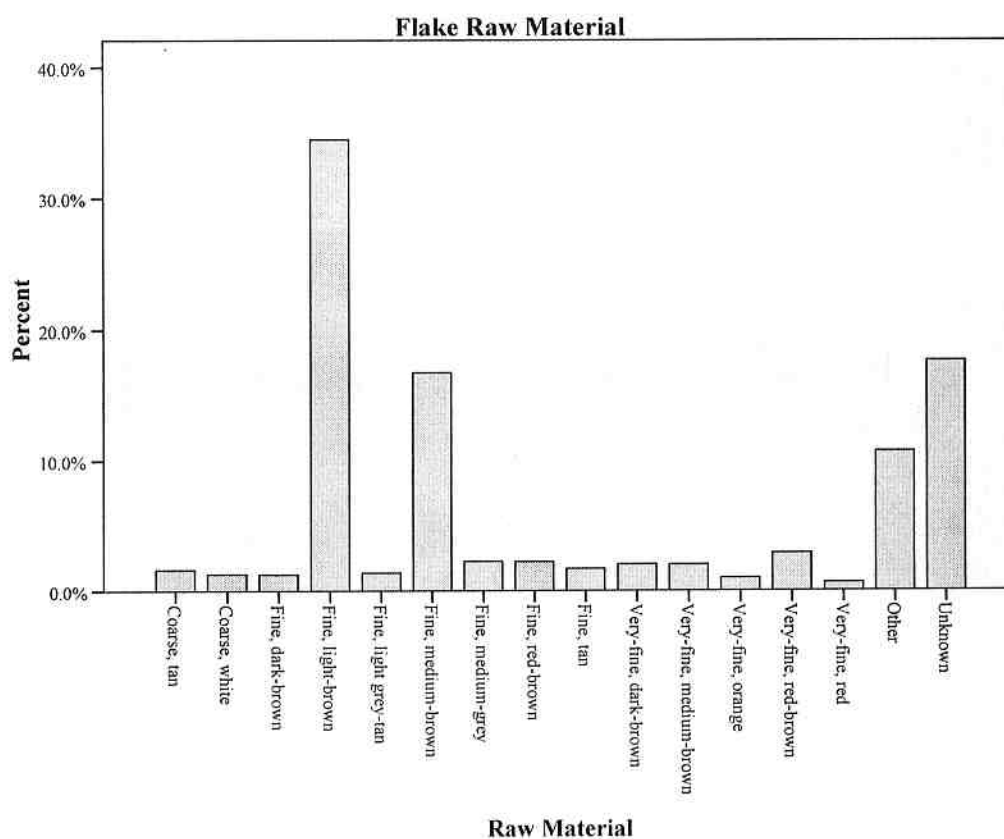


Figure 6.1 Distribution of Flake Raw Material

As this bar-graph illustrates, the raw material most frequently used for flake production is the fine, light-brown flint. Coarse raw materials represent 2.9% of the over all

assemblage. Fine raw materials represent 60.2% and very-fine raw materials represent 8.6%. Other categories of rarely used material are 10.7% and material that can not be identified are 17.6% of the assemblage. Fine materials, which are available in near-by flint outcrops, appear to be the most popular raw materials for flake production. Their homogenous structure makes them easy for flint knapping and the ubiquity of fine nodules in Wadi Ziqlab means that people were utilizing the local resources for the majority of their activities.

BLADE RAW MATERIAL

Question: What is the distribution of raw material type within the blade debitage category? To investigate this question a frequency table was developed to illustrate blade raw material types, their frequency within the blade category and raw material's percent within the variability of material types (Table 6.13).

Raw Material	Frequency	Percent
Fine, dark-brown	51	1.4
Fine, light-brown	1615	43.1
Fine, light grey-tan	48	1.3
Fine, medium-brown	768	20.5
Fine, medium-grey	78	2.1
Fine, red-brown	82	2.2
Fine, tan	78	2.1
Other	322	8.6
Unknown	374	10.0
Very-fine, dark-brown	78	2.1
Very-fine, light-brown	19	0.5
Very-fine, medium-brown	75	2.0
Very-fine, orange	46	1.2
Very-fine, red-brown	114	3.0
Total	3748	100.0

Table 6.13 Blade Raw Material Distribution

As with the flakes, there is considerable variability seen in the raw materials. Thus, every raw material category that represents less than 1% of the overall blade assemblage was lumped into the “Other” category. The “Unknown” category consists of pieces whose raw material identification is obscured by post-depositional alterations or burning. The information in the frequency table is displayed in a bar graph to illustrate the percent of raw material in blades (Figure 6.2).

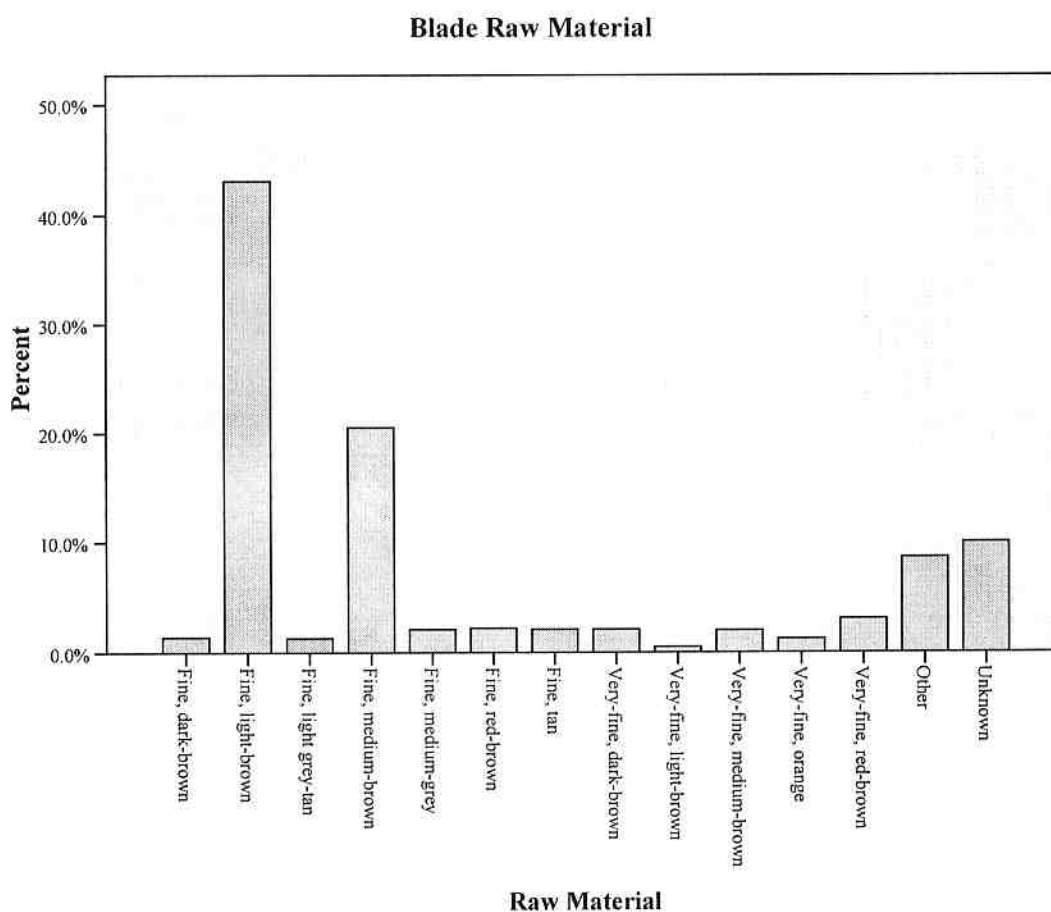


Figure 6.2 Distribution of Blade Raw Material

Similar to the distribution of flake raw material, the most frequent raw material for blade production is fine, light-brown flint. However, unlike the flakes, coarse materials are not represented in the raw material. Fine materials represent 72.7% of the blade assemblage. Very-fine materials are 8.8% of the blade assemblage. Rarely used materials that have been lumped into the “Other” category are 8.6% and unidentifiable materials represent 10.0% of the assemblage. When comparing blades to the flake raw material distribution to blade raw material, a difference can be seen. Fine and very fine categories have similar distributions and percentages within the two categories; however coarse raw materials are not represented in the assemblage at all. This suggests that finer quality raw material is preferred for blade production while flake production does not require the same level of quality. The differences in raw material selections for blades and flakes suggests that flakes production was undertaken both for the preparation of bladelet cores, in the fine and very-fine raw materials, and also for the production of flakes as the target removal, in the coarse raw material category.

FLAKES AND BLADES RAW MATERIAL

Question: Is the relationship between the debitage type (flake or blade) and the type of raw material significant? To investigate this question a cross-tabulation table was developed with “debitage type” (flake or blade) as the independent variable and “raw material” as the dependent variable (Table 6.14).

		Raw Material														Total		
		Coarse, tan	Coarse, white	Fine, dark-brown	Fine, light grey-tan	Fine, light-brown	Fine, medium-brown	Fine, medium-grey	Fine, red-brown	Fine, tan	Very-fine, dark-brown	Very-fine, light-brown	Very-fine, medium-brown	Very-fine, orange	Very-fine, red	Very-fine, red-brown		
Debitage Type (DT)	Blade	Count	0	0	51	48	1615	768	78	82	78	78	19	75	46	0	114	3052
	% within DT		.0%	.0%	1.7%	1.6%	52.9%	25.2%	2.6%	2.7%	2.6%	2.6%	.6%	2.5%	1.5%	.0%	3.7%	100.0%
Flake	Count	120	95	93	103	2541	1236	168	165	126	152	0	150	73	46	214	5282	
	% within DT	2.3%	1.8%	1.8%	2.0%	48.1%	23.4%	3.2%	3.1%	2.4%	2.9%	.0%	2.8%	1.4%	.9%	4.1%	100.0%	
Total	Count	120	95	144	151	4156	2004	246	247	204	230	19	225	119	46	328	8334	
	% within DT	1.4%	1.1%	1.7%	1.8%	49.9%	24.0%	3.0%	3.0%	2.4%	2.8%	.2%	2.7%	1.4%	.6%	3.9%	100.0%	

Table 6.14 Debitage Type (Flake or Blade) and Raw Material

The null hypothesis is that there is no significant relationship between debitage type and raw material. The results of a chi-square test show that there is a significant relationship between the type of debitage (flake or blade) and the types of raw material (Table 6.15).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	203.288	14	<0.001
Likelihood Ratio	295.860	14	0.000
N of Valid Cases	8334		

Table 6.15 Chi-square of Flakes and Blades by Raw Material

The chi-square rejects the null hypothesis. This means that the raw material is dependent on the type of debitage and the visual differences seen in the bar graphs are supported. Fine materials were selected for blade production while a greater variety of raw materials were chosen for flake production.

FLAKES- PERCENT OF CORTEX AND RAW MATERIAL

Question: Do different raw material categories have larger percentages of cortex? To investigate this question a cross-tabulation table was developed with "raw material" as the independent variable and "percent of cortex" as the dependent variable. This cross-

tabulation table is given in Appendix B, Table 3. The null hypothesis is that there is no significant relationship between raw material and the percent of cortex. A chi-square test was then run to test this significance. The results of the test show that there is a significant relationship between raw material and the percent of cortex with a p value of $<.001$ (Table 6.16).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	759.050	372	< 0.001
Likelihood Ratio	606.209	372	0.000
N of Valid Cases	7372		

Table 6.16 Chi-square for Flake Raw Material and Percent of Cortex

The chi-square rejects the null hypothesis. This means that the percent of cortex on flakes is dependent on the raw material type. However, because of the great variability in raw material types for flakes, patterns in the data are hard to see. Therefore, all of the raw material that represents $<1\%$ of the data was collapsed into an “Other” category to better see the patterns in the frequently used raw materials (Table 6.17).

