The Significance of Relationships Between Lithic Production Traditions: A Case Study of Four PPN Lithic Assemblages from Southern Jordan.

Thesis submitted in accordance with the requirements of the University of Liverpool for the degree of Doctor in Philosophy.

By

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I hereby declare that the work within this thesis was entirely composed by myself.

Eileen Rebecca Clegg

For my mother, Jane, and my son, Andrew James.

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Abstract

Within archaeology one of the most interesting questions concerns the social context surrounding the production of the archaeological record. This social context includes the interaction between communities and the nature of networks of information sharing. Previous archaeological approaches to this issue have equated a correlation between the 'final products' of a material culture (ranging from arrowheads to houses) with a relationship of interaction between groups. However, this level of understanding simply establishes the existence of a relationship, it does not explain why this relationship exists. This thesis aims to explain why this relationship exists using the medium of technology, by identifying similarities in the way in which 'final products' were produced (i.e. technology) and by identifying what mechanisms were necessary to create these similarities. In this thesis I compare and contrast the lithic technology from three Levantine PPNB sites (Ghwair 1, Wadi Fidan A and Baja) and one PPNC/6thmbc site (Wadi Fidan C); all lie within a small geographical area. Using an attribute based recording system I was able to establish the knapping techniques used by artisans within each community. This enabled me to reach conclusions concerning the level and nature of social interaction between knapping communities within this small region and how this had changed over time. I was then able to make comparisons with other similar studies in other areas of the Levant. The results led me to conclude that the Levant, during the PPNB, was made up of communities with strong regional identities though existing under the general umbrella of a PPNB material culture, which covered the Levant as a whole. These regions differed in size and developed at different paces; changing little and gradually in arid areas like Jilat and Azraq, though more quickly and significantly in other less marginal areas such as the Faynan/Fidan Wadi system.

Commonly Used Abbreviations

PPNA	Pre-Pottery Neolithic A
PPNB	Pre-Pottery Neolithic B
PPNC	Pre-Pottery Neolithic C
PN	Pottery Neolithic
mbc	millennium b.c. (uncalibrated)
WFA	Wadi Fidan A
WFC	Wadi Fidan C

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Chapter 1

Introduction

The archaeological record of the Levantine PPN (including Southern Jordan) displays a broad similarity in its material culture, from arrowheads to housing. The archaeologist will naturally ask, when presented with this record, what is the social context of this material culture? It is the people behind the material culture and not the material culture itself that interests us. However, the first difficulty all archaeologists encounter is how to relate behaviour to the material culture present in the archaeological record.

"In practice, many of our attempts at understanding the past are short-circuited through a comparison of unlike phenomena." (DeBoer and Lanthrap 1979, 103)

Previous approaches to the Levantine PPN have been to make a regional wide comparative study of the distinctive 'final products' in the archaeological record, for example, Bar-Yosef's work on the association of arrow heads and other aspects of material culture with neolithic 'tribes' in the Levant (Bar-Yosef 2001) and Goring-Morris and Belfer-Cohen's discussion on the role of lithic prestige items and caches in symbolic realms of utilitarian material culture (Goring- Morris and Belfer-Cohen 2001). Archaeologists have equated a material culture correlation with a relationship of interaction between groups. Ethno-archaeology has supported the idea that comparative material culture shows affinity between peoples. Jordan and Shennan have statistically demonstrated a relationship between basket weaving, geographic propinquity, and particularly, linguistic affinity amongst the Californian Indians (Jordan and Shennan 2003). However, this level of understanding simply explains that there is a relationship; it does not explain the social context of this relationship. In other words, it does not explain the behaviours that resulted in the production of the material culture.

The next logical step would be to ask the question, what is the nature of interaction between PPN communities? Answering this will go a long way to explaining the social context of the PPN material culture. Are these 'final products' of the Levantine PPN related in any other way? For example have they been produced in similar ways? This leads us to technology. The modern western approach to technology is to perceive it as something apart from the pattern of human social and cultural life. Analysing a technology in detail will not bring the observer any closer to understanding social interaction in daily life. However, anthropologists have been looking at the social context of technology both within our society and other more traditional societies for some time and have been able to demonstrate how human choice makes technology, and the replication of technology, part and parcel of social and cultural life.

"Any technology should be seen as a system, not just of tools, but also of related social behaviours and techniques." (Pfaffenburger 1988, 241)

Therefore, the analysis of PPN technologies will enable archaeologists to understand, to a degree, the social behaviours that produced and replicated them. It is through this type of analysis that we can compare unlike phenomena, because we are comparing behaviours and not 'final products'.

Lithic technology can provide a good medium for this type of analysis because it enables the archaeologist to identify relatively clearly when the transmission of technological information is occurring. The complexity of this technology predisposes it to increasing levels of variation; therefore, a lack of variation can be an indication of the impact of social constraints on the technology. It is also an individualistic technology, only one individual (or a very small group of individuals in the case of anvil and punch technique) can work on one lithic artifact at the same time. This makes it easier to identify information sharing between individuals than in a technology like house building, which requires many individuals involved in the same process.

The analysis of lithic technology in isolation can only take understanding so far. It is important to understand the wider social context of lithic production, and this can be gained through the understanding of craft production. Lithic technology is a craft production in itself but it is also producing tools to be used in other forms of craft production (as well as food procurement). Therefore it is closely connected to, and part of the social context of craft production. Ethno-archaeology can be relevant here; ethnographic studies of craft production within 'traditional societies' have demonstrated that the social context of craft production has an influence on the technological production of a craft product. Many aspects of production, especially those requiring a high skill level, are often carried out in groups of craftsmen and women specifically for sharing of technological information and learning. The Hopi and Hopi-Tewa potters of Arizona gather in groups to prepare and paint their pots resulting in a relatively conservative decorative tradition (Stanislawski and Stanislawski 1978). The Adze makers of Langda village, Irain Jaya (Indonesia) also gather in groups in order to knap and instruct apprentices (Stout 2002). At this point it is important to understand the difference between the overall strategy and techniques applied to that strategy, as far as knapping is concerned. Strategy is a term referring to the general approach to the reduction of the raw material, involving a series of stages in the knapping process. These stages include the preforming and preparation of the cores, the creation and maintenance of striking platforms and the subsequent pattern of removals from the major removal surfaces (Baird 1994). Technique refers to the methods involved in removing the debitage from the core, and includes preparing and developing the platforms, hammer technology, body stance and movement, force and angle of blow. Some archaeologists choose to separate the hammer technology out from technique labelling it as flaking mode (Nishiaki 2000, Baird 1994 following Newcomer). However, it is not yet clearly established which features on flint artifacts are related to technique and which to mode (Baird 1994, Bradley *pers. comm.* 2003). Therefore, it is not practical at this stage to separate mode from technique in the recording of data. Strategy is a relatively simple concept in comparison to technique and can be verbally discussed. Technique requires demonstration as well, because it encompasses aspects like body stance and striking position, which are difficult to describe verbally and/or the knapper may not even be conscious of.

Group craft activity is clearly one of the mechanisms by which the variability in production and transmission of technological information is controlled. Therefore, a comparative study of the processes involved in lithic technology can help to indicate the social context in which the production occurs, on a site. By comparing this data to that from other sites the archaeologist can open a window on the sharing of technological knowledge on a regional basis.

The next logical step would be to pose the question, do these networks of sharing reflect regional identity or not? Certainly the presence or absence of shared lithic technological strategies on more than one site, and the geographical propinquity of these sites can help to understand the development of knapping traditions and interactions. However, taken in isolation, the lithic technology is not enough to form a sound understanding of regional identity. It is the interplay of other aspects of the material culture and the technologies behind them that will lead to a greater understanding of regional identity. However, I will be unable to look in detail at other aspects of material culture due to the time constraints of a PhD.

The difficulty encountered in the interpretation of lithic technologies is distinguishing between the aspects of lithic technology that are constrained by functional requirements and parameters, and those constrained by social structure and interaction. A good understanding of the raw materials found in the assemblage, their sources, and the raw materials found in the site locality will help to refine the impact that the distinction between functional and social constraints had on the production of the lithic assemblage. An understanding of the raw material will also help the archaeologist to trace the different technological knapping strategies throughout the complete lithic assemblage, which can often be quite difficult to accomplish.

Previous approaches to the analysis of lithic technology has often been to concentrate on distinctive 'products' like cores and tools, in much the same way that many archaeologists have approached other aspects of the PPN archaeological record. The analysis of the debitage part of lithic assemblages has consisted of simple counts. However, just as with other aspects of material culture, because the distinctive lithic 'products' look the same does not necessarily mean that they have been made in the same way. Lithic technology cannot be fully understood until the complete *chaîne opératoire* or operational chain is understood. It is necessary to develop a typological framework that can identify the relationship between these lithic 'products'. Bordes was one of the first to develop such a typology using the experience he gained from experimental knapping.

"By using the concept of technique, dissimilar forms, e.g., flakes and cores, are linked on the basis of common production features." (Bonnichsen on Bordes 1997, 17-18)

The concept of *chaîne opératoire*, first coined by Leroi-Gourhan (Leroi-Gourhan 1964/5), was developed as a mechanism for understanding the role of choice within the development and implementation of a lithic technology.

"Whilst the production of stone tools takes place within a broad physical and mechanical constraints imposed by the raw material, the artisan is nevertheless capable of implementing a number of different strategies to create a particular artifact." (Edmonds 1990, 57)

Lithic debitage forms a significant part of the *chaîne opératoire* and so should not be ignored as had previously been done. Edmonds, following Cleghorn and Pelegrin *et al*, states that:

"At the very least, this form of practical understanding [chaîne opératoire] *provides us with further dimensions in which to monitor variability in the choices people made in the process of tool production and use."* (Edmonds 1990, 58)

The *chaîne opératoire* also gives the archaeologist more meaningful data in which to compare technologies than is gained by simply comparing 'products'. It is the comparison of these choices made within the *chaîne opératoire* of the lithic technology that will enable me to make some interpretations of the broader social context of flint knapping and networks of information sharing.

It is these issues that dictate the structure of my thesis; I shall be analysing four PPN lithic assemblages, concentrating on the debitage, using the concept of *chaîne opératoire*.
The four lithic assemblages come from Ghwair 1, a middle PPNB site, Wadi Fidan A and Baja, both late PPNB sites, and from Wadi Fidan C, a PPNC/6th mbc site. By comparing the data from the contemporary sites in a small region (up to 25km between the four sites), I can achieve some understanding of the social context of knapping, the presence or absence of networks for information sharing, and the level and form that these networks take. Comparing the lithic assemblage data of all four sites can provide an interpretation on how the networks developed through time, and the beginnings of an understanding on the development of regional identity (though this will require further research on technologies relating to other aspects of the material culture and to other sites outside of the regional extent of my thesis). I shall also be able to make a general comparison with similar analytical work carried out by D. Baird on the lithic assemblages from the Azraq basin, work done by A. Betts on the Harra and the Hamad and with work done by Y. Nishiaki on assemblages from Syria (Baird 1993/4, Betts 1988, Nishiaki 2000). This will help to broaden the scope for understanding the development of regional identity, and whether information sharing networks functioned on such a wide scale, particularly during the period of PPNB collapse (because my analysis only covers one PPNC/6th mbc site).

By weaving the data collected from a raw material survey of the area (carried out in 1998) throughout my analysis, I can refine my analytical approach and the quality of the data it produces, enhancing an understanding of raw material use and treatment at each stage of the reduction sequence rather than simply at a more general strategy level. Comparing raw material use at this level can also give some insight into attitudes to raw material that are not necessarily only related to practical limitations.

The importance of this thesis lies in two areas. The first is that the Fidan/Faynan area is archaeologically important because it has been intensively populated at least from the Pre-Pottery Neolithic A (possibly even earlier though no archaeological research has yet been directed towards earlier periods) to the present day. Therefore, there are sufficient sites to make a comparison of technology relatively straightforward as environmental conditions can be taken out of the equation to a certain extent, and this kind of research has not been applied to this area before. The other area of importance lies in the fact that there are only a limited number other examples of this type of research (Baird 1993/4, Betts 1998, Nishiaka 2000), therefore, little is understood about social complexity and interaction from the perspective of technology across the Levant as a whole during this period. My thesis will help build on our current understanding on the nature and development of information sharing networks, and the impact of regional identity; during the unique period of the Pre-Pottery Neolithic B and the Pre-Pottery Neolithic C transition.

My thesis is separated into ten chapters; chapters two and three will cover the background of the Pre-Pottery Neolithic in general and the background of the four sites in this thesis (Ghwair

1, Wadi Fidan A, Baja, and Wadi Fidan C). Chapter four will cover the theory behind my methodological approach and my methodology itself. Chapters five to eight encompass the analysis of the lithic assemblages from the four sites Ghwair, Wadi Fidan A, Wadi Fidan C and Baja. Chapter nine makes an inter-site comparison of the preceding four analysis chapters, and draws some significant conclusions about the nature of information sharing between these four sites. Chapter ten is my conclusion and discusses how my case study relates to the Levant as a whole. It makes a comparison with other similar works carried out on groups of sites in Syria and the Jordanian Black desert. The final section of this thesis includes five appendixes where I list definitions of the terms I use in this thesis, and a bibliography.

Chapter 2

Background of the Pre Pottery Neolithic (PPN)

The main issues ensuing from the analysis of the PPN archaeological record of the Levant (particularly the southern Levant) will be discussed in this chapter. Figure 2 is a map of Jordan marking all the sites mentioned in this chapter. Figure 1 (Based on a map by D. Harris, Harris 1996:190) is a map showing the general type and extent of vegetation typical to the Levant during the Pre-Pottery Neolithic. The Levant, particularly areas closer to the coast, was a relatively fertile area where the all important cereal species occurred naturally in the wild.

It is clear from a review of published reports that, on a general level, the material culture of the PPN Levant is unusually homogeneous. Such a level of homogeneity does not occur in earlier or later periods. The key development during the PPN is the consolidation of agricultural practices partially begun in earlier periods (including the domestication of cereals, sheep and goat); this had a profound effect upon human population and social organization during this period (Rollefson 2001). As a result of the importance of agriculture, PPN communities built more permanent housing, though they may not have occupied them all year round (particularly in the more arid zones).

A separation of the PPN into two distinct periods, PPNA and PPNB, has become the standard classificatory system used by most archaeologists studying this period. This division was first proposed by Kathleen Kenyon (Kozłowski 2001:283) on the basis of archaeology at Jericho (the term PPNC is a more recent and controversial addition referring to the transition between the PPN and the PN). Latterly questions regarding the functioning of this chronological framework have been raised by people like Stephan Kozłowski (Kozłowski 2001) who argue that the material cultures considered to be characteristic of either the PPNA and the PPNB are not necessarily contemporary on all sites. For example, material culture typical of the PPNB appears on north Levantine sites like Mureybet phase III at a time period contemporary with PPNA sites in the southern Levant (Moore 1978:119-127, Baird *pers. com.* 2004).

The Pre-Pottery Neolithic A

The key development during this period is the clear beginnings and consolidation of agriculture and sedentism. Though the archaeology of the PPNA suggests that sedentism and agriculture do not always occur at the same time.

The PPNA is separated into two periods, first proposed by Crowfoot-Payne on the basis of the lithic assemblages from Jericho, Salibiya IX and Jericho (Kuijt 1996:8), Khiamian and Sultanian. The Khiamian represents the gradual change from the preceding late Natufian material culture, and the Sultainian a consolidation of a clearly PPNA material culture and its innovations. In the absence of ^{14}C dates, the Khiamian and Sultanian lithic typologies have been used for relative dating, for example at the site of Salibiya IX (Enoch-Shiloh Bar-Yosef 1997). However, the Khiamian/Sultanian divide is a contentious issue as current research has indicated that it is not as clear-cut as previously thought. Kuijt argues that microliths (excluding lunates) are probably intrusive from preceding Natufian levels and therefore, that the Khiamian, as a typology, does not exist (Kuijt 1996).

Regardless of the difficulties with chronology, the PPNA remains a generally distinct material culture that is evident right across the Levant.

Change in settlement patterns

A change in climate to wetter, cooler conditions at the end of the Natufian period, roughly co-insides with a change in settlement patterns. PPNA sites appear to be concentrated in what is known as the 'Levantine corridor', this runs from the Damascus basin and down the Jordan Valley (based on the PPNA sites so far discovered). This settlement pattern, which appears to be a result of an increasing focus on the consumption of cereal crops as the staple of the PPNA diet, continues on throughout the PPNB.

Site Type

There are several different types of site apparent during the PPNA:

- Sedentary or semi-sedentary village sites occupied by groups engaged in either cultivation or systematic and intensive foraging. Good examples of this type of site include Jericho (Kenyon 1985) and Netiv Hagdud (Bar-Yosef, Gopher 1997).
- Campsites for hunting task groups probably from village communities. An example of these being the cave site of 'Iraq ed-dubb (Bar-Yosef, Gopher 1997).
- Campsites for hunter-gatherers found in arid areas like the Negev and Sinai deserts. Abu Madi I in the Sinai being the classic example of this type of site (Bar-Yosef, Gopher 1997, Moore 1978).

Domestic architecture

Unlike the PPNB period, the general shape of dwellings during the PPNA is relatively consistent across much of the Levant (though size can vary). Domestic structures are oval to circular and semi-subterranean. The superstructures have not survived and archaeologists have suggested a range of different types from rounded to flat roofs (Kenyon 1985: 19-40, Bar-Yosef, Gopher 1997: 249). There are exceptions to the rule, at Nahal Oren the oval structures are particularly small, are often joined together, and are described as *"resembling the compound arrangement of preceding Natufian communities."* (Bar-Yosef 1998: 192).

At WF16 the oval dwellings are connected by an extensive network of walls (Finlayson *et al* 2000). The interiors of PPNA dwellings are relatively simple, interior divisions are only seen at Jericho, Mureybet phase III and at Qermez Dereh (Bar-Yosef, Gopher 1997: 247-266). It is interesting to note that internal divisions are generally considered to be an innovation of the PPNB. Hearths are often centrally placed and lined with stone, good examples can be seen at Netiv Hagdud, Jericho and Nahal Oren (Bar-Yosef, Gopher 1997). Other features which are relatively common, and found inside PPNA domestic structures, are limestone slabs with cup holes in them. These can be seen at Netiv Hagdud, Nahal Oren, Mureybet (Bar-Yosef, Gopher 1997) and at Beidha (Kirkbride 1966: 34). Storage bins can also be seen inside domestic structures and like the hearths; they too are often lined with stone. Good examples can be seen at Netiv Hagdud, Jericho and Mureybet (Bar-Yosef, Gopher 1997).

Non-domestic architecture

Though not as common as in the PPNB, non-domestic structures are present at many PPNA sites. However, and again unlike the PPNB, all appear to have a practical rather than a cultic use. Large grain silos or storage facilities can be seen at Gilgal I and at Hallan Çemi (Bar-Yosef, Gopher 1997) and at WF16 (Finlayson *et al* 2000). At Jericho there are the obvious examples of the tower and surrounding wall, originally thought to be for defence by Kenyon (Kenyon 1985), but are now considered to have been built as flood defences by Bar-Yosef (Bar-Yosef 1998). Some of the walls at WF16 are also thought to protect the site from flooding (Finlayson *et al* 2000). An open area around the tower at Jericho is considered to have public significance, as is the central open area at Hallan Çemi (Bar-Yosef, Gopher 1997). There are also oval structures at Hallan Çemi, which are larger than the domestic structures on the same site, and which were found to contain large quantities of prestige goods like imported obsidian and decorated stone bowls (Bar-Yosef, Gopher 1997).

Construction materials and methods

Stone and mud brick were most commonly used to construct PPNA structures. The lower courses lined a pit making the structures semi-subterranean. The one exception is at Mureybet phase IB where the walls are made of wooden posts and mud (Moore 1978:119-127). Originally thought to date to the Natufian period, phase IB has been re-classified as Khiamian (Bar-Yosef, Gopher 1997). The superstructures of PPNA houses are not well understood. Both Kenyon and Bar-Yosef have suggested that they were constructed using mud plaster, matting and wood, based on remains found inside structures at Jericho and Netiv Hagdud (Kenyon 1985, Bar-Yosef, Gopher 1997). During the PPNB, the 'PPNA like' semi-subterranean oval dwellings common in the more arid zones (examples include Dhuweila, and sites at Azraq and Jilat) were suggested to have tent like superstructures (Betts 1998:48), and this could possibly have originated in the PPNA.

The interior floors of PPNA dwellings were made of beaten mud or in some cases of plaster. Walls were often plastered as well. Good examples can be seen at Jericho (Bar-Yosef, Gopher 1997:251) and at WF16 (Finlayson *et al* 2000:22).

Arid Zone architecture

There are no significant differences between structures built in arid zones such as those at the site of Abu Madi, and those built in the Mediterranean zone at sites such as Jericho and Netiv Hagdud. This is a very different situation to that seen during the PPNB.

Lithic Technology

I have previously mentioned that the PPNA is commonly separated into two periods based on lithic typologies. The Khiamian lithic typology is characterised by:

- The introduction of El-Khiam points, the first true arrowhead.
- An increase in the number of sickle blades
- A continued dependence on microliths (which are a common tool during the Natufian), the term microliths used here, includes lunates (Bar-Yosef 1998)

Kuijt considers these microliths (excluding lunates) to be intrusive from Natufian levels, rendering the Khiamian no different from the Sultanian (Kuijt 1996). The Sultanian lithic typology is characterized in the following way by (Bar-Yosef 1998):

- Tahunian tranchet axes/adzes (which are bifacially retouched)
- Polished celts
- Perforators
- El-Khiam points

- Rare microliths, namely lunates
- Netiv Hagdud truncations

The general size of lithic artifacts by the Sultanian is larger than preceding periods because the importance of microliths has significantly decreased. This general trend of size increase continues through to the PPNB.

Khiamian and Sultanian industries are found across the Levant, and certain aspects of these industries can even be seen as far as Qermez Dereh and Nemrik 9 in northern Iraq. However, they are not found everywhere. The lithic technology evident at sites in the Sinai and Negev deserts is known as the Harifian industry because it includes Harif points and is largely microlithic. It is contemporary with the Khiamian (early PPNA) and considered to be more closely related to the preceding Natufian lithic industries than to other PPNA industries (Belfer-Cohen and Bar-Yosef 2000, Baird *pers. com* 2004).

Current research on PPNA lithics has demonstrated that assemblages between sites can vary greatly and that they do not necessarily fit neatly into the two typologies of the Khiamian and Sultanian mentioned above (Kuijt 1996).

Small finds and cultic objects

Cultic objects are not found on the same scale as they are during the PPNB. However, a limited number of clay or stone figurines are found on most PPNA sites. They often depict a seated woman and examples can be seen at Netiv Hagdud, Gilgal I (Bar-Yosef, Gopher 1997), and at WF16 (Finlayson *et al* 2000). Prestige goods are, relatively, more common and an extensive and long distance trade in obsidian is evident from the varying quantities of Anatolian obsidian present at many PPNA sites. Greenstone and marine shells (for bead and pendant production) are also present at many PPNA sites. The quantity of greenstone and obsidian, in conjunction with site size has been used by Bar-Yosef to argue for centres of redistribution and a hierarchy in the relationships between sites. One such centre could have been Jericho, which was a relatively large settlement during the PPNA and controlled a larger quantity of obsidian and greenstone than nearby sites such as Netiv Hagdud (Bar-Yosef, Gopher 1997). However, on a general level, there are fewer small finds or artifacts found at PPNA sites than at PPNB sites, and the relationships between communities did not necessarily take a similar form to those during the PPNB.

Burials

PPNA burial practices appear to be relatively consistent across the Levant, and are a combination of previous Natufian practices (Belfer-Cohen and Bar-Yosef 2000 following Kuijt), and developments that became more pronounced during the PPNB.

Burials are typically flexed and without grave goods, features seen earlier during the Natufian, a good example can be seen at WF16 (Finlayson *et al* 2000). However, PPNA burials were beneath floors or in the fill of abandoned houses, and often the skull was removed, as seen at Jericho, Netiv Hagdud and Hatful (Bar-Yosef and Gopher 1997: 247-266). These are features, which became very common during the PPNB.

Spatial organization within sites

During the PPNA we see the beginnings of spatial differentiation and organisation, specific areas being used for specific purposes, which is not seen during the Natufian. The presence of a few non-domestic structures is a good example of this, but it can also be seen in the increasing differentiation in the variability and quantity of lithics between contexts within a site. This can be seen clearly at Netiv Hagdud (Bar-Yosef and Gopher 1997:249, Navel 1998: 8-10). At WF16 the excavators (Finlayson *et al* 2000) suggests that the site is divided into two areas, in trench 1 the rough structures appear to have been built for some form of storage and in trench 2 as dwellings, based on the finer construction methods and the sequence of floors (not seen in trench 1 Finlayson *et al* 2000:22).

Economy and environment

The PPNA period was given the label 'Neolithic', which assumes that the economy is based on cultivation. Kenyon, who coined the term, considered the economy of Jericho to be Neolithic, based on the identification of domesticated emmer wheat in the PPNA levels (Kenyon 1985: 27). In a survey of early Neolithic plant husbandry, Van Zeist "*was willing to speculate and suggest that plant cultivation began between the Damascus basin and Jericho*"(Bar-Yosef 1998:196 following Van Zeist). However, there are two problems to overcome: the first is that there is no evidence for irrigation as early as the PPNA (the earliest evidence dates back to the Chalcolithic, several millennia later) and current conditions in this area are such that farming is not successful without irrigation. The second problem is that there are still questions about the morphology of domesticated cereals. Environmental evidence from several lake cores indicate that the PPNA roughly coincided with the onset of cooler wetter conditions than today and that farming could have been conducted without irrigation on a seasonal basis in the Levantine corridor (Moore 78:140, Bar-Yosef). However, this does not mean that all PPNA sites within the Levantine corridor were engaged in full-scale cultivation. At Mureybet there is no evidence for domesticated cereals but cereals do dominate the community's diet. One suggestion is that they were cultivating wild varieties (Bar-Yosef 1998:195), though this is difficult to demonstrate conclusively. At Netiv Hagdud there are a few examples of domesticated barley grains mixed in with a larger quantity of wild barley. Kislev, who analysed this assemblage from Netiv Hagdud, originally proposed that the inhabitants were engaged in the cultivation of both wild and domesticated barley. However, he subsequently changed his mind considering the domesticated examples to be natural mutations of the wild barley (Kislev 1997). Kislev considers that, because so little tends to remain of the ancient grain it is difficult to make a clear case for a domesticated morphology, and that previous diagnosis of domesticated morphology at other sites may be inaccurate. He argues that the domestication of cereals probably did not occur during the PPNA, but the period witnessed the onset of systematic harvesting of wild stands, the evidence for which can be seen in the massive cultural change to a more sedentary way of life (Kislev 1997). Whether or not the domestication of cereals occurred during the PPNA, we do see the establishment of one of the main consumption habits of Near Eastern peoples.

Summary of the PPNA

Archaeologists generally consider the material culture of the PPNA to be far more variable than the PPNB. This argument has been based on the lithic technology that does vary considerably between sites (Nadel 1998: 8-10, Enoch-Shiloh and Bar-Yosef 1997: 33). However, this variability on a general level is only seen in the lithics, particularly at south Levantine sites. The rest of the material culture is relatively standardized; we certainly do not see the stark differences between arid and Mediterranean areas that are so evident during the PPNB. There is homogeneity (on a general level) across the southern Levant. North Levantine

PPNA material culture is arguably different partly due to the introduction of aspects of PPNB material culture at a period contemporary to the PPNA of the southern Levant (this is an issue I will return to later on in this chapter) and contemporary sites like Hallan Çemi, Qermez Dereh and Nemrik 9 which lie outside of the Levantine corridor provide good contrasts. They retain some similarities in the lithic assemblages (particularly El-Khiam points) but the architecture and other artifacts are considerably different (Bar-Yosef and Gopher 1997:247-266). These distinctions between the north and south Levant appear to continue into the PPNB.

PPNA/B transition and the early PPNB (EPPNB)

The chronology of this transition is very contentious and is a problem not helped by the dearth of sites relating to this period in the southern Levant. A major complication arises from the confusing use of the terms PPNA and PPNB both as part of a chronological framework and also as material culture typologies. Kenyon first broached subject of the PPNA/B transition on the basis of evidence from Jericho. Kenyon and Mellaart both argue for a replacement of peoples in the southern Levant, which marks the end of the PPNA and the beginning of the PPNB (Kenyon 1985:19-40, Mellaart 1975:18-69). Kenyon established her argument on the basis of a layer of erosion sediments that separated the PPNA from the PPNB at Jericho. She suggested that this represented a period of abandonment preceding the reoccupation of Jericho by peoples who exhibit a PPNB material culture (Kenyon 1985:19-40). Later arguments considered this transition was not about the replacement of people, but rather about the spread of a material culture and spheres of influence. At sites like Beidha and Nahal Issaron where there is no stratigraphic break during this transition period, we see the gradual introduction of rectilinear architecture and other aspects of the PPNB material culture, alongside the phasing out of PPNA circular architecture. Additionally there are no major interruptions in the lithic assemblages from these two sites (Gopher 1994:226).