			Percent of Cortex					Total
			0%	1-5%	6-25%	26-50%	51-75%	0%
Raw Material	Coarse, tan	Count	110	4	3	2	1	120
		% within Raw Material	91.7%	3.3%	2.5%	1.7%	0.8%	100.0%
	Coarse, white	Count	91	3	1	0	0	95
		% within Raw Material	95.8%	3.2%	1.1%	0.0%	0.0%	100.0%
	Fine, dark-brown	Count	70	5	7	9	0	91
		% within Raw Material	76.9%	5.5%	7.7%	9.9%	0.0%	100.0%
	Fine, grey-brown	Count	58	5	5	2	0	70
		% within Raw Material	82.9%	7.1%	7.1%	2.9%	0.0%	100.0%
	Fine, light grey-tan	Count	90	3	8	1	0	102
		% within Raw Material	88.2%	2.9%	7.8%	1.0%	0.0%	100.0%

Fine, light-brown	Count	2339	90	67	44	1	2541
	% within Raw Material	92.1%	3.5%	2.6%	1.7%	0.0%	100.0%
Fine, medium-brown	Count	982	71	100	81	2	1236
	% within Raw Material	79.4%	5.7%	8.1%	6.6%	0.2%	100.0%
Fine, medium-grey	Count	136	7	15	9	1	168
	% within Raw Material	81.0%	4.2%	8.9%	5.4%	0.6%	100.0%
Fine, red-brown	Count	112	12	20	21	0	165
	% within Raw Material	67.9%	7.3%	12.1%	12.7%	0.0%	100.0%
Fine, tan	Count	112	6	7	1	0	126
	% within Raw Material	88.9%	4.8%	5.6%	0.8%	0.0%	100.0%
Other	Count	731	27	65	40	1	864
	% within Raw Material	84.6%	3.1%	7.5%	4.6%	0.1%	100.0%
Unknown	Count	1225	21	26	29	0	1301
	% within Raw Material	94.2%	1.6%	2.0%	2.2%	0.0%	100.0%
Very-fine, dark-brown	Count	104	14	19	10	1	148
	% within Raw Material	70.3%	9.5%	12.8%	6.8%	0.7%	100.0%
Very-fine, medium-brown	Count	106	12	19	11	0	148
	% within Raw Material	71.6%	8.1%	12.8%	7.4%	0.0%	100.0%
Very-fine, red-brown	Count	154	11	19	13	0	197
	% within Raw Material	78.2%	5.6%	9.6%	6.6%	0.0%	100.0%
Total	Count	6420	291	381	273	7	7372
	% within Raw Material	87.1%	3.9%	5.2%	3.7%	0.1%	100.0%

Table 6.17 Flake Raw Material with “Other” Category and Percent of Cortex

A chi-square test was then run on the new cross-tabulation table to see if there is still a significant relationship between flake raw material and percent of cortex. The results of the chi-square show that there is still a significant relationship with a p value of <0.001 (Table 6.18).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	411.828(a)	56	<0.001
Likelihood Ratio	387.422	56	0.000
N of Valid Cases	7372		

Table 6.18 Chi-square of Flake Raw Material with “Other” Category by Percent of Cortex

Looking at the cross-tabulation table, all of the very-fine categories of raw material show higher percents of cortex than other categories. Interestingly, these very-fine material are not located in Wadi Ziqlab, but many are from neighboring river valleys. This suggests that these raw materials are being transported to ‘Uyun al-Hammâm in nodule form, with the cortex, for reduction at the site.

BLADES- PERCENT OF CORTEX AND RAW MATERIAL

The previous test was also run on the blade category. The question asked was: is there a relationship between the percent of cortex and different blade raw material categories? To investigate this question a cross-tabulation table was developed with “raw material” as the independent variable and “percent of cortex” as the dependent variable. This cross-tabulation table is given in Appendix B, Table 4. The null hypothesis is that there is no significant relationship between raw material and the percent of cortex. A chi-square test proved that there is a significant relationship between raw material and the percent of cortex with a p value of <0.001 (Table 6.19).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	530.836(a)	272	<0 .001
Likelihood Ratio	298.776	272	0.127
N of Valid Cases	3748		

Table 6.19 Chi-square for Blade Raw Material and Percent of Cortex

The chi-square rejects the null hypothesis. This means that the percent of cortex on blades is dependent on the raw material type. Like the flakes, there is considerable variability within the blade category of raw material. In order to facilitate the interpretation, each raw material that represents <1% of the overall blade assemblage was collapsed into an “Other” category. A cross-tabulation table 6.20 shows the percentages of raw material with the “Other” category.

		Percent of Cortex					Total	
		0%	1-5%	6-25%	26-50%	51-75%	0%	
Raw Material	Fine, dark-brown	Count	40	4	4	2	1	51
	% within Raw Material	78.4%	7.8%	7.8%	3.9%	2.0%	100.0%	
	Fine, light grey-tan	Count	46	0	2	0	0	48
	% within Raw Material	95.8%	0.0%	4.2%	0.0%	0.0%	100.0%	
	Fine, light-brown	Count	1517	47	34	17	0	1615
	% within Raw Material	93.9%	2.9%	2.1%	1.1%	0.0%	100.0%	
	Fine, medium-brown	Count	644	41	56	27	0	768
	% within Raw Material	83.9%	5.3%	7.3%	3.5%	0.0%	100.0%	
	Fine, medium-grey	Count	69	3	4	2	0	78
	% within Raw Material	88.5%	3.8%	5.1%	2.6%	0.0%	100.0%	
	Fine, red-brown	Count	64	6	9	3	0	82
	% within Raw Material	78.0%	7.3%	11.0%	3.7%	0.0%	100.0%	
	Fine, tan	Count	75	3	0	0	0	78
	% within Raw Material	96.2%	3.8%	0.0%	0.0%	0.0%	100.0%	
	Other	Count	296	6	29	16	1	348
	% within Raw Material	85.1%	1.7%	8.3%	4.6%	0.3%	100.0%	
	Unknown	Count	355	2	14	3	0	374
	% within Raw Material	94.9%	0.5%	3.7%	0.8%	0.0%	100.0%	
	Very-fine, dark-brown	Count	65	2	8	2	0	77
	% within Raw Material	84.4%	2.6%	10.4%	2.6%	0.0%	100.0%	
Very-fine, medium-brown	Count	66	2	4	3	0	75	
% within Raw Material	88.0%	2.7%	5.3%	4.0%	0.0%	100.0%		
Very-fine, orange	Count	39	2	4	1	0	46	

	% within Raw Material	84.8%	4.3%	8.7%	2.2%	0.0%	100.0%
Very-fine, red-brown	Count	77	11	13	6	0	107
	% within Raw Material	72.0%	10.3%	12.1%	5.6%	0.0%	100.0%
Total	Count	3353	129	181	82	2	3747
	% within Raw Material	89.5%	3.4%	4.8%	2.2%	0.1%	100.0%

Table 6.20 Blade Raw Material with "Other" Category and Percent of Cortex

A new chi-square test was run on the collapsed categories. The results of this chi-square are still significant (Table 6.21).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	212.826(a)	52	<0.001
Likelihood Ratio	184.672	52	0.000
N of Valid Cases	3748		

Table 6.21 Chi-square of Blade Raw Material with "Other" Category by Percent of Cortex

The overall percentages of cortex are lower than those for the flake category.

Interestingly, the very-fine categories of blade raw material show lower percentages of cortex than the flake categories. However, the very-fine, red-brown category shows higher percents of cortex in the blade category than the flake. This shows that the knapping sequence for this raw material category is different than the others, with blades and flakes both being removed at the beginning of the sequence.

FLAKE AND BLADE PLATFORM TYPES

Question: Is there a relationship between debitage type (flake or blade) and striking platform type? It was my hypothesis that flakes will show a higher percent of cortical platforms indicating their initial removal in the reduction sequence. To test this hypothesis a cross-tabulation table was created with debitage type (flake or blade) as the independent variable and striking platform type as the dependent variable (Table 6.22).

		Striking Platform Type						Total	
		Abraded	Broken	Cortical	Faceted	Other	Single		
Debitage Type	Blade	Count	1	45	5	519	5	892	1467
		% within Debitage Type	0.1%	3.1%	0.3%	35.4%	0.3%	60.8%	100.0%
	Flake	Count	3	127	82	976	15	1680	2883
		% within Debitage Type	0.1%	4.4%	2.8%	33.9%	0.5%	58.3%	100.0%
Total	Count		4	172	87	1495	20	2572	4350
	% within Debitage Type		0.1%	4.0%	2.0%	34.4%	0.5%	59.1%	100.0%

Table 6.22 Debitage Type (Flakes and Blades) and Striking Platform Type

A chi-square test was done to test the significance of the relationship between debitage type and striking platform. The results of this analysis are in Table 6.23.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.395	5	<0.001
Likelihood Ratio	47.215	5	0.000
N of Valid Cases	4350		

Table 6.23 Chi-square of Debitage Type (Flake and Blade) by Striking Platform

The chi-square test shows that there is a significant relationship between debitage type (flake or blade) and the striking platform. When evaluating the cross-tabulation table it can be seen that flakes have a significantly higher percent of cortical platforms thus proving the initial hypothesis.

FLAKE AND BLADE- PLATFORM WIDTH

Question: Is there a significant relationship between the mean blade platform width and the mean flake platform width? It was my initial hypothesis that blade platforms would have a significantly smaller mean if they were made later in the reduction sequence. To

test this hypothesis histograms were made for both blade platform width (Figure 6.3) and flake platform width (Figure 6.4) omitting the broken platforms.

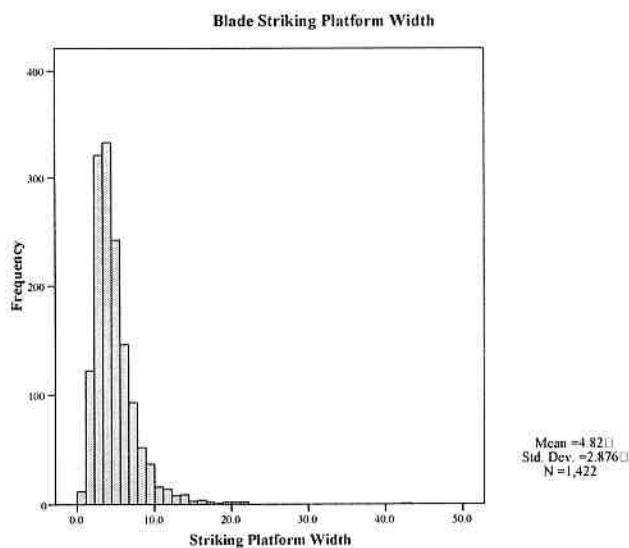


Figure 6.3 Blade Striking Platform Width

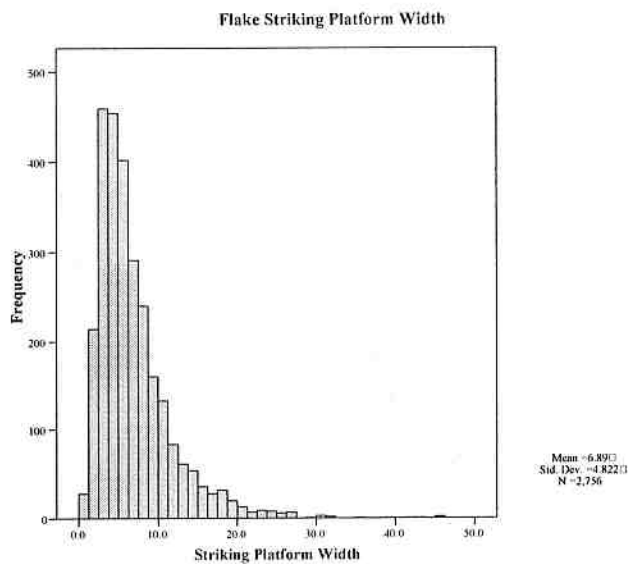


Figure 6.4 Flake Striking Platform Width

Debitage Type		N	Mean	Std. Deviation	Std. Error Mean
Striking Platform Width	Flake	2756	6.9	4.8	0.0919
	Blade	1422	4.8	2.9	0.0763

Table 6.24 Statistics of Flake and Blade Platform Widths

The results show that the mean for flakes, 6.9 mm, is higher than the mean for blades 4.8 mm. This suggests that the initial hypothesis was correct; flakes have a larger platform size suggesting that they were removed prior to blades in the reduction sequence. A t-test was run to test the significance between the two means, to lend support to the interpretation that the difference is significant and not the result of error (Table 6.25).

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Upper	Lower
Striking Platform Width	Equal variances assumed	226.758	0.000	14.916	4176	0.000	2.0751	0.1391	1.8024	2.3479
	Equal variances not assumed			17.382	4092.298	0.000	2.0751	0.1194	1.8411	2.3092

Table 6.25 T-test Results for Flake and Blade Platform Widths

The two-tailed significance test shows that the p value is $<.001$, meaning that there is a significant difference between the mean platform width for flakes and the mean platform width for blades.