Typical aspects of PPNB culture such as rectilinear architecture, naviform cores and Helwan points first appeared in the northern Levant. Mureybet is often mentioned as one of the sites from which the PPNB culture originated. Helwan points and naviform cores are rare but present in Mureybet phase III dated to between *c.*9000-8,500 B.C. (Moore 1978:119-127) these dates are contemporary with the PPNA of the southern Levant. Rectilinear architecture first appears at Mureybet at the very end of phase III and the beginning of phase IV, from 8,500 B.C. onwards (Baird *pers. com* 2004). At Jerf el-Ahmar, on the middle Euphrates, we see the introduction of rectilinear architecture as well as the presence of a few rare naviforms and Helwan points (which exist alongside El-Khiam points), by *c.*8,400 B.C. (Baird *pers. com.* 2004, Mottram 1997:14-16). Gopher considers the northern Levant to be an *"innovative source area"* and the southern Levant to be a *"recipient area"* (Gopher 1994:265). He traces the gradual movement of cultural influence south through the medium of arrowheads. Helwan, Byblos and Oval or Amuq first appear in the north and are related to the introduction of the naviform blade production strategy (Gopher 1994: 262-268). This argument, suggesting the spread of a PPNB culture from the north slowly replacing the PPNA in the south, is based on key features of PPNB material culture; namely rectilinear architecture and lithics (specifically, naviform blade production and Helwan points). Key sites supporting this argument have been Mureybet and more recently, Jerf el-Ahmar. However, at a recently discovered site called Motzah, in the southern Levant, rectilinear structures have been ^{14}C dated to 8,400/300 B.C. (Baird *pers. com.* 2004). These dates are contemporary to those at

Jerf el-Ahmar and only a little later than at Mureybet. Therefore, Naviform cores and Helwan points may well have originated in the north of Levant, but it is questionable whether rectilinear architecture did. In the arid areas of the Levant rectilinear architecture was not consistently adopted until well into the Pottery Neolithic. At Beidha, circular or oval structures are not phased out until into the PPNB (Kuijt 1997) and we also see the continued use of Khiam points at Beidha as late as the middle PPNB (Baird 1993). Therefore, I do not consider it useful to talk about the spread of an 'entire' PPNB culture, instead we see the adoption and adaptation of individual aspects of PPNB material culture, in different areas, at different times. Certainly the inconsistent coverage of domesticated cereals across the Levant during both the PPNA and the PPNB (Kozłowski 2001:283-284) indicates that the transition to the Neolithic in its economic sense was also more erratic than previously thought. The adoption of new ideas and technology at the beginning of the PPNB was not necessarily a gradual and smooth process spreading from the north to the south, but possibly occurred on a more localised basis, with each region being influenced by others but developing their own interpretations on a theme. It is clear that further research is required in relation to the PPNA/B transition (or the EPPNB as this period is known in the southern Levant), in particular, the search for more sites relating to this period in the southern Levant.

The Pre-Pottery Neolithic B

The Pre-Pottery Neolithic B is most relevant to my thesis with three of the four sites analysed in the thesis being of a PPNB date. The PPNB is generally separated into two or three phases:

- The Early PPNB (EPPNB): which represents the transition from the PPNA to the PPNB (discussed previously in this chapter). This term is often used in reference to sites in the northern Levant as the transition to the PPNB is considered to occur much earlier here than in the southern Levant. However, there are questions as to whether the EPPNB exists at all in the southern Levant because the framework for the EPPNB is based on what is happening in the northern Levant. Few sites have stratigraphy dating to this period, and it does not appear to be a cultural entity in the same way that the PPNA or the middle PPNB do. For example, the PPNA levels at Jericho were suggested to be EPPNB by Bar-Yosef on the basis of Kenyon's later ^{14}C dates for the PPNA levels *c.*8,350 B.C. (Bar-Yosef and Gopher 1997:251). However, the material culture of these levels can be described as typical of the PPNA. At Beidha the PPNA material culture appears to last well into the MPPNB (Kuijt 1997), and at Motzah rectilinear structures appear as early as *c.*8,400-8,300 B.C.

- The Middle PPNB (MPPNB); which is a well established term relating to a period dating roughly to between *c.*8,000-7,500 B.C. (Baird *pers. com.* 2004). A population explosion leads to a proliferation of sites with a very typical PPNB material culture. We also can trace the possible beginnings of animal domestication in the Levant to this period.
- The Late PPNB (LPPNB) relates, roughly, to the period between *c.* 7,500-7000 B.C. This is identified as a separate phase because sites become dramatically larger, and we see the consolidation and expanding practice of animal husbandry.

Settlement patterns

The settlement patterns of the PPNB Levant were established during the PPNA, permanent village sites concentrate along the 'Levantine corridor', but become more numerous, as the population explodes. Some of these village sites, particularly in the southern Levant, like Jericho and ‘Ain Ghazal grow to become ‘mega’ sites by the late PPNB (Rollefson 1989:135-40). Communities in more arid areas such as the east Jordanian Plateau, Sinai and the Negev, remain semi-permanent, moving around their region on a seasonal basis. However, these desert communities are either in contact with the permanent farming communities of the ‘Levantine corridor’ and are involved in exchange centred on cereal crop surpluses or the desert communities are cultivating cereals themselves, though on a seasonal basis.

Domestic architecture

During the first half of the mid PPNB the most common type of domestic structure was the single roomed rectangular house, as is found at sites such as ‘Ain Ghazal (Rollefson 1997) and Ghwair 1 (Najjar 1994). However, at Beidha ^{14}C dates indicate that during the early middle PPNB (levels VI-IV) polygonal structures were built, arranged in tessellating clusters like that of a honeycomb (unfortunately the ^{14}C dates for these structures may not be secure, Kirkbride 1966). Though dating is problematic with these two phases at Beidha, these honeycomb structures appear to be unique during the PPNB. Other examples of less striking variation in building morphology can be seen at various sites. The multi-roomed houses, typical to the late PPNB at es-Sifiya consist of several small rooms set around not one, but at least two or more larger central rooms (Mahasneh 1997). At ‘Ain Jemmam, rooms contain stone pillars which are either set in the middle, or to one side (Waheeb and Fino 1997). At ‘Ain Ghazal, Basta and Baja complex split level terracing within some houses can be seen, which is a response to the contours of the sites (Rollefson 1997, Gebel 1988, 1997). However this technique is not employed at all terraced sites where the internal structures of houses are on the same level.

Non-domestic architecture

Non-domestic structures are commonly found at many Levantine sites, particularly during the late PPNB. However, they are neither consistent in their form nor possible uses. The number of non-domestic structures also differs from site to site across the Levant both, contemporarily and chronologically. There are several different types of non-domestic structure found at 'Ain Ghazal, ranging from circular or apsidal to rectangular forms. Rollefson and Simmons (Rollefson and Simmons 1988) give them labels relating to ritual concepts. For example, the circular buildings are "shrines" and the rectangular building is a "temple". They have related these structures to the practice of ritual because of their distinctive shapes and centrally placed features such as the hole with a plaster imprint, previously discussed, and standing stones (Rollefson and Simmons 1988). The 'temple' and apsidal structures are considered contemporary (based on relative dating methods) though situated in different areas of the site. The 'shrines' are later as one is a reconstruction of a late PPNB apsidal building (Rollefson and Simmons 1988). The presence of more than one contemporary non-domestic building on site is important because it raises questions pertaining to their possible link with ritual practices; the nature and social context of ritual practices and concepts held by the community, and how the two types of buildings related to each other and to the community at large.

At Beidha there appears to be more than one type of contemporary domestic structure (Kirkbride 1966), but nothing that can be singled out as significantly distinct. Whether these differences are due to ritual practices or social context is difficult to establish. At Ghwair 1 there is a small circular structure contemporary with the late/mid PPNB, and an elaborate feature that is an open space with a large set of stone steps suggested to be a "theatre or public area" by the excavators (Najjar and Simmons forthcoming). The circular building is distinct because it contains the only sub-floor burial found to date as well as caches of goat skulls and of fine blades placed on the plastered floor. A figurine was also found on the plastered floor close to a wall niche (Najjar and Simmons forthcoming).

Construction materials and methods

Variation can also be seen in the use of building materials. In the southern Levant, both domestic and non-domestic structures are largely built of stone. On the sites of 'Ain Jemmam and es-Sifiya, the same type of tabular limestone has been used in construction. These two sites are in fairly close proximity and took advantage of locally available stone (Waheeb and Fino 1997, Mahasneh 1997). Other sites like 'Ain Ghazal, Basta, Beidha and Baja also took advantage of locally available stone. However, at Jericho the structures have been largely built of mud brick (Mellaart 1975), a tradition employed throughout the long history of Jericho. Using mud brick as a building material seems to have more in common with PPNB sites in the Northern Levant.

Other features in construction methods of the PPNB in the southern Levant include the use of sub floor channels at several sites. Here again there is variation both in construction and possible use. The best examples are at Basta, where they run underneath the length of two terraced houses (Gebel *et al.* 1988). Their sides are lined with stones; the bottoms with dark stained plaster and they are capped with stone slabs and then the plaster floor of the house. The fill of these channels consists of fine silt, suggesting some form of water action. However, the channels are not watertight and in some cases there are burials in them. This would have been a little unsavoury if their original purpose was for drainage. Any water action probably occurred after the houses were abandoned, therefore, it may be possible that the channels were originally constructed for burial purposes; it is well documented that PPNB burials were often placed under the floors of houses, and can be seen on many of the PPNB sites mentioned in this chapter. However, as the channels at Basta were not completely filled with burials, it is difficult to determine whether or not burial was the primary purpose of these features. No other channel features on other south Levantine sites contain burials. At es-Sifiya there are channel features underneath three of the smaller rooms on the eastern extent of the site and along the outside edge of the most western rooms of the excavation. These channels have been constructed using very similar methods to those seen at Basta, only with mud rather than plaster bottoms (Mahasneh 1997). Again, like Basta, the es-Sifiya channels have fine silt fills and though they would not have been watertight they probably attracted water action after the houses fell into disuse. At 'Ain Ghazal the sub-floor channels are only found on a distinct (probably non-domestic) circular structure (Rollefson 1997). The channels radiate from a central hole, and were constructed using similar methods to Basta and es-Sifiya and are also not watertight. The channels would have provided a good flow of air to the central hole and the plaster imprint around the hole suggests that something was originally placed over it, possibly a stand for a fire; which would have burned well and at a high temperature with a good supply of air (Rollefson 1997). It is possible that all the channels had a similar primary purpose, for ventilation, but they are used in unique ways at each site. Sub-floor channels are not found elsewhere in the southern Levant.

Many of the sites in the less marginal areas are situated on hillsides surrounding wadis and so it was necessary for these sites to be terraced. By the late PPNB a degree of town planning can be seen, for example partition walls separating houses on these terraces. This can be found at 'Ain Ghazal, where a walled street was created by the use of these partition walls. Stone steps ran up part of the street's extent (Rollefson and Simmons 1988). There are some traces of town planning as early as the middle PPNB, as seen at Ghwair 1 where a 'theatre' was constructed as well as a substantial perimeter wall, the latter possibly being used to prevent colluvial action burying nearby houses (Najjar and Simmons forthcoming). At Beidha, old abandoned houses appear to have been deliberately demolished and cleared, possibly to create public spaces (Kirkbride 1966). These developments are possible responses to increasing competition for resources as population levels increase to levels that required public cooperation to smooth tensions.

Interior decoration

The interior treatment of structures from PPNB sites of the Levant is remarkably similar over an extensive region. The most common form of treatment is the use of lime plaster on walls and floors. The plaster was put on in layers, with each layer utilising different levels of lime content. In particular, the floors were made up of a base layer of gravel or pebbles set in a hard matrix of lime plaster, over the top of this a thin layer of fine lime plaster was used to create a smooth finish. In many cases the wall and floor plaster was then painted or stained with red ochre. Examples of this type of floor can be found at many sites including 'Ain Ghazal and Beidha. In fact the plaster floor is one of the hallmarks of the PPNB in the Near East. However, it is evident that there is some variation in the use, preservation and formula of wall and floor plaster. The evidence for wall plaster is less clear because very little has survived in *situ*. It is common to find fragments of plaster lying on the floor of the houses that may have come from the walls, particularly where there are no gravel inclusions in the fragment, however, this is not always clear. At sites such as Baja and Ghwair 1 there are no complete plaster floors, only fragments of red stained plaster, and it is not possible to determine whether these small fragments came from walls or floors. At es-Sifiya and 'Ain Ghazal there are traces of plaster remaining on the walls and this is made from a combination of mud plaster and a lime plaster finish, but at es-Sifiya there are no traces of red pigment. However, at Beidha and 'Ain Jemmam, the traces of plaster found have been made entirely of lime. The proportional differences of lime plaster cannot be argued to be a feature of local raw material accessibility because lime is present at many sites; rather the makeup of plaster types is probably more to do with local preferences and traditions. There is also a lot of variation in the application of red pigment on plaster. Red is the most common colour used in the southern Levant which differs to the northern Levant where black is common. Good examples can be seen at sites such as Abu Hureyra in northern Syria (Fig. 2, Moore *et al.* 1975). The most common method of application was to smear it onto the surface and it probably covered the entire area of wall or floor. Occasionally archaeologists have found evidence of designs in red pigment on the wall and/or floor plaster. At Ghwair 1 there are indications of red geometric designs on wall plaster from the second architectural phase (Najjar and Simmons forthcoming), and at 'Ain Ghazal there are examples of finger painted designs, some geometric, on plastered floors (Rollefson and Simmons 1988). At Beidha, furniture appears to have been plastered into the floors, plaster sills are built around several hearths and in a level II house there is a roughly squared, slightly concave stone slab plastered into the wall and floor. Designs in red pigment have been painted around the plaster furniture and around door sills and a stone lined pit, making it clear that these were permanent features of the houses (Kirkbride 1966). This kind of feature does not appear to occur at any other south Levantine site except possibly over the 'hole' feature in one of the 'Ain Ghazal 'shrines', but here no red pigment has been used. Cream pigment has also been used at Beidha, in association with the red designs. These are the same colours as used at Jericho though in different ways (Kirkbride 1966). It is clear that there is greater variation in interior decoration during the PPNB of the Levant than is often attested to in general overviews of the period, for example Mellaart's *The Neolithic of the Near East* (Mellaart 1975) and Bar-Yosef's *Investigations into South Levantine Prehistory* (Bar-Yosef and Vandermeersch 1989).

Arid zone architecture

Thus far I have discussed the architecture of the more moderate Mediterranean zone, however there is also plenty of evidence to show that the Jordanian desert, where permanent farming practices would have been more problematic, was extensively occupied during the PPN. Though there is variation in the architecture of the Mediterranean zone, there is enough similarity to show that the sites were constructed using the same basic building tradition. In the desert, the picture is different, though there are assemblages of chipped stone and small finds which indicate they belong to the PPNB period, the architecture is very different. The Wadi Jilat, a tributary into the Azraq basin, and the Azraq basin itself, are the locations of five PPNB sites. The structures found on these sites range from curvilinear and oval to rectilinear.

They are generally constructed with upright stone slabs lining a cut, which make the buildings semi-subterranean, presumably with a semi-permanent (tent like) superstructure that has not survived the ravages of time (Baird 1993). In the southern Negev, a PPNB site called Nahal Issaron is made up of structures, which range from circular to oval and polygonal forms and are constructed in a similar way to the Azraq sites. Nahal Issaron is one of several similar PPNB sites in the area (Gorring-Morris and Gopher 1983). These structures on the desert sites do not appear to be as substantial or permanent as those on less marginal sites despite having similarly long periods of occupation; this suggests that these sites are seasonal camps (Baird 1993). The architecture in these areas are clearly linked to different ecological conditions and lifestyle than that occurring at the Mediterranean zone sites. The Azraq and Negev sites are similar, despite the distance between them, because local conditions are similar. Family groups would have moved continuously with the seasons in order to take full advantage of limited resources, and would have required sturdy foundations as the base for portable superstructures that did not utilize large amounts of wood.

Lithic technology

Other features of the PPNB material culture share strong general similarities across the southern Levant. The lithic technology is no exception. Certain typological forms are so common they can often be used to date sites, for example arrowheads like Byblos and Amuq points. Other points like Jericho points are common but do not have as extensive a distribution as the Byblos and Amuq points. Other common typological forms are the naviform core, which is also found almost everywhere across the Levant. The latter being used to produce distinctive, regular blades as blanks for specific tool types, including the points mentioned previously. However, the form of the naviform cores does differ from site to site and I shall be discussing this variation across the Levant in chapter 10 of this thesis. The lithic technology in general appears to have a 'dual' character, with formal reduction strategies based around the production of naviform core blades common across the entire Levant; and more *ad hoc* reduction strategies, centred largely around the production of flakes, which tend to differ more between sites. However, many ecological and social factors affected the knapping processes and these are evident to a certain extent in the lithic assemblages. I shall not discuss these issues here, but address them in the summaries of chapters 5-10.

Small finds

A great variety of small finds can be found at all PPNB sites and, though there are general themes like the production of beads, this is probably one of the most variable aspects in the PPNB material culture. On some sites there are suggestions of craft specialisation. For example at Baja, artifacts relating to stone ring production are found at specific loci, suggesting that specific households were responsible for their production (Gebel 1997). Similar types of small find assemblages, and the tools that produced them, can be found at sites where their special distribution is less distinct than at Baja and so we cannot identify a workshop as such (for example, Jilat 7 and 31). However, a similar level of skill, time and effort has been invested in their production. Stone rings are common to many PPNB sites in the Mediterranean zone, but they range greatly in size, from small examples that could fit on fingers to larger sizes that could fit on wrists (it is important to bear in mind that these rings may not have been produced to be worn on the body). They are found on many sites including Baja (as previously mentioned, Gebel and Bienert 1997a), Basta (Starck 1988), es-Sifiya (Mahasneh 1997), 'Ain Ghazal (Rollefson and Simmons 1988), Abu Gosh and Tell Ramad (Starck 1988). The various types of beads and pendants, and therefore perforating tools like piercers, are common on many sites across the Levant. Only a limited amount of modification can be done to a small bead and so it is difficult to distinguish possible local traditions of bead production and a more general PPNB tradition. It is the raw materials used to produce beads that might help to make this distinction. Baja and Basta have quite an extensive craft production in mother-of-pearl though neither of these sites is situated on the coastal plain. Other seashells are common at PPNB sites, including desert sites like Jilat 7, 13 and 26 (Garrard *et al* 1994). 'Green stone' or copper ore also moves around the landscape because, though it is found at Ghwair 1 (Najjar and Simmons forthcoming) and Wadi Fidan A (Moreno forthcoming), the closest PPNB sites to the ore source, it is also found further a field at sites such as Baja and Basta (Gebel and Bienert 1997a and 1997b). Bead raw materials or possibly even the finished products are clearly involved in an extensive trade network covering much of the Levant, however a good understanding of the nature of this network would require further research, which has, as yet, not been methodically attempted. A better understanding of this trade network would shed further light on the extent of the relationships between individual sites of the PPNB and the social context in which these relationships functioned. Though there are strong commonalities in bead and stone ring assemblages, craft production on each site would have been very much influenced by the skills and desires of the artisan and the desires of those individuals that were to use the finished product. Therefore, there are many small finds that are unique to particular sites. Good examples of these are gaming tokens and objects, human and animal figurines. Limestone slabs that have small indented "cup" holes laid out in rows, with grooved lines weaving between them, are unique to PPNB Beidha and were possibly used as gaming boards (Kirkbride 1997). Assortments of gaming tokens of clay can be found at Ghwair 1 and Baja (Najjar and Simmons forthcoming, Gebel and Bienert 1997a) and stone gaming tokens at WFA (included in the lithic assemblage analysed in this thesis). Though figurines are found on many sites across the Levant, there does not appear to be any standardization either in figurine morphology nor production methods. At Beidha, animal and human figures have been produced in clay (Kirkbride 1966), a common medium for the production of figurines. At Ghwair 1 the inhabitants used a similar medium though here they baked the clay, turning it to ceramic (Najjar and Simmons Forthcoming). At es-Sifiya, a human figurine was found made of white quartz (Mahasneh 1997).

Burials

The standard view of burials in the PPNB Levant is that interments, probably of family members, were placed under the floors of domestic structures. It was also common practice to remove the skulls, particularly of adults, and either re-deposit them elsewhere, or place them within living quarters. It was also common to modify the skulls in some way, either re-modelling the face using a medium such as plaster. However, the evidence for burial during the PPNB indicates that there is more variation both within and between sites than with any other aspect of the lifestyle of these people. This variation is reflected in the variety of non-domestic, possibly ritual orientated, architecture and in other ritual orientated artifacts such as figurines; suggesting that there was very little standardization in the expression of spirituality and ritual behaviour practiced, and possibly in the spiritual beliefs held, by PPNB communities. The placement of grave cuts was not necessarily under the floors of domestic structures, there are examples of what have been identified as 'trash pit burials' at Basta and 'Ain Ghazal (Gebel *et al* 1988, Rollefson and Simmons 1988). Individuals appear to have been buried in deep deposits of organic material in these trash pits. At Beidha, young children were buried in buildings that were no longer in use at the time of burial, and at Ghwair 1 a young child was buried in a circular, non-domestic building (Kirkbride 1966, Najjar and Simmons forthcoming). At 'Ain Ghazal there are also examples of foundation burials placed underneath the foundations of walls (Rollefson and Simmons 1988). Also, features possibly unique to Basta are the aforementioned sub-floor channel burials, though this may be the result of a sampling issue (Gebel and Bienert 1997). Within the grave there is also extensive variability. At Basta bodies were orientated in numerous different directions and one individual was buried kneeling, with his face close to his knees and his arms tucked under his torso (Gebel *et al* 1988). The removal and subsequent treatment of the skull also differs from site to site, even though it is considered a distinctive feature of PPNB burials. Not all skulls were removed and the practice does not appear to have been restricted to age, sex, or the position of the grave cut. Skulls were re-deposited, painted, plastered or left unmodified, as in the case of a skull cache at Basta (Gebel *et al* 1998). There is also extensive variation in the methods of skull modification. At 'Ain Ghazal, Jericho and Tell Ramad, skulls have been found with plaster or asphalt re-modelling of the face, and have been placed (possibly after use) in buried caches (Rollefson and Simmons 1988, Kenyon 1960-83, Mellaart 1975). At Tell Ramad the plastered skulls were also painted red or black (Mellaart 1975). Re-deposition of the skulls includes reburial with other skeletons (as at 'Ain Ghazal and Beidha), or in skull caches (examples being found at Jericho, 'Ain Ghazal and Basta), or in one case at Beidha, the crushed skull of a young boy was found on the floor of a house (Kirkbride 1966). Grave goods are generally rare during this period in the southern Levant, but one or two burials do contain a few artifacts. Again, there does not appear to be any standardization of grave good type or a common burial type that contain grave goods. At Basta, one of the *in situ* burials contains a number of beads, and bone and stone tools (Gebel *et al* 1988). A similar situation can be found at 'Ain Ghazal (Rollefson and Simmons 1988). The sub-floor child burial at Ghwair 1 also contained what was a bead necklace (Najjar and Simmons forthcoming). These are obviously personal items used for adornment and a variety of daily tasks. However, the disparity of grave good distribution could indicate that they were used as status symbols or to represent a secure position within the family or community hierarchy, though there was not as yet any standard way of representing this through burial. This level of standardization clearly contrasts with many sites in the northern Levant, for example Abu Hureyra, where a particular 'butterfly' shell bead is often and exclusively found in the burial contexts (Moore 1975). The evidence for burial is, on the whole problematic because despite the extensive variation in burial type, it is clear that the number of PPNB burials discovered by archaeologists does not conform to population estimates of the period (Rollefson 2001). Therefore the current burial evidence found on sites cannot have been the norm. The majority of burials or other burial practices must have occurred off site though they may not, necessarily, have been standardized (judging from the non-standardized nature of artifacts pertaining to ritual behaviour). In desert areas where archaeologists have concentrated on survey, therefore, excavating fewer sites, there is little evidence of burial. This might suggest that the behaviour surrounding death in the arid zone diverged from that in the Mediterranean zone, or that the disparity is the result of a major sampling issue. It is my opinion that the communities of the PPNB Levant held a very loose belief structure surrounding death and burial which was influenced as much by the deceased's circumstances in life and death as by the culture currently identified as the PPNB tradition.

This loose belief structure can be seen in aspects of architecture and artifacts from PPNB sites, that archaeologists have linked to ritual. Ritual architecture is very evident at 'Ain Ghazal and it is found in many different forms. At other sites, the interior furniture and artifacts of the non-domestic architecture are also distinct. However, at other sites there are unusual forms of architecture, though the assemblages found within them do not make it clear whether or not these structures were used for ritual purposes. For example, the distinct large single roomed square houses at Beidha (level II, Kirkbride 1966). These structures contain assemblages that can be linked to domestic activities. However, it is also important to bear in mind that ritual activity surrounding some burials happened within the domestic area of houses, and so other ritual activities may not have been segregated from domestic areas, except in a few instances. This is evidence for a very practical use of spiritual behaviour and thought, it was not as segregated from daily life as we are used to today, therefore it is probably not surprising that there is so much variation in non-domestic architecture, ritual related artifacts, and burials across the Levant.

Economy and environment

The evidence indicates that the cultivation of cereals in the southern Levant is well established by the PPNB. The evidence for animal husbandry, however, suggests that these practices are only just beginning to emerge during this period. The main issue here is how the communities managed to balance the conflicting demands of grazing and cultivation. The types of cereals being cultivated across the Levant were not necessarily standardized. Clear-cut cultivation of only domesticated cereals was probably not being practiced because many sites show evidence of the use of wild cereal species along side their domesticated relatives. On desert sites such as Jilat 7, wild and domesticated barley and einkorn and wild emmer were found, which is probably unsurprising in an area where resources were scarce. This could mean that they may have been harvesting wild stands where they found them, or cultivating wild cereals along side domesticated varieties, or that the examples of morphologically wild cereals amongst the domesticated varieties are weeds of cultivation (Garrard *et al.* 1994). At Beidha an intermediate (between wild and domesticated) variety of wheat and wild barley were being cultivated or collected along side the cultivation of domesticated wheat. What is clear is that a wide variety of different cereals species were favoured at different sites and so farming was complex with less standardization than is seen in other aspects of the material culture of the PPNB. The complexity of cultivation was, possibly, partly a mechanism to ease the conflicting demands of grazing and cultivation in different local environments. The range of species involved in animal husbandry is much lower because fewer animal species were suitable for domestication. The process of animal (morphological) domestication is a lengthy process due to the way in which animals reproduce, fewer individuals are produced from each reproductive episode than in plant species, and animals also take longer to grow to sexual maturity. Therefore, identifying the origins of animal husbandry is difficult for archaeologists as the animals will not be morphologically distinct from wild varieties. Sheep and Goat are the likely candidates as they are the first species to show clear morphological domestication in the late PPNB. There is some evidence of animals with domesticated morphology dating to the beginning of the MPPNB in the northern Levant at sites like Abu Hureyra and Tell Halula (Peters *et al* 2000:38-9). In the southern Levant sheep and goat with a domesticated morphology do not appear until the LPPNB and can be seen at sites like Baja and Basta (Horwitz *et al* 1999:72-74). Wild forms of Sheep and Goat appear in abundant numbers on most PPNB sites in the

Mediterranean zone of the Levant and these animals are part of the natural fauna of this area, and so it is difficult to identify herded animals prior to them becoming morphologically domesticated. At 'Ain Ghazal there is a little evidence for the herding of goat. By the end of the MPPNB, there is a high frequency of pathological changes on the toe bones, that may be due to a change in natural movements of the goat commensurate with being kept in a confined space at night (or at other periods of the day or year) rather than being free to range around the landscape at will. The goat kill pattern indicates that less than 50% reached adulthood and there is an apparent predominance of females among the adult population. This is consistent with the kill pattern of later domesticated herds where all excess animals are killed off for winter, including the majority of male adolescents born during the spring and summer (Köhler-Rollefson 1989). There is evidence to suggest morphologically domesticated sheep and goat at Wadi Fidan A (WFA) and Wadi Fidan C (WFC) (Richardson 1997). WFA is securely dated to the late PPNB and WFC is relatively dated to the PPNC/6thmbc, and so domestication has certainly occurred in the area of the Wadi Fidan (Fig. 2) by the late PPNB. The conflict between using land for grazing or cultivation has led many archaeologists to put forward a model arguing that by the late PPNB, when population levels were at their greatest, there reached a point where it was necessary for a sections of the community to move, at least on a seasonal basis, with the goats to fresh pastures where there were no conflicts of land use (Köhler-Rollefson 1989).

Pre-Pottery Neolithic C

The use of the term PPNC is contentious and not recognized across the board. It is not generally used in reference to north Levantine sites. Kenyon originally suggested that this was a period of abandonment, immediately preceding re-occupation by new peoples. She based this argument on a layer of ancient erosion at the site of Jericho (Kenyon 1985:19-40). This feature became known as the *"hiatus Palestinian"*(Rollefson 2001:86). Many sites in the southern Levant certainly were abandoned around this time, including the site WFA. The term PPNC itself was first coined by Rollefson and Simmons on the basis of the archaeology at 'Ain Ghazal, where we see uninterrupted stratigraphy spanning the *'hiatus Palestinian'* and a distinct material culture (Rollefson 2001:86). This was considered to justify the use of a new term. However, other archaeologists have only gradually adopted the term PPNC.

Settlement patterns

Rollefson argues that though many sites in the southern Levant were abandoned, particularly mega sites like Jericho, some mega sites did manage to survive. Good examples are 'Ain Ghazal, Tell Ramad, Wadi Shu'eib and possibly Basta (Rollefson 1989:138). The problems occurring in the southern Levant do not appear to be as extensive in the north. Rollefson put this down to the fact that the mega site phenomenon is not so evident in the north and sites are, on the whole, smaller. Also the fertile areas of the northern Levant are flatter and therefore the effect of deforestation will not be so great, resulting in there being not such a need to abandon old established farming settlements by the PPNC (Rollefson 1989:135-40). Rollefson suggests that those people who did not occupy mega sites like 'Ain Ghazal probably dispersed into new smaller village or hamlet settlements (Rollefson 1989:135-40). How much of this apparent settlement pattern is due to lack of excavation and survey is unclear. WFC, though not fully excavated, is not a mega site, but neither is it a hamlet, possibly being of similar proportions to WFA.

Domestic architecture

Due to the rarity of extensively excavated sites dating to the PPNC, it is difficult to talk about a typical PPNC type of architecture particularly in the southern Levant. The main evidence comes from 'Ain Ghazal where two different types of domestic structure are evident. The first are small simple one-roomed rectangular houses with floors of dirt or chalk and mud plaster. Rollefson argues that these were the dwellings of full time residents who practiced cultivation (Rollefson 2001:87-88). The second type of domestic structure was 'corridor buildings'. These were semi-subterranean with a series of narrow rooms of a corridor. They had thick walls that supported an upper story. The fill of these dwellings suggests that the upper story did not consist of a number of rooms and was possibly a temporary tent like structure. Rollefson suggests that these dwellings were occupied by seasonal pastoralists, who used the lower levels of these buildings as storage. Corridor buildings can also be seen at Beidha, but a ^{14}C has dated them to the MPPNB. Rollefson suggests that the semi-subterranean nature of these buildings could have resulted in the contamination of the fill resulting in an earlier date (Rollefson 2001:87-88). Rollefson also suggests that the cell plan house at Ghwair (fig. 2, pp. 48) could possibly be a PPNC corridor building, despite the ^{14}C and typological dates that place Ghwair in the MPPNB (Rollefson 2001:87-88). At WFC the excavation reviled part of a building, the extent of which is unknown. However, what have been uncovered are the remains of a relatively large rectilinear room making it unlikely that this structure is a corridor building. It is possible that the structure at WFC is similar to the single roomed dwellings at 'Ain Ghazal.

Non-domestic architecture

Again, the lack of extensive excavation means that it is unclear whether the construction of non-domestic buildings was relatively rare during the PPNC (in comparison to the PPNB), or that few buildings have as yet been uncovered, certainly at 'Ain Gazal there are few examples. One such structure has been called the *'great wall'* by the excavators, Rollefson and Simmons (Rollefson and Simmons 1988). This sizeable wall separates two chalk and mud plaster courtyards, which do not appear to have a domestic function (Rollefson 2001:89). The other non-domestic structure at 'Ain Ghazal is a walled street to the north of the great wall (Rollefson 2001:89).

Arid Zone architecture

It is interesting to note little changes in the architecture at desert sites from the PPNB right through to the PN (Baird 1993).

Lithic technology

The main change seen during the PPNC across most of the Levant (north and south) is the decline of the naviform blade production strategy. This in turn has an effect on the tool kit as blanks have changed. Flake production increases and flakes become more important as tool blanks. We see the introduction of new point types along side preceding PPNB types. These are ha-Parsa, Nizzanim and Herzliya points (Gopher 1994:41). The ha-Parsa point is based on the Jericho point (common in the southern Levant during the PPNB), Nizzanim on the Byblos point and Herzliya on the Amuq point, though all are under 40mm in length, unlike the similar PPNB points (Baird 1993). Rollefson argues that these changes are a result of a decline in craft specialism which is in turn due to a decline in hunting and the evolution of domesticated cereal grains which remain intact with stalk at maturity (Rollefson 2001:87). However, change in the lithic technology at desert sites on the Jordanian Plateau is far more gradual. The lithic assemblages remain roughly the same as those dating to the PPNB though proportions of types have changed. For example, the number of naviform cores has dwindled, but it remains an important blade blank production strategy. Flake production is not as important as seen on contemporary sites further east in the more Mediterranean zone (Baird 1993, Baird *et al* 1992).

Small finds and cultic objects

Comparable to the PPNA, small finds and cultic objects are less common than during the PPNB. Only one example of a female figurine (carved in limestone) was found at 'Ain Ghazal (Rollefson 2001).

Burials

Evidence for burial practices dating to the PPNC is rare. At 'Ain Ghazal there appears to be several types of burial, single internments and multiple internments in the same grave (Rollefson 2001:90-91). Secondary burials are also common (up to half the burials are secondary), and possibly relate to the pastoral part of the community (they were possibly bringing back those who died away from the settlement (Rollefson 2001:90-91). The practice of removing skulls (typical to the PPNB) does not appear to be a feature of PPNC 'Ain Ghazal (Rollefson 2001:90-91).

Economy and environment

Bar-Yosef has argued that the end of the LPPNB and the PPNC roughly coincided with a decrease in rainfall and a retreat of the 'monsoonal' system (Bar-Yosef 1998:201) and that the cultural changes were a result of climatic changes across the whole of the Levant. Rollefson disagrees; arguing that if there was decline in precipitation levels across the entire region then all agricultural sites would have been abandoned (Rollefson 1989:137). He argues that settlements were abandoned as a direct result of local over-exploitation and deforestation. This was particularly acute in the southern Levant where the geography is hilly and fertile soils were easily washed away during the rainy season (Rollefson 1989:137).

There is clear evidence for an increasing reliance on domesticated animals, particularly sheep and goat, and less reliance on the hunting of wild species, this pattern can be seen at 'Ain Ghazal (Rollefson 2001:87). Domesticated cattle are also becoming relatively common by the LPPNB and the PPNB; both communities at Baja and Basta herded domesticated cattle (Horwitz *et al* 1999:77). Domestic pig is attested to at 'Ain Ghazal by the PPNC (Horwitz *et al* 1999:77, Rollefson 2001:87). By the PPNC many Near Eastern archaeologists consider that pastoralism had spread into the desert and steppe areas of the east Jordanian Plateau in response to the conflicting interest of grazing and cultivation and population pressure (Rollefson 2001:87, Horwitz *et al* 1999). However, there is no evidence for the grazing of sheep and goat at desert sites until the early Pottery Neolithic when a large number of bones abruptly appear on sites in the Azraq Basin and the Wadi Jilat (Garrard *et al.* 1994). Though this is not to say that parts of the desert steppe were not used for grazing during the PPNC. If the long established communities in Azraq and Jilat were not the same people as the seasonal pastoralists from 'Ain Ghazal then you would not necessarily expect to see domesticated sheep and goat bones at Azraq and Jilat until the desert communities adopted pastoralism themselves.

Regional identity and traditions over time

The main difficulty when considering possible regional identity and local traditions arises from the lack of consistent coverage of archaeological research across the Levant. Much excavation has concentrated on the larger sites such as 'Ain Ghazal and Jericho, without looking in as much detail at their surrounding districts. Therefore, little is understood about how these larger sites relate to the smaller sites in their locality. Bar-Yosef argues that during the PPNA, large sites such as Jericho became centres of redistribution for exotic raw materials like obsidian and prestige goods (Bar-Yosef and Gopher 1997:261). However, it is not possible to establish the nature of this redistribution, whether exchange, trade or some other system. Some studies have been done on clusters of smaller sites, for example Gebel's work on Baja, Basta and Beidha (Gebel *et al* 1988, Gebel and Bienert 1997a/b), Garrard's work on the Azraq/Jilat sites (Garrard *et al* 1994, Baird 1994) and this thesis on the area of Faynan and Fidan. These studies demonstrate that, in the regions they cover, there is certainly evidence to suggest local traditions and regional identity. However, it is difficult to relate this to the larger sites because their sheer size makes them distinct from those in the studies mentioned above.

During the PPNA, the material culture from sites in the southern Levant suggest that this was a general sphere of influence, from the Mediterranean to the arid zones. A similar and contemporary sphere of influence could be argued for the northern Levant where significant differences in the PPNA material culture can be seen. By the PPNB, despite the dearth of evidence, it clear that there is a dual nature to PPNB material culture. There is a general similarity forming a cultural umbrella covering the vast area of the Levant as a whole (possibly with a minor distinction between the north and the south still in existence, and a greater distinction between the desert and the sown). This general uniformity is what makes the PPNB very distinct from that which went before and that which came after. However, under this PPNB cultural umbrella there is extensive variation, which clearly forms local traditions in areas where the relevant research has been done. Over time, local traditions developed at a different pace in different areas. In the Faynan area we see significant change by the PPNC/6thmbc (this thesis), but in the Azraq/Jilat areas almost no change occurs right through out the Pre-Pottery Neolithic and well into the Pottery Neolithic (Baird 1993,1994).

The general PPNB culture has been well established by current research. However, further research is necessary to increase our understanding of the relationships between communities that lead to the dual nature of the PPNB culture. It is also important to investigate how these relationships developed and changed during the transition periods of the PPNA and the PPNC, in order to place the unique nature of the PPNB culture within its proper context.

In the next chapter (Chapter 3) I provide more specific information on the excavation history, environment, archaeology and economy of the four sites, Ghwair 1, Wadi Fidan A, Baja and Wadi Fidan C, from which the lithic assemblages (analysed in this thesis) came.

List of Figures: Chapter 2 (Background of the PPN)

Fig. 1 Map depicting the general vegetational zones of the Levant during the PPN.

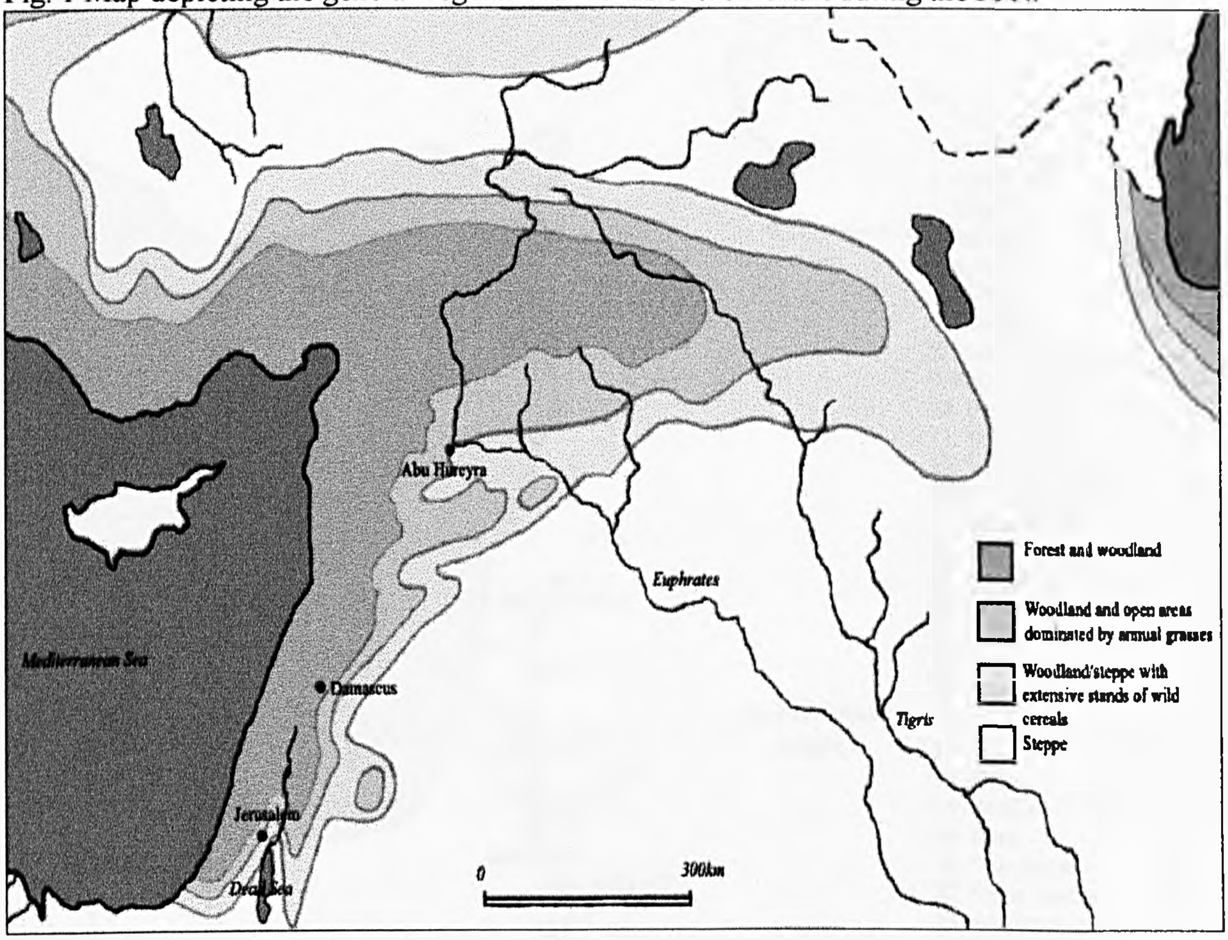
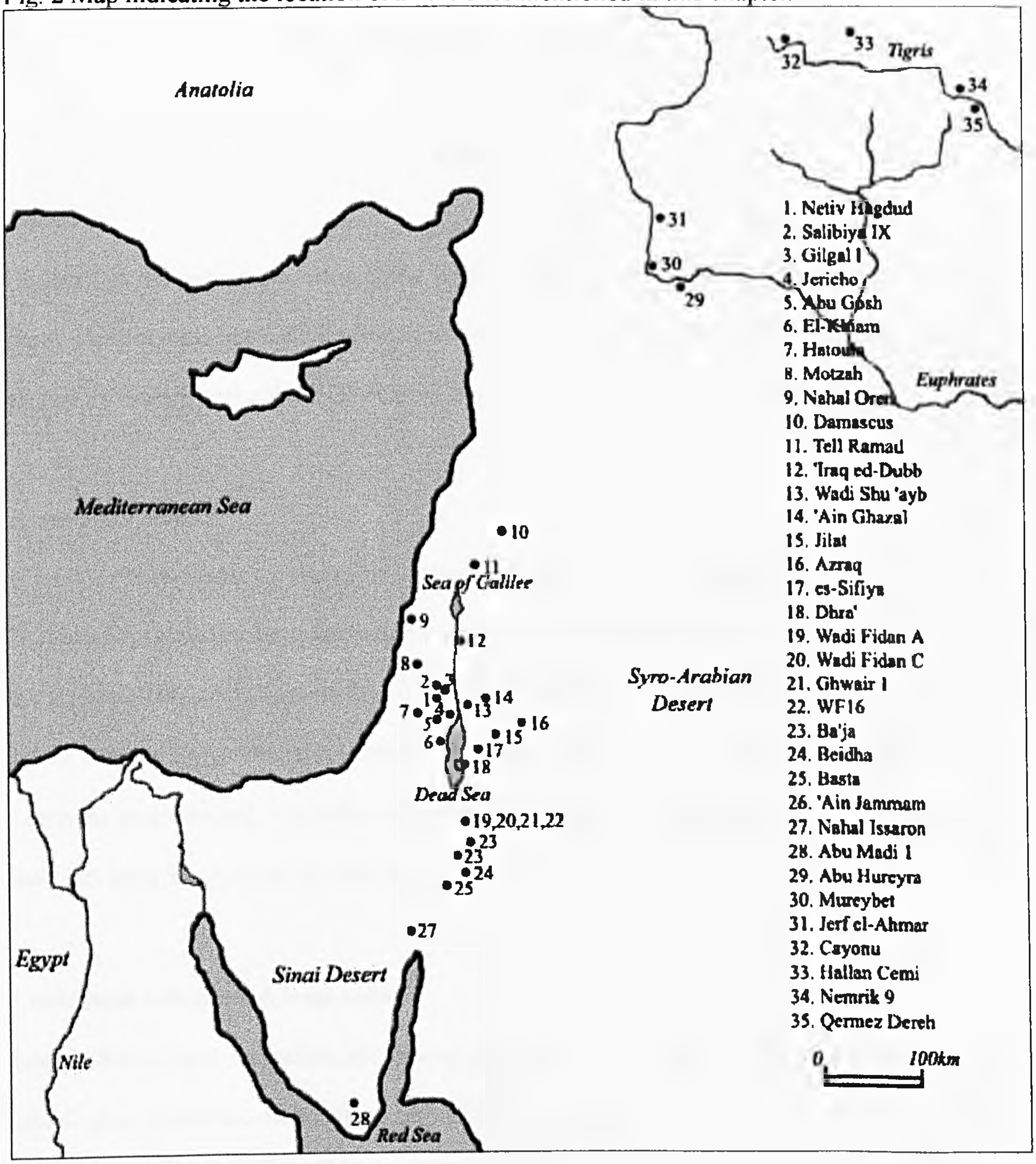


Fig. 2 Map indicating the location of all the sites mentioned in this chapter.



Chapter 3

Sites

Ghwair 1

Location

Ghwair 1 is situated on the banks of the Wadi Ghwair (southern Jordan fig. 8) close to the point where it joins the Wadi Faynan at its western end (fig. 7). The site is cut at its western end by a tributary of the Wadi Ghwair, which is causing some erosion of the site itself.

Excavation history

A joint German-Jordanian team first located Ghwair, lead by A. Haupmann of the Duetsches Bergbau Museum, Bochum, Germany, carrying out an archaeometallurgical investigation into the area in 1984-1993 (Moreno forthcoming). The first excavations of the site were carried out in 1993 by Najjar and later excavated by Najjar and Simmons in 1998-2000 (Najjar and Simmons forthcoming). The lithic assemblage analysed in this thesis was recovered during the 1993 excavations (now known as area 1).

Contextual information from area 1

I do not have much contextual information on the 1993 excavation; therefore I have been unable to complete a contextual analysis of the lithic assemblage. However, the excavation dug through a sequence of room fills, representing a range of different contexts relative to the occupation of the site. The room fills probably derive from several different types of activity, including room use, infill and dumping, and the 1993 excavation trenches look generally similar to later excavations. Therefore, the lithic assemblage possibly represents a good cross section of the knapping practices across the site as a whole.

Retrieval methods

The majority of the lithic assemblage has been recovered during excavation; only 8.1% of the 'pails' or bags of lithics were retrieved using sieving methods.

Site size and date

Ghwair is a relatively small site, *c.* 0.5 hectares (Najjar and Simmons forthcoming). The site has been dated to 8000-7600 B.C. or middle PPNB; the architecture and diagnostic lithic types, such as, arrowheads support these dates.

Architecture

The architecture on this site is well preserved, with walls standing several meters high in some areas (fig. 1). The layout of the architecture is compact and similar to other PPNB villages. The structures are well built and rectangular, with gently curving walls and rounded corners, typical of the period. The first phases consist of structures with larger rooms (as seen in area 1) with compact earth or paved floors. Stone or plaster-lined silos are also associated with this phase. During the second phases the large rooms have been subdivided with partition walls into smaller rooms. Remains of red lime plaster can be found on walls and floors during this phase. There is also evidence for a separate unique circular structure, enclosing an open space, during this second phase. The third and latest architectural phase consisted of cell plan houses, which possibly had a second floor for living quarters (fig. 2, Najjar 1994, Najjar and Simmons forthcoming).

Ground stone industry

The ground stone industry has both agricultural and more specialized functions. Examples include mortars, grinding slabs and trough querns and other more specialized items such as possible gaming tokens, mauls, axes and wall plastering implements (Najjar 1994, Najjar and Simmons forthcoming).

Small finds

Extensive bead and ornament production is occurring on site, produced in a range of local and exotic raw materials. Products include pendants made of mother-of-pearl, stone and marine shell beads, and a few ornaments made out of carnelian. The community at Ghwair was also making use of the local copper ores or 'green stone' for the production of beads, pendants and mace heads.

Figurines

Clay figurines of humans and animals are found at this site. Interestingly evidence suggests that the community were purposely baking the figurines (Najjar 1994).

Burials

A sub-floor burial was found in the open circular structure (related to the second architectural phase). This is clearly a special or cultic room as cachets of goat skulls, blades, polishing stones, and malachite pendant blanks were also found directly on a plaster floor. The burial is of an infant in a flexed position, with its skull intact. The infant was adorned with a mother of pearl ornament around its neck. Three other burials were found of adults in flexed positions and with their craniums present. They were buried in cobble-lined graves in structure 'tumble'. It is unclear whether these adult burials date to the Neolithic (Najjar and Simmons forthcoming).

Environment

Ghwair 1 is considered to be in a marginal arid environment due to the low level of rainfall it received. Paleoenvironmental and geomorphic investigations are currently ongoing but results have not been produced yet (Najjar and Simmons forthcoming). However, there is a permanent water source in the Wadi Ghwair today, which increases in level significantly during the wet season, and so it is not necessarily a marginal environment today (fig. 3). Farming could be achieved with the use of irrigation during the wet season and there is extensive evidence for ancient field systems, particularly in the wide Wadi Faynan. The architecture of the site itself is clearly built for permanent occupation (as opposed to seasonal occupation) and according to the excavators, the diet of the Ghwair community was varied, with plenty of evidence for agriculture (Najjar and Simmons forthcoming), the area also has seen intensive permanent occupation over a considerable period of time (including throughout the Neolithic); suggesting that the environment was similar, if not even more favourable during the PPNB.

Wadi Fidan A (WFA)

Location

The Wadi Fidan A site mound forms an 'island' located in the Wadi Fidan at its western end, close to where it joins the Wadi Araba in southern Jordan (fig. 4 and 7). Wadi Fidan A is *c.* 15.7km from Ghwair along the wadi beds (the easiest route), which is roughly 3-4 hours walk for a fit person (though not in the heat of the midday during the summer months). However, this route cannot be taken during the rainy season when the wadis are full of water.

Excavation history

Wadi Fidan A was first identified by T. Raikes in the late 1970's and he designated it as WFA (Raikes 1980). This is the title I shall be using for the purpose of this thesis because it is consistent with the title of Wadi Fidan C (also named by Raikes). The site was later re-surveyed by the 'Arabah Archaeological Survey' with the Duetsches Bergbau Museum in the mid to late 1980's (Moreno forthcoming); it was designated as site 12 in this survey. The first test excavation was carried out in 1989 by R. Adams, working in collaboration with the German Mining Museum, Bochum, under the umbrella of the Wadi Fidan Project. Adams designated WFA as site 008. The assemblage analysed in this thesis was recovered from this 1989 Adams excavation. The latest excavations were carried out in 1999 by the Jabal Hamrat Fidan Regional Archaeological Project (JHF), lead by T. Levy, R. Adams and M. Najjar. For the purposes of the JHF project Wadi Fidan A was designated as Wadi Fidan 001.

Contextual information from the 1989 excavation

I do not have any specific contextual information on the 1989 test trench. However, the contexts represent a sequence of fills from one relatively big room, as well as some slightly later material from surface layers (1.3% of the total context numbers), and some material from a section cut by water erosion at the edge of the site (4.1% of the total context numbers). The fills probably derive from a range of activities including, room use, infill and dumping; representing a range of depositional processes. The classificatory types of the 1989 lithic assemblage has proved to be similar to the lithic assemblage recovered during the 1999 excavation season, suggesting that the fill contexts from the 1989 trench represent a range of context types common to the rest of the site.

Retrieval methods

The bulk of lithic assemblage was recovered using general excavation methods during the excavation of the 1989 test trench (including the contexts referring to the surface layers). The rest was recovered during the cleaning of a section created by water erosion. No sieving was utilized.

Site size and date

Raikes recorded that the island mound of WFA as *c.*100m in diameter, which is roughly similar to Ghwair *c.* 100m by 50m (Raikes 1980, Najjar and Simmons forthcoming). The ^{14}C date of the 1989 excavation places WFA between 7575-6700 b.c., or during the late PPNB; the assemblage corresponds with this date.

Architecture

The 1989 excavation revealed a large single room with well-preserved and substantial walls, up to 2m high. The room had a red painted lime plaster floor (fig. 5). The 1999 excavation revealed structures made up of small rectangular rooms surrounding larger spaces, either courtyards or larger rooms (fig. 6, Moreno forthcoming). There is also some evidence for a two level structure in area 'J' (Moreno forthcoming). Walls retaining red lime plaster have also been found, again in area 'J' (Moreno forthcoming).

Ground stone industry

The ground stone industry is typical of the late PPNB, including both ground stone objects involved in food processing and also more prestigious goods such as stone bowls (Moreno forthcoming).

Small finds

These include clay tokens, lambis rings, beads and pendants. The beads were produced in a variety of raw materials including copper ore or 'green stone' and seashells. Lithic piercing tools are often found in association with beads and bead raw materials (Moreno forthcoming).

Figurines

A significant number of clay figurines were found within various structures (Moreno forthcoming), though I do not have details on their morphology.

Burials

I have little information on burials as this information is as yet unpublished, but one 'burial niche' was found in stratum '2b' and was situated within a structure (Moreno forthcoming).

Environment

As in the Wadi Ghwair there is a permanent water source, provided by a spring named 'Ain el Fidan' which is situated at the eastern end of the Wadi Fidan (fig. 7). However, the water level rises significantly during the wet season. Farming is possible with the aid of irrigation both today and in the past. Raikes identified ancient field systems at three points in the Wadi Fidan, one of them very close to Wadi Fidan A (Raikes 1980). The faunal assemblage from the 1989 test trench suggests that the economy at WFA was based on cereal cultivation and the maintenance of sheep and goatherds (Richardson 1997).

Baja

Location

Baja is located *c.*20km to the south of Wadi Fidan A and Ghwair (fig. 8), as the crow flies. However, it is not possible to reach Baja via a direct route as it is situated on an intramontane terrace amongst steep sandstone formations. Therefore, a circuitous route must be taken, possibly requiring just over a days walk to complete on foot.

Excavation history

Baja was originally identified by mountaineering members of M. Linder's team carrying out archaeological surveying in the area during the summer of 1983 (Gebel and Bienert 1997b). Gebel relocated the site in 1984 and excavated three soundings (Gebel and Bienert 1997a). Large-scale excavations were begun in 1997, directed by H.G. Gebel and H.D. Bienert under the auspices of the German Protestant Institute for Archaeology. The Baja lithic assemblage analysed in this season was recovered from the large-scale excavations.

Contextual information

The general context from which the Baja lithic assemblage was retrieved (analysed in this thesis) was a self contained loci described by the excavator as a workshop dump (Gebel *pers. com.* 1998), it probably represents fills from more than one episode of dumping and does not represent general contexts common to the rest of the site. It is in this respect that the contextual information relating to the recovery of the lithic assemblages from Ghwair and WFA diverge from Baja. The analysis of the Baja assemblage will shed more light on the range of depositional processes that this workshop dump was subject to.

Retrieval methods

The lithics were retrieved during excavation; no sieving was employed.

Site size and date

Baja is *c.*1.2-1.5 hectares, which is considerably larger than both Ghwair and WFA. Baja is dated to the late PPNB based on the architecture and material culture found on site (Gebel and Bienert 1997a). This places Baja as broadly contemporary with WFA.

Architecture

The architecture at Baja is typical of the late PPNB; with well-preserved structures made up of small, generally rectangular rooms connected by wall openings and providing some evidence to suggest second stories (fig. 9). The architecture roughly follows a scheme of small rooms that surround a courtyard. There is one example of an unpainted lime plaster floor, though these appear to be rare (Gebel and Bienert 1997a).

Ground stone industry

Again, this assemblage is typical of the late PPNB, however, stone vessels are rare. Types include trough and saddle shaped grinding querns, mortars and hand stones. These are all related to food processing (Gebel and Bienert 1997a).

Sandstone ring industry

This industry is related to the ground stone in so far as general production techniques are concerned, however, they are part of prestige craft production. Final products and other artifacts relating to production and the waste from this craft specialization was found in several specific loci suggesting that specific households were responsible for the production of these sandstone rings (Gebel and Bienert 1997a).

Small finds

Ornaments were rarely recovered during the 1997 excavation; this is probably related to the fact that the contexts where small finds are commonly found have not as yet been excavated (e.g. burials). The few examples of small finds include beads produced from sea sells and stone; ornaments and objects produced from mother-of-pearl and 'green stone' (Gebel and Bienert 1997a).

Baked clay industry

Some fragments of ceramic vessels or 'container-like installations' were found. Gebel and Bienert argue that the absence of stone vessels may be partly explained by the presence of 'clay containers' (Gebel and Bienert 1997a).

Burials

In 1997 the excavators were still removing room fills, and burials during the PPNB tend to be found directly below floors. However, some human remains (post cranial) were found in the nearby Snake Wadi, which appears to have been a refuse dump (Gebel and Bienert 1997a).

Environment/ food economy

The animals commonly exploited by the inhabitants of Baja include both domestic and wild sheep and goat; and a range of other wild animal species including gazelle, wild boar, aurochs, and equid. The majority of botanical remains consist of the juniper species, which remains the most common species in the woody vegetation growing in the area of Baja. Other species include wild pistachio, hawthorn and fig. Very few domesticated species of plant were found and these consist of remains from the processing of emmer wheat (Gebel and Bienert 1997a). The absence of evidence for extensive agriculture is probably related to the local topography where there is little space for field layout. This is a similar environment to that found in the Wadi Faynan area (were the wadis flow with water during the wet season) though with less space for agriculture.