BURNING BETWEEN FLAKES AND BLADES

Question: Are flakes burned more than blades? It was my hypothesis that flakes would be burned more than blades. Working under the assumption that flakes are removed first in the flint knapping sequence, the raw material that produces flakes would be subjected

to heat treatment because it forms the outside of the nodule. To investigate this question a cross-tabulation table was created with debitage type (flake or blade) as the independent variable and burning as the dependent variable (Table 6.26)

			Burning		Total
			No	Yes	
Debitage Type	Blade	Count	3374	374	3748
		% within Debitage Type	90.0%	10.0%	100.0%
	Flake	Count	6035	1337	7372
		% within Debitage Type	81.9%	18.1%	100.0%
Total	Count		9409	1711	11120
	% within Debitage Type		84.6%	15.4%	100.0%

Table 6.26 Debitage Type (Flake or Blade) and Burning

A chi-square test was run to see if there is a significant relationship between type of debitage and burning (Table 6.27). The null hypothesis was that there is no significant relationship.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	127.003(b)	1	<0 .001		
Continuity Correction(a)	126.377	1	0.000		
Likelihood Ratio	135.045	1	0.000		
Fisher's Exact Test				0.000	0.000
N of Valid Cases	11120				

Table 6.27 Chi-square of Debitage Type (Flake or Blade) by Burning

The chi-square rejects the null hypothesis, there is a significant relationship between debitage types (flake or blade) and presence of burning. The cross-tabulation table shows that 18.1% of the flake assemblage shows evidence for burning, while 10.0% of the blade assemblage showed evidence. Thus, the initial hypothesis was supported. If thermal alteration is a stage in the flint knapping sequence then the raw material on the external portion of the core would show more evidence of burning (crazing, pot-lid

fractures) then the internal portions. One possible interpretation of the higher percent of flake burning could be that these pieces are removed before blade removal. Another interpretation is that the burning is not the result of intentional heat treatment but the result of accidental placement of lithic material in or near a fire, and action that could be either intentional or unintentional. This interpretation suggests the flint knapping flakes were deposited near the fire slightly more often than blades. However, to date there have not been any hearths discovered at 'Uyun al-Hammâm. If blades are being used as blanks for tool production, and flakes primarily as core reduction, then perhaps the flakes are being swept into fires while cleaning up debris.

BLADE LENGTH AND WIDTH

Question: Is there a relationship between blade length and width? It was my hypothesis that blade length and width would increase at the same rate creating a consistent dimension ratio. Length of complete blades was chosen as the independent variable and blade width was chosen as the dependent variable. Based on the definition of a blade, the length to width ratio has to be over 2.5, with the length 2.5 times as long as the width. Using this measurement as a zero point, the relationship between length and width can be calculated to understand the degree of dependence between the two variables. Linear regression analysis was chosen to show the relationship between the two ratio variables (Figure 6.5).

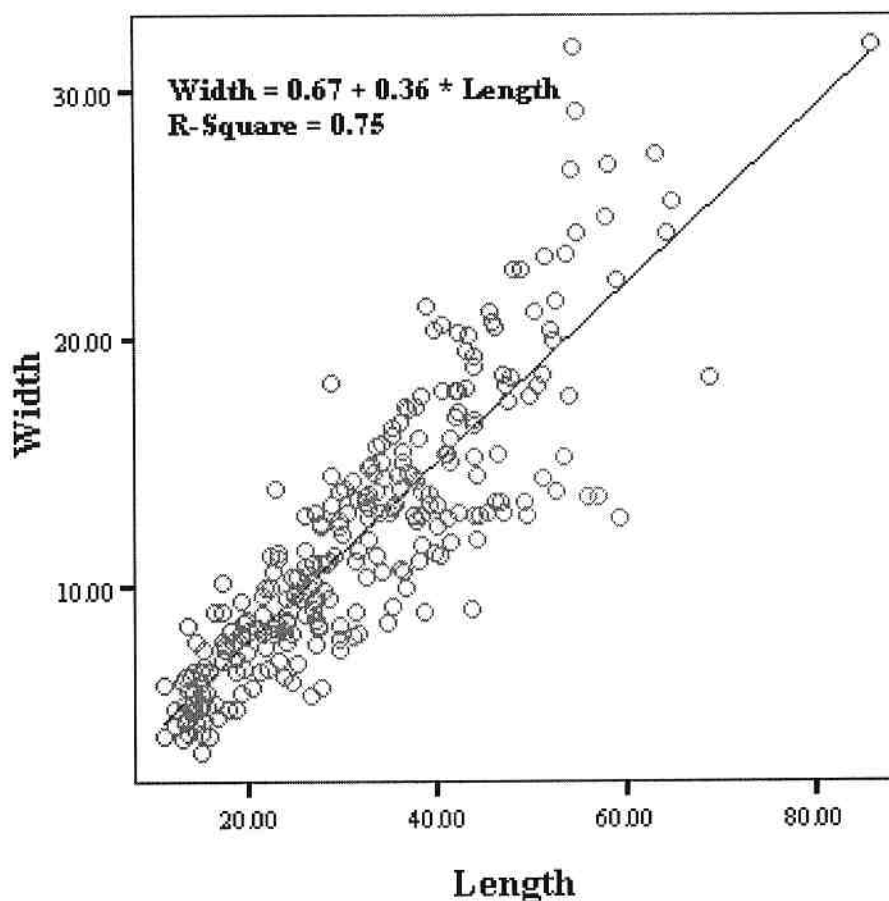


Figure 6.5 Linear Regression for Blade Length and Width

The results of the regression analysis showed there was a significant relationship between blade width and blade length. An r-square value of 0.75 indicates that 75% of the distribution in width measurements can be explained by the length of the blade. This shows a very strong relationship between length and width of complete blades. Mean blade length is 32.2 mm and the mean of blade width is 12.2 mm, demonstrating that, on average, blades are 2.6 times long then they are width. Thus the debitage of 'Uyun al-Hammâm shows continued choice for the production of blades slightly larger then the defined dimensions.

BLADE LENGTH

Question: Is there a standard size of blade length? It was my hypothesis that the length of complete blades would represent a bimodal distribution, with one mode around 20mm with an inter-quartile range of 7mm, representing blades produced for microliths². The other mode is hypothesized to be around 58 mm, with an inter-quartile range of 20mm, representing blades produced for large tools³. The frequency of blade length was plotted on a histogram to see the distribution of size (Figure 6.6).

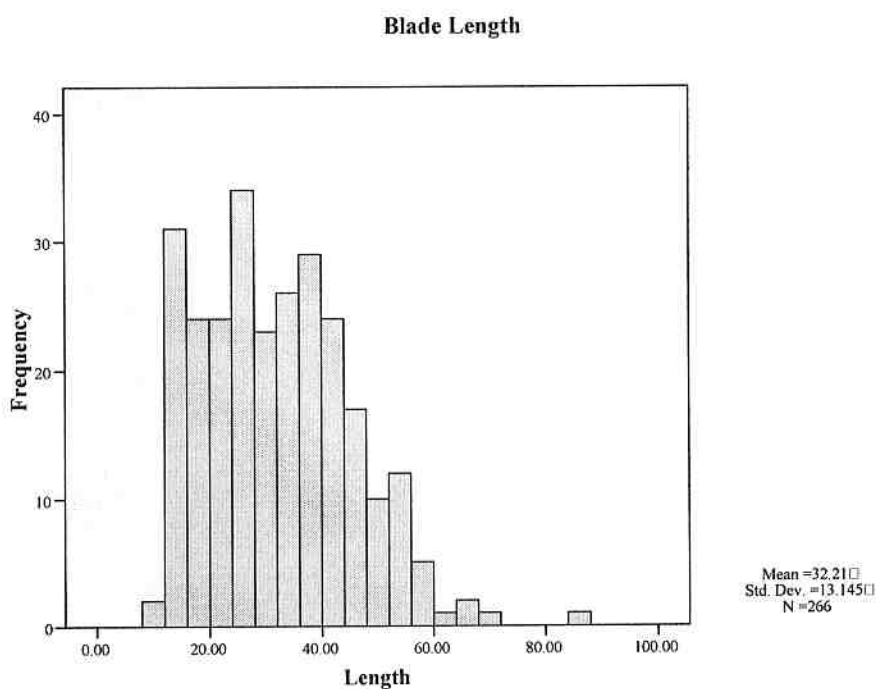


Figure 6.6 Blade Length

² These measurements are from the mean length and range of trapeze-rectangles analyzed from the 2002 and 2005 excavations.

³ These measurements are from the mean length and range of complete blade tools analyzed from the 2002 and 2005 excavations.

The results of the test showed that the histogram is not bimodal as predicted.

The distribution shows that the majority of the blades made at 'Uyun al-Hammâm were made for the production of microlith tools, and not for large blade tools. Furthermore, because of the large ranges in the two tool types there appear to be no strict mental template or standard size for either the trapeze-rectangles or the larger blade tools. The smaller blades show increased production of blades of 24-28mm, a measurement just about the inter-quartile range for trapeze rectangles of 7mm. This suggests that because the ends of the blades were being snapped off for the production of the trapeze-rectangles the majority of blade production was slightly larger than the size of the finished tool.

TRAPEZE-RECTANGLE LENGTH AND BLADE LENGTH

Question: Is there a relationship between the length of trapeze-rectangles and the length of blades? I hypothesize that blades will show a significantly higher mean than the trapeze-rectangles due to snapping during manufacture. The means for both the trapeze-rectangle length and blade length were calculated (Table 6.28).

	N	Mean	Std. Deviation	Std. Error Mean
Tool Maximum Length (mm)	124	20.2	5.4	0.4880
Debitage Maximum Length (mm)	266	32.2	13.1	0.8060

Table 6.28 Statistics for Trapeze-Rectangle Maximum Length and Blade Maximum Length

A t-test was then run on the means to see if the difference perceived between the two is significant (Table 6.29). The two-tailed significance test shows that the results are significant at <0.001 .

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Tool Maximum Length (mm)	41.5	123	<0.001	20.2	19.3	21.2
Debitage Maximum Length (mm)	39.9	265	0.000	32.2	30.6	33.8

Table 6.29 T-test for Trapeze-Rectangle Maximum Length and Blade Maximum Length

These results suggest that on average, 12mm of the blade would be snapped off to create the trapeze-rectangle. Thus, 6mm from the proximal end and from the distal end would be removed to transform a blade into a tool. Although not all of the blades were used to produce trapeze-rectangle microliths, they represent over 46% of the tool assemblage, including flake tools, suggesting that the majority of the blades were produced for the production of trapeze-rectangles.

CORES

CORE TYPE

Question: Are the final removals on the core from blades or flakes? It was my hypothesis that there would be a higher frequency of blade cores than flake cores, because of the belief that flakes were being used for initial raw reduction and blades were the intended target. This is based on the earlier evidence that blades have significantly lower percentages of cortex, placing later in the reduction sequence. A frequency table was made for the type of core removals (Table 6.30)

Type	Frequency	Percent
Blade Removals	63	54.3
Flake Removals	53	45.7
Total	116	100.0

Table 6.30 Frequency Table for Type of Core Removal

This table shows that blades are more likely to be the final removals. However, 45.7% of the assemblage are flake cores. This suggests that flakes were also the intended target for removal, although slightly less often.

CORE SHAPE

Question: Does core shape predict the type of removal (flake or blade)? The hypothesis is that flakes will have a higher percent of amorphous cores while blades will have a stronger relationship with sub-pyramidal/pyramidal and wedge shaped cores. This is because the production of microliths requires the preparation of core shape to produce standardized blade shape. To test this hypothesis a cross-tabulation table was generated with removal type (flake or blade) as the independent variable and core shape as the dependent variable (Table 6.31).