Wadi Fidan C (WFC)

Location

Wadi Fidan C is situated on a hill almost opposite WFA on the other side of the Wadi Fidan where the latter joins the Wadi Araba (fig. 7).

Excavation history

As with WFA, WFC was first identified by T. Raikes in the late 1970's (Raikes 1980). R. Adams later excavated a test trench in 1990 (Richardson 1997). The WFC lithic assemblage analysed in this thesis was recovered from this test trench. No further field research has been carried out on WFC.

Contextual information

The sounding put in by Adams was a relatively shallow step trench cut down the edge of the site. This differs from the 1989 test trench put into WFA and the 1993 excavation at Ghwair, which were both sunk into the center of the sites, and were deeper but covered smaller areas. The trench at WFC includes fills from both internal and external architectural areas, but probably represent similar depositional processes to those at WFA and Ghwair (for example, room use, infilling and dumping).

Retrieval methods

The lithic assemblage was recovered using general excavation methods.

Site size and date

The full extent of the site has not yet been determined. However, Raikes describes WFC as much larger than WFA (Raikes 1980). The site has been dated to roughly the PPNC/6th mbc on the basis of material culture, particularly lithic classificatory types (Baird *pers. com.* 2002).

Architecture

Adam's excavation did not reveal extensive sections of architecture and so little is known about house plans, but rooms appear to be generally rectangular (fig.10). Raikes was able to identify traces of the architecture on the surface of the site and describes them as:

'small houses, built of river boulders carried up from the river bed for this purpose.' (Raikes 1980)

Ground stone, small finds and burials

These aspects of the material culture have either not yet been excavated or have not been published.

Environment

It is likely that the general environment in the locality of WFC was similar to that when WFA was occupied. It certainly could not have become significantly more degraded or marginal as it supported a larger community at WFC than at WFA (if site size is taken as a good indicator of population density). Evidence recovered from the excavation in 1990 suggests that, like WFA, the most important aspects of the economy were based on cereal cultivation and sheep/goat herding. However, the faunal remains of gazelle were significantly higher at WFC than at WFA (Richardson 1997). This may have been the result of a rise in population, putting increased pressure on the annual agricultural yields, requiring the inhabitants of WFC to increasingly rely on hunting.

In the next chapter (Chapter 4) I shall discuss the theory of classification and the methodology used to analyse the lithic assemblages that came from the four sites outlined in this chapter (Chapter 3).

List of tables: Chapter 3 (Sites)

Table 1 list of basic information on the lithic assemblages analysed from each site.

Site name	Date of excavation	Context type	Size of assemblage	Nature of assemblage	Sampled, fully recorded?	Material removed by excavator?
Ghwair	1993	Sequence of room fills	4875 pieces	Tools and debitage	Yes	Tools and large blade blanks (quantity not clear)
WFA	1989	1. Surface collection. 2. Sequence of fills from one room. 3. Section cut	3978 pieces	Tools and debitage	No (secondary sort incomplete)	Tools (quantity not clear)
Baja	1997	Self contained loci-workshop dump	1266 pieces	Tools and debitage	No about 50% of assemblage recorded fully (1266 pieces)	Tools, naviform cores and large blade blanks (quantity not clear)
WFC	1990	Step trench-fills from internal and external architectural areas	654 pieces	Tools and debitage	No 328 pieces fully recorded (secondary sort incomplete)	Tools (quantity not clear)

List of figures: Chapter 3 (Sites)

Fig. 1 Photograph demonstrating the level of preservation of the architecture at Ghwair I (Area 1).

Fig. 2 Examples of the architectural remains of a cell plan house at Ghwair I.

Fig. 3 Water flow through the Wadi Ghwair during the dry season. The trees demarcate the point to which water level rises during the wet season.

Fig. 4 Photograph showing Wadi Fidan A in relation to the point where the Wadi Fidan joins the Wadi Araba.

Fig. 5 Photograph showing the 1989 test trench at WFA (Richardson 1997)

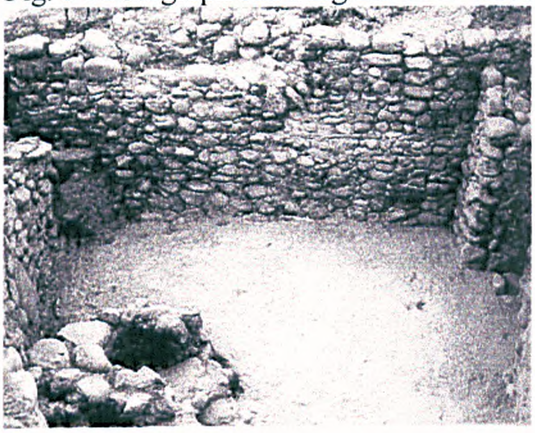
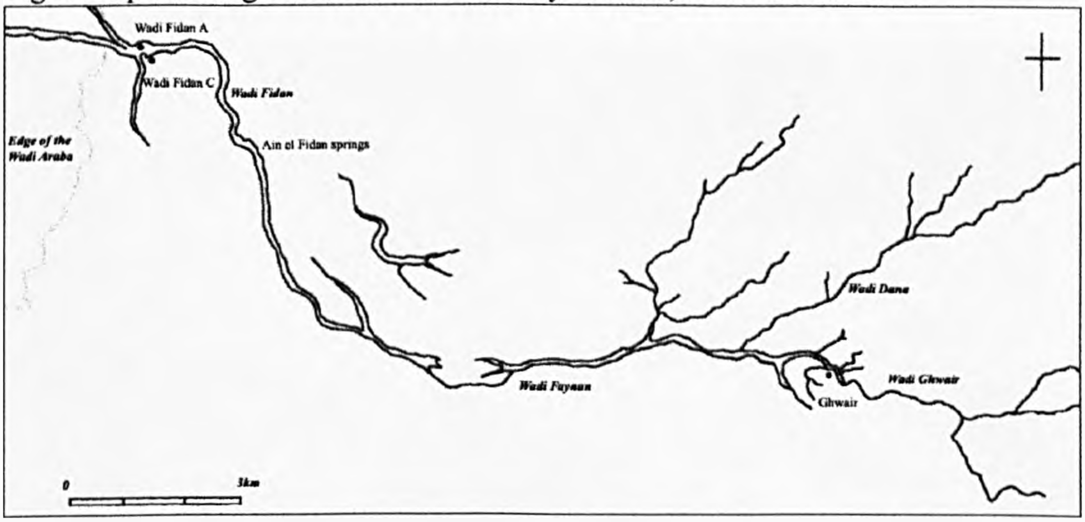


Fig. 6 Arial photograph of the 1999 excavation at WFA (Moreno forthcoming)

Fig. 7 Map showing all three sites in the Faynan area, southern Jordan.



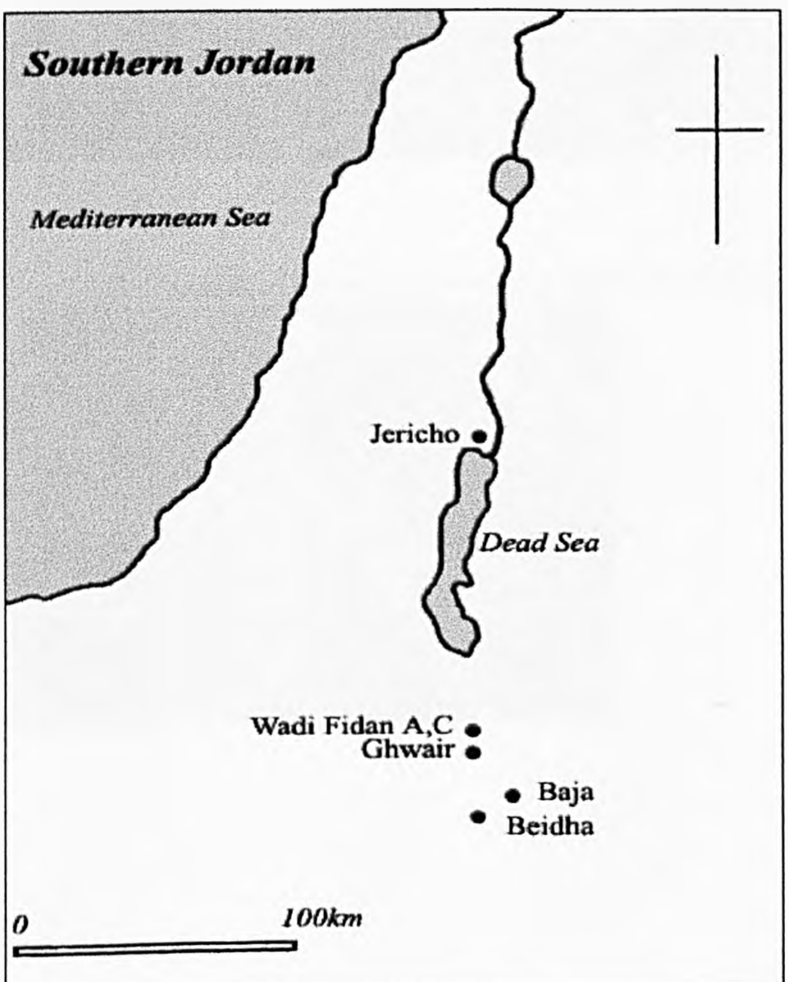


Fig. 8 A map showing the relative positions of Wadi Fidan A and C, Ghwair, and Baja.

Fig. 9 Photograph of the 1997 excavation at Baja, illustrating the type of architecture present (Gebel and Bienert 1997).

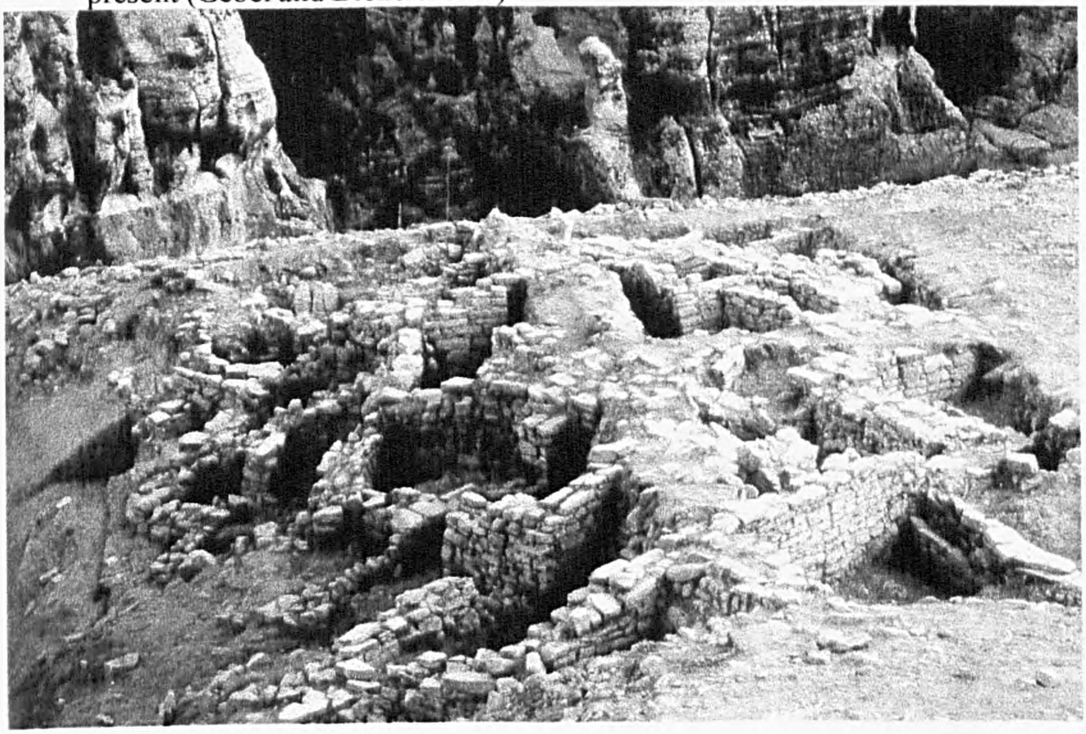


Fig. 10 Photograph of the test excavation at WFC (Richardson 1997)

Chapter 4

The Theory of Classification and Methodology

Theory of classification

As discussed in my introduction, the basic concept behind my approach to the assemblages of Ghwair, Baja and Wadi Fidan A and C is the theory of *chaîne opératoire* (Leroi-Gourhan 1964/5). Bordes typology uses technological indices to identify and represent aspects of debitage or attribute classes (debitage refers to types such as blades, and attributes refers to features such as platform type).

"[Bordes typology] *provides a summarized view of technological characteristics*" (Nishiaki, following Bordes, 2000, 31).

However, the Bordean approach is static and gives little insight into time-trajectory behaviour (Nishiaki 2000) and to the role of choice within this behaviour. This is why the concept of *chaîne opératoire* is so useful, covering the reduction sequence from raw material procurement trough to tool production and maintenance.

The first difficulty in the practical application of the *chaîne opératoire* requires prior recognition and understanding of all stages within the reduction sequence. In this sense it is similar to Bordes typology. The operational sequence may differ between assemblages, but Nishiaki identifies a general sequence common to all assemblages:

Core Reduction	*Tool Manufacture*
1 Raw material	*1 Blank selection*
2 Initial flaking (and test flaking)	*2 Blank roughout*
3 Core preparation	*3 Final modification*
4 Core reduction	*4 Tool maintenance*
5 Core maintenance	
6 Core abandonment	

(Nishiaki 2000, 38)

Each stage will be distinguished by a series of diagnostic types (e.g. crested blades and rejuvenation spalls, Fig. 2). Nishiaki recognises that in order to 'read' the archaeological assemblage it is necessary to understand what kind of objects or attributes are produced by what kind of human behaviour. In the case of lithic technology, experimental knapping has proved invaluable for providing insight into this issue, for example Wilke and Quintero's work on naviform core production (Wilke and Quintero 1994, Fig 2).

A further difficulty in the practical application of lithic classification is in the recording of types and attributes. As mentioned in my introduction, previous approaches to the archaeology of the PPNB have concentrated on distinctive and diagnostic final products, and as in the case of lithic assemblages, diagnostic types. Good examples of diagnostic types are arrowheads and naviform cores which are often used for typological dating (Avi Gopher 1994, Bar-Yosef 2001). Type also refers to the diagnostic lithic artifacts of reduction sequences. The existence of types is problematic (Baird, following Binford, 1993). Types can be identified by clusters of re-occurring attributes. Is it always possible to define type using such an empirical premise? Type is reliant on a set of attribute variables, therefore, is it more useful to record type or attributes in the investigation of past human behaviour? Baird discusses the theory developed by Clark on attributes, which argues that:

"an attribute should reflect an action or a micro-sequence of linked actions [....] *an attribute should be a fossil behavioural element."* (Baird, following Clark, 1993, 138)

Baird argues that this is an important concept only if all attributes are culturally meaningful. Clark implies a certain level of intention, whether conscious or unconscious on the producer's part, and the nature of design within the mind of the producer will constrain the variability of these attribute clusters (Baird, following Clark, 1993).

However, Baird identifies an unintentional element of preconditions set by accidents or interruptions in the micro-sequences and the nature of the raw material, and attribute variability will also not be constrained if the design is non-specific.

'What is important then is classification, not as the formation of types, but as the documentation of variability and the observation of differences. "(Baird 1993, 139)

It is variation between attributes and types that holds the key to the role of choice within the *chaîne opératoire*, which aspects of lithic technology are constrained by functional parameters and requirements and which by social structure and interaction?

"future identification of significant variation is more likely to be achieved using assemblages described in attribute terms." (Baird 1993, 140)

Classification methodology

My classification methodology is strongly influenced by Baird's system combining the recording of basic type, in order to conveniently deal with large assemblages and enable comparison with other assemblages, but also recording attributes associated with each individual lithic artifact. I also combine raw material data to include the early stages of the *chaîne opératoire* in the analysis of the assemblage as a whole and also as a mechanism of tracing each reduction sequence throughout the operation chain.

The term 'reduction strategy' refers to the general approach of knappers to their material in the pursuit of a finished product (Baird 1994). It involves a series of steps, or sequence of removals, beginning with the raw material and ending with both the final products and any material discarded along the way. Examples include naviform blade production or change of orientation flake production strategies. Raw material needs to be considered in relation to reduction strategy because the potential nature of the sequence and removals must take account of the morphology and nature of the material. Raw material location also informs on procurement strategies, which is affected by the socio-economic situation of the time. 'Technique' refers to individual factors in the application of force when reducing the flint and fashioning the final product (Baird 1994). It encompasses all aspects of knapping, how the core is prepared for blank removal, how much pressure is applied, at what angle and so on. Technique also includes the kinds of tools used to do the knapping and the way in which they are used (for example, hard or soft hammer). Ohnuma and Bergman call this 'mode' (Ohnuma and Bergman 1982) but most analysts make no distinction between mode and technique because both are interdependent on the other, and it is not yet clear which features on the debitage have been produced by which aspects of technique.

The categorisation of the flint debitage assemblages can be separated into two parts, the recording of morphological type, relating to strategy (for example, cores blades and flakes etc), and the recording of attributes relating to technique (for example platform type, preparation and platform and bulb features).

It is technique that will vary most between assemblages, sites and even household because of the inherent variability of aspects like hammer types, direction, strength and accuracy of blow. These aspects will be dictated by the skill, experience and even luck of the knapper. Therefore, the variability of technique can provide the greatest comparative data relating specific knapping practices between communities.

The main difficulty I have encountered in my classification methodology is that many formal tools have been removed from the Ghwair, Wadi Fidan A and C assemblages.

Therefore, I cannot carry out detailed quantative analysis of the formal tool assemblage (one of the final stages of the reduction sequence). However, as the assemblages do retain some formal tools, I can look at the tool types in detail and produce comparative studies on this basis.

Raw Material Survey

In August 1998 I carried out a raw material survey of the wadi's Ghwair, Faynan and Fidan in order to establish where the local flint sources were and what types of flint they produced. I was unable to carry out a survey of the area around Baja (but I did tour in the general area and took note of the local flint types).

The Wadi's Ghwair, Faynan and Fidan are part of a complex of wadi systems running east to west, which begin in the mountains to the east of the vast Wadi Araba and run down (generally at a right angle to the Wadi Araba) and end in the Wadi Araba itself. The Wadi Ghwair begins at source in the mountains, opening out into the Wadi Faynan, which in turn runs into the Wadi Fidan. The Wadi Fidan ends where it joins the Wadi Araba (fig.1). The survey area in the Wadi Ghwair covered 1km up the wadi towards its source, from the point where it joins the Wadi Faynan at its western end (the site itself is on the southern bank of the Wadi Ghwair, close to the point where it joins the Wadi Faynan (fig. 1)). I examined the wadi bed and the banks on either side for flint material. I completed a similar survey of the Wadi Fidan along the full extent of the wadi from the eastern end where it joins the Wadi Araba to the western end (the source of the wadi) where it joins the Wadi Faynan (fig. 1). In the Wadi Faynan itself, I surveyed a cross section of the wadi every 1km across its length (fig. 1). It is important to bear in mind that this survey was not a full geological survey of the area; I was simply looking at the types of flint that make up the closest raw material source to the sites. The flint in the wadi beds actually relates to the geology further up in the mountains, at the wadi sources. I did not produce a distribution map of the flint types as it was clear that the same flint types could be found across the full extent of the Ghwair, Faynan and Fidan wadi system. The only difference between the Wadi Ghwair and Fidan is the greater occurrence of conglomerate types in Fidan; conglomerate types are lighter and, therefore, were carried further during the wet season thus explaining the concentration of these types at Fidan.

When recording raw material types (appendix 1) I began with the debitage assemblages themselves. I took notes on the colour, texture and inclusions of the flint types and did the same with any cortex visible. Because flint can be so variable within one nodule, I concentrated my observations on larger pieces preferably with cortex still visible (gathering as much information as possible on individual flint artifacts). Description of colour is very subjective and in an attempt to reduce this I used the Munsell colour charts though this too, turned out to be subjective and so I simply used the Munsell colour descriptions as a general guide rather than using the catalogue numbers. Cortex provided the most useful information for flint sourcing, not only in the nature of the cortex itself, but also in its degree of weathering. All this was then recorded in the format of a written description, illustration and photography.

The same procedure was carried out during the raw material survey in the field, recording flint cobbles found in the wadi beds, nodules and cobbles found on the banks of the wadis and on the surface of the sites themselves.

I was then able to eliminate a large number of flint types, which did not appear in the archaeological assemblages, and identify two flint types, which do not appear naturally in the immediate area of the sites. For a description of all flint types found on these sites see appendix 1.

Categorisation of the lithic debitage assemblages

I based my system of recording on that of Douglas Baird's PhD. thesis (Baird 1993) with a few changes to suite the particular circumstances of this assemblage. These I added during recording as the need arose. I chose to use Baird's system of recording as it is detailed without being overlong, this is important because of the time restrictions of a PhD. His system includes most of the important categorisation terms, which have been developed over the last 20 years in Near Eastern archaeology so it was ideally suited to the material. I have placed the lists of all my categories, attributes and descriptions in appendixes 1-4 as they are too large to fit within the main body of this section of the text.

The first stage of recording begins with the preliminary sort, which is carried out before any written record is made. This involves dividing each piece up into their relevant debitage categories followed by bagging and labelling them (appendix 2). The categories can be separated into three types, cores, removals and tools. This thesis concentrates on cores and removals as some tools have been removed from the assemblages. The categories have been sorted according to two basic parameters. The first is the amount of cortex retained on the removal surface. Pieces with dorsal surfaces completely covered with cortex are likely to have come from early stages in the knapping sequence; quantifying these pieces can give insight as to what stages of the reduction sequence are represented in the assemblages. The other parameter is based on the size and morphology of the removals. It has long been recognised that the production of elongated removals was a deliberate strategy (Baird 1993) involving careful preparation of the cores. Therefore an arbitrary criteria was developed to distinguish the more elongated removals that could be simply applied by all analysts. Labelled as blades, each piece would have to be twice as long as it is wide (2:1 ratio). It also became clear to analysts of Near Eastern assemblages that the production of small blades, termed bladelets, was also a deliberate strategy (Baird 1993) and so arbitrary criteria has also been developed to distinguish bladelets from blades. Bladelets should be twice as long as they are wide, but also 50mm or below in length and 12mm or below in width. The length measurement of both blades and bladelets should be taken along the full removal axis of the blade or bladelet and the width across this axis at the widest point of the blade or bladelet. A thickness measurement was taken from the dorsal to the ventral surface at the thickest point. The same three measurements were taken on all debitage except on broken debitage. Broken debitage (labelled indeterminate) had all dimensions recorded, except for the dimension cut by the break (e.g. if the piece is broken along its length, then length was not recorded). Replacing the missing dimension was a record of my impressions as to whether the piece was a broken blade or flake, because the complete dimension of the broken axis can never be known. The next stage involved completing a secondary sort, recording all attributes on the cores, removals and tools, and entering all counts onto computer (appendix 3). This stage also involved looking closely at the platforms and bulbs, where visible. At this point I also included some terms described by Inizan, Roche and Tixier (Inizan, Roche and Tixier 1992). I included extra categories, for recording cores, crested pieces and rejuvenation pieces in order to fully describe them in the database (appendix 4). The length, width and thickness dimensions were also recorded on the cores. Length is taken along the main removal axis from the main removal surface at its longest point when possible, otherwise I made an arbitrary decision as to what was the length for the main removal surface. Width was taken across these same axis, and thickness from the main removal surface to the opposite side of the core (at its thickest point).

Summary

The key issue in the approach I take to recording my data is to use an attribute rather than a type-based methodology. This will enable me to make specific comparisons of strategy and technique between all four sites. Type alone would not provide as much comparative data and could not inform about the behaviours that produced them. Raw material data will be included at every stage of the recording system enabling me to trace individual strategies throughout the *chaîne opératoire*. I shall conduct two sorts; the preliminary sort using a type based recording system in order to divide up large assemblages into manageable general categories, and the secondary sort using the attribute based recording system.

In the next chapter (Chapter 5) I shall discuss the results and analysis of the Ghwair assemblage.

List of Figures: Chapter 4 (Methodology)

Fig. 1 Map depicting the area of the raw material survey

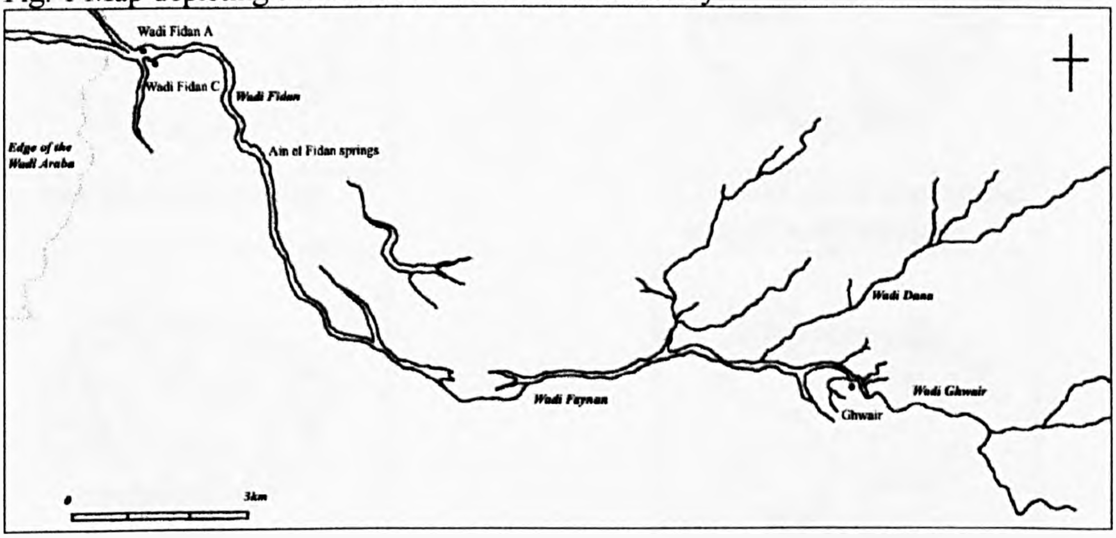
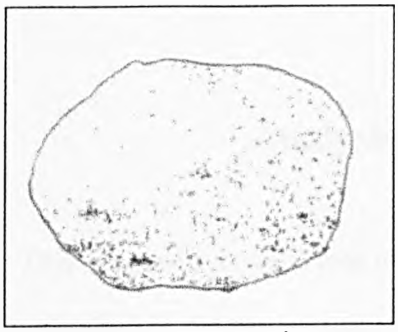
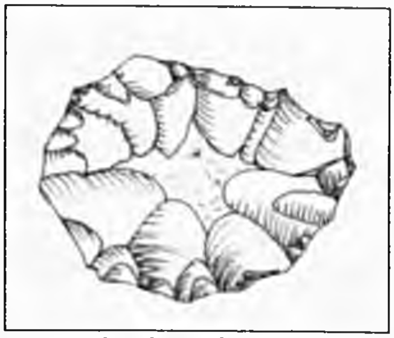


Fig. 2

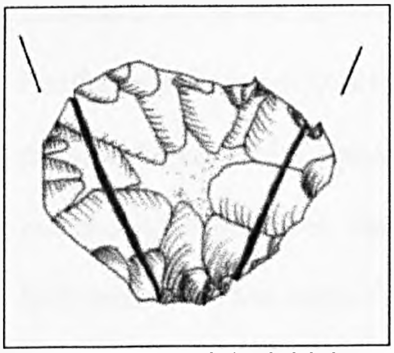
An illustration of the naviform reduction sequence.



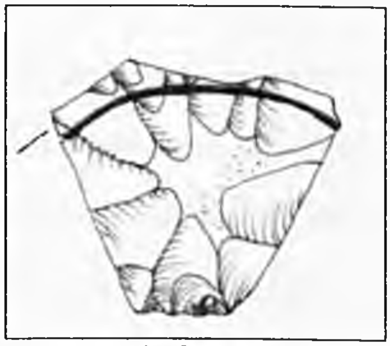
1. Raw material sourcing.



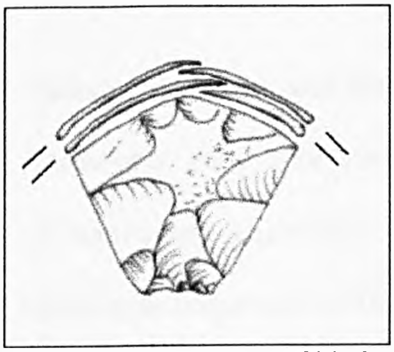
2. Production of a rough-out using bifacial knapping.



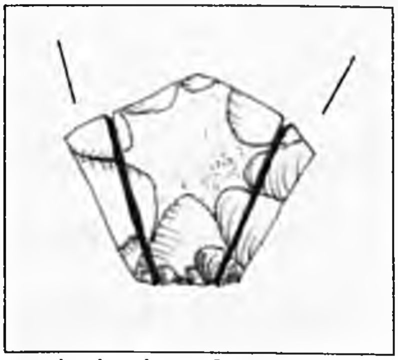
3. Production of the initial removal platforms, prodcing a 'boat' shaped core.



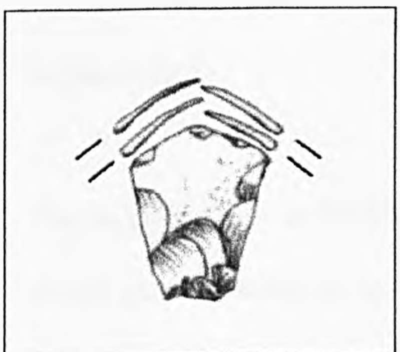
4. Removal of the first (crested) blade.