Core Type		Core Shape				Total
		Amorphous	Other	Sub-pyramidal/ pyramidal	Wedge	
Blade	Count	3	7	37	16	63
	% within Core Type	4.8%	11.1%	58.7%	25.4%	100.0%
Flake	Count	33	6	14	0	53
	% within Core Type	62.3%	11.3%	26.4%	0.0%	100.0%
Total	Count	36	13	51	16	116
	% within Core Type	31.0%	11.2%	44.0%	13.8%	100.0%

Table 6.31 Core Type (Flake or Blade) and Core Shape

A chi-square test was run on the table to see if there is a significant difference between removal type and core shape (Table 6.32). The null hypothesis is that there is no relationship between the type of removal and the core shape.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	50.966	3	<0.001
Likelihood Ratio	61.405	3	0.000
N of Valid Cases	116		

Table 6.32 Chi-square of Core type (Flake or Blade) and Core Shape

The results of the chi-square show that there is a significant relationship between the core type and the core shape with a p value of <0.001 . As predicted flakes have a tendency towards amorphous cores while blades have a tendency towards sub-pyramidal/pyramidal and wedge shaped cores. Amorphous cores are so named because there is no pattern to the removals. The high percent of flake amorphous flake cores shows that there was no predetermined template for the shape of flakes, therefore no specific core shape was needed in preparation of creating flakes. In contrast, the blades are from cores which require preparation in order to produce the desired length and width of cores. The distribution above suggests that the sub-pyramidal/pyramidal cores were the most popular for producing bladelets. These cores allow for the removal of blades from 360° around the platform, thus maximizing the number of blades that could be removed from each core.

CORES- RAW MATERIAL

Question: What is the variability in core raw material of types? To investigate this question a frequency table was constructed to illustrate the raw material types for cores and their frequency within the core category (Table 6.33). The raw material type for cores was plotted on a bar graph to see the relative frequency of types within the core category (Figure 6.7).

Raw Material	Frequency	Percent
Coarse, grey	1	0.9
Coarse, tan	2	1.7
Coarse, white	3	2.6
Fine, dark-grey	1	0.9
Fine, grey	4	3.4
Fine, light-brown	36	31.0
Fine, light-grey	4	3.4
Fine, medium-brown	31	26.7
Fine, medium-grey	4	3.4
Fine, mottled-grey	1	0.9
Fine, pink-brown	1	0.9
Fine, red-brown	1	0.9
Fine, tan-pink	1	0.9
Fine, tan	2	1.7
Fine, white	2	1.7
Very-fine, brown	1	0.9
Very-fine, brown with yellow strips	1	0.9
Very-fine, dark-brown	3	2.6
Very-fine, grey	2	1.7
Very-fine, light-brown	1	0.9
Very-fine, medium-brown	9	7.8
Very-fine, red-brown	1	0.9
Unknown	4	3.4
Total	116	100.0

Table 6.33 Frequency of Core Raw Material Types

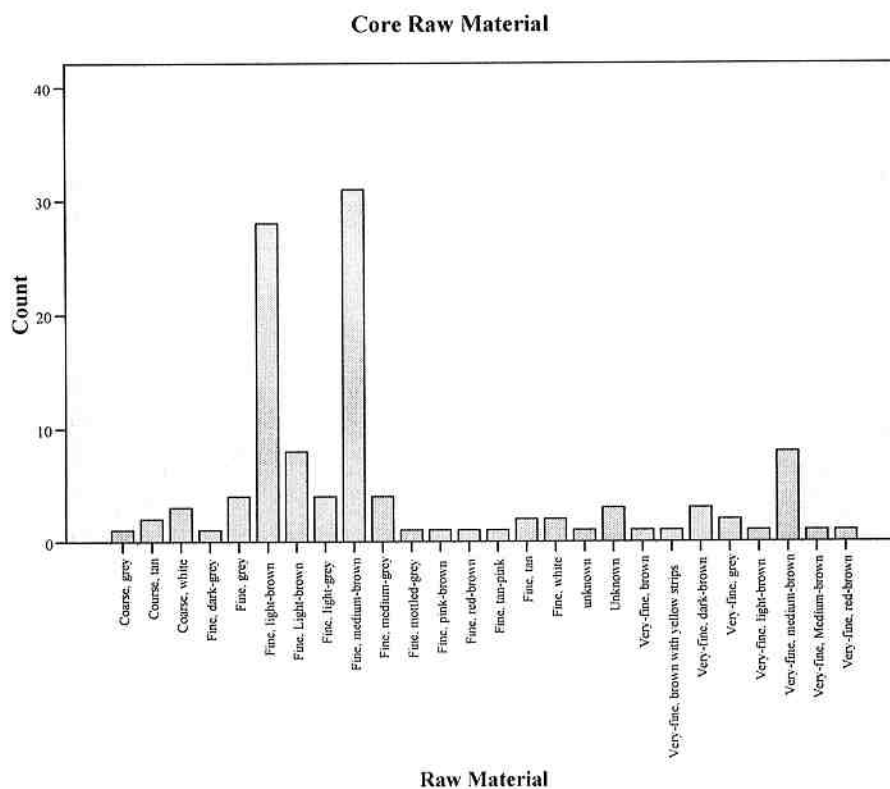


Figure 6.7 Raw Material Categories for the Core Assemblage

The fine, light-brown category represents the largest percentage of cores, 26.7%, correlating with the largest raw material category for flakes and blades at 34.5% and 43.1% respectively. The very-fine categories of raw material are expressed in the core sample as well, suggesting the complete nodules were brought to site (as seen in the raw material and cortex tests) and then the full reduction sequence took place on site.

CORE ABANDONMENT

Question: Why were cores abandoned? It was my hypothesis many cores would be abandoned due to hinged terminations and exhaustion. A bar graph was made to answer this question (Figure 6.8).

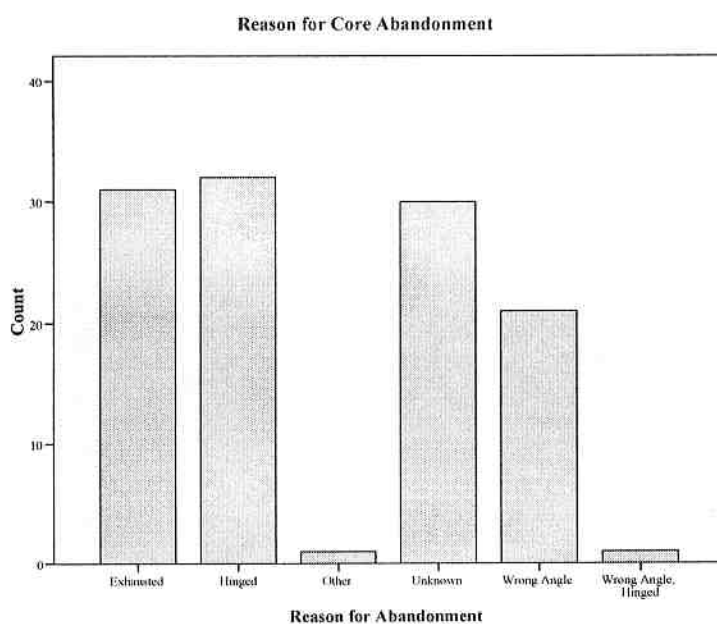


Figure 6.8 Reason for Core Abandonment

The main difference between hinged, wrong angled and exhausted cores is that the first two have the potential to be rejuvenated by the removal of a core tablet. Exhausted cores have no potential for further use. The results show that there is little difference for abandonment between the percentage of exhausted, hinged and unknown abandonment. This suggests that there is no consistent reason to discard a core. Furthermore, the high percent of unknown abandonment suggests that there was little reason to curate cores. Thus, the large quantity of available raw material suggests that the inhabitants of 'Uyun al-Hammâm had no reason to conserve raw materials.

CORE MAXIMUM FACET LENGTH

What is the size of the final core removals? I hypothesize that the final removals on the cores will reflect the smaller debitage sizes, therefore corroborating the earlier hypothesis that smaller pieces of debitage were removed towards the end of the reduction sequence. The measurement of facet length is taken from the largest complete negative scar remaining on the core, skewing the information towards larger sizes. A histogram was generated to examine the distribution of core facet length (Figure 6.9).

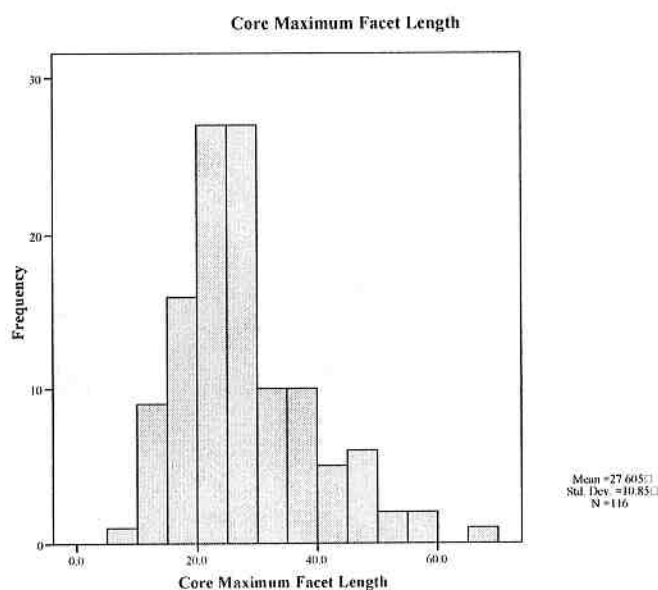


Figure 6.9 Core Maximum Facet Length

The mean length of core facets is 27.6 mm placing them towards the lower range of debitage size, but within the 2-3cm category. This suggests that cores are being discarded before the debitage removal becomes too small to remove blanks for trapeze-rectangle production (of a mean length of 32mm).

CORE- LOCATION AND PERCENT OF CORTEX

Question: Does the percentage of cortex on the cores relate to the location of cortex? The hypothesis is that there will be a very small percent of cortex on the platforms, with more located on the dorsal surface (the surface with negative removal scars). A cross-tabulation table was created with location of cortex as the independent variable and percent of cortex as the dependent variable (Table 6.34).

			Percent of Cortex				Total
			1-5%	6-25%	26-50%	51-75%	
Location of Cortex	Dorsal Surface	Count	10	29	22	5	66
		% within Location of Cortex	15.2%	43.9%	33.3%	7.6%	100.0%
	Platform	Count	4	7	2	1	14
		% within Location of Cortex	28.6%	50.0%	14.3%	7.1%	100.0%
Total	Count	14	36	24	6	80	
	% within Location of Cortex	17.5%	45.0%	30.0%	7.5%	100.0%	

Table 6.34 Core Location of Cortex and Percent of Cortex

A chi-square test was run to see if there is a significant relationship between the location of cortex and the percent of cortex (Table 6.35).

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.683	3	0.443
Likelihood Ratio	2.802	3	0.423
N of Valid Cases	80		

Table 6.35 Chi-square of Core Location of Cortex and Percent of Cortex

The results of the chi-square show that there is no significant relationship with a p value of 0.443. This result demonstrates there is no significant difference between the percent

of cortex found on the core platform and the core dorsal surface. However, the overall count of pieces that display cortex shows that 82.5% of the assemblage has cortex on the dorsal surface, while 17.5% has cortex on the platform. This shows that although there is no significant relationship between the percent of cortex and the location of cortex, dorsal surfaces have a larger overall percent of cortex. In context with the rest of the cores, 57% of the cores have persevered dorsal cortex and 23% have over 26% persevered cortex. This suggests that at least a quarter of the cores were produced on small wadi cobbles with very minimal removal of cortical material prior to the discard of the core.

CORE TRIMMING ELEMENTS

CORE TRIMMING ELEMENTS- FREQUENCY OF TYPES

Question: What type of Core Trimming Element (CTE) is most common? To investigate this question a frequency table and a bar-graph were created for the CTE types (Table 6.36).

CTE Type	Frequency	Percent
Core Tablet	19	30.6
Other	6	9.7
Ridged Blade	36	58.1
Ridged Flake	1	1.6
Total	62	100.0

Table 6.36 Frequency of Core Trimming Elements

The frequency table and the bar graph (Figure 6.10) show that ridged blades are the most common type of CTE at 'Uyun al-Hammâm. Ridged blades are produced during the initial stages of bladelet removal, these blades are created through the removal of flakes

to establish a ridge down the core, and then the ridged blade is removed to initiate bladelet removal. Core tablets are removals perpendicular to the previous removals off the platform thereby removing the entire platform. This creates a new platform from which to remove debitage. The presence of CTEs in the artifact assemblage strengthens the interpretation that extensive lithic production and core rejuvenation was taking place at 'Uyun al-Hammâm.