5. continued removal of blades from the opposing platforms.



6. rejuvination of the original removal platforms, in order to recreate the correct platform angle.



7. continued use of core to produce bladelets.

8. Discard the core because it is too small, or re-use it as a flake core.

Chapter 5

Analysis of the Ghwair lithic assemblage

This chapter is divided into ten sections, nine lithic types and a summary. The lithic types consist of Cores, Blades, Flakes, Indeterminates, Crested elements, Rejuvenation elements, Overshots, Tools and Spalls. Within each lithic type section I discuss individual attributes. For the cores I discuss core type, dimensions, platform preparation and platform angle. For the tools I discuss tool type and dimensions only. For all other lithic types (blades to overshots) I discuss type, dimensions, platform type, platform preparation and platform and bulb features. In the summary I review each reduction strategy identified in the Ghwair lithic assemblage, discussing each stage in the *chaîne opératoire*.

Ghwair: core types and dimensions

A total of 67 cores came out of the 1993 excavation at Ghwair (Najjar 1994) and 46 of these are blade cores. The blade core assemblage comprises mainly of naviform blade cores (appendix 4). These can be divided into two groups, the first and most common was produced in type 1 raw material and the other in type 16. The naviform cores in type 16 raw material tend to be a more 'classic' naviform shape (appendix 4) with full cresting along the back (fig 1).

The majority of the naviform cores in type 1 raw material are produced without any cresting or only partial cresting along the back. This rather 'variant' method (appendix 4) takes advantage of the natural cortical shape of the nodule, only modifying the pre-form where necessary (fig 1). There is only one example of these cores with complete cresting along its back. The difference between the naviform types is probably due to the fact that the nodules of type 16 are more tabular in shape than the rounded nodules of type 1. The two types of bladelet core in type 1 (table 1 and appendix 4) are likely to be exhausted naviform cores because they are producing smaller debitage but they still retain both or one of the original platforms.

There are three change of orientation (appendix 4) flake cores in type 16 raw material and eight in type 1. The other flake core types are also in type 1. There is one single platform flake core, one irregular flake core and one flake core (appendix 4). These two raw material types have been mainly used for naviform production in the blade assemblage. By comparing the two scatter plots (graph 1 and 2) it is possible to see that the type 1 and 16 flake cores group within the naviform width range and at the lower end of the naviform length range. This indicates that these particular cores are likely to be examples of exhausted naviforms, which have then been reused as flake cores. In total this group comprises of 14 flake cores, which is a significant proportion of the total. This suggests that producing small flakes was an important aspect of the reduction strategy aside from the blade production. This conservation of the type 1 and type 16 raw materials, suggests that it was highly valued. These raw materials are not found in the immediate locality of the site and are possibly imported from a significant distance away.

The largest group of flake cores (54% of the flake core total) that came out of the 1993 excavation are actually flake cores in the medium wadi raw material (appendix 1). Twentytwo are change of orientation, two are single platform, and one is a multiple orientation flake core (table 1). The medium wadi change of orientation flake cores are not being reduced as much as other cores on site. This is not surprising because the raw material is so easily available in the wadi Dana. These cores are also producing larger flakes than flake cores in any other material, suggesting that the flakes being made out of the medium wadi material may have been used in a different way to flakes in type 1 raw material. Looking closely at the medium wadi core dimensions (graph 1) there appears to be two groups. One clusters with the naviform cores and the other, comprising of much longer and wider flake cores, has a wider range. This, combined with the knowledge that there are a significant number of medium wadi blades in the assemblage, led me to investigate whether some of these medium wadi flake cores were originally blade cores. In graph 3 I show the dimensions of type 1, type 16 and medium wadi cores in comparison to the medium wadi blade dimensions. This shows that the majority of blade lengths do correspond roughly to the lengths of the medium wadi cores[1]. However, looking at the morphology of the medium wadi flake cores it is highly unlikely that most of them were ever blade cores. Of this type of core the majority are not heavily reduced and have a good deal of cortex remaining on the core surface. The flake removals tend to be large, few in number and do not obscure any evidence of previous smaller removals. There are, however, a few that do prove an exception to the rule. They are more heavily reduced, by smaller flake removals, and it is feasible that they could once have produced blades, though they do not show any current evidence of this. The size similarities between the medium wadi blades and cores is more likely due to the fact that the raw material was collected from the same source. The medium wadi cobbles in the area of the wadi bed closest to Ghwair are

[1] Many of the larger blades were removed from the assemblage. However, general lengths of those illustrated in Najjar's 1994 publication *(Najjar 1994)* fit into the upper dimensional ranges of this assemblage. I do not have any raw material data on these blades.

generally of a similar size and shape to these particular cores. This still leaves us with the question of where the cores, which produced this relatively large number of medium wadi blades, are located? At this point it is important to remember that the trenches of the 1993 season are quite small, that they are only located in one area of the site and that the assemblage comes from similar deposits within structures. It is possible that the medium wadi blade cores are located somewhere else on the site or are located off the site altogether.

The blades themselves do display the occasional opposed platform scar on their dorsal surfaces. This could suggest that the medium wadi blade cores were opposed platform cores, possibly even naviform cores. But the number of these scars identified, in comparison to those on the type 1 blades associated with the type 1 naviform cores (medium wadi 0.2%, type 1 43.5%, these percentages are based on the number of blades with scars from the total blades in each raw material), leads me to believe that the medium wadi blade cores were only expediently opposed platform. The knapper only turned them into opposed platform cores on occasion, perhaps to correct errors, rather than representing a systematic opposed platform strategy.

There are six other change of orientation flake cores in the fine wadi raw material and one double platform core (appendix 4) in the rough wadi raw material (table 1). The community at Ghwair did not make much use of rough wadi raw material for any cores because though it is common, it does not easily lend itself to knapping. However fine wadi raw material is found in the wadi Dana and it is particularly good for knapping. The only explanation I can suggests as to why it is not used as much as the medium wadi and why, when it is used, the discarded cores are smaller than the medium wadi type, is that the fine wadi cobbles found locally tend to be smaller and less common than the medium wadi cobbles. They also retain cracks from wadi rolling, and this would also explain why they were not used for blade production at all.

The naviform blade core reduction strategy is a very formal and standardised method of producing blades. Most blade cores at Ghwair are naviform (25.4% are naviform 3% are non naviform blade cores. This percentage is based on the numbers of blade cores in the total core assemblage). However, within this you can find two different types of naviforms with a possible third blade core type in medium wadi raw material, which is not represented in these trenches. So in a sense there is a formal but wide ranging approach to blade production at Ghwair. In comparison, change of orientation flaking is a reduction strategy that does not result in any standardised form when the core is discarded. In this sense the flake reduction strategy at Ghwair is informal, though it does follow a regular strategy. Looking at the flake industry as a whole it is interesting to note that the majority (58%) of all cores are actually change of orientation flake cores. The fact that most cores are made in this way suggests that though informal, there is a rather limited approach to flake production at Ghwair.

Ghwair: core platform preparation

At Ghwair, the knappers used all three preparation techniques bashing, platform edge flaking and grinding (appendix 3), usually in combinations of varying degrees, to prepare their core platforms. Grinding tends not to appear in high levels on the cores because it is removed by the latest removal. On the naviform cores the most common technique was platform edge flaking, and then the combination of bashing and platform edge flaking. Only a tiny amount of grinding remains on the naviforms (table 2). On the flake cores, the flint knappers used a combination of bashing and pressure flaking and platform edge flaking on its own. These are divided into roughly 50:50 proportions (table 2). From the evidence on the blade and flake cores, there does not appear to be much distinction in the preparation of platforms at this site. This rather surprised me because the level of platform preparation is a reflection of the time spent preparing the core before each removal. At Ghwair, all other industrial factors indicate that there was much more time and effort put into producing blanks from the type 1 and 16 naviform cores. It was, therefore, important to look at the platforms of the flakes and blades to see if a similar pattern occurs (tables 5-9 for blades and tables 20-24 for flakes). The blades reveal an emphasis on grinding (18.5% of the whole blade assemblage), grinding and platform edge flaking (7.3%) and platform edge flaking (7.6%). It is clear that they were preparing the naviform platforms very carefully; the only reason that the final stage of preparation, grinding, is not really found on the cores is because they were knapping it off and were not bothering to continue with grinding once the decision to discard the core was made. The flakes show a slightly more complicated picture. They do show less preparation with almost no grinding (2.7% in all raw materials). The emphasis is on bashing, bashing and platform edge flaking and platform edge flaking. In comparison to the blades this is actually predictable, but when looked at the total amount of flakes with platform preparation it tallied up to only 59.9% of the entire flake assemblage. The flake cores on the other hand all display platform preparation. It seems that the flake cores show proportionally more preparation than the flakes that were supposedly removed from them. It is possible that the flakes we have here were removed early in the knapping sequence and consequently very little preparation was carried out. However, it is also possible that they were preparing the core platforms for use as tools before discarding them.

Ghwair: cores platform angle

The measurement I took for this was the inside angle (effectively the angle within the stone). The frequency chart (graph 4) shows that length and platform angle on the naviforms follow a similar bell curve. So at Ghwair the naviform platform angles get smaller as the core reduces in length. This is a predictable pattern for a knapping sequence, which starts with larger naviform cores that are, on the whole, consistently and heavily reduced. There are no naviform preforms being produced at a smaller size, and so the blades and bladelets are coming from the same cores at different stages of the knapping sequence. There is no such clear correlation between core size and platform angle in the change of orientation cores. This is because there is no direct relationship between core size and platform angle. All that can be said is that there tends to be a range of angles, which are most common (70^0- 95^0 graph 5). These are found across the full range of core sizes and the outlying platform angles do not form a distinct group. The same can be said for all the other flake cores found at Ghwair (graph 6). This pattern suggests that getting the platform angle right on the flake cores was not a priority for the knappers but that the angles tended to cluster naturally within a certain size range possibly due to the general shape of the nodule and the sequence in which they were knapped.

Ghwair: blade types

The majority of blades and bladelets at Ghwair are in the type 1 raw material, (65.6% of the total blade assemblage (table 3), and most of the total blade assemblage are retouched type 1 blades and bladelets (53.7%). Only a third of the type 1 blades retain cortex and there are no examples of primary blades, suggesting that the earliest stages of reduction are not represented here. Only a third of the type 16 blades also retains cortex, however, here there are a very few primary blades and so the earliest stages of the reduction sequence are at least partially present. However, these blades are not clear indicators of early stages on there own and it remains to be seen if other indicators of the core preforming stage, such as crested blades, are present. The other significant portion of the blade assemblage is made of medium wadi raw material and again, like the type 1 blades, most of these are retouched (16.1%). Under a third of the medium wadi blades retain cortex suggesting that this is possibly a figure typical of ongoing reduction rather than representing early stages of reduction, particularly as there are no medium wadi blade cores in this area of the site.

As the majority of all blades in all raw materials are retouched, this indicates an emphasis on using blades as retouched tools as opposed to utilising the blanks as they come off the core. However, there is an overall preference for type 1 blades. This may be linked to the production of arrowheads and tiny pierces which have clearly come from the type 1 blades and bladelets.

Ghwair: blade dimensions

The type 1 blade dimensions on the scatter plot (graph 7) range mainly between 20mm and 90mm in length with a few outliers above and below this size range. They all cluster between 5-30mm in width generally getting wider as they get longer. However, looking at the scatter plots of the cores (graphs 1 and 2) it is clear that not all the naviform cores are represented in the blade assemblage. The naviforms range between 50-90mm which covers the size range of the larger blades but not the smaller ones, though a few of the naviform blade removals will not run the full length of the removal surface. It is possible that some of the smaller blades and bladelets have come from the type 1 flake cores because they range between 25mm and 50mm in length. As discussed earlier, I consider these flake cores to be exhausted naviform blade cores.

It is important to mention at this point that when this assemblage was initially collected, the excavators (M. Najjar) removed roughly 150 large blades. Many of these blades showed evidence of opposed platform scarring on their dorsal surfaces (D. Baird *pers. com.* 2002). In the remaining assemblage, that I have sorted, most scarring occurs on the type 1 blades. There is also some evidence of scarring on the medium wadi blades. So it is most likely that the majority of the blades Najjar removed were in type 1 raw material. This situation may change the picture on the blade dimensions scatter plot (graph 7). Looking at the photograph of arrowheads removed from assemblage (Najjar 1994) they range between 60-90mm and so the blades from which these were produced would fall in the upper end of the size ranges we have on the scatter plot.

The fine wadi blades range between 29-68mm in length and 10-25mm in width. There are no blade cores in fine wadi, but the dimensional range of the blades easily fit within the metrics of the flake cores. The low number of fine wadi blades and their dimensions suggest that they were not produced as a separate blade production strategy, but as part of the flake production strategy present in this area of the site.

The medium wadi blades cluster both within the type 1 size range and spread out from this, getting longer and wider by about 60mm in length. What is interesting about these blades is that, as discussed earlier, some are longer than any of the medium wadi cores present in this assemblage (graph 3). It is probable, therefore, that the medium wadi blades were transported here from elsewhere on the site.

Fine and rough wadi blades are all found within the type 1 size range. The blade dimensions as a whole suggested that the knappers had a preferred blade size with the exception of the medium wadi blades, which vary most in size. On one hand, this could be the result of the types of tools being made out of the type 1 and type 16 raw materials; on the other, as some of the medium wadi blades are being treated in a very different way, it may support the idea that they were made elsewhere on the site.

The rough wadi blades range between 39-61mm in length and 13-22mm in width. Like the fine wadi flakes, the rough wadi blade dimensions fit within the metrics of the only rough wadi core (which is a flake core) and the low number of blades suggest that they were produced as part of the flake core reduction sequence.

Ghwair: blades platform type

The most common platform type on blades of type 1 (other than blade/bladelets without a platform) is punctiform, then filiform and finally plain platforms. There are very few faceted, crushed and winged platforms (table 4). This is consistent with the careful preparation carried out on the naviform cores. In fact, punctiform and filiform platforms are typical for naviform production across the Levant (Baird *pers. com.* 2003).

On the medium wadi blades, the majority of platforms are plain. Other significant platforms are punctiform and filiform. This makes the platform strategies similar to those on the naviforms though there is less emphasis on careful preparation because plain platforms dominate. However, though there are very few winged platforms, there are proportionally more being produced here than in the naviform platform strategy. Winged platforms are a feature produced by removing blade after blade from roughly the same position on the core platform. Opposed platform techniques tends not to produce winged platforms because the knapper uses the ridges left by the ventral surface edges of the previous removal. So the striking position moves around the edge of the core platform. This would suggest that the relatively large number of winged platforms on the medium wadi blades indicate that cores relating to this blade production were largely single platform cores, or at least only turned into opposed platform cores when it was expedient; so it was probably not a naviform strategy. This is consistent with the number of opposed platform scars on the medium wadi blades which is significantly lower than on the type 1 and 16 blades. But it is difficult to say much about this particular industry as no medium wadi blade cores were found in the 1993 trenches.

Ghwair: blade platform preparation

The analysis of platform preparation on the blades has had to exclude many blade/bladelets because they do not retain their platforms. So the statistics have been collated from the total number of blades with platforms, 612 out of the total blade assemblage of 752. This total was then divided up on the basis of raw material types because platform preparation is connected to raw material.

In type 16 raw material most platforms are plain, punctiform and filiform. Less than half of the plain platforms have been prepared, and platform edge flaking has been the preferred method of preparation (table 5). However, all of the punctiform platforms and 93.4% of the filiform platforms have been prepared (table 5). Here the emphasis is on grinding and then on grinding/platform edge flaking. It is clear that grinding is very important in the preparation of these smaller platforms because is appears in almost all the combinations of platform preparation methods.

The blades in type 1 raw material have been produced using mainly punctiform (129 in total), filiform (97 in total) and plain platforms (75 in total). A little over half of the plain platforms are prepared (table 6) and here the emphasis of preparation is on grinding. As in type 16, most of the type 1 punctiform and filiform platforms have been prepared and again the emphasis is on grinding whether on its own or in combination with other methods. On the small platforms the knappers at Ghwair have utilized almost all the different ways and combinations of preparing the platforms, but they have not done this as extensively on all the other types of platforms found in type 1.

In fine wadi, the majority of platforms are plain (11 in total) and only a very small percentage of these have been prepared (table 7). The sample is so small that it is hard to identify any preferences in preparation methods. I can only suggest that grinding and platform edge flaking is most popular because more than one platform has received these two kinds of preparation.

The majority of platforms in medium wadi are plain (71 in total) and punctiform (19 in total). Less than half of the plain platforms have been prepared and most preparation takes the form of bashing (table 8). Most of the punctiform platforms have been prepared in a similar way to the type 1 blades, using grinding. However, though fewer of the plain platforms have been prepared, and most preparation is bashing, we do see the application of a wider variety of preparation methods than on the small punctiform and filiform platforms. This situation is the reverse of that on the type 1 blade platforms. In general, proportionally fewer blade platforms have been prepared in medium wadi than in type 1 and 16 raw materials.

The blade platforms in rough wadi have hardly been prepared at all. Most are plain platforms (6 in total) and only 2 of these have received preparation that is platform edge flaking (table 9). The only other preparation is bashing on a crushed platform. There is a link between crushed platforms and bashing preparation because a crushed platform is the result of heavy but inaccurate blows. This is a similar action to that which produces bashing on a platform edge. Unfortunately the amount of preparation on rough wadi flakes is too small to reach to any clear conclusions.

To summarise, most effort is put into preparing the type 1 blade platforms, especially punctiform and filiform types. All methods are used particularly on the platforms that receive most attention but grinding is most popular and is even used on type 1 plain platforms. Less effort is put into preparing the medium wadi blade platforms. Most attention is paid to the smaller medium wadi platforms and grinding is commonly used. However, overall, a more limited range of methods is applied to the smaller platforms than to the plain platform on medium wadi blades. Very little preparation is applied to fine and rough wadi blade platforms.

Ghwair: blade platform and bulb features

Because the platform types are related to reduction strategy and raw material, I felt it was necessary to sort the number of platform and bulb features according to raw material as well. So the tables 10 to 17 show the percentage of features from the total number of blades in each raw material category.

The platform features I have described are lips and ringcracks, which can be found on platforms, and large eraillures, clear cones and siret fractures which can be found on the bulbs (appendix 3). These bulb features, particularly clear cones, tend to be associated with harder hammer or at least a heavier blow (Ohnuma and Bergman 1982). Judging from these results, lips and ringcracks appear in similar, though small, numbers on type 16, type 1, and medium wadi blades (tables 10-12, they do not feature on fine and rough wadi blades). There is no particular association between lips, ringcracks, and prominent and diffuse bulbs. The bulb features mainly consist of large eraillures and clear cones. On type 16 blades these are mostly found in association with plain and crushed platforms (table 13). In this raw material the clear cones are more often associated with diffuse or unclear bulbs (because they are lost either though an eraillure or retouch) than with prominent bulbs. On type 1 blades most bulb features are found with plain, punctiform, and filiform, and crushed platforms (table 14). The majority of clear cones are actually associated with diffuse platforms in this raw material. On fine wadi blades most bulb features are found with plain and punctiform platforms (table 15). Again, the majority of clear cones are associated with diffuse bulbs in fine wadi. On medium wadi bulb features are associated with plain, punctiform, dihedral, winged and faceted platforms (table 16). The majority of clear cones on blades in this raw material are found in association with diffuse bulbs. Finally on rough wadi, clear cones are found in association with plain and winged platforms (table 17). The only two clear cones are associated with both diffuse and prominent bulbs.

At a very simple level lips and diffuse bulbs have been linked to softer hammer percussion and ringcracks, prominent bulbs and all the bulb features are linked to harder hammer percussion (Ohnuma and Bergman 1982). However, Bonnichsen (Bonnichsen 1977) discusses the possibility that lips are produced as a result of the striking angle rather than softer hammer alone. Bruce Bradley (*pers. com.* 2003) considers that lips are produced because the striking point is on an isolated platform (very close to the edge of the platform). However both these theories do accept that a low striking angle and an isolated platform tend to be associated with softer hammer because it is easier to use in these situations.

There is little research that has clearly linked bulb features to hardness of hammer; it is possible that these could be due to speed or force of the blow. In the blade assemblage at Ghwair there are no clear patterns indicating a preference for hammer type. Both hard and soft hammer indicators, including the bulbs (table 10), are found within all raw material categories and on all platform types. The difficulty is that recording attributes like prominent and diffuse bulbs are subjective. So the almost equal numbers of prominent and diffuse bulbs in the type 1 and 16 raw materials may be inaccurate. But this record is a good indication of what is prominent and diffuse relative to the Ghwair assemblage itself.

A possible solution to the subjectivity of diffuse and prominent bulbs is to combine platform and bulb features and look for the blades that show both (table 18). The only examples of platform and bulb features found in association with each other are found in type 1; a possible reason for this being type 1's prominence as the most common raw material in the blade assemblage. Eraillures are not meaningful unless found in association with clear cones, and so it is examples of platform features in association with clear cones that are the important results. There are no 'incorrect results' where lips (softer hammer) are found on the same blades as clear cones (harder hammer). Three ring cracks, out of eight, are found in association with clear cones. This is a relatively significant number, suggesting that in these cases at least harder hammer was applied. However, it is difficult to ignore the fact that the number of lips on type 1 blades is double that of the ring cracks, even though the bulbs do not confirm that they are related to harder hammer technique. There are several possibilities that might produce these results. The lips may relate to the isolation of the platform here rather than hammer technique (Bruce Bradley *pers. com.* 2003) or that the knappers at Ghwair were skilled enough to use harder hammer techniques, at least, in parts of the naviform blade reduction sequence. It is also possible that the striking angle was slightly higher than that which produced Bonnichsen's results on lips. And finally, it is possible that these results are a combination of both using harder hammers (without much force) on isolated platforms and striking at a slightly high angle. The residents of Ghwair were mass-producing blades from naviform cores, in two different raw materials, and their local source for hammer stones was a wadi bed containing many different types of cobbles. I believe that this is, probably, the main reason for such a confused set of results on features and attributes pertaining to hammer type; especially as current reconstructive studies have, so far, really only conclusively demonstrated that results are so complex and unpredictable that far more research is needed.

Ghwair: flake types

At Ghwair, medium wadi is more substantially represented in the flake assemblage than in the blade assemblage. Medium wadi comprises 46.7% of flakes (table 19), but this raw material does not dominate in the same way type 1 does in the blade assemblage (65.6% of the total blades). Throughout all the raw materials the majority of flakes are retouched debitage and there is no particular preference for secondary or tertiary flakes for tool use (table 19). This indicates that the flakes were considered important as tool blanks. A lot of the retouched and unretouched flakes retain cortex (21.3%in type 1. 22% in medium wadi, 3.4% in fine wadi, 3.1% in type 16 and 1.9% in rough wadi. Total 51.7%) so there is no particular preference for tertiary flakes in any raw material. This does not occur in the blade assemblages where much less than half the assemblage (30.8% table 3) retains any cortex.

Ghwair: flake dimensions

There are some interesting features in the flake dimensions scatter plot (graph 8). The majority of flakes (across all raw materials) cluster between 0-75mm in length and 0-60mm in width. There does not appear to be distinguishable groups of flakes in type 1 raw material that might suggest which are flakes produced in the creation and maintenance of naviform cores in contrast to flakes that have been removed after the naviform has been exhausted and turned into change of orientation flake cores. However, the pattern of dimensions in type 1 and 16, fine wadi and rough wadi flakes differs to medium wadi flakes. There is a group of flakes in medium wadi which, though fewer in number, are generally longer than the main body of flake sizes. When I compare their dimensions to the medium wadi blades (graph 7) they are remarkably similar in length (though obviously not in width). It is, therefore, possible that these flakes are somehow connected to the missing medium wadi blade cores. It cannot be proven definitively whether these flakes are produced after the blade cores have been changed into flake cores, or that the elongated flakes were produced in order to create scars from which blades can then be removed. The presence or absence of crested blades in medium wadi would help to indicate the latter strategy, because using elongated flakes scars in order to begin producing blades is a very different strategy to removing small flakes in order to create a crested blade. The assemblage does show a distinct lack of medium wadi crested blades, however, it also shows an absence of medium wadi blade cores. It is likely that all medium wadi blanks must have been introduced to the area of the site from which these assemblages derive. As a result, it is difficult to investigate whether these elongated flakes were produced instead of crested blades.

Ghwair: flake platforms

The most common platform on type 16 flakes are plain (table 20). This is similar to the type 16 blade platforms, but the smaller platforms (punctiform and filiform) have a greater proportional importance than on the flakes (table 4). There is a more limited range of platform types on the type 16 flakes than on the equivalent blades.

On type 1 flakes, plain and then crushed are the most numerous platform types (table 20). This differs to the type 1 blade assemblage where the smaller platforms are more important than plain (table 4). There is a slightly wider range of platform types on the type 1 flakes than on the blades.

The most important platform type on fine wadi blades is plain and then crushed (table 20). This is similar to the fine wadi blades where plain is most common, though there are no crushed platforms (table 4). The flakes show a wider range of platform type than the blades in fine wadi.

The most common platform type on medium wadi flakes are plain and then crushed (table 20). This is similar to the blades, though punctiform platforms have a greater proportional importance than crushed (table 4). There is a wider range of platform type on the medium wadi flakes than on the blades.

Plain platforms are most common on rough wadi flakes (table 20). This is similar to the rough wadi blade assemblage (table 4). However, there is a wider range of platform types on the flakes than on the blades in rough wadi.

It is clear that, with the exception of type 16, there is more variety of platforms being used to produce flakes than blades. This is hardly surprising as blade production at Ghwair is more systematic and formal than in the production of flakes, which largely come from change of orientation flake cores.

Ghwair: flake platform preparation

The basis for these statistics comes from the total number of flakes that retain their platforms, 672, from a total flake assemblage of 674. The two remaining flakes being examples where the platform has been obscured by retouch.

The flakes in type 16 are produced mainly with plain platforms (17 in total) that have been prepared using platform edge flaking (table 21). Generally, there is more preparation than not across the platforms. However, the sample size of all platforms except plain is small.
The majority of platforms in type 1 are plain (100 in total) and most of these are prepared (table 22). The most common method of preparing these platforms is using platform edge flaking. Other significant numbers of platforms are crushed (34 in total) and faceted (21 in total) and these are mainly prepared using platform edge flaking and, or bashing (table 21). Though punctiform platforms are relatively small in number (17 in total), they do receive, proportionally, the most preparation, as is seen on the type 1 blades (table 22). However, unlike the blades, the level of grinding across all the platforms is extremely low[2]. The grinding does tend to occur on similar platforms to those on the type 1 blades, for example

[2] It is interesting to note that the preferred way of preparing plain/cortical platforms is to use grinding. This is possibly because cortex is difficult to flake and so grinding is an easier way of preparing the platform

plain and plain cortical, punctiform and faceted platforms. It does not occur on crushed platforms as seen on flake platforms in the wadi raw materials. Despite this low level of grinding the type 1 flake platforms are generally well prepared (table 22), *c.*71% of the total 241 type 1 flakes have received some kind of preparation.

The flakes in fine wadi have been largely produced with plain platforms (24 in total) and the majority of these platforms have been prepared using platform edge flaking (table 23). There are not many other types of platforms but all of these have been prepared. The only exception is crushed platforms that have, on the whole, been left unprepared. Grinding hardly figures, with only 6 platforms from a total of 49 having been prepared using grinding, and where it does occur is often used in combination with other methods of preparation. However, grinding is used on an unusual variety of platforms, which differs from the group of flake platforms in type 1. For example, plain and plain/cortical, punctiform, dihedral and most unusually, crushed platforms. Like the type 1 and 16 flakes, the fine wadi flakes are relatively well prepared because the majority of platforms have received some form of preparation. It is interesting to note that over half of the fine wadi flake platforms have been prepared (63.4%), but less than half of the equivalent blades have been prepared (38.9%).

Most platforms on medium wadi flakes are plain (187 in total) and only half of these have been prepared. The most important form of preparation on the plain platforms is platform edge flaking and then bashing/platform edge flaking (table 24). Unlike the fine wadi flakes, many of the crushed platforms (30 in total) have received preparation, with an emphasis on bashing. Faceted platforms (27 in total) also figure in relatively significant numbers and most are prepared with platform edge flaking. Grinding occurs in low levels (usually in combination with other methods) on a wide range of platforms as it does in fine wadi. The examples include plain and plain cortical, punctiform, faceted and crushed. Overall, 57% of platforms from the total 304 medium wadi flakes have been prepared. This proportion is lower than type 1 and fine wadi.

The majority of platforms in rough wadi are plain and much of the preparation on these is bashing (table 25). Grinding occurs only three times in combination with other preparation methods. It is found on plain and faceted platforms. The overall amount of preparation in this raw material is 36.1%, lower than all the other raw materials in the flake assemblage. This low level of preparation is reflected in the rough wadi blades where only 37.1% of the total rough wadi blades (with platforms) have been prepared. Rough wadi raw material is not important in the production of either flakes or blades and so less effort is put into preparing platforms.

In conclusion, it is clear that the proportions of preparation on the flakes are generally similar between the raw materials, with the exception of rough wadi flakes. This is very different to the proportions of preparation on the blades, which vary greatly.