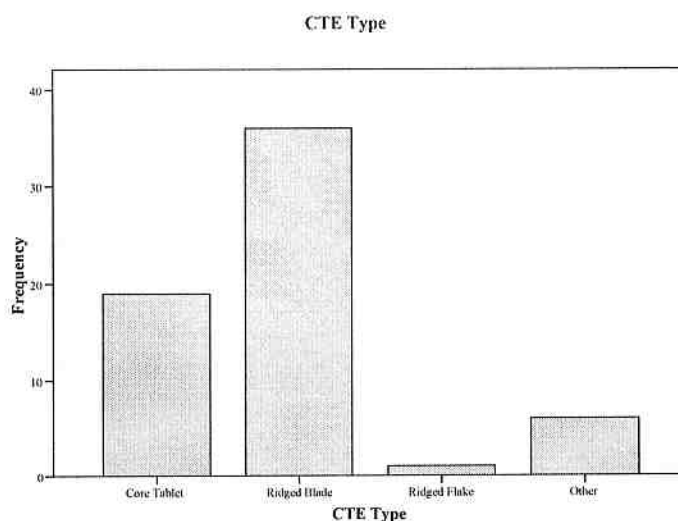


Figure 6.10 Core Trimming Element Types

CTE AND RAW MATERIAL

Question: Is there a difference between intensity of core maintenance for different types of raw materials? It was my hypothesis that there would be a larger percent of CTEs within raw material types that are more frequent (i.e. Fine, light-brown and Fine, medium-brown) because these local materials would be undergoing the full range of knapping activities on site. Core trimming elements were chosen as the independent

variable and raw material was chosen as the dependent. A bar graph was created for to illustrate the distribution of raw material across CTEs (Figure 6.11).

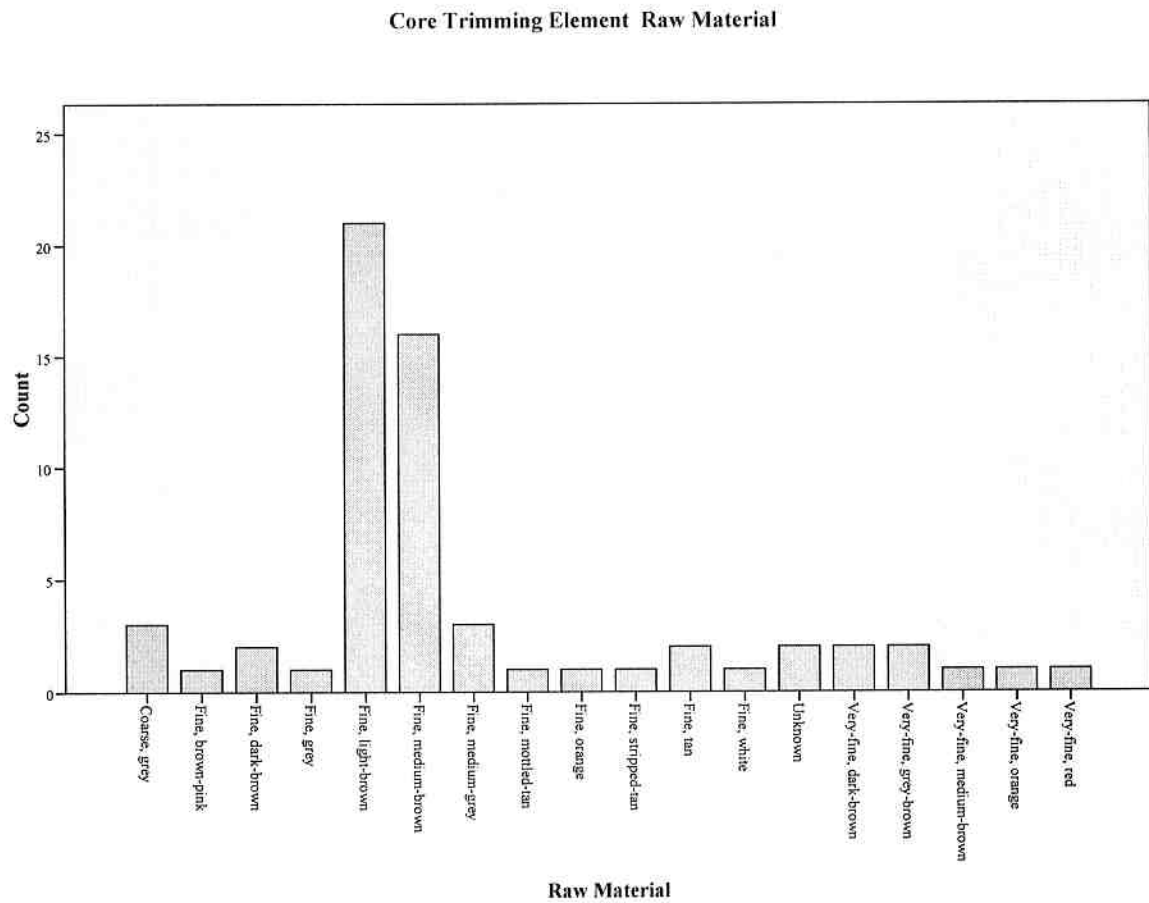


Figure 6.11 Core Trimming Element Raw Material

A chi-square test was run to see if there is a significant relationship between CTE and raw material. The null hypothesis was that there is no significant relationship. Table 6.37 outlines the results of the analysis.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	88.301	51	<0.001
Likelihood Ratio	40.474	51	0.855
N of Valid Cases	62		

Table 6.37 Chi-square for CTE and Raw Material

The chi-square proved the null hypothesis wrong. There is a significant relationship between CTE and raw material type. As the bar graph illustrates, fine, light-brown and fine, medium-brown show the highest percent of CTE. This suggests that intensive core maintenance activities were taking place for fine raw material categories.

CHIPS AND SHATTER

CHIPS RAW MATERIAL

Question: Is there a difference in the amount of chips per raw material? It is my hypothesis that there will be more chips for the raw materials that are local, suggesting that these raw materials were knapped more on the site than non-local raw materials. Chips are the product of flint knapping activities and are created most often during core reduction. The chips were originally recorded with one count per raw material type in each bag, thus ten chips of fine, light-brown were recorded as 1. A total count of chips was recorded within each record. Going through the observations and summing the counts within each raw materials shows the complete count for chips within the assemblage (Table 6.38).

Chips Raw Material Type	Count of Chips per Raw Material
Coarse, grey	20
Coarse, medium-grey	27
Coarse, tan	46
Coarse, white	75

Coarse, white-red	1
Coarse, yellow-brown	3
Fine, brown-pink	3
Fine, dark-brown	30
Fine, dark-grey	4
Fine, grey	94
Fine, grey-brown	7
Fine, light-brown	626
Fine, light-grey	14
Fine, medium-brown	232
Fine, medium-grey	50
Fine, mottled-grey	2
Fine, pink	1
Fine, pink-tan	2
Fine, red	2
Fine, red-brown	30
Fine, red-grey	1
Fine, tan	68
Fine, tan-brown	1
Fine, white	12
Fine, white-grey	5
Unknown	1362
Very-coarse, white-grey	1
Very-fine, dark-brown	46
Very-fine, dark-grey	5
Very-fine, grey-brown	2
Very-fine, light-brown	7
Very-fine, light-grey	5
Very-fine, medium-brown	13
Very-fine, orange	3
Very-fine, pink	2
Very-fine, purple	1
Very-fine, red	13
Very-fine, red-brown	19
Very-fine, translucent	4
Total	2839

Table 6.38 Count of Chips per Raw Material Type

Table 6.38 shows that the unknown raw material category, which is actually burned pieces, represents 48% of the chip assemblage. Burning results in the fragmentation of flint and creates high counts of angular, small, and fire-fractured chips. This process results in the high count of burned chips as small pieces fractured from the original piece during burning including potlids. Within the chips, 6% of the assemblage is from coarse-

grained raw material, 42% are fine pieces, and 4% are from very-fine flint. This suggests that fine materials are being knapped most often at the site but all quality categories are represented. Thus, all qualities of raw material were knapped on site and even non-local, very-fine raw material is represented in the chip category.

SHATTER RAW MATERIAL

Question: Is there a difference in the amount of shatter from different raw material types? It is my hypothesis that there will be more shatter for the raw materials that are local, suggesting that these raw materials were knapped more on the site than non-local raw materials. Shatter is the product of flint knapping activities and is created most often during core reduction where angular pieces with no flaking attributes fracture from the core. Like the chips, shatter was originally recorded with one count for each raw material type per bag. Within each record a total count was recorded. Going through the observations and summing the counts of raw materials shows the complete count for shatter within the assemblage (Table 6.39).

Shatter Raw Material Type	Count Shatter per Raw Material
Coarse, dark-grey	8
Coarse, fossils	1
Coarse, grey	64
Coarse, grey-brown	1
Coarse, grey-white	1
Coarse, light-brown	2
Coarse, light-grey	6
Coarse, medium-grey	6
Coarse, mixed	3
Coarse, mottled-grey	10
Coarse, pink-tan	2
Coarse, tan	56
Coarse, tan-brown	5
Coarse, white	125
Coarse, yellow-brown	1
Coarse, brown-pink	1

Coarse, brown-stripped	1
Fine, cream	1
Fine, dark-brown	23
Fine, dark-grey	7
Fine, grey	130
Fine, grey-white strips	1
Fine, grey-brown	11
Fine, grey-tan	3
Fine, light-brown	166
Fine, light-grey	37
Fine, medium-brown	100
Fine, medium-grey	45
Fine, mottled-brown	1
Fine, mottled-grey	3
Fine, red	6
Fine, red-brown	16
Fine, red-grey	3
Fine, stripped	1
Fine, tan	49
Fine, tan-brown	11
Fine, white	12
Fine, white-grey	43
Unknown	1065
Very-coarse, grey	4
Very-coarse, white-grey	1
Very-fine, dark-brown	20
Very-fine, grey	5
Very-fine, light-grey	2
Very-fine, medium-brown	7
Very-fine, medium-grey	8
Very-fine, mottled-grey	3
Very-fine, mottled-black	1
Very-fine, orange	4
Very-fine, pink	1
Very-fine, tan-pink	2
Very-fine, red	1
Very-fine, red-brown	5
Very-fine, translucent	1
Total	2091

Table 6.39 Count of Shatter per Raw Material Type

Table 6.39 shows that the unknown category, which is burned pieces, represents 51% of the shatter assemblage. Burning results in the fragmentation of the original piece thereby creating angular and fractured debitage, explaining the high percent of burned pieces in the shatter assemblage. Within the shatter category 14% of the assemblage are coarse

pieces, 32% are fine pieces, and 3% are very-fine pieces. This suggests that fine materials are being knapped most often at the site but all quality categories are represented. Shatter shows the largest representation of coarse materials in the debitage assemblage. This might relate to the fracture patterns of the coarser material, which could be further tested through experimentation. Very-fine chert that is not local to the site is still represented in the shatter category, suggesting again that the knapping of these materials took place on site.

REFITTING

Within the tool assemblage a pattern of breakage was noted on the endscrapers. This tool class is produced on large blades and constitutes a major portion of the non-microlithic tool assemblage. Many endscrapers were broken close to the distal end of the blade, approximately one inch from the retouched end. It appears from these consistent breaks that endscrapers were broken in their hafting element. The breakage patterns are all identified as bending breaks, indicating that this pattern was caused from downward pressure at the end of the endscraper. Bending fractures in the middle of a piece result when both ends are supported, for example when one end is supported in the haft and the other by pressure on the working surface (Cotterell and Kamminga 1987). These breaks are identifiable by their concave scar at the initiation point and the absence of a bulb of percussion (Cotterell and Kamminga 1987). The presence of these breaks on the endscrapers indicates that many of these tools were broken during use and discarded on the site.

Debitage refitting was done for these broken endscrapers in an attempt to reunite the broken endscraper with broken portion of the blade (the element that would have been in the haft). If these endscrapers could be refitted with the proximal blade portion it would suggest that these tool were used, broken and subsequently discarded on the site. Endscrapers from locus 005 were chosen to refit with thedebitage from this locus for all three areas.

Thedebitage from 005 was divided by raw material type. From these raw material types the proximal and medial-distal blades were separated for refitting with the endscrapers. Volunteers then went through each broken endscraper to try and refit the missing proximal portion of the blade. Despite many hours of work, no refits were discovered.

This suggests that once the endscrapers were broken they were removed from their haft, the broken end was retouched to create another working edge, and they continued to be used. This would result in the inability to refitdebitage with the endscrapers since the broken tools would be retouched and reused, rather than discarded immediately in the archaeological record. This shows evidence of tool manufacture, maintenance and reuse at the site.

DISCUSSION

The results of the univariate statistical tests show numerous significant relationships in the data set. Thedebitage assemblage is composed of six main categories, flakes, blades, cores, core trimming-elements, shatter, and chips that are composed of numerous raw material types. Within these types are several patterns that emerge from the data. The

chaîne opératoire is reconstructed by examining these patterns and reconstructing the process of tool production from raw material acquisition through to discard.

Flakes represent the most numerous of the debitage types at 7372 individual pieces. Through the statistical tests run on the flake category, some distinct patterns arose. To begin, there are more complete flakes in the assemblage than there are complete blades. Following Sullivan and Rozen's (1985) interpretation of flake fragmentation patterns this suggests that flakes are the result of core reduction in contrast to tool production. This hypothesis is further strengthened by other statistical tests. The high percentage of small debitage, too small for tool production, can be interpreted as core maintenance flakes. Also some pieces may be retouch flakes from tools.

Flakes also show a high percentage of preserved cortex in comparison to blades. Thirteen percent of the overall flake assemblage had preserved cortex. The reduction process initiated with the removal of large cortical flakes, followed by smaller pieces. This is shown by the overall decreasing percent of cortex as flake size decreases. Flakes also show a higher percent of cortical platforms than blades. These flakes would have been removed while the platform was still cortex bearing, thus their presence suggests that the cobble was not fully reduced.

Like the flakes, blades show a decrease in cortex with decreasing size, suggesting that larger blades were removed early on in the reduction sequence. However, blades show overall less cortex than flakes with only 10% of the overall assemblage having some evidence of cortex. These blades primarily have cortex located on a lateral dorsal scar. This suggests that blades are being removed around the circumference of the core while there is still cortex present on the back of the core. As the blades move further

around the core small amounts of cortex are removed at the edges of the removal face. This pattern can be created through the removal of blades from both wedge shaped cores (Figure 6.12) and subpyramidal/pyramidal bladelet cores (Figure 6.13). When evaluating the results of this analysis, it seems that large flakes were removed initially to prepare the core, followed by ever decreasing sizes of flakes and blades as the size of the core decreased.

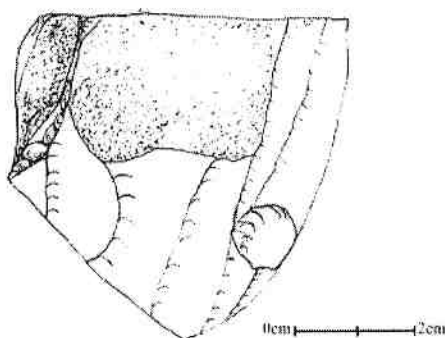
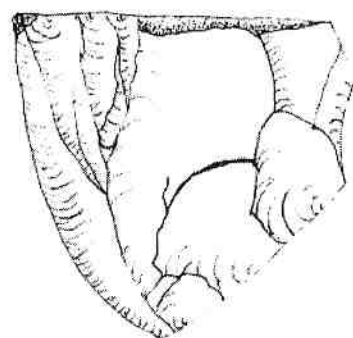


Figure 6.12 Wedged Shaped Core
(WZ148.G16.73.206)

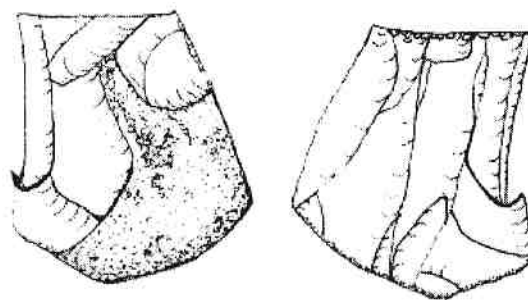


Figure 6.13 Sub pyramidal Core
(WZ148.H15.92.265)

There is a significantly high percent of proximal blades in the debitage. The high frequency of proximal blades suggests that snapping for tool production was undertaken on the site. These proximal pieces seem to be discarded with no evidence of retouch or use, suggesting that they are the by-product of tool manufacture. Thus initial core reduction and the subsequent tool production was taking place at 'Uyun al-Hammâm.

There is evidence of standardization in the blade category. The regression analysis of blade length and width showed that there is a strong correlation between these two variables, with blades being 2.6 times longer than they are wide. However, there is more variance as the blade gets larger. This increase in variance shows that the length to width ratio in larger tools was less important than in microliths. Thus blade dimension was more of a concern in the production of trapeze-rectangles than in the production of blade tools. This may relate to the hafting constraints of the smaller pieces. It is inferred that microliths are hafted in composite tools, the hafts of which would require standardized pieces to replace broken and missing elements.

The standardization of blades is also witnessed in the bladelets produced as blanks, probably for trapeze-rectangles. Within this standardized category there is a range of 16mm in length, but this range is possible because the ends of the blade can be snapped to achieve a more standardized length of trapeze-rectangle. Larger blade tools, such as endscrapers, do not show the same standardization in size as the smaller tools. The debitage does not show a high percent of large blades. Perhaps the majority of large blades produced during reduction were retouched into tools? Or these larger blades may have been produced off site. Furthermore, there are no large blade cores in the

assemblage, only cores to produce bladelets and flakes, suggesting that larger blades are not the intended final target of production.

There is a lot of variety of raw material use at the site, however the majority of the raw material types used, such as fine light-brown material, can be located on the local landscape. Very-fine materials come from neighbouring valleys suggesting that some higher quality materials were actively sought out from other sources. Despite the prominent use of light-brown and medium brown fine-quality chert for flake production, coarse and very-fine materials are also represented in the flake category. This suggests that flakes could, and were, produced on any available material. The very-fine materials come from wadis other than Wadi Ziqlab but they show the highest percent of cortex. This shows that raw materials are being transported as complete nodules to be retouched into tools on site.

In contrast blades show a slightly more regimented raw material selection. Although fine, light-brown and fine, medium-brown raw cherts are again the most prominent materials, there is no coarse chert in the assemblage. From this it can be inferred high quality materials here required or preferred for blade production.

The cores represent the range of different raw material qualities suggesting that there were no preferential use for cores of different raw material types. A large percent, 30%, of the cores had no discernable reason for abandonment, suggesting that the wealth of raw materials on the landscape did not require the people of 'Uyun al-Hammâm to conserve raw materials.

The endscrapers show that these tools were being used and broken at the site, however refitting these broken tools was fruitless. This exercise suggests that although

the tools are broken they are not immediately discarded, instead they are retouched to create another working edge. Thus refitting the endscrapers is impossible since the broken edge is continually retouched. Tool maintenance, as well as manufacture, was a part of the *chaîne opératoire* of endscrapers at 'Uyun al-Hammâm.

SUMMARY

There is considerable variability within the debitage assemblage analyzed from 'Uyun al-Hammâm. Within this variability patterns emerge, and significant relationships can be established, showing evidence of past human decisions and ideas. The statistical tests analyzed in this chapter outline some of the possibilities for discovery from this assemblage.

For the production of their stone tools the inhabitants of 'Uyun al-Hammâm transported nodules to the site and used local raw materials. The full range of knapping activities occurred on site, for both local and non-local materials. The evidence suggests that flake debitage was primary the result of core reduction while blades were intended for subsequent tool production. Perhaps the most significant finding is the standardization of the blades for microlith production, while larger blades were not produced systematically.

Through the results of the analysis it can be seen that initial core reduction, tool manufacture, tool maintenance and discard were all taking place at 'Uyun al-Hammâm. This shows that the inhabitants were enacting a wide variety of activities while they occupied the site, suggesting that this is not a specialized activity area on the landscape but instead an area of multiple uses and actions.

CHAPTER 7: CONCLUSIONS

The debitage assemblage of 'Uyun al-Hammâm helps to reconstruct the *chaîne opératoire* for the site, giving insight into the behaviours and patterns of the people living there. The debitage suggests that there was intensive use of the site for multiple lithic purposes, including all stages of core reduction, stone tool manufacture, tool maintenance and discard. Through the patterns seen in the debitage the “knapping concept”, the over-arching processes that define the tool assemblage, can be discerned (Davidzon and Goring-Morris 2003). The knapping concept of the site includes:

- The use of both locally available materials and material within a short distance from the site brought to 'Uyun al-Hammâm unmodified.
- The choice of high-quality raw materials for blades and less raw material quality requirements for flakes.
- The removal of cortical flakes for primary reduction of the nodules and preparation for the removal of ridged blades.
- Bladelet cores prepared through the removal of ridged blades. Some cores were never prepared for blade removal and were used as flake cores only.
- The intended product for most cores (except amorphous) were small bladelets later shaped into trapeze-rectangles. Large blades were opportunistically used with little standardization in size. These blades were either removed earlier on in the reduction sequence or they were produced off-site.
- Cores were maintained by the removal of core tablets.
- Tools, indicated through the endscraper refitting, were maintained after breakage through retouch.

- Debitage, cores, and tools were all discarded on the site.

This knapping sequence shows that there was a wide variety of activities undertaken at 'Uyun al-Hammâm and all stages of lithic reduction were taking place at the site. The processes enacted at 'Uyun al-Hammâm represent the full *chaîne opératoire*, including raw material procurement from both local and non-local sources, core reduction, tool manufacture, maintenance and discard.

There have been numerous interpretations for the reasons behind microlith production as opposed to bifacial technologies. It has been suggested that the production of these standardized blades was in response to risk through the conservation of raw material and low costs for tool maintenance (Kuhn and Elston 2002, Neeley and Barton 1994). However, many cores were discarded at 'Uyun al-Hammâm with no discernable reason for abandonment. Unexhausted, discarded cores have been interpreted as representing reduced mobility patterns (Neeley 2002), however this interpretation does not reflect the pattern of core reduction while the individuals are off site. When raw material is known to be readily available on the landscape than there is no reason to conserve materials. Thus, the large quantity of discarded cores at 'Uyun al-Hammâm that show no evidence of exhaustion or problems suggests that a) there was no reason for the conservation of raw material, meaning there was no risk, and b) the inhabitants could afford to discard cores because of their continual proximity to wadi cobbles at the site. This suggests that the occupants of 'Uyun al-Hammâm had no need to conserve raw materials while inhabiting the site.

Thedebitage of 'Uyun al-Hammâm contributes to understanding the site's function during the Middle Epipalaeolithic and in context with the other site information

this interpretation becomes more robust. The preliminary faunal analysis shows, through the presence of both high and low utility index items, that complete carcasses were butchered at 'Uyun al-Hammâm (Humphrey 2003). Thus, animals were killed in close proximity to the site and were brought back for dismemberment, distribution and consumption. The human burials suggest attachment to the landscape, and to the site in particular, over continued periods of time (Maher 2006). The lithic assemblage shows that there is a wide diversity of tool types, representing multiple reduction sequences, however trapeze-rectangles dominate the tool assemblage at 46.4% (Maher 2005). The debitage assemblage shows that tools were being produced, used, maintained, and discarded at the site. The target product of the reduction sequence appears to be small, standardized microliths. Raw material abundance shows that core conservation was unnecessary, however very-high quality materials were still transported to the site in nodule form. Through these multiple lines of evidence it can be seen that 'Uyun al-Hammâm represented a site on the landscape that was a focal point for a community where many daily activities took place showing traits of long-term attachment, whether physical or ideological, to a single place on the landscape.

The interpretation that 'Uyun al-Hammâm is a favoured and continually occupied locale is in direct contrast to previous interpretations that Geometric Kebaran sites east of the Jordan Valley represent an ephemeral, highly-mobile settlement system (Edwards 2001). This interpretation of 'Uyun al-Hammâm suggests that regional identification of ethnicity is not a valid distinction. The behaviours witnessed at the site show a pattern that is very different from other sites in the region such as Wadi Hammeh, despite the statement that sites east of the Jordan Valley are typologically distinctive from other

Epipalaeolithic sites in the Levant (Edwards 2001). Thus, bounding ethnicity by geographical region conflates the variability between sites and does not allow for functionalist and behavioural interpretations. I would suggest that the focus of our research should not be on defining the groups into which we try to compartmentalize Epipalaeolithic material culture but instead to observe the trends and patterns between groups to understand movement and dynamism across time and space.

Through the deconstruction of a morphological approach to lithic analysis and a focus on technological production, new insights into the Epipalaeolithic are given. The combination of multiple lines of evidence presents a robust interpretation that focuses on long term trends of behaviour, thus moving beyond ethnic interpretations of the Epipalaeolithic. Evidence of decreasing mobility and increasing attachment to a place on the landscape is seen at the site through the large accumulation of a variety of cultural material and human burials, suggesting that the transition from hunting and gathering to later farming communities was a slow and gradual process that took place over thousands of years.