Flakes	**Amount of prep**	**Blades**	**Amount of prep**
Type 16	53.1%	Type 16	70.1%
Type 1	69.7%	Type 1	77.0%
Fine wadi	63.4%	Fine wadi	38.9%
Medium wadi	57.6%	Medium wadi	41.2%
Rough wadi	36.1%	Rough wadi	37.1%

These results indicate that the preparation of flake platforms is less specialised than the preparation of blade platforms. Grinding was mainly utilized on the blades for the specific purposes of ensuring that the platform was strong, directing the force of the blow accurately when the platform was small. On the flakes, grinding was used to solve a wider variety of problems. Small platforms are not produced as often because the ultimate shape of the flake is less important than the shape of the blade. So we see low levels of grinding on many different kinds of platforms and in rougher less important raw materials. The flake platforms are generally well prepared across the raw materials because the majority of flake core do not have a regular form in the way that blade cores do, particularly change of orientation cores which make up the majority of the flake cores. Debitage production from these cores is unpredictable and so platform preparation may have helped to reduce this level of unpredictability.

Ghwair: flake platform and bulb features

The results from the analysis of platform and bulb features on the flakes show that in type 1 and 16 ring cracks are more common than lips (tables 26-27) and that most occur on plain platforms. This could suggest a preference for harder hammer in the more exotic raw materials, this is a clearer pattern than can be seen on the blades in similar raw materials. However, the ring cracks are found in association with both prominent and diffuse bulbs. I think that this difference between the type 1 and 16 blades and flakes is possibly more to do with the fact that the technology was simpler (a smaller range of hammer types) making the picture less complicated. In fine and medium wadi there is also a dominance of ringcracks but again they are found on both prominent and diffuse bulbs (tables 28-29). This may indicate that harder hammer was a common technique in the production of both fine and medium wadi flakes. Therefore, it may be that technique separates the medium wadi flake industry from the equivalent blade industry. This could well be possible as other evidence suggests that the medium wadi blades did not come from the medium wadi flake cores found in the 1993 season. The bulb features also suggest a confused picture. Like the platform features, most bulb features can be found in association with plain platforms (tables 30-34). This is most likely due to the fact that plain platforms are most common in the flake industry at Ghwair. Clear cones dominate across the raw materials; however, they are associated with both prominent and diffuse bulbs.

As the perception of bulb type can be subjective, it may be useful to consider the platform features in relation to the bulb features. A significant proportion, 67.5%, of all the ring cracks in all raw materials are associated with clear cones (table 35). There is only one example of a lip in association with a clear cone on a medium wadi flake. However, there are 15 other examples of ring cracks associated with clear cones, out of a total of 19 ring cracks on medium wadi flakes. Therefore, I believe that this one incongruous example in medium wadi can be safely disregarded. According to Ohnuma and Bergman's (Ohnuma and Bergman 1982) argument, the platform and bulb features on the flake assemblage indicate a use of harder hammer techniques throughout all the raw materials. Even if platform and bulb features are not just a simple indication of hammer type, it is clear that the techniques used to produce the flakes were different and less complicated than those used to produce the blades. Possibly the knappers were using fewer numbers and varieties of hammer types, but spending a fair amount of time preparing the platforms rather than the core preforms.

Ghwair: indeterminate types

The indeterminate assemblage refers to all the broken pieces (see appendix 2). Many are quite clearly broken blades and flakes but it is not possible to prove this beyond doubt so I have placed them together in this category. Though they cannot provide accurate data on dimensions, they can provide good information on raw material use and, in some instances, good information on platforms. The majority of indeterminate pieces are in type 1 raw material (table 36) and most of these are retouched (34.9%) with secondary (retains cortex) retouched indeterminate pieces coming a close second (15.4%). This suggests that the knappers at Ghwair had no particular preference for secondary or tertiary blanks for use as tools. In fact this pattern repeats itself (though in lower numbers) in all the raw materials except rough wadi where they obviously preferred to remove the cortex. This is probably due to the fact that the rough wadi cobbles are full of inclusions and retain a lot of cracks close to the surface, which were probably inflicted when they rolled down the wadi bed. As a consequence of the latter it may have been necessary to remove the entire outer cortex. Most opposed platform scars can be found on type 1 indeterminate pieces (graph 9) and this information, in combination with the data from the cores and blades, suggests that most of these type 1 indeterminates are probably associated with the naviform blade production and are broken blades. There are a few opposed platform scars on the dorsal surface of the medium wadi indeterminates; this could be linked to the medium wadi blade industry discussed earlier.

Ghwair: indeterminate platform types

Only 36.8% of the indeterminate assemblage retains platforms, but this is a large enough number (1135 pieces) to give useful data. Most pieces that retain their platforms are in type 1 raw material (61.4% of the total number that retain platforms, see table 37). The majority are punctiform (23.2%) and filiform (17.9%) platform types. The pattern is very similar to the data produced by the blades in type 1 and so it is probable that most of these are broken blades from the naviform cores. Medium wadi indeterminates retain the second largest number of platforms (23.5%) and the majority of these are plain platforms (11.9%). Surprisingly, a significant number of punctiform (4.7%) and filiform (2.3%) platforms are retained in medium wadi, considering that this raw material was mainly used for flake production. The unusually high number of these small platforms (which is not reflected in the medium wadi flake data, see table 20) suggests that many of the medium wadi indeterminates with small platforms are broken blades. As so many medium wadi flakes have plain platforms it is difficult to separate out the indeterminate broken blades and flakes with plain platforms. In the type 16 raw material, punctiform (3.9%), filiform (1.9%) and plain (1.1%) platforms are the most common; this is consistent with the results on type 16 blades (table 3) but not with the results on flakes (table 20). So, like the type 1 indeterminates, most of these are probably broken blades. The indeterminate pieces that retain their platforms in fine wadi present a rather confused picture (table 37). The dominant platform types here are plain (1.7%) and punctiform (1.6%). The data on fine wadi blades and flakes show that plain platforms are the dominant type (tables 3 and 20) but punctiform barely figure. Here in the indeterminates, punctiform platforms are almost as common as plain. Therefore, it is difficult to tell whether the fine wadi indeterminates with plain platforms are broken blades or flakes.

Those with punctiform platforms are an unknown separate entity which are either more easily broken than the other blades and flakes, or are deliberately broken. Indeterminate rough wadi pieces with platforms show a similar pattern to both the rough wadi blades and flakes. Plain platforms are most numerous (table 34). So again, as for some of the medium wadi and fine wadi indeterminates, it is difficult to tell the difference between broken blades and flakes. As there are more flakes than blades found in fine and rough wadi (tables 3 and 20), it is reasonable to assume that most of the indeterminates in these two raw materials are flakes.

Ghwair: indeterminate platform preparation

For the purposes of this particular analysis I separated out the indeterminate pieces that still retained their platforms (1135 in total) from the indeterminate assemblage as a whole (3081 in total). Then further divided them into groups on the basis of raw material, as platform preparation is linked to raw material.

In type 16 raw material, most of the platforms produced were punctiform (44 in total) and the most common methods used to prepare them was grinding and grinding/platform edge flaking (table 36). Indeterminate filiform platforms (21 in total) are also important and here the emphasis of preparation was on grinding/platform edge flaking. The number of plain platforms (12 in total) is relatively significant as well and the majority of platform preparation on these was platform edge flaking (table 36). This picture is similar to the type 16 blades (table 5) but not to the type 16 flakes where there is very little preparation on the smaller platforms (table 19).

The indeterminates in type 1 have largely been produced using punctiform (263 in total) and filiform (203) platforms. Here, grinding and grinding/platform edge flaking are the most important methods of preparation (table 37). Plain platforms (86 in total) form the next most significant group and platform edge flaking is commonly used to prepare them. This picture reflects what was happening to the type 1 blades (table 6), suggesting that the majority of these type 1 indeterminates are broken blades. There is extensive use of preparation across the board with particular emphasis on the smaller platforms, where grinding and platform edge flaking is most important. This differs from the type 1 flakes because there are generally lower levels of preparation and grinding is not as important. However, the presence of any broken type 1 flakes, will be obscured by this extensive picture of preparation.

In fine wadi raw material, the largest number of platforms are plain (19 in total). Bashing and bashing/platform edge flaking are the main methods of preparation (table 54). Only 58% of the plain platforms have been prepared. Punctiform platforms (18 in total) are also an important group and grinding is the most important method of preparation. Unlike the plain platforms, 71.8% of the punctiform platforms have been prepared; this is a significant difference between two groups that are very similar in size. The proportion of preparation on the indeterminate plain platforms falls in-between the proportions of preparation on the flake and blade plain platforms. Also, the type of preparation on plain platforms of both blades and flakes are similar to the indeterminate plain platform preparation (tables 7 and 22). This suggests the possibility that the indeterminates with plain platforms are a mixture of both broken flakes and blades. The level and type of preparation on the punctiform platforms suggests the presence of an unknown entity, which does not feature in either the fine wadi blade or flake assemblages. This kind of platform preparation is reminiscent of the preparation on type 1 blades with punctiform platforms. As they are completely absent from the blade or flake assemblage it is possible that these punctiform indeterminates are being consistently broken. Data on the tool assemblage may help to clarify why these lithics are being treated in this manner. There are a few smaller tools (piercers and broken points) in fine wadi that are like the type 1 tools produced from blades with punctiform platforms (table 56). The fine wadi tool numbers are relatively low, but I do not thing this matters greatly because there are only 18 fine wadi indeterminates with punctiform platforms. Assuming that these particular indeterminates are broken blades (because of their similarity to type 1 blades), it is interesting that there are no fine wadi blade cores present in this area of the site. It is possible that, like the medium wadi blade cores, the fine wadi blade cores were being reduced elsewhere on the site. However, it is also possible that the fine wadi flake cores are exhausted blade cores. They are relatively small and extensively worked. It will be impossible to know because we do not have the full dimensions of these fine wadi blades with punctiform platforms.

The majority of platforms in medium wadi are plain (135 in total) and they have been prepared mainly with platform edge flaking and bashing (table 39). Punctiform (35 in total) and filiform (26 in total) platforms have been prepared using mainly grinding and grinding/platform edge flaking. The indeterminates with plain platforms have generally received less preparation than those with smaller platforms. This can be seen on both the medium wadi flakes and blades (tables 8 and 23) suggesting that these indeterminate pieces are a mixture of the two. Therefore, as is seen in the fine wadi indeterminates, it is impossible to separate out preparation on broken blades with plain platforms from broken flakes with plain platforms. Indeterminates with punctiform and filiform platforms are likely to be largely broken blades because they have been prepared in a similar way to the medium wadi blades. The general level of preparation is high and grinding is extensively used (table 39) and this is seen on the blades with punctiform platforms (table 8) but not in the preparation of equivalent medium wadi flakes (table 23). The indeterminates with smaller platforms make up a considerable chunk of the assemblage, but it is difficult to establish whether broken blades dominate because we cannot tell how many of the indeterminates with plain platforms are broken blades.

The rough wadi indeterminates have largely been produced with plain platforms and most of these have been prepared with platform edge flaking (table 40). There is very little use of grinding (5.3%). There is slightly more use of grinding on the rough wadi flakes (8.3% table 24), suggesting that the rough wadi indeterminates are broken blades rather than broken flakes. However, the numbers we are dealing with are so small that it would only take one more example of grinding to change the picture.

The data of platform preparation on the indeterminates generally supports the picture established by dimensions and platform type. Additionally, the platform preparation reflects the way platforms have been prepared on blades and flakes. However, the data has also identified the one exception of fine wadi indeterminates with punctiform platforms.

Ghwair: indeterminate platform and bulb features

The samples of platform and bulb features are greatly reduced in the indeterminate assemblage because so many do not retain their platforms; therefore, a small sample is difficult to analyse. Considering that the indeterminate assemblage is essentially made up of broken flakes and blades, I felt it unnecessary to analyse platform and bulb features in detail as the evidence for technique is already established in the flake and blade assemblage.

Ghwair: crested element types

There are three different types of crested element at Ghwair (appendix 4). 'Crested', these have bifacial cresting down the dorsal ridge. 'Ridge refreshing', which is crested down one side of the dorsal ridge only. 'Unclear' refers to cresting down one side of the dorsal ridge and then down the other (not bifacial). When I write about the cortex remaining on the crested elements, I mean that it runs up either side of the cresting along the edge of the piece. There are only a few examples where this is not the case and these are classed as crested pieces because they are not blades. The position of cortex on the crested blades is important because it can help to indicate whether the blade is an initial crested removal or one later on in the sequence (without cortex in the right places, it is not possible to establish whether the crested blade is initial or not, dimensional information can only hint at the stage of the reduction sequence but not prove it). If there is cortex running up either edge of the blade then obviously there have been no previous removals close by which interfered with the dorsal surface. However, this cannot exclude other removals, which were taken from elsewhere on the core. So we cannot conclusively prove the initial crested blade removal, but only several early crested blades. Another indicator of initial crested blades are their dimensions; I shall discuss these later on in the chapter.

In the type 16 raw material, the majority of crested elements are retouched blades with ridge refreshing on the dorsal surface (33.3%, table 44). But added together, there are equal amounts in all three categories of the crested elements. Most of these elements in both categories do not retain any cortex and so are probably not initial removals. This suggests that what we have here are the later stages of core use rather than the initial preparation. However, it is important to bear in mind that the numbers of crested elements in this raw material are low (6 in total).

Most of the crested elements in type 1 raw material are 'crested' and these are dominated by indeterminate retouched pieces (21.7%, probably broken blades, see table 45). Other significant numbers, in order of importance are: secondary indeterminate retouched pieces (12.7%, again probably all broken blades), indeterminate pieces (10.9% in total of which 7.3% are broken blades and 3.6% broken pieces), retouched blades (10.9%), secondary retouched blades (9.1%), and retouched pieces (9.1%). Therefore, much of these are either blades or broken blades that have been retouched. A similar pattern can be seen in the ridge refreshing and unclear elements. By far the majority of these crested elements do not retain cortex (80%). As the nature of ridge refreshing is maintenance of an already established removal surface (appendix 4), this coupled with the low levels of cortex, indicates that the ridge refreshing and unclear pieces are probably not initial crested elements. The type 1 crested element assemblage shows evidence for the latter stages of core maintenance rather than the initial stages of core shaping. There is proportionally more removal surface refreshing going on with type 1 than type 16. Though the type 16 crested element collection is small in number, the type 1 raw material is generally more heavily utilised (they are reducing many of the type 1 naviforms to such a size that they are turning them into small flake cores) at this site so the comparison may be fairly accurate.

In medium wadi, most crested elements are 'crested' and there are a few 'ridge refreshing' elements. These are dominated by retouched crested blades (21.4% table 47). There are only two examples of 'crested' and ridge refreshing pieces that are clearly not blades or broken blades. This data might, therefore, be the result of the medium wadi blade technology for which we do not have any evidence of cores. Proportionally (in comparison to type 1 and 16), there are very few pieces in this group that retain any cortex, and the sample number (14 in total) is low. This may support the idea that the majority of medium wadi blade production occurred elsewhere, either on or off the site. It also suggests, however, that blade initiation resulted from cresting rather than elongated flakes (This chapter, 16). It also suggests the possibility of medium wadi blade core reduction on this area of the site, although, these crested pieces could have been introduced as blanks or tools.

In fine and rough wadi raw material, there is only one example each of a crested element (tables 46 and 48). The low number of crested elements probably reflects the low number of blades produced in these raw materials. But the sample is not sufficiently large to give us any useful information.

In general, the crested elements in all raw materials, except fine and rough wadi, have demonstrated that the initial stages of blade core preparation are not occurring within the areas of the 1993 excavation. Type 1 blade cores are being the most heavily utilised due to the proportions of ridge refreshing. Medium wadi is being utilised at the latest stage of production in this area due to the low levels of cortex. What is also interesting is that they are utilizing most of the crested elements as tools regardless of the amount of cortex retained on the piece, the reason for this is probably that crested blades are particularly robust and do not break easily.

Ghwair: crested element dimensions

The dimensions of a crested element are important because they can indicate at what stage in the knapping sequence they were removed from the core. The larger they are the earlier they are likely to have been produced in the reduction sequence. The type of crested element also plays a part here, I would expect the crested blades to make up most of the larger dimensions in this category and the majority of ridge refreshing blades to be smaller because they probably come later on in the knapping sequence.

Cresting is usually used to create a long ridge in order to remove a blade and so tends to be an attribute of blade core preparation. To make a judgement about the relative size of the crested elements, it is important to compare the crested element dimensions to the dimensions of the blades (table 49). The initial *chaîne opératoire* when preparing a blade core will produce more large blades than crested blades. The naviform blade core technique, for example, requires the knapper to produce three initial crested blades; two for the opposed platforms, which will usually be shorter, and one longer blade to prepare the full length of the removal surface. Any further blade removals will quickly reduce in length, particularly as the majority will not run the full length of the removal surface. So in the naviform blade technology you could expect a low ratio of roughly 1:3 long crested blades to large blades (and possibly 1:1). The comparison between the scatter plot on the crested element dimensions to the equivalent one on the blades, throws up some interesting questions (see graphs 7 and 10). In the type 16 raw material, there are three blades that are larger than the largest crested blade. All we can conclusively say about this is that the longest crested blades are missing from this group because the initial crested blade (if successfully removed) should be longer or the same size as the biggest blades. It is possible that they were knapped elsewhere on or off the site or were broken up and retouched (and so appear lower down on the scatter plot) but it is difficult to conclusively demonstrate this. The rest of the type 16 crested elements are comparable to the group of blades around 70-80mm in length. As previously discussed, the cortex and type of crested element, suggest that this group is not part of the initial cresting sequence but rather part of the ongoing maintenance of these type 16 naviform cores.

The type 1 crested elements are generally of a similar size to all of the type 1 blades (with the exception of a few crested flakes). This includes the larger sizes of crested blades and blades. However, the cortex, cresting type and dimensions together indicate that initial cresting is only partially present. Possibly some crested blades were produced elsewhere, but many have been broken up and reused as tools (most of the type 1 crested element assemblage is retouched). However, it is important to bear in mind that a significant number of the type 1 naviform cores produced fewer initial crested blades than normal because the knappers often did not crest the backs of these cores.

The crested elements in medium wadi, are of similar dimensions to the medium wadi blades. However, on the larger end of the scale, the ratio of crested blades to blades is very low, therefore, some crested blades are missing. There are 26 blades over 80mm long and only three crested blades, and 7 of these blades are longer than the longest crested blade (which is 105mm). So not only are there some crested blades missing from the group that is over 80mm but the longest (over 105mm) are not present at all. This pattern coupled with the low level of crested elements that retain cortex in this raw material supports the theory that most of the crested blade production occurred elsewhere. Because we do not have any evidence for medium wadi blade cores in this assemblage, it is possible that the knappers were initiating blades using a different method to cresting. Possibly removing fully cortical blanks or elongated flakes to prepare the removal surface. However, there are no primary blades in medium wadi raw material in this assemblage, but there are some elongated flakes. The lack of blade cores makes it likely that they are producing the crested blades and elongated flakes elsewhere on the site but not away from Ghwair (because the raw material can be found close by) then bringing them to the area of the 1993 excavation. Of the three raw materials with crested elements, I think that it is the medium wadi blade cores that have the greatest spatial differentiation in their operational chain on the site of Ghwair. There is evidence for some special differentiation in the operational chain of the type 1 and 16 naviform cores as initial cresting and core shaping debitage is not present. However, the type 1 and 16 raw material is not found in the immediate locality of the site and so it is entirely possible that the initial core shaping occurred well away from Ghwair.

Ghwair: crested element platform type

There are only two crested elements that retain their platforms in type 16 (table 50). This number is unfortunately too low to be considered as reliable data.

The type 1 crested elements that retain their platforms is also a small sample but I do think it is possible to discuss this data (tables 50-52). What is conspicuous here is that there does not seem to be any particular pattern. The dominant percentage is punctiform platforms (28.6%) and this could be linked to the fact that the most common platforms on type 1 blade blanks are punctiform and filiform. However, 28.6% out of a total of 14 is technically a very small number. I think what is relevant here, is not numbers but the fact that there are examples of a very wide range of platforms in all three different types of cresting. This situation is very different to the production of blade blanks in type 1, it is clear that the type of platform is not a priority. This is probably because the crest does a good job ensuring accuracy in the direction of force and so small isolated platforms are not necessary.

In medium wadi, the crested blades are all produced with plain platforms and this is similar to the dominance of plain platforms on medium wadi flakes and blades. However, they number only 4 out of 7 examples, the other three (which have other types of cresting) show no distinctive pattern. This number is so small I feel it precludes the possibility of discussing the data seriously.

There is only one example of a crested element that retains its platform in fine wadi and, again, this sample is too small to discuss.

Ghwair: crested element platform preparation

The number of crested elements with platform preparation in type 16 and medium wadi are too low to be discussed seriously (tables 53-55). There are no examples in fine and rough wadi. This leaves only type 1 crested elements. All of the platform preparation here consists of grinding, platform edge flaking, or both. It is clear that there is some care taken in preparing the platforms even if there was no preference for platform type.

Ghwair: crested element platform and bulb features

The platform and bulb features in all raw materials present in this group, generally suggest harder hammer techniques (tables 56 to 58). However, the numbers are too small and the arguments surrounding hammer type indicators are too contentious, to enable much to be said about these features.

Ghwair: rejuvenation types and raw materials

There are several different types of rejuvenation (appendix 4 and table 59). There are platform rejuvenations that relate to rejuvenating the core platform only. Edge rejuvenations that relate to the rejuvenation of the edge of the platform, and, or the removal surface. The edge rejuvenation can be distinguished by the proportion of platform or removal surface that they remove (so if more platform is removed than removal surface, it is a platform edge rejuvenation and vice versa. If the proportions are equal then it is a platform edge/removal surface edge rejuvenation (table 59)). Removal surface rejuvenation relates to the core removal surface only. I refer to 'unclear rejuvenation' when it is unclear whether it rejuvenates a core platform, removal surface or even an area of the core that is not being continuously utilised in the reduction process (e.g. the back of a naviform core). Finally, there is the rejuvenation of a tool cutting edge in order to make it more robust. It appears that the Ghwair rejuvenation pieces were predominantly reused as tools, regardless of whether they retained any cortex or not (a total of 75.5% table 59) The nature of rejuvenation pieces means that they are relatively thick in comparison to the majority of blanks and so they will make particularly robust tools. Were the rejuvenations favoured as tools because of their robust nature? This can be investigated by comparing the proportions of retouched blanks with the rejuvenations. Retouched blades come out at, 81.8% retouched and flakes at 82.2% retouched (tables 2 and 8). It is clear that the rejuvenations are actually receiving slightly less retouch than the blades and flakes and so they are not particularly favoured as tools (though it is interesting that overall, the majority of the debitage are tools).

Most rejuvenations were being produced in type 1. This raw material is associated with the majority of the naviform blade production and it is also exotic so it is being carefully conserved. This fits well with the numbers of rejuvenation pieces.

Interestingly, medium wadi also has relatively high number of rejuvenation pieces. As change of orientation flake cores are less likely to produce rejuvenations, these are likely to come from the medium wadi blade cores. As I discussed previously, the lack of any medium wadi blade cores on this particular area of the site, and the low number of crested elements suggests that the knappers of Ghwair were bringing the blades into this area having knapped them elsewhere. So the presence of a significant number of medium wadi rejuvenation pieces is unexpected. However, by far the majority of these particular rejuvenations are retouched. This offers an explanation as to how they got there, they were being brought in and used as tools in much the same way as the blanks in this raw material. This presence of rejuvenations in medium wadi, as with crested blades, also suggests that the blade production is being carried out close by on the site and, as the raw material can be found in the immediate locality of Ghwair, this is to be expected.

The proportions of medium wadi rejuvenations are similar to the type 1 rejuvenations (table 60). This is a possible indication that the medium wadi blade cores are being rejuvenated in a similar way to the type 1 naviform cores; more evidence to suggest that the medium wadi blade cores were at least opposed platform blade cores, if not naviform cores.

Ghwair: rejuvenation dimensions

The dimensions of rejuvenations cannot give much useful information because they tend to be quite irregular in shape and form. However the scatter plot showing length/width dimensions (graph 11) of the rejuvenations does indicate that in medium wadi and type 1 they generally cover a similar range of sizes. This again supports the argument discussed earlier, that these rejuvenations are from a similar type of core.

Ghwair: rejuvenation platform type, preparation and features

The data here indicates that, like the crested elements, there is no pattern that indicates particular preferences for any platform types in all the raw materials (graph 12). As with the crested blades, grinding and platform edge flaking is most commonly used (graph 13). This shows that there is some careful preparation, carried out across all the platform types. The platform and bulb features also give little information (graph 14). Lips are marginally more common than ringcracks (though the numbers are small, 3 lips and 1 ringcrack). But there is no distinctive pattern of either diffuse or prominent bulbs. Harder hammer bulb features are also present. The fact that there is no clear picture of hammer technique, and that there is a question concerning the validity of the indicators we use for identifying hammer technique, means that little can be said on this issue.

Ghwair: overshot types

Overshots tend to be knapping mistakes when the debitage removes the opposite end of the core at its termination. So the overshot can give us some useful information about the form of core it came from. In the case of opposed platform blade cores, a new platform will have to be made. And more often than not, the core is too small to do this and is promptly discarded. The number of overshots in this assemblage are low, only six in total. However, they do consist of three different types of overshot, relating to the core types from which they came. Four overshots have come from type 1 naviform cores, one from a type 1 flake core and one from a medium wadi blade core. The type 1 naviform core overshots are straightforward and remove part of the opposed platforms, further attesting to the reduction of type 1 naviforms on the site and probably within the excavation area. The type 1 flake core overshot is identifiable because it is short and wide. Interpretation of the medium wadi overshot is as straightforward. I suggest that it is from a unidirectional blade core because the blade scars on the dorsal surface were removed from the same platform as the overshot. However, there is evidence of an opposite platform that has been worked on by bashing and platform edge flaking, in much the same way as the original overshot platform. This could mean that blades taken from the opposite platform were removed from a slightly different section of the core (the evidence for which is not present on the overshot) or that it really was a unidirectional core with some preparation done at the opposite end. However, a few opposed platform scars on the blade blanks, and the similarity of rejuvenation pieces in medium wadi to type 1 naviform rejuvenations, suggests that the medium wadi blade cores were at least expediently opposed platform. The overshot also points to knapping of medium wadi blade cores on site if not in the area of excavation.

Ghwair: overshot dimensions

The dimensions of all these overshots place them firmly within the blade size ranges in both type 1 and medium wadi raw materials (table 61) so the cores were probably not much larger than the blades suggest. There is only one example of overshot (in type 1) that occurred early on in the reduction sequence, because it is at the 80mm benchmark, which separates out the largest blades. The rest occur later on in the reduction sequence.

Ghwair: overshot platforms, preparation and features

This data does not provide any useful information because the sample is so small.

Ghwair: tool types (formal and non-formal)

Tools are the end products in the operational chain. By the term ' formal tool', I am referring to tool forms that reoccur and can be separated out from the informal tools that are retouched debitage and have no reoccurring shape (appendix 5, fig 2). Identifying what type of tool is part of which sequence will complete the picture. For this reason, understanding the raw material use is vital. It is important to point out at this stage that Mohammed Najjar removed a number of formal and non-formal tools from this assemblage and so the overall proportions may be inaccurate. However, what is left can give a good indication of the different uses of raw materials.

The majority of tools are made out of type 1 raw material (50.4% of the total tool assemblage, table 62), and all of these are smaller tool types. According to Mohamed Najjar, a significant number of points were removed and so this proportion will differ (the points are to be published along with points recovered in later excavations, Najjar and Simmons forthcoming). I am unable to identify which of the points are in type 1 raw material, but judging from the percentages I have, it is probable that the majority will be in type 1. The type 1 burins in the formal tool assemblage are a fairly important number (when secondary burins and burins are combined), however the number is not large enough to indicate whether the burin, spall or both were most important to the knappers at Ghwair. The burin spalls may help to clarify this. Type 16 seems to have been used in a similar way to type 1 raw material, and has been predominantly used for smaller formal tools like points and piercing tools. But the overall formal tool numbers in this raw material are very low (14.9%), unsurprising considering the low numbers of cores in this raw material.

Medium wadi is the most commonly used material for formal tools after type 1 (24.8%). It has been partially used in a similar way. There is a relatively full repertoire of the formal smaller tools made on debitage blanks. However, there are also a significant number of larger core tools that are produced on a core rather than on debitage (table 62). This results from the fact that there are two separate strategies employed using medium wadi, beginning with the flake and blade cores. As with the type 1 burins, the medium wadi burins make up a significant proportion of the formal tools, but again the number is too low to assess whether it is the burin, spall or both that is the aim of this production sequence.

In fine and rough wadi, it seems that the majority of tool production has stopped at non-formal tools on debitage blanks, formal tools hardly figure at all (table 63). However, there are a very few fine wadi piercing tools and broken points which could relate to the unusual fine wadi indeterminates with punctiform platforms and grinding platform preparation. The tool assemblage (including formal and non-formal tools) makes up 81.8% of the total assemblage from the 1993 excavation area at Ghwair (table 64). This is exceptionally high, demonstrating the great importance of tool production in the assemblage as a whole. The majority of the tool assemblage consists of non-formal tools (97.4%) and the most important raw material for tool production is type 1, followed by medium wadi (table 63). The pattern of raw materials in the tool assemblage is reflected in the assemblage as a whole (table 65), with type 1 and medium wadi being clearly the most important raw material throughout the reduction sequence, from core to tool.

Ghwair: formal tool dimensions

By comparing the tool dimensions to the dimensions of the debitage we can establish which strategies they derive from.

The type 1 formal tools cluster at the lower end of the type 1 blade dimensions, below 60mm (see graph 15 and 7). As a result, it is possible that these tools derive from flake blanks (see graph 9). However, the blades are complete pieces but many of the tools are broken and so their original lengths are unknown, making length metrics difficult to compare. Therefore, the debitage and tool widths are more comparable, and the widths of the type 1 tools fit best into the widths of type 1 blades under 60mm. So the tools are probably made on type 1 bladelets or broken blades.

In medium wadi, the tools cluster within two different size ranges. The smaller tools fit into the same size range as the type 1 tools, in much the same way as the medium wadi blades fit into the size range of the type 1 blades. So it is fair to say these tools have been produced on medium wadi blades that are of a similar size to the type 1 blades (graph 15 and 7). The larger tools in medium wadi are of more comparable dimensions to the medium wadi flakes (see graph 8). However, some of the larger medium wadi tools are core tools, and not made from debitage at all. The others are made from large flake blanks and could possibly be cores and not tools. However, the general size and shape of the large tools separate them from the smaller tools and they are clearly not from the medium wadi blade industry.

Ghwair: spall

Burin spalls can provide insight into the purpose of the burins. Though burins are classed as a formal tool, occasionally they are made, not for use as tools, but as cores for the production of spalls.

Most burins and spalls can be found in type 1 raw material (table 66). It is clear they are then going on to further retouch both some of the burins and most of the spalls. Some of the spalls have the label 'with retouch', this refers to evidence of previous retouch on the original piece that the burination has cut (appendix 5). This occurs when the knapper deems it necessary to rejuvenate the tool edge, usually in order to re-sharpen it, but occasionally to turn it into a burin tool. These types of spall make up 20% of the burin and spall category, evidence for a significant amount of tool maintenance.
Medium wadi comes next with the second largest number of burins and spalls. It is proportionally similar to type 1 but there are fewer numbers of spalls 'with retouch' and so there is less tool maintenance in this category. I have a very small number of spalls in type 16, fine and rough wadi, but no burins and so not much can be said about these three raw materials.

A few burins are possibly being treated as tools in their own right, but others are being retouched further. And most of the spalls are being treated as tools. This fits into the general trend at Ghwair of retouching almost everything, particularly in type 1 and medium wadi raw materials. In general there are more spalls than burins, and though you can get more than one spall off a burin, there are burins missing in the assemblage. At face value it would seem that the main purpose of burination is to create spalls, however, it depends on what has happened to the type 16, fine and rough wadi burins. They may have been removed from the assemblage because they are useful tools or they may have been completely reshaped into something else and therefore are unimportant as tools, it is difficult to assess. The mixture of spall types (resulting from tool maintenance and specific burin spall production) suggests that the burins were produced for a range of different reasons, where both the spall and burin are the aim of the production.

Ghwair: summary and conclusion

There are three blade reduction strategies present in the 1993 excavation area at Ghwair. The first is a 'classic' naviform blade industry, which is produced in the exotic type 16 raw material. The earlier stages of this reduction sequence are not present in the assemblage (for example the longest secondary crested blades), and possibly did not occur on the site at all (the preforms were possibly produced close to the raw material source). Otherwise the reduction sequence is generally present, the crested and rejuvenation elements indicating ongoing core reduction and maintenance.

Platforms are not well prepared unless they are the smaller punctiform and filiform platforms. These platforms are intensively prepared, particularly using grinding in order to isolate and consolidate them, increasing the chances of an accurate blade removal. Hammer technique is unclear; the bulb and platform features indicate the possibility of both harder and softer hammer use or the use of complicated techniques not necessarily relating to hammer type. The type 16 blade industry is a relatively unimportant strategy in terms of debitage quantity, but require more time and effort in preparing the core platforms than, for example, the flake industry.

The second blade production strategy is a 'variant' naviform blade industry. This is less formal than the type 16 naviforms, and cresting down the back of the core is only used when absolutely necessary. The reduction sequence is similar to the type 16 naviforms. The earlier stages are not present in the assemblage, though these cores will produce fewer initial crested blades from the back of the core. The preforms could also be prepared off the site because the raw material source is not in the immediate locality of Ghwair. The rest of the reduction sequence is generally present, as indicated by the secondary blades, crested and rejuvenated elements. Platforms are prepared in a similar way to the type 16 blades, with the majority occurring on the smaller platforms. Again, like the type 16 blade industry, hammer technique is unclear as there are indications of the use of both harder and softer hammer. This is the most important blade production strategy in terms of quantity, effort put into platform preparation and tool use. However, the variant nature of the type 1 naviform cores shows that the knappers at Ghwair were trying to cut down on the time spent preparing the cores, cutting corners where the raw material allowed it.

There is the possibility of a third blade production strategy in medium wadi. None of the cores are present in this assemblage but the blade debitage suggests that it was only an opposed platform strategy when it was expedient (This chapter, 9-10). The reduction sequence is incomplete, aside from the cores, the early stages of reduction are missing. The presence of some crested and rejuvenation elements suggest that either the latter stages of reduction occurred in this area of Ghwair and the cores were then removed, or these elements were introduced to the assemblage along with the blades and tools. The reduction of these medium wadi blade cores probably occurred elsewhere on the site or in the immediate locality of

Ghwair because the source of this raw material is in the wadi bed immediately below the site (unlike the sources of type 1 and 16 which are exotic raw materials). Less time is spent preparing the medium wadi blades than those in type 1 and 16, but there is a wider use of different preparation methods. This indicates that the intensive preparation seen in the type 1 and 16 blade industry is not absolutely necessary to simply remove a blade, but only increases the likelihood of removing a regularly shaped blade. The hammer technique indicators on the platforms and bulbs of medium wadi blades do not give a clear indication of hammer type, possibly suggesting that technique is similar to that applied to the type 1 and 16 blade industries (a combination of both harder and softer hammer). The medium wadi blades are the second most important blade production strategy (after type 1) in terms of debitage quantity, but less time is spent on preparing platforms than in type 1 and 16 blade industries. However, it is important to consider the fact that this reduction sequence has probably been introduced to this assemblage incomplete and so it may have a greater importance elsewhere on the site. Though there are many different types of flake cores in this assemblage, they can be separated into two different strategies, blade cores reused as flake cores and dedicated flake cores.

The type 16 flake cores are exhausted naviform blade cores (This chapter, 1-2). The reduction sequence is fully present in this assemblage. Relatively high levels of preparation have been used on these cores though grinding is not as common as it is in the blade industries. The high level of preparation is probably used because the cores are so irregular in form; it is necessary to put some effort into preparing the platform in order to reduce unpredictability in the flake removal. The hammer technique indicators on the type 16 flake bulbs and platforms possibly suggest the use of harder hammer. Certainly, the technique used to produce these flakes is less complicated than that used to produce blades. Technique is relatively homogeneous throughout the flake industry in all raw materials. The quantity of debitage from the type 16 flake industry indicates that it is the least important flake production strategy.

The type 1 flake cores are also exhausted naviform cores (This chapter, 1-2), and again the reduction sequence is complete in this assemblage. Platform preparation and hammer technique is much like that used to produce type 16 flakes. The quantity of the debitage from the type 1 flake cores indicate that this is the second most important flake production strategy after medium wadi. This differs to the blade industry where type 1 naviforms are the most important blade production strategy.

Fine wadi is used to produce only dedicated flake cores. The reduction sequence is generally present, though it is difficult to link any crested or rejuvenation elements to this industry because the cores are so irregular in form. Though the basic form of this strategy differs to type 1 and 16 flake cores (dedicated flake cores as opposed to reused blade cores), platform preparation and hammer technique are generally similar to the rest of the flake assemblage; high levels of preparation, though not grinding, and indications of harder hammer use. Fine wadi flake cores are not an important flake production strategy, because the quantity of flake debitage in this raw material is low.

Medium wadi is also used to produce dedicated flake cores that are clearly distinct from the blade core industry. The reduction sequence is generally present, including the cores (unlike the medium wadi blade cores). Platform preparation and hammer technique are similar to the rest of the flake core industry, and the technique is simpler than in the blade core industry.

The quantity of flake debitage in medium wadi indicates that it is the most important strategy used for the production of flakes.

Rough wadi has been used to produce only dedicated flake cores. The reduction sequence is complete in this assemblage. Platform preparation and hammer technique is similar to the flakes in all the other raw materials. Flake debitage quantity indicates that this is the least important flake production strategy after the strategy in type 16 raw material.

The overriding issue throughout the assemblage from the 1993 excavation at Ghwair is the relationship between raw material and reduction strategy. The knappers at Ghwair are retouching almost the entire assemblage, indicating at least an intention to use most of the debitage rather than discarding it as waste (it is difficult to distinguish unretouched debitage that has been used unless it shows signs of edge ware or organic residue). Type 1 and 16 are the most extensively conserved raw materials and are also the most important for tool use. The production of the type 1 and 16 preforms off the site and the reduction of medium wadi blade cores elsewhere on the site suggests a certain degree of specialisation at the debitage production stage. However, the high level of nonformal tools across the raw materials suggests that specialisation is not as prevalent at the final stages of the operational chain.

The next chapter (Chapter 6) will cover the analysis of the lithic assemblage from Wadi Fidan A. I shall also return to the results discussed in this chapter in Chapter 9, where I make a comparative analysis of all four assemblages.

List of tables: Chapter 5 (Ghwair)

Table 1

Ghwair core type total 67	type 16	type 1	burnt type1/16	fine wadi	med wadi	rough wadi
flk core		1.5%				
single plat flk core		1.5%			3.0%	
double plat flk core						1.5%
irregular flk core		1.5%				
change of the orient flk core	4.5%	12.0%		9.0%	32.9%	
multiple orient flk core					1.5%	
naviform	4.5%	19.4%				
brkn naviform			1.5%			
opp plat bldlet core (exhausted navi)		1.5%				
double plat bldlet core		1.5%				

Table 2

Ghwair core plat prep (total cores 67)	grin	bashing	plat edge flk	grin/bashing	grin/plat edge flk	bashing/plat edge flk	grin/bashing/plat edge flk
flk core			1.5%				
single plat flk core			1.5%	1.5%			
double plat flk core			1.5%				
irregular flk core			1.5%				
change of orient flk core		1.5%	20.9%		3.0%	23.9%	7.5%
multiple orient flk core							1.5%
total % of flk cores		**1.5%**	**26.9%**	**1.5%**	**3.0%**	**23.9%**	**9.0%**
navi		3.0%	14.9%		1.5%	7.5%	
brkn navi			1.5%				
opp plat (exhausted navi)			1.5%				
double plat bldlet core							
total % of bld cores		**3.0%**	**17.9%**		**1.5%**	**7.5%**	

Table 3

Ghwair blds total 751 pieces					
bld type	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
sec bld	0.3%	0.9%		0.5%	
sec bld rtch	2.1%	11.1%	0.9%	4.5%	
bld	0.3%	2.4%	0.1%	1.1%	
bld rtch	3.9%	15.3%	1.1%	8.8%	1.1%
sec bld/bldlet	0.3%	2.7%	0.1%		
sec bld/bldlet rtch	0.4%	3.7%			
bld/bldlet	1.3%	3.7%		1.3%	0.1%
bld/bldlet rtch	1.5%	18.9%	0.3%	1.7%	
sec bldlet	0.3%	0.8%		0.1%	
sec bldlet rtch	0.1%	0.9%	0.1%	0.3%	
bldlet	0.5%	0.8%		0.3%	
bldlet rtch	0.4%	3.7%		0.8%	
prim bld		0.5%			
prim bld rtch		0.1%			
prim bld/bldlet rtch		0.1%			
Total %	**11.4%**	**65.6%**	**2.6%**	**19.4%**	**1.2%**

Table 4 (Please note that the % of each platform type is a % of the total no. of blades in that raw material, not from the total assemblage.)

Ghwair blades total 751 (with plat. 627)					
plat type	**type 1**	**type 16**	**fine wadi**	**med wadi**	**rough wadi**
no plat	21.4%	19.3%	15.0%	11.1%	11.1%
plain/cort.	2.1%	3.6%		2.6%	
plain	15.4%	24.0%	55.0%	47.0%	66.7%
punc/cort.	1.2%		5.0%		
punc	26.5%	20.5%	5.0%	12.4%	
fil/cort.	0.2%				
fil	20.1%	18.1%		5.9%	
dih/cort	0.4%				
dih	0.6%	1.2%		3.9%	
faceted/cort.	0.2%				
faceted	4.3%	7.2%	10.0%	5.9%	
winged	1.4%	1.2%	10.0%	6.5%	11.1%
crushed/cort.	0.2%				
crushed	5.7%	4.8%		4.6%	11.1%
total % of total bld assemblage	**64.8%**	**11.0%**	**2.7%**	**20.3%**	**1.2%**

Table 5 (Please note that the percentages are worked out from the total number of platforms and not from the total number of blades in this raw material.)

Ghwair bld type 16 (total with plat 67)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	total prep %
plain/cort total 3								0.0%
plain total 20	3 (15%)		4 (20%)		2 (10%)			45.0%
punc total 17	9 (52.9%)		1 (5.9%)	2 (11.8%)	4 (23.5%)		1 (5.9%)	100.0%
fil total 15	9 (60%)	1 (6.7%)		1 (6.7%)	2 (13.3%)		1 (6.7%)	93.4%
faceted total 6	1 (16.7%)		1 (16.7%)			1 (16.7%)		50.1%
dih total 1			1 (100%)					100.0%
winged total 1								0.0%
crushed total 4		1 (25%)	1 (25%)			1 (25%)		75.0%

Table 6 (Please note that the percentages are worked out from the total number of platforms and not from the total number of blades in this raw material.)

Ghwair bld type 1 (total with plat 382)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	total prep %
plain/cort. total 10	2 (20%)		2 (20%)		1 (10%)			50.0%
plain total 75	23 (30.7%)	1 (1.3%)		2 (2.7%)	4 (5.3%)	4 (5.3%)	4 (5.3%)	50.6%
punc/cort. total 6	2 (33.3%)		1 (16.7%)			1 (16.7%)		66.7%
punc total 129	61 (47.3%)	3 (2.3%)	19 (14.7%)	3 (2.3%)	23 (17.8%)	3 (2.3%)	3 (2.3%)	89.0%
fil/cort. total 1	1 (100%)							100.0%
fil total 97	42 (43.3%)	1 (1%)	9 (9.3%)	8 (8.2%)	25 (25.8%)	2 (2.1%)	4 (4.1%)	93.8%
faceted/cot. total 1			1 (100%)					100.0%
faceted total 21	3 (14.3%)		10 (47.6%)		2 (9.5%)			71.4%
dih/cort. total 2	2 (100%)							100.0%
dih total 3		1 (33.3%)			1 (33.3%)			66.6%
winged/cort. total 1								0.0%
winged total 7	2 (28.6%)		1 (14.3%)			1 (14.3%)		57.2%
crushed/cort total 1		1 (100%)						100.0%
crushed total 28		5 (17.9%)	5 (17.9%)			3 (10.7%)	3 (3.6%)	50.1%

Table 7 (Please note that the percentages are worked out from the total number of platforms and not from the total number of blades in this raw material.)

Ghwair bld fine wadi (total with plat 18)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	total prep %
plain total 11	1 (9.1%)	1 (9.1%)	2 (18.2%)					36.4%
punc/cort total 1								0.0%
punc total 1					1 (100%)			100.0 %
fil total 1	1 (100%)							100.0 %
faceted total 2			1 (100%)					100.0 %
winged total 2								0.0%

Table 8 (Please note that the percentages are worked out from the total number of platforms and not from the total number of blades in this raw material.)

Ghwair bld med wadi (total with plat 153)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	total prep %
plain/cort total 4	1 (25%)							25.0%
plain total 71	6 (8.5%)	10 (14.1%)	7 (9.9%)	1 (1.4%)	1 (1.4%)	6 (8.5%)		43.8%
punc total 19	7 (36.8%)	2 (22.2%)	4 (21.1%)		3 (15.8%)			95.9%
fil total 9	5 (55.6)	1 (11.1%)						66.6%
faceted total 9			3 (33.3%)		2 (22.2%)	1 (11.1%)		66.6%
dih total 6						1 (16.7%)		16.7%
winged total 10								0.0%
crushed total 7		2 (28.6%)						28.6%

Table 9 (please note that the percentages are worked out from the total number of platforms and not from the total number of blades in this raw material.)

Ghwair bld rough wadi (total with plat 8)	grin	bashing	plat edge flk	grin/ bash	grin/plat edge flk	bash/ plat edge flk	grin/ bash/ plat edge flk	total %
plain total 6			2 (33.3%)					33.3%
winged total 1								0.0%
crushed total 1		1 (100%)						100.0%

Table 10

Ghwair blds type 16 (total blds 85)			
platform		**lip**	**ringcrack**
plain	prom		
	diff		1.2%
	conical	1.2%	
	no bulb		
punc	prom		
	diff		
	no bulb		
fil	prom	1.2%	
	diff		
	no bulb		
crushed	diff		

Table 11

Ghwair blds type 1 (total blds 486)			
platform		**lip**	**ringcrack**
plain	prom		0.4%
	diff		0.2%
	conical		
	no bulb		0.2%
punc	prom	1.6%	0.2%
	diff		
	no bulb	0.2%	
fil	prom	0.4%	0.6%
	diff	0.2%	
	no bulb	0.2%	
crushed	diff	0.2%	

Table 12

Ghwair blds med wadi (total blds 153)			
platform	bulb	lip	ringcrack
plain	prom		0.7%
	diff	1.3%	1.3%
	conical		
	no bulb		
punc	prom		
	diff		
	no bulb		
fil	prom		
	diff		
	no bulb		
crushed	diff		

Table 13

Ghwair blds type 16 (total 85)					
platform	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone	siret
plain/cort	prom				
	diff		1.2%		
	no bulb		1.2%		
plain	prom		1.2%		
	diff		3.5%		
	no bulb	2.4%	2.4%		
fil	prom				
	diff				
	no bulb		1.2%		
crushed	prom				
	no bulb	3.5%			

Table 14

Ghwair blds type 1 (total 486)					
platform	**bulb**	**lrg eraillure**	**clear cone**	**lrg eraillure/clear cone**	**siret**
plain/cort	prom				
	diff		0.4%		
	no bulb		0.2%		
plain	prom		1.0%		
	diff	0.2%	2.1%		
	no bulb	2.5%	0.6%	0.2%	
punc/cort	prom	0.2%			
	diff				
	no bulb	0.4%			
punc	prom	0.6%	0.6%		
	diff	0.2%	3.3%		
	no bulb	0.2%	1.6%		
fil	prom	0.2%	0.2%		
	diff	0.6%	0.4%	0.2%	
	no bulb	1.2%	0.4%	0.2%	
winged	prom				
	diff				
	no bulb	0.2%			0.2%
dih/cort	prom	0.2%			
	diff	0.2%			
	no bulb				
dih	prom				
	diff	0.2%			
	no bulb				
faceted	prom			0.2%	
	diff	0.2%			
	no bulb		0.2%	0.2%	
crushed	diff	0.4%			
	no bulb	2.3%	0.2%		0.2%

Table 15

Ghwair blds fine wadi (total 21)					
platform	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone	siret
plain	prom		4.8%		
	diff				
	no bulb	9.5%	9.5%		4.8%
punc/cort	prom				
	diff				
	no bulb	9.5%			
punc	prom				
	diff	4.8%			
	no bulb				
winged	prom				
	diff		4.8%	4.8%	
	no bulb				
faceted	prom				
	diff		4.8%		
	no bulb				

Table 16

Ghwair blds med wadi (total 153)					
platform	**bulb**	**lrg eraillure**	**clear cone**	**lrg eraillure/clear cone**	**siret**
plain/cort	prom				
	diff				
	no bulb		0.7%	0.7%	
plain	prom		2.6%		
	diff	0.7%	13.7%		
	no bulb	3.3%	5.9%		
punc	prom				
	diff		0.7%		
	no bulb	0.7%			
fil	prom				
	diff				
	no bulb	1.3%			
winged	prom		2.0%		
	diff		1.3%		
	no bulb		0.7%		
dih	prom				
	diff		0.7%		
	no bulb		0.7%	0.7%	
faceted	prom	0.7%			
	diff				
	no bulb			0.7%	
crushed	prom				
	no bulb	1.3%			

Table 17

Ghwair blds rough wadi (total 9)					
platform	**bulb**	**lrg eraillure**	**clear cone**	**lrg eraillure/clear cone**	**siret**
plain	prom				
	diff		11.1%		
	no bulb				
winged	prom		11.1%		
	diff				
	no bulb				

Table 18

Ghwair bld total 751					
platform	bulb	lip/lrg eraillure	lip/clear cone	ring crack/lrg eraillure	ring crack/clear cone
type 1 total with and without plat 485					
plain	diff				0.2%
	no plat			0.2%	
punc	prom			0.2%	
	no plat	0.2%			
fil	prom				0.2%
	no plat				0.2%

Table 19

Ghwair flks total 674					
flk type	type 16	type 1	fine wadi	med wadi	rough wadi
sec flk	0.6%	3.1%	0.3%	2.8%	0.4%
sec flk rtch	2.5%	17.2%	3.1%	18.7%	1.5%
flk	0.6%	1.6%	0.6%	8.5%	0.6%
flk rtch	2.7%	13.0%	3.3%	16.2%	2.7%
prim flk		0.1%		0.1%	
prim flk rtch		0.9%		0.4%	
total% no rtch	**1.2%**	**4.8%**	**0.9%**	**11.4%**	**1%**
total% rtch	**5.2%**	**31.1%**	**6.4%**	**35.3%**	**4.2%**
total%	**6.4%**	**35.9%**	**7.3%**	**46.7%**	**5.2%**

Table 20

Ghwair flk total 674					
	type 16	type 1	fine wadi	med wadi	rough wadi
no plat			0.1%	0.1%	
plain/cort		2.1%	0.6%	1.5%	0.3%
plain	3.1%	14.8%	3.4%	27.7%	3.4%
punc/cort		0.1%	0.1%	0.1%	
punc	0.6%	2.5%	0.4%	2.2%	0.1%
fil/cort		0.1%			
fil		2.1%	0.3%	0.6%	0.1%
dih/cort		0.1%	0.1%		
dih	0.7%	2.4%	0.4%	2.7%	0.3%
faceted/cort		0.6%		0.1%	
faceted	0.6%	3.1%	0.4%	4.0%	0.3%
winged/cort		0.1%		0.1%	
winged	0.1%	2.2%		1.5%	0.1%
crushed/cort		0.3%			
crushed	0.9%	5.2%	1.2%	4.2%	0.6%
siret				0.1%	
conical				0.3%	

Table 21 (Please note that the percentages are worked out from the total number of platforms and not from the total number of flakes in this raw material.)

Ghwair flk type 16 (total with plat 49)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total prep %**
plain/cort **total 4**								**0.0%**
plain total 17	1 (5.9%)	2 (11.8%)	6 (35.3%)			4 (23.5%)	1 (5.9%)	**82.4%**
punc **total 4**			1 (25%)			1 (25%)		**50.0%**
faceted total 4			3 (75%)					**75.0%**
dih total 5		1 (20%)	2 (40%)			1 (20%)		**80.0%**
winged total 1		1 (100%)						**100.0%**
crushed total 6		1 (16.7%)				1 (16.7%)		**33.4%**

Table 22 (Please note that the percentages are worked out from the total number of platforms and not from the total number of flakes in this raw material.)

Ghwair flk type 1 (total with plat 241)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash /plat edge flk	**total prep %**
plain/cort total 14	4 (28.6%)	1 (7.1%)	4 (28.6%)					**64.3%**
plain total 100	1 (1%)	10 (10%)	37 (37%)		2 (2%)	18 (18%)	1 (1%)	**69.0%**
punc/cort total 1								**0.0%**
punc total 17	2 (11.8%)	2 (11.8%)	6 (35.3%)	1 (5.9%)	1 (5.9%)	2 (11.8%)		**82.5%**
fil/cort total 1								**0.0%**
fil total 14			4 (28.6%)			3 (21.4%)	1 (7.1%)	**57.1%**
faceted/ cort total 4		1 (25%)	1 (25%)					**50.0%**
faceted total 21	1 (4.8%)	3 (14.3%)	11 (52.4%)			2 (9.5%)		**81.0%**
dih/cort total 1			1 (100%)					**100.0%**
dih total 16		2 (12.5%)	4 (25%)			4 (25%)		**62.5%**
winged/ cort total 1								**0.0%**
winged total 15		4 (26.5%)	6 (40%)					**66.7%**
crushed/ cort total 2		1 (50%)	1 (50%)					**100.0%**
crushed total 34		12 (35.1%)	7 (20.6%)			7 (20.6%)		**76.3%**

Table 23 (Please note that the percentages are worked out from the total number of platforms and <u>not</u> from the total number of flakes in this raw material.)

Ghwair flk fine wadi (total with plat 49)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total %**
plain/cort total 4		1 (25%)	2 (50%)		1 (25%)			**100.0%**
plain total 24		4 (16.7%)	8 (33.3%)		1 (4.2%)	3 (12.5%)		**66.7%**
punc/cort total 1				1 (100%)				**100.0%**
punc total 3	2 (66.7%)		1 (33.3%)					**100.0%**
fil total 2		1 (50%)						**50.0%**
faceted total 3		1 (33.3%)	1 (33.3%)					**66.7%**
dih/cort total 1			1 (100%)					**100.0%**
dih total 3	1 (33.3%)					1 (33.3%)		**66.6%**
crushed total 8		1 (12.5%)					1 (12.5%)	**25.0%**

Table 24 (Please note that the percentages are worked out from the total number of platforms and <u>not</u> from the total number of flakes in this raw material.)

Ghwair flk med wadi (total with plat 304)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total prep %**
plain/cort		1 (10%)	1 (10%)	1 (10%)	1 (10%)			**40.0%**
plain total	4 (2.1%)	21 (11.2%)	45 (24.1%)	1 (0.5%)	2 (1.1%)	22 (11.6%)	1 (0.5%)	**51.1%**
punc/cort		1 (100%)						**100.0%**
punc total		5 (33.3%)		1 (6.7%)		1 (6.7%)		**46.7%**
fil total 4		1 (25%)	1 (25%)			1 (25%)		**75.0%**
faceted/cort								**0.0%**
faceted	1 (3.7%)	7 (25.9%)	8 (29.6%)		1 (3.7%)	5 (18.5%)	1 (3.7%)	**85.1%**
dih total 18		3 (16.7%)	4 (22.2%)			1 (5.6%)		**44.5%**
winged/cort								**0.0%**
winged		3 (30%)	4 (40%)			2 (20%)		**90.0%**
crushed	1 (3.3%)	15 (50%)	2 (6.6%)	1 (3.3%)		4 (13.3%)		**76.6%**
siret total 1			1 (100%)					**100.0%**

Table 25 (Please note that the percentages are worked out from the total number of platforms and not from the total number of flakes in this raw material.)