FURTHER RESEARCH

Further refining current Epipalaeolithic typologies will enhance our understanding of social complexity and the transition to food production during the complicated transition to the Neolithic period. The integration of lithic analysis with faunal, burial, and other site data creates robust interpretations of the Epipalaeolithic and with more information added to these interpretations they will become better informed. Further research at 'Uyun al-Hammâm, including use-wear analysis on the tool assemblage, can contribute

to our current understanding of the site. Through the combination of all these lines of evidence, both previous work and this Master's thesis, a robust typology for the site can be constructed.

In a neighboring area to Wadi Ziqlab, Wadi Taiyyba, two Epipalaeolithic sites have been identified. Initial excavations of these sites have been done but no material has been published. The use of these sites as a comparative collection to the Epipalaeolithic sites of Wadi Ziqlab could help to create further interpretations as to the function and importance of sites in the eastern regions of the Jordan Valley.

Reassessment of Epipalaeolithic typologies, focusing on constructions that combine multiple lines of evidence, can create a more dynamic interpretation of the period. This approach moves away from bounded typological construction that currently dominates Epipalaeolithic literature; strict typological adherence ignores the dynamic and interactive nature of human culture. Through this approach I suggest a reassessment of the Natufian and the pre-Natufian dichotomy by embracing a fluid notion of social complexity, seeing the construction of the past as a long-term dynamic process and not as a spark of innovation. Future research goals will focus on understanding the processes of social complexity within the archaeological record prior to the Natufian through the creation of Epipalaeolithic typologies that highlight change over time.

The combination of debitage reduction stages, future use-wear analysis and current morphological typologies will create a multifaceted approach applicable to Epipalaeolithic sites across the region. This research challenges the current notion that the origins of agriculture and social complexity began with the Natufian by arguing for a more gradual development of these phenomenon, pushing back the traits to at least the

Middle Epipalaeolithic. Thus, future research will contribute to both the regional understanding of the Epipalaeolithic and will rewrite our current understanding of the origins of agriculture and social complexity.

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APPENDIX A: DEBITAGE DATABASE

FLAKES AND BLADES

Debitage Number	WZ148 616.38 400	Percent of Context	0%
Locus Number	013	Location of Context	
Date Excavated	22/06/05	Burning	<input type="checkbox"/>
Debitage Type	Flake	Post-Depositional Alterations	
Raw Material	Fine, light-brown	Utilized	<input type="checkbox"/>
Flake/Blade Portion	Complete	Drawn	<input type="checkbox"/>
Size Category	<2cm	Comments	
Weight	0.0		
Striking Platform Type	Faceted		
Striking Platform Width	3.20		
Striking Platform Thickness	1.30		
CTE Type			

Record: 1 of 11753
Additional comments

Figure A.1 Screenshot of Flakes and Blades Database Form

CORES AND CORE FRAGMENTS

Debitage Number	M2148163840	Core Platform Maximum Width	0.00	Comments <div style="border: 1px solid black; height: 40px; width: 100%;"></div>
Locus Number	013	Core Maximum Length	0.00	
Date Excavated	22/05/05	Core Maximum Width	0.00	
Debitage Type	Flake	Weight	0.00	
Raw Material	Fine, light brown	Reason for Abandonment	▼	
Core Shape	▼	Percent of Cortex	▼	
Core Type	▼	Location of Cortex	▼	
Core Platform Orientation	▼	Burning	<input type="checkbox"/>	
Core Platform Type	▼	Post-Depositional Alterations	<input type="checkbox"/>	
Core Maximum Facet Length	0.00	Drawn	▼	
Core Maximum Facet Width	0.00			
Core Platform Maximum Length	0.00			

Record: 14 of 1788
 Debitage Number started at 400 for each bag, including bag number

Figure A.2 Screenshot of Cores and Core Fragments Form

CHIPS AND SHATTER

Debrlage Number

Locus Number

Date Excavated

Debrlage Type

Raw Material

Shatter Count

Shatter Weight

Chips Count

Chips Weight

Burning

Post-Depositional Alterations

Comments

Record: of
Debrlage Number started at 400 for each bag, including bag number

Figure A.3 Screenshot of Chips and Shatter Database

APPENDIX B: RAW MATERIAL CROSS-TABULATIONS

Table 1: Debitage Type and Raw Material Cross-Tabulation

		Debitage Type									
		Flake	Blade	Core	Core Fragment	CTE	Shatter	Chips	Other	Total	
Raw Material (RM)	Coarse, brown	Count	0	1	0	1	0	0	0	0	2
		% in RM	0.0%	50.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	Coarse, brown-grey stripped	Count	4	1	0	0	0	0	0	0	5
		% in RM	80.0%	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	Coarse, dark-grey	Count	8	0	0	0	0	3	0	0	11
		% in RM	72.7%	0.0%	0.0%	0.0%	0.0%	27.3%	0.0%	0.0%	100.0%
	Coarse, fossils	Count	0	0	0	0	0	1	0	0	1
		% in RM	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	Coarse, grey	Count	59	3	1	0	3	11	7	0	84
		% in RM	70.2%	3.6%	1.2%	0.0%	3.6%	13.1%	8.3%	0.0%	100.0%
	Coarse, grey-brown	Count	2	2	0	0	0	1	0	0	5
		% in RM	40.0%	40.0%	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	100.0%
	Coarse, grey-fossils	Count	1	0	0	0	0	0	0	0	1
		% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	Coarse, grey-mottled	Count	1	0	0	0	0	0	0	0	1
		% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	Coarse, grey-purple	Count	1	0	0	0	0	0	0	0	1
		% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	Coarse, grey-stripped	Count	0	1	0	0	0	0	0	0	1
		% in RM	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Coarse, grey-white	Count	0	0	0	0	0	1	0	0	1	
	% in RM	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%	
Coarse, light-brown	Count	6	2	0	0	0	2	0	0	10	
	% in RM	60.0%	20.0%	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	100.0%	

	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Fine, grey-tan	Count	0	0	0	0	0	1	0	0	1
	% in RM	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Fine, grey-white strips	Count	0	1	0	0	0	1	0	0	2
	% in RM	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	100.0%
Fine, light grey-tan	Count	103	48	0	0	0	1	0	0	152
	% in RM	67.8%	31.6%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	100.0%
Fine, light-brown	Count	2541	1615	36	5	22	25	30	0	4274
	% in RM	59.5%	37.8%	0.8%	0.1%	0.5%	0.6%	0.7%	0.0%	100.0%
Fine, light-brown-red	Count	1	1	0	0	0	0	0	0	2
	% in RM	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Fine, light-grey	Count	36	14	4	1	0	8	2	0	65
	% in RM	55.4%	21.5%	6.2%	1.5%	0.0%	12.3%	3.1%	0.0%	100.0%
Fine, medium-brown	Count	1236	768	31	3	21	21	24	0	2104
	% in RM	58.7%	36.5%	1.5%	0.1%	1.0%	1.0%	1.1%	0.0%	100.0%
Fine, medium-grey	Count	168	78	4	1	3	8	7	1	270
	% in RM	62.2%	28.9%	1.5%	0.4%	1.1%	3.0%	2.6%	0.4%	100.0%
Fine, mottled grey-brown	Count	5	0	0	0	0	0	0	0	5
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Fine, mottled red-brown	Count	2	0	0	0	0	0	0	0	2
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Fine, mottled red-grey	Count	1	2	0	0	0	0	0	0	3
	% in RM	33.3%	66.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Fine, mottled-brown	Count	11	2	0	0	0	1	0	0	14
	% in RM	78.6%	14.3%	0.0%	0.0%	0.0%	7.1%	0.0%	0.0%	100.0%
Fine, mottled-grey	Count	17	3	1	0	0	3	1	0	25
	% in RM	68.0%	12.0%	4.0%	0.0%	0.0%	12.0%	4.0%	0.0%	100.0%

Coarse, light-brown										
% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very- Coarse, white-grey	Count	0	0	0	0	0	1	1	0	2
% in RM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
Very-fine, brown	Count	2	0	1	0	0	0	0	0	3
% in RM	66.7%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, brown with yellow strips	Count	0	0	1	0	0	0	0	0	1
% in RM	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, dark-brown	Count	152	78	3	1	2	5	8	0	249
% in RM	61.0%	31.3%	1.2%	0.4%	0.8%	2.0%	3.2%	0.0%	0.0%	100.0%
Very-fine, dark-grey	Count	23	14	0	0	0	0	1	0	38
% in RM	60.5%	36.8%	0.0%	0.0%	0.0%	0.0%	0.0%	2.6%	0.0%	100.0%
Very-fine, dark-purple	Count	1	1	0	0	0	0	0	0	2
% in RM	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, grey	Count	17	0	2	0	0	1	0	0	20
% in RM	85.0%	0.0%	10.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	100.0%
Very-fine, grey-brown	Count	34	18	0	0	2	0	1	0	55
% in RM	61.8%	32.7%	0.0%	0.0%	3.6%	0.0%	1.8%	0.0%	0.0%	100.0%
Very-fine, light-brown	Count	31	19	1	0	0	0	4	0	55
% in RM	56.4%	34.5%	1.8%	0.0%	0.0%	0.0%	0.0%	7.3%	0.0%	100.0%
Very-fine, light-grey	Count	13	3	0	0	0	1	1	0	18
% in RM	72.2%	16.7%	0.0%	0.0%	0.0%	0.0%	5.6%	5.6%	0.0%	100.0%
Very-fine, medium red-brown	Count	5	2	0	0	0	0	0	0	7
% in RM	71.4%	28.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, medium- brown	Count	150	75	9	5	2	4	4	0	249
% in RM	60.2%	30.1%	3.6%	2.0%	0.8%	1.6%	1.6%	0.0%	0.0%	100.0%
Very-fine, medium- grey	Count	2	2	0	1	0	1	0	0	6

	% in RM	33.3%	33.3%	0.0%	16.7%	0.0%	16.7%	0.0%	0.0%	100.0%
Very-fine, medium-red	Count	13	5	0	0	0	0	1	0	19
	% in RM	68.4%	26.3%	0.0%	0.0%	0.0%	0.0%	5.3%	0.0%	100.0%
Very-fine, mottled grey-white	Count	1	0	0	0	0	0	0	0	1
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, mottled-black	Count	0	0	0	0	0	1	0	0	1
	% in RM	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Very-fine, mottled-brown	Count	1	0	0	0	0	0	0	0	1
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, mottled-grey	Count	1	1	0	0	0	2	0	0	4
	% in RM	25.0%	25.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	100.0%
Very-fine, orange	Count	73	46	0	0	1	3	2	0	125
	% in RM	58.4%	36.8%	0.0%	0.0%	0.8%	2.4%	1.6%	0.0%	100.0%
Very-fine, pink	Count	7	1	0	0	0	1	2	0	11
	% in RM	63.6%	9.1%	0.0%	0.0%	0.0%	9.1%	18.2%	0.0%	100.0%
Very-fine, pink-tan	Count	7	8	0	0	0	2	0	0	17
	% in RM	41.2%	47.1%	0.0%	0.0%	0.0%	11.8%	0.0%	0.0%	100.0%
Very-fine, purple	Count	4	5	0	0	0	0	1	0	10
	% in RM	40.0%	50.0%	0.0%	0.0%	0.0%	0.0%	10.0%	0.0%	100.0%
Very-fine, purple-tan	Count	0	0	0	1	0	0	0	0	1
	% in RM	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, red	Count	46	25	0	0	1	1	5	0	78
	% in RM	59.0%	32.1%	0.0%	0.0%	1.3%	1.3%	6.4%	0.0%	100.0%
Very-fine, red-brown	Count	214	114	1	0	0	4	5	0	338
	% in RM	63.3%	33.7%	0.3%	0.0%	0.0%	1.2%	1.5%	0.0%	100.0%
Very-fine, tan	Count	5	4	0	1	0	0	0	0	10
	% in RM	50.0%	40.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, tan-orange	Count	5	1	0	0	0	0	0	0	6

	% in RM	83.3%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, translucent	Count	18	4	0	0	0	1	4	0	27
	% in RM	66.7%	14.8%	0.0%	0.0%	0.0%	3.7%	14.8%	0.0%	100.0%
Very-fine, translucent-brown	Count	0	1	0	0	0	0	0	0	1
	% in RM	.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, white	Count	2	0	0	0	0	0	0	0	2
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Very-fine, white-tan	Count	1	0	0	0	0	0	0	0	1
	% in RM	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Total	Count	7372	3738	116	23	68	241	218	1	11788
	% in RW	62.5%	31.8%	1.0%	0.2%	0.6%	2.0%	1.8%	0.0%	100.0%

Table 2: Debitage Type and Raw Material Cross-Tabulation, with "Other" Category

		Debitage Type							Total	
		Blade	Chips	Core	Core Fragment	CTE	Flake	Other		Shatter
Debitage Raw Material	Coarse, brown	0	0	0	1	0	0	0	0	1
	Coarse, dark-grey	0	0	0	0	0	0	0	3	3
	Coarse, grey	0	7	0	0	3	0	0	11	21
	Coarse, light-brown	0	0	0	0	0	0	0	2	2
	Coarse, medium-grey	0	0	0	0	0	0	0	3	3
	Coarse, mottled-grey	0	0	0	0	0	0	0	3	3
	Coarse, tan	0	8	2	0	0	120	0	8	138
	Coarse, white	0	7	3	0	0	95	0	12	117
	Fine, dark-brown	51	5	0	1	2	91	0	7	157
	Fine, dark-grey	0	0	0	0	0	0	0	3	3
	Fine, grey	0	11	4	0	0	0	0	8	23
	Fine, grey-brown	0	2	0	0	0	70	0	6	78
	Fine, light grey-tan	48	0	0	0	0	102	0	0	150
	Fine, light-brown	1615	31	36	5	22	2541	0	25	4275
	Fine, light-grey	0	0	4	1	0	0	0	8	13
	Fine, medium-brown	768	23	31	3	21	1236	0	20	2102
	Fine, medium-grey	78	7	4	1	3	168	1	8	270
	Fine, mottled-grey	0	0	1	0	0	0	0	3	4
	Fine, red-brown	82	5	0	0	0	165	0	5	257
	Fine, tan	78	8	2	1	2	126	0	8	225
	Fine, tan-grey	0	0	0	1	0	0	0	0	1
	Fine, white	0	3	2	0	0	0	0	5	10
	Other	348	30	8	0	7	864	0	37	1294
	Unknown	374	42	4	0	2	1301	0	40	1763
	Very-fine, dark-brown	77	8	3	1	2	148	0	5	244
	Very-fine, grey	0	0	2	0	0	0	0	0	2
	Very-fine, grey-brown	0	0	0	0	2	0	0	0	2
	Very-fine, light-brown	1	4	1	0	0	0	0	0	6
	Very-fine, medium-brown	75	4	9	5	2	148	0	4	247
	Very-fine,	0	0	0	1	0	0	0	0	1

medium-grey									
Very-fine, orange	46	0	0	0	0	0	0	3	49
Very-fine, purple-tan	0	0	0	1	0	0	0	0	1
Very-fine, red	0	5	0	0	0	0	0	0	5
Very-fine, red- brown	107	5	0	0	0	197	0	4	313
Very-fine, tan	0	0	0	1	0	0	0	0	1
Very-fine, translucent	0	4	0	0	0	0	0	0	4
Total	3748	219	116	23	68	7372	1	241	11788

Table 3: Flakes-Percent of Cortex and Raw Material Cross-Tabulation

	Percent of Cortex					Total
	0%	1-5%	6-25%	26-50%	51-75%	0%
Coarse, brown-grey stripped	4	0	0	0	0	4
Coarse, dark-grey	5	0	2	1	0	8
Coarse, grey	55	1	1	2	0	59
Coarse, grey-brown	1	0	0	1	0	2
Coarse, grey-fossils	1	0	0	0	0	1
Coarse, grey-mottled	1	0	0	0	0	1
Coarse, grey-purple	1	0	0	0	0	1
Coarse, light-brown	6	0	0	0	0	6
Coarse, light-grey	21	0	0	0	0	21
Coarse, medium-brown	5	0	0	0	0	5
Coarse, medium-grey	36	0	1	0	0	37
Coarse, mixed	1	0	0	0	0	1
Coarse, mottled-brown	4	0	1	0	0	5
Coarse, mottled-grey	13	0	1	1	0	15
Coarse, pink-tan	8	0	0	0	0	8
Coarse, speckled-brown	1	0	0	0	0	1
Coarse, tan	110	4	3	2	1	120
Coarse, white	91	3	1	0	0	95
Coarse, white-grey	2	0	0	0	0	2
Coarse, yellow-brown	1	0	0	0	0	1
Fine, brown	1	0	0	0	0	1
Fine, brown-pink	11	0	2	1	0	14
Fine, brown-stripped	1	0	1	0	0	2
Fine, dark red-brown	1	0	0	0	0	1
Fine, dark-brown	71	5	7	10	0	93
Fine, dark-grey	22	0	0	0	0	22
Fine, grey	62	2	4	3	0	71
Fine, grey-brown	58	5	5	2	0	70
Fine, grey-pink with stripes	1	0	0	0	0	1
Fine, light grey-tan	91	3	8	1	0	103
Fine, light-brown	2339	90	67	44	1	2541
Fine, light-brown-red	1	0	0	0	0	1
Fine, light-grey	34	0	2	0	0	36
Fine, medium-brown	982	71	100	81	2	1236
Fine, medium-grey	136	7	15	9	1	168
Fine, mottled grey-brown	5	0	0	0	0	5
Fine, mottled red-brown	2	0	0	0	0	2
Fine, mottled red-grey	1	0	0	0	0	1
Fine, mottled-brown	9	1	1	0	0	11
Fine, mottled-grey	15	2	0	0	0	17
Fine, mottled-red	1	0	0	0	0	1

Flake Raw Material

Fine, orange	2	0	0	0	0	2
Fine, orange-brown	3	0	0	0	0	3
Fine, pink	17	2	0	0	0	19
Fine, pink stripped	2	0	0	0	0	2
Fine, pink-brown	8	0	1	0	0	9
Fine, pink-grey	2	0	0	0	0	2
Fine, pink-tan	6	0	0	0	0	6
Fine, purple-brown	0	0	1	0	0	1
Fine, red	14	0	3	3	0	20
Fine, red-brown	112	12	20	21	0	165
Fine, red-brown stripped	3	0	0	0	0	3
Fine, red-grey	0	0	1	0	0	1
Fine, speckled-grey	1	0	0	0	0	1
Fine, stripped	2	1	0	2	0	5
Fine, stripped-grey	1	0	0	0	0	1
Fine, stripped-tan	1	0	0	0	0	1
Fine, tan	112	6	7	1	0	126
Fine, tan-brown	2	0	0	0	0	2
Fine, tan-grey	2	0	0	0	0	2
Fine, tan-pink	11	0	0	2	0	13
Fine, tan-red	4	1	0	1	0	6
Fine, tan-white	1	0	0	0	0	1
Fine, white	35	0	3	0	0	38
Fine, white-grey	14	2	0	0	0	16
Unknown	1225	21	26	29	0	1301
Very-Coarse, grey	5	0	0	0	0	5
Very-Coarse, light-brown	2	0	1	0	0	3
Very-fine, brown	2	0	0	0	0	2
Very-fine, dark-brown	108	14	19	10	1	152
Very-fine, dark-grey	17	1	4	1	0	23
Very-fine, dark-purple	0	0	1	0	0	1
Very-fine, grey	16	0	0	1	0	17
Very-fine, grey-brown	25	2	4	2	1	34
Very-fine, light-brown	26	1	3	1	0	31
Very-fine, light-grey	12	0	0	1	0	13
Very-fine, medium red-brown	3	0	2	0	0	5
Very-fine, medium-brown	108	12	19	11	0	150
Very-fine, medium-grey	1	0	1	0	0	2
Very-fine, medium-red	10	0	2	1	0	13
Very-fine, mottled grey-white	1	0	0	0	0	1
Very-fine, mottled-brown	1	0	0	0	0	1
Very-fine, mottled-grey	1	0	0	0	0	1
Very-fine, orange	54	5	10	4	0	73
Very-fine, pink	7	0	0	0	0	7
Very-fine, pink-tan	5	0	1	1	0	7

Very-fine, purple	3	0	0	1	0	4
Very-fine, red	35	3	5	3	0	46
Very-fine, red-brown	164	12	22	16	0	214
Very-fine, tan	2	0	1	2	0	5
Very-fine, tan-orange	2	0	2	1	0	5
Very-fine, translucent	17	1	0	0	0	18
Very-fine, white	2	0	0	0	0	2
Very-fine, white-tan	0	1	0	0	0	1
Total	6420	291	381	273	7	7372

Table 4: Blades- Percent of Cortex and Raw Material Cross-Tabulation

	Percent of Cortex					Total
	0%	1-5%	6-25%	26-50%	51-75%	0%
Coarse, brown	1	0	0	0	0	1
Coarse, brown-grey stripped	1	0	0	0	0	1
Coarse, grey	3	0	0	0	0	3
Coarse, grey-brown	2	0	0	0	0	2
Coarse, grey-stripped	0	0	1	0	0	1
Coarse, light-brown	2	0	0	0	0	2
Coarse, light-grey	1	0	0	0	0	1
Coarse, medium-grey	4	0	1	2	0	7
Coarse, mottled grey-brown	1	0	0	0	0	1
Coarse, mottled-grey	3	0	0	0	0	3
Coarse, pink-tan	1	0	0	0	0	1
Coarse, tan	30	1	3	0	0	34
Coarse, white	7	0	2	0	0	9
Fine, brown	2	0	0	0	0	2
Fine, brown-grey	1	0	1	0	0	2
Fine, brown-pink	18	1	1	1	0	21
Fine, brown-red	1	0	1	0	0	2
Fine, dark-brown	40	4	4	2	1	51
Fine, dark-grey	11	0	0	0	0	11
Fine, grey	19	0	1	0	0	20
Fine, grey-brown	23	0	0	1	0	24
Fine, grey-mottled	1	0	0	0	0	1
Fine, grey-white strips	0	0	1	0	0	1
Fine, light grey-tan	46	0	2	0	0	48
Fine, light-brown	1517	47	34	17	0	1615
Fine, light-brown-red	1	0	0	0	0	1
Fine, light-grey	14	0	0	0	0	14
Fine, medium-brown	644	41	56	27	0	768
Fine, medium-grey	69	3	4	2	0	78
Fine, mottled red-grey	2	0	0	0	0	2
Fine, mottled-brown	1	0	1	0	0	2
Fine, mottled-grey	2	0	1	0	0	3
Fine, orange	1	0	0	0	0	1
Fine, pink	8	0	0	1	0	9
Fine, pink-brown	13	1	1	0	0	15
Fine, purple	2	0	0	0	0	2
Fine, red	4	0	1	0	0	5
Fine, red stripped	2	0	0	0	0	2

Blade Raw Material

Fine, red-brown	64	6	9	3	0	82
Fine, red-brown stripped	1	0	0	0	0	1
Fine, stripped	3	0	0	0	0	3
Fine, stripped-tan	3	0	0	0	0	3
Fine, tan	75	3	0	0	0	78
Fine, tan-pink	5	0	1	1	0	7
Fine, tan-red	2	0	1	0	0	3
Fine, white	3	0	0	0	0	3
Fine, white-grey	1	0	0	0	0	1
Unknown	355	2	14	3	0	374
Very-fine, dark-brown	66	2	8	2	0	78
Very-fine, dark-grey	9	2	3	0	0	14
Very-fine, dark-purple	1	0	0	0	0	1
Very-fine, grey-brown	13	0	2	2	1	18
Very-fine, light-brown	16	0	2	1	0	19
Very-fine, light-grey	2	0	1	0	0	3
Very-fine, medium red-brown	1	0	0	1	0	2
Very-fine, medium-brown	66	2	4	3	0	75
Very-fine, medium-grey	2	0	0	0	0	2
Very-fine, medium-red	4	0	0	1	0	5
Very-fine, mottled-grey	1	0	0	0	0	1
Very-fine, orange	39	2	4	1	0	46
Very-fine, pink	1	0	0	0	0	1
Very-fine, pink-tan	7	1	0	0	0	8
Very-fine, purple	5	0	0	0	0	5
Very-fine, red	22	0	1	2	0	25
Very-fine, red-brown	81	11	14	8	0	114
Very-fine, tan	3	0	0	1	0	4
Very-fine, tan-orange	1	0	0	0	0	1
Very-fine, translucent	4	0	0	0	0	4
Very-fine, translucent-brown	0	0	1	0	0	1
Total	3354	129	181	82	2	3748