Ghwair flk rough wadi (total with plat 36)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total prep %**
plain/cort total 2								**0.0%**
plain total 23		5 (21.7%)	4 (17.4%)		2 (8.7%)			**47.8%**
punc total 1								**0.0%**
fil total 1								**0.0%**
faceted total 2			1 (50%)	1 (50%)				**100.0%**
dih total 2								**0.0%**
winged total 1								**0.0%**
crushed 4		1 (25%)						**25.0%**

Table 26

Ghwair flks type 16 (total 42)			
plat	**bulb**	**lip**	**ringcrack**
plain	prom		
	diff		4.8%
dih	prom		
	diff	2.4%	

Table 27

Ghwair flks type 1 (total 241)			
plat	**bulb**	**lip**	**ringcrack**
plain	prom	0.4%	4.1%
	diff	0.4%	2.1%
fil	prom	0.4%	
	diff		
dih	prom		0.4%
	diff		
faceted	prom		
	diff	0.4%	
punc	prom		
	diff		0.4%

Table 28

Ghwair flks fine wadi (total 49)			
plat	**bulb**	**lip**	**ring crack**
plain	prom		2.1%
	diff		2.1%

Table 29

Ghwair flks med wadi total 306			
plat	bulb	lip	ringcrack
plain	prom		2.9%
	diff	0.3%	2.9%
fil	prom		
	diff		
dih	prom		
	diff		
faceted	prom		
	diff		0.3%
punc	prom		
	diff		

Table 30

Ghwair flk type 16 total 42							
plat	bulb	clear cone	lrg eraillure	clear cone/lrg eraillure	conical	siret
plain/ cort	prom					
	diff	2.4%				
	no bulb					
plain	prom	9.5%				
	diff	9.5%				
	no bulb			2.4%		
punc/ cort	prom					
	diff					
	no bulb					
punc	prom					
	diff	2.4%				
	no bulb					
fil	prom					
	diff					
	no bulb					
winged/ cort	prom					
	diff					
	no bulb					
winged	prom	2.4%				
	diff					
	no bulb					
dih	prom	2.4%				
	diff					
	no bulb					
faceted/ cort	prom					
	diff					
	no bulb					
faceted	prom					
	diff					
	no bulb			2.4%		
crushed	prom					
	diff		2.4%			
	no bulb					

Table 31

Ghwair flk type 1 total 241						
plat	bulb	clear cone	lrg eraillure	clear cone/lrg eraillure	conical	siret
plain/ cort	prom	0.4%	0.4%			
	diff	0.8%				
	no bulb					
plain	prom	7.5%	1.7%	0.4%		
	diff	8.3%	0.4%	1.7%		
	no bulb					
punc/ cort	prom				0.4%	0.4%
	diff					
	no bulb					
punc	prom	1.7%	0.4%		0.4%	0.4%
	diff	1.7%	0.4%			
	no bulb					
fil	prom	0.4%				
	diff	0.4%				
	no bulb					
winged/ cort	prom					
	diff					
	no bulb					
winged	prom	2.5%				
	diff	0.4%				
	no bulb					
dih	prom	0.4%	0.4%	0.4%		
	diff		0.8%			
	no bulb					
faceted/ cort	prom					
	diff	0.4%				
	no bulb					
faceted	prom	0.4%				
	diff	1.7%				
	no bulb					
crushed	prom					
	diff		0.4%			
	no bulb					

Table 32

Ghwair flk fine wadi total 49						
plat	bulb	clear cone	lrg eraillure	clear cone/lrg eraillure	conical	siret
plain/cort	prom					
	diff	2.0%				
	no bulb					
plain	prom	10.2%	2.0%			
	diff	8.2%	4.1%			
	no bulb					
punc/cort	prom	4.1%				
	diff					
	no bulb					
punc	prom					
	diff					
	no bulb					
fil	prom					
	diff	2.0%				
	no bulb					
winged/cort	prom					
	diff					
	no bulb					
winged	prom					
	diff					
	no bulb					
dih	prom					
	diff					
	no bulb					
faceted/cort	prom					
	diff					
	no bulb					
faceted	prom					
	diff	2.0%	2.0%			
	no bulb					
crushed	prom					
	diff		4.9%			
	no bulb		4.0%			

Table 33

Ghwair flk med wadi total 306						
plat	bulb	clear cone	lrg eraillure	clear cone/lrg eraillure	conical	siret
plain/cort	prom	0.3%				
	diff		0.3%			
	no bulb					
plain	prom	6.9%	0.7%	0.7%		0.3%
	diff	18.0%	2.3%	1.3%	0.3%	0.3%
	no bulb		1.3%			
punc/cort	prom					
	diff	0.3%				
	no bulb					
punc	prom					
	diff	1.6%	0.3%	0.3%		
	no bulb					
fil	prom					
	diff	0.3%				
	no bulb					
winged/cort	prom					
	diff	0.3%				
	no bulb					
winged	prom	0.3%				
	diff	0.7%	0.3%			
	no bulb					
dih	prom					
	diff	1.0%				
	no bulb		0.3%			
faceted/cort	prom					
	diff					
	no bulb					
faceted	prom	0.7%				
	diff	0.7%	0.3%	0.7%		
	no bulb		0.3%	0.3%		
crushed	prom					
	diff	0.3%				
	no bulb		1.0%			

Table 34

Ghwair flk rough wadi total 36						
plat	**bulb**	**clear cone**	**lrg eraillure**	**clear cone/lrg eraillure**	**conical**	**siret**
plain/cort	prom					
	diff					
	no bulb					
plain	prom	2.8%				
	diff	5.6%				
	no bulb		2.8%			
punc/cort	prom					
	diff					
	no bulb					
punc	prom					
	diff					
	no bulb					
fil	prom					
	diff					
	no bulb					
winged/ cort	prom					
	diff					
	no bulb					
winged	prom					
	diff					
	no bulb					
dih	prom					
	diff	2.8%				
	no bulb					
faceted/ cort	prom					
	diff					
	no bulb					
faceted	prom					
	diff	2.8%				
	no bulb					
crushed	prom					
	diff					
	no bulb					

Table 35

Ghwair flks total 674					
platform	bulb	lip/clear cone	ring crack/clear cone	ring crack/ clearcone/ lrg eraillure	ring crack/conical
type 16 total 42					
plain	diff		2.4%		
type 1 total 241					
plain	prom		2.9%		
	diff		1.2%		
punc	diff		0.4%		
fine wadi total 48					
plain	prom		2.1%		
	diff		2.1%		
med wadi total 306					
plain	prom		1.6%	0.3%	
	diff	0.3%	1.6%	0.7%	0.3%
faceted	diff		0.3%		

Table 36

Ghwair total indeterm 3081	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
prim indeterm	0.0%	0.2%	0.2%	0.1%	0.0%
prim indeterm rtch	0.0%	0.6%	0.2%	0.1%	0.0%
sec indeterm	0.8%	1.1%	1.3%	1.9%	0.5%
sec indeterm rtch	2.4%	15.4%	1.7%	6.0%	0.6%
indeterm	0.9%	3.9%	0.8%	3.8%	1.1%
indeterm rtch	4.2%	34.9%	1.9%	13.1%	1.3%

Table 37

Ghwair indeterm total with plat 1135 (with plat=36.8% of total interm assemblage)					
plat type	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
plain/cort	0.4%	2.3%	0.2%	0.7%	
plain	1.1%	7.6%	1.7%	11.9%	1.0%
punc/cort		0.4%	0.2%		
punc	3.9%	23.2%	1.6%	4.7%	0.2%
fil/cort		0.4%			
fil	1.9%	17.9%	0.3%	2.3%	0.1%
winged	0.2%	0.7%			0.4%
dih	0.2%	1.0%	0.2%	0.4%	0.1%
faceted/cort		0.1%		0.1%	
faceted	0.2%	3.6%	0.1%	1.5%	0.1%
crushed/cort		0.1%			
crushed	0.6%	4.1%	0.6%	1.9%	0.3%
Total %	**8.5%**	**61.4%**	**4.9%**	**23.5%**	**2.2%**

Table 38

Ghwair	**blades**	**flakes**
type 16	83.0%	6.1%
type 1	64.5%	35.9%
fine wadi	2.8%	7.3%
medium wadi	20.3%	45.4%
rough wadi	1.2%	5.3%
total	**752**	**674**

Table 39 (Please note that the percentages are worked out from the total number of platforms and <u>not</u> from the total number of indeterminates in this raw material.)

Ghwair indeterm type 16 (total with plat 94)	grin	bashing	plat edge flk	grin/ bash	grin/plat edge flk	bash/ plat edge flk	grin/bash /plat edge flk	**total %**
plain/cort total 5	1 (20%)			1 (20%)				**40%**
plain total 12	1 (8.3%)	2 (16.7%)	4 (33.3%)		1 (8.3%)	2 (16.7%)	2 (16.7%)	**100%**
punc total 44	14 (31.8%)	4 (9.1%)	2 (16.7%)	7 (15.9%)	12 (27.3%)		2 (16.7%)	**93.10 %**
fil total 21	4 (19%)	5 (23.8%)	1 (4.8%)	1 (4.8%)	7 (33.3%)		1 (4.8%)	**90.50 %**
winged total 2			1 (50%)					**50%**
faceted total 2					1 (50%)			**50%**
dih total 2								**0%**
crushed total 6		1 (16.7%)	1 (16.7%)			2 (33.3%)		**66.70 %**

Table 40 (Please note that the percentages are worked out from the total number of platforms and not from the total number of indeterminates in this raw material.)

Ghwair indeterm type 1 (total with plat 699)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total %**
plain/cort total 26	11 (42.3%)			7 (26.9%)	1 (3.8%)			**73.0%**
plain total 86	8 (9.3%)	6 (7%)	19 (22%)	1 (1.2%)	12 (14%)	12 (14%)	8 (9.3%)	**76.8%**
punc/cort total 5	4 (80%)				1 (20%)			**100.0%**
punc total 263	46 (17.5%)	10 (3.8%)	29 (11%)	16 (6.1%)	120 (45.6%)	3 (1.1%)	26 (9.9%)	**95.0%**
fil/cort total 4	2 (50%)				1 (25%)			**75.0%**
fil total 203	22 (10.8%)	7 (3.4%)	3 (1.5%)	24 (11.8%)	90 (44.3%)	10 (4.9%)	40 (19.7%)	**94.4%**
winged total 8		5 (62.2%)	2 (25%)					**87.2%**
faceted/cort. total 1			1 (100%)					**100.0%**
faceted total 41	1 (2.4%)	1 (2.4%)	14 (34.1%)	1 (2.4%)	7 (17.1%)	7 (17.1%)	3 (7.3%)	**82.8%**
dih total 11	2 (18.2%)		3 (27.3%)	2 (18.2%)	1 (9.1%)			**72.8%**
crushed/ cort. total 1	1 (100%)							**100.0%**
crushed total 47		22 (46.8%)	6 (12.8%)	2 (4.3%)	2 (4.3%)	6 (12.8%)		**81.0%**

Table 41 (Please note that the percentages are worked out from the total number of platforms and not from the total number of indeterminates in this raw material.)

Ghwair indeterm fine wadi (total with plat 54)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total %**
plain/cort total 2		1 (50%)			1 (50%)			**100.0%**
plain total 19		4 (21.1%)	2 (10.5%)		1 (5.3%)	4 (21.1%)		**58.0%**
punc/cort total 2								**0.0%**
punc total 18	5 (27.8%)	3 (16.7%)	2 (11.1%)	2 (11.1%)	2 (11.1%)			**77.8%**
fil total 4				2 (50%)	1 (25%)	1 (25%)		**100.0%**
faceted total 1								**0.0%**
dih total 2								**0.0%**
crushed total 7		3 (42.9%)				1 (14.3%)		**57.2%**

Table 42 (Please note that the percentages are worked out from the total number of platforms and not from the total number of indeterminates in this raw material.)

Ghwair indeterm med wadi (total with plat 272)	grin	bashing	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total %**
plain/cort total 8	3 (37.5%)	1 (12.5%)						**50.0%**
plain total 135	3 (2.2%)	17 (12.6%)	35 (25.9%)	1 (0.7%)	5 (3.7%)	26 (19.3%)	1 (0.7%)	**65.1%**
punc total 53	12 (22.6%)	7 (13.2%)	4 (7.5%)	4 (7.5%)	10 (18.9%)		2 (3.8%)	**73.5%**
fil total 26	8 (30.8%)	2 (7.7%)	2 (7.7%)	2 (7.7%)	9 (34.6%)	1 (3.8%)	1 (3.8%)	**96.1%**
faceted/cort total 1								**0.0%**
faceted total 17	1 (5.7%)	4 (23.5%)	4 (23.5%)			2 (11.8%)		**64.7%**
dih total 5	1 (20%)	1 (20%)				2 (40%)		**80.0%**
winged total 5		2 (40%)	2 (40%)					**80.0%**
crushed total 7		12 (54.5%)		1 (8.3%)		1 (8.3%)		**71.1%**

Table 43 (Please note that the percentages are worked out from the total number of platforms and <u>not</u> from the total number of indeterminates in this raw material.)

Ghwair inderetm rough wadi (total with plat 19)	grin	bashing	plat edge flk	grin/ bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total %**
plain total 11		1 (9.1%)	5 (45.5%)			1 (9.1%)		**63.7%**
punc total 2	1 (50%)							**50.0%**
fil total 1		1 (100%)						**100.0%**
faceted total 1								**0.0%**
dih total 1								**0.0%**
crushed total 7		2 (66.7%)						**66.7%**

Table 44

Ghwair crested type 16 total 6			
	crested	ridge refreshing	unclear
sec indeterm			
sec indeterm rtch			
indeterm	16.7%		
indeterm rtch			
sec bld/bldlet			
sec bld/bldlet rtch			
bld/bldlet	16.7%		
bld/bldlet rtch			
sec bld			
sec bld rtch			
bld			
bld rtch		33.3%	
sec piece			
sec piece rtch			
piece			
piece rtch			

Table 45

Ghwair crested type 1 total 55			
	crested	ridge refreshing	unclear
sec indeterm	5.5%		
sec indeterm rtch	12.7%	1.8%	
indeterm	10.9%		
indeterm rtch	21.8%	14.5%	5.5%
sec bld/bldlet			
sec bld/bldlet rtch			
bld/bldlet	1.8%	1.8%	
bld/bldlet rtch	1.8%		
sec bld	1.8%		
sec bld rtch	9.1%	7.3%	
bld			
bld rtch	10.9%		1.8%
sec piece			
sec piece rtch	1.8%	3.6%	
piece	1.8%	1.8%	
piece rtch	9.1%	1.8%	

Table 46

Ghwair crested fine wadi total 1		
sec bld rtch	crested	100%

Table 47

Ghwair crested med wadi total 14			
	crested	ridge refreshing	unclear
sec indeterm			
sec indeterm rtch			
indeterm	14.2%		
indeterm rtch	7.1%	7.1%	
sec bld/bldlet			
sec bld/bldlet rtch			
bld/bldlet	7.1%	7.1%	
bld/bldlet rtch	7.1%		
sec bld			
sec bld rtch	7.1%	7.1%	
bld			
bld rtch	21.4%		
sec piece			
sec piece rtch			
piece	7.1%	7.1%	
piece rtch			

Table 48

Ghwair crested rough wadi total 1		
sec indeterm rtch	crested	100%

Table 49

Ghwair no. of blades and crested elements over 80mm long			
raw mat	bld	crested element	**total crest elements (all dim)**
type 16	9	1	**6**
type 1	30	10	**55**
fine wadi	0	0	**1**
med wadi	26	3	**14**
rough wadi	0	0	**1**

Table 50

Ghwair crested elements plat type 'crested' % with plat.					
	type 16	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
plain/cort		7.1%		75.0%	
plain		7.1%		25.0%	
punc		28.6%			
fil/cort		7.1%			
fil		14.3%			
dih/cort					
dih		14.3%			
faceted		14.3%			
crushed/cort		7.1%			
crushed			100.0%		
total no. with plat	0	14	1	4	0

Table 51

Ghwair crested elements plat type 'ridge refreshing' % with plat					
	type 16	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
plain/cort					
plain					
punc	100.0%	25.0%			
fil/cort					
fil					
dih/cort		25.0%			
dih					
faceted		25.0%		50.0%	
crushed/cort					
crushed		25.0%		50.0%	
total no. with plat	2	4	0	2	0

Table 52

Ghwair crested elements plat type 'unclear' % with plat					
	type 16	type 1	fine wadi	med wadi	rough wadi
plain/cort					
plain					
punc		33.3%		100.0%	
fil/cort					
fil		33.3%			
dih/cort					
dih		33.3%			
faceted					
crushed/cort					
crushed					
total no. with plat	0	3	0	1	0

Table 53

Ghwair crested elements crested									
	plat type	grin	bashing	plat edge flk	grin/bashing	grin/plat edge flk	bashing/plat edge flk	grin/bashing/plat edge flk
type 16 total 2	punc							50.0%
type 1 total 21	plain					4.8%		
	punc	9.5%				4.8%		
	fil/cort					4.8%		
	dih			4.8%				
	faceted	4.8%						9.5%
	crushed/cort			4.8%				
med wadi total 14	punc	7.1%						

Table 54

Ghwair crested elements ridge refreshing								
	plat type	grin	bashing	plat edge flk	grin/bashing	grin/plat edge flk	bashing/plat edge flk	grin/bashing/plat edge flk
type 1 total 21	punc					4.8%		
	fil	4.8%						
	dih/cort				4.8%			
	crushed						4.8%	
med wadi total 14	faceted			7.1%				

Table 55

Ghwair crested elements unclear								
	plat type	grin	bashing	plat edge flk	grin/bashing	grin/plat edge flk	bashing/plat edge flk	grin/bashing/plat edge flk
type 1 total 21	punc			4.8%				
	dih			4.8%				

Table 56

Ghwair crested elements crested				
type 1 total 21	**plat**	**bulb**	**lip**	**ringcrack**
	fil	prom		4.8%

Table 57

	Ghwair crested elements crested					
	plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone	siret
type 1 total 21	plain	diff		4.8%		
	faceted	diff	4.8%			
med wadi total 14	plain	prom		7.1%		

Table 58

	Ghwair crested elements ridge refreshing					
	plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone	siret
type 1 total 21	fil	no bulb	4.8%			
	crushed	no bulb	4.8%			

Table 59

Ghwair rejuv Total no. 53	type 1	type 16	fine wadi	med wadi	rough wadi
sec rejuv	1.9%			1.9%	
sec rejuv rtch	22.6%	3.8%		1.9%	
rejuv	7.5%	3.8%	7.5%	1.9%	
rejuv rtch	28.3%	1.9%	1.9%	15.1%	

Table 60

Ghwair rejuv Total no. 53	type 16	type 1	fine wadi	med wadi	rough wadi
plat rejuv	1.9%	7.5%		1.9%	
plat edge rejuv	1.9%	34.0%	3.8%	11.3%	
plat edge/rem surf rejuv		5.7%	1.9%	3.8%	
rem surf rejuv		3.8%	1.9%	1.9%	
ski spall	3.8%	7.5%			
(unclear) core rejuv				1.9%	
tool edge rejuv	1.9%	1.9%			

Table 61

Ghwair overshots		
Overshot type	length mm	width mm
type 1 navi	39.5	13
type 1 navi	49.5	20.1
type 1 navi	68.3	33.1
type 1 navi	81.5	27.6
type 1 flk	7.3	16.9
med wadi bld	59.2	20.2

Table 62

Ghwair formal tools total 121					
tool type	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
sec core tool				1.7%	
core tool				2.5%	
sec indeterm flk/core/tool				2.5%	
indeterm flk/core/tool	0.8%		0.8%	4.1%	0.8%
brkn cobble rtch					0.8%
adze				0.8%	
sec borer		1.7%			
borer				0.8%	
borer/piercer		0.8%			
sec pick				0.8%	
sec burin rtch		3.3%		1.7%	
burin		3.3%		1.7%	
sec piercing tool	0.8%	2.5%			
piercing tool	5.8%	23.1%	0.8%	5.8%	
brkn point	4.1%	6.6%	0.8%	1.7%	
byblos point		0.8%			
sec sickle bld		1.7%			
sickle bld	3.3%	6.6%		0.8%	
sec scraper				0.8%	
total %	**14.9%**	**50.4%**	**5.8%**	**22.3%**	**1.7%**

Table 63

Ghwair non-formal and formal tools total 3988						
	type 16	type 1	fine wadi	med wadi	rough wadi	**total %**
bld	1.6%	10.7%	0.5%	3.2%	0.2%	**16.1%**
flk	0.8%	5.3%	1.1%	6.2%	0.8%	**14.2%**
indeterm	5.1%	39.6%	3.0%	14.9%	1.6%	**64.2%**
crest elements	0.1%	1.2%	0.02%	0.2%	0.02%	**1.5%**
overshot		0.1%		0.02%		**0.2%**
rejuv	0.1%	0.7%	0.02%	0.2%		**1.0%**
spall	0.02%	0.2%		0.1%		**0.3%**
formal tools	0.5%	1.3%	0.1%	0.7%	0.1%	**2.6%**
total %	**8.2%**	**67.2%**	**4.7%**	**25.5%**	**2.7%**	

Table 64

Ghwair assemblage total 4875
Ghwair tool (formal/non-formal) total 3988
total % of tools in ghwair assemblage 81.8%

Table 65

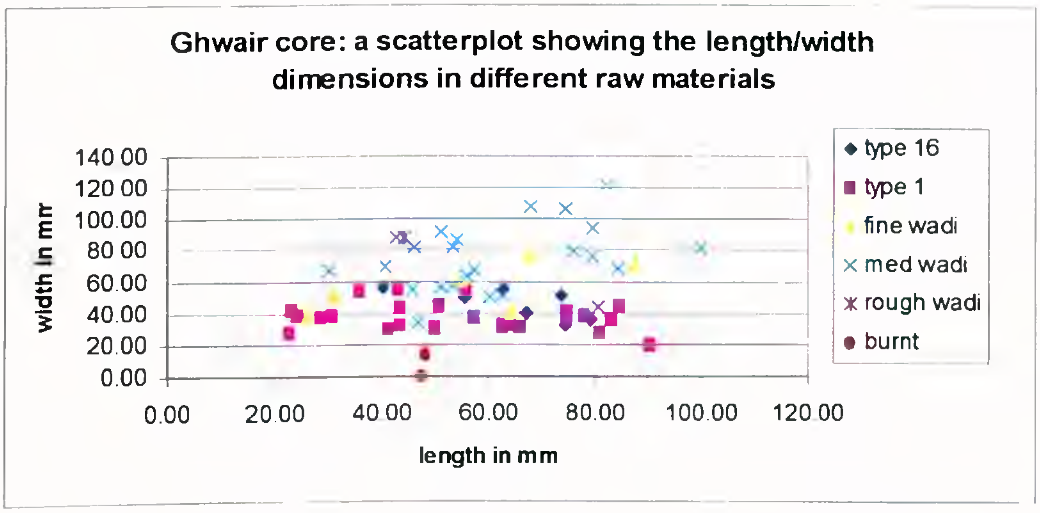
Ghwair assemblage total 4875	type 16	type 1	fine wadi	med wadi	rough wadi
total	418	2656	275	1325	157
total %	**8.6%**	**54.5%**	**5.6%**	**27.2%**	**3.2%**

Table 66

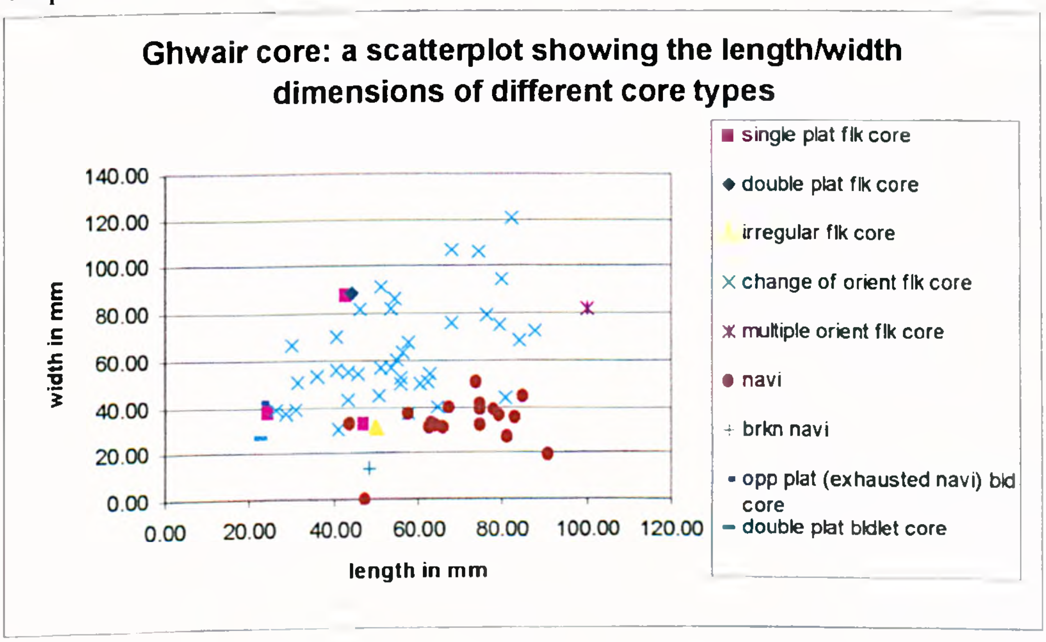
Ghwair burin spalls total 23					
	type 1	**type 16**	**fine wadi**	**med wadi**	**rough wadi**
spall	5.7%	2.9%	2.9%	5.7%	2.9%
sec spall rtch	5.7%			2.9%	
sec spall rtch/with rtch	5.7%				
sec spall with rtch	2.9%				
spall rtch	2.9%				
spall rtch/with rtch	11.4%	2.9%		5.7%	
spall with rtch				8.6%	
total	**57.1%**	**5.7%**	**2.9%**	**34.3%**	**2.9%**

List of graphs: Chapter 5 (Ghwair)

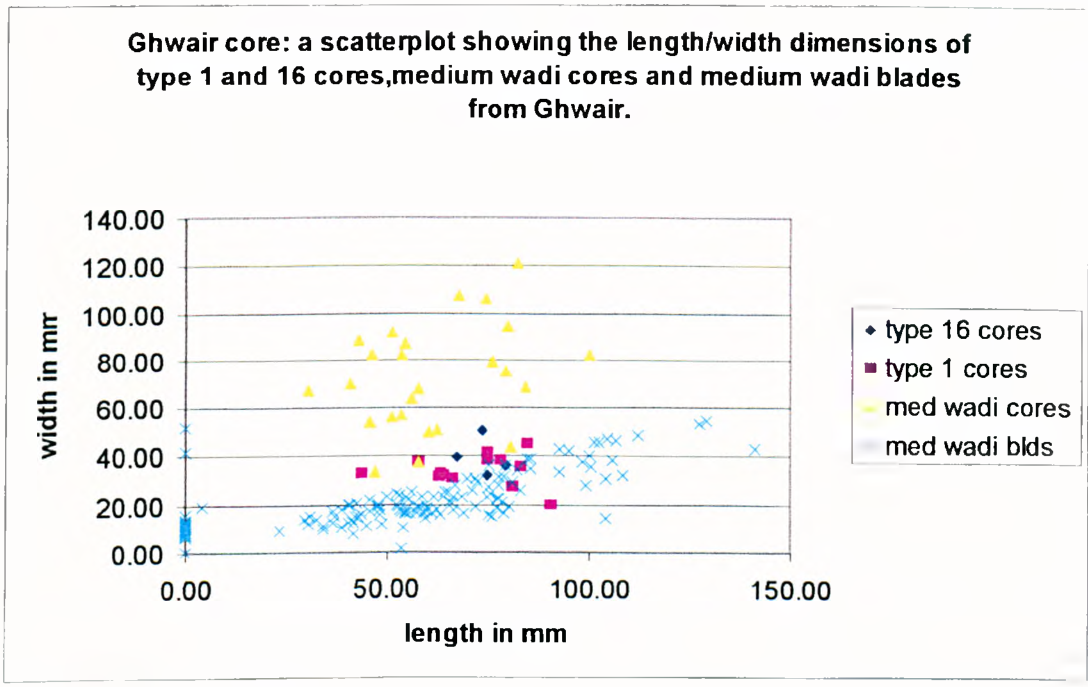
Graph 1



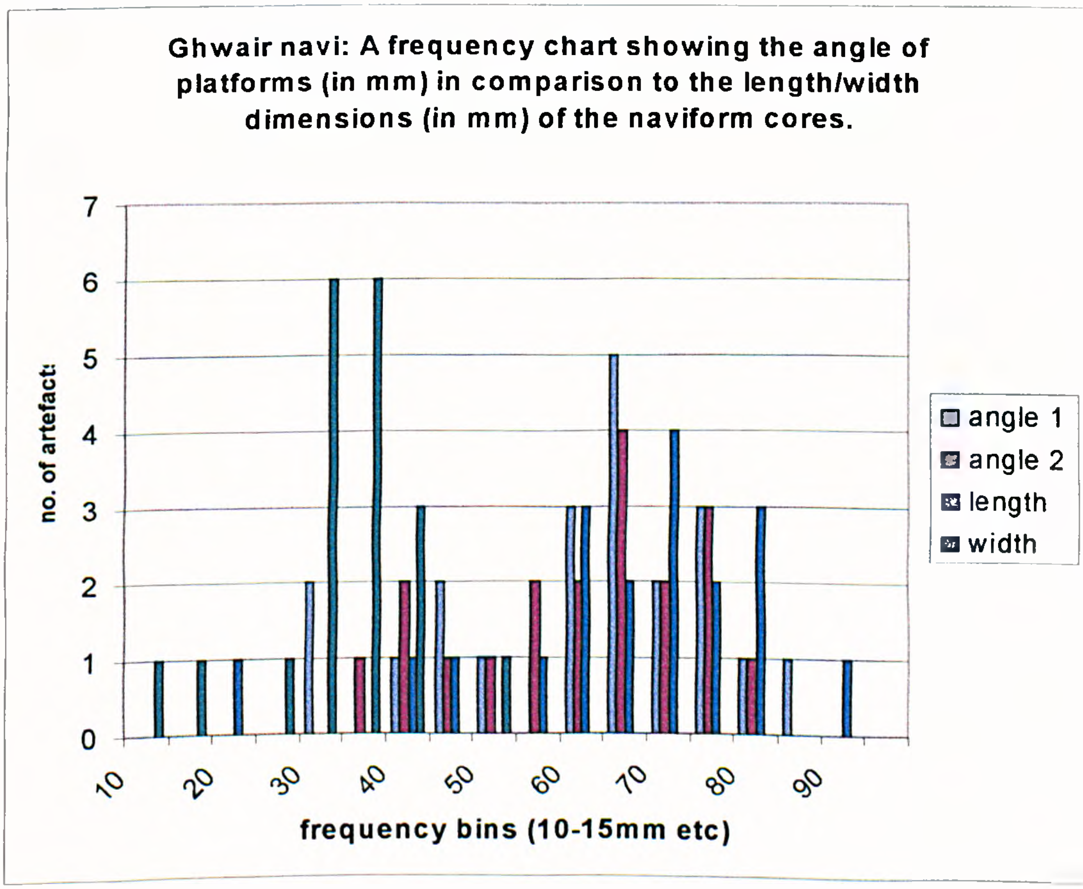
Graph 2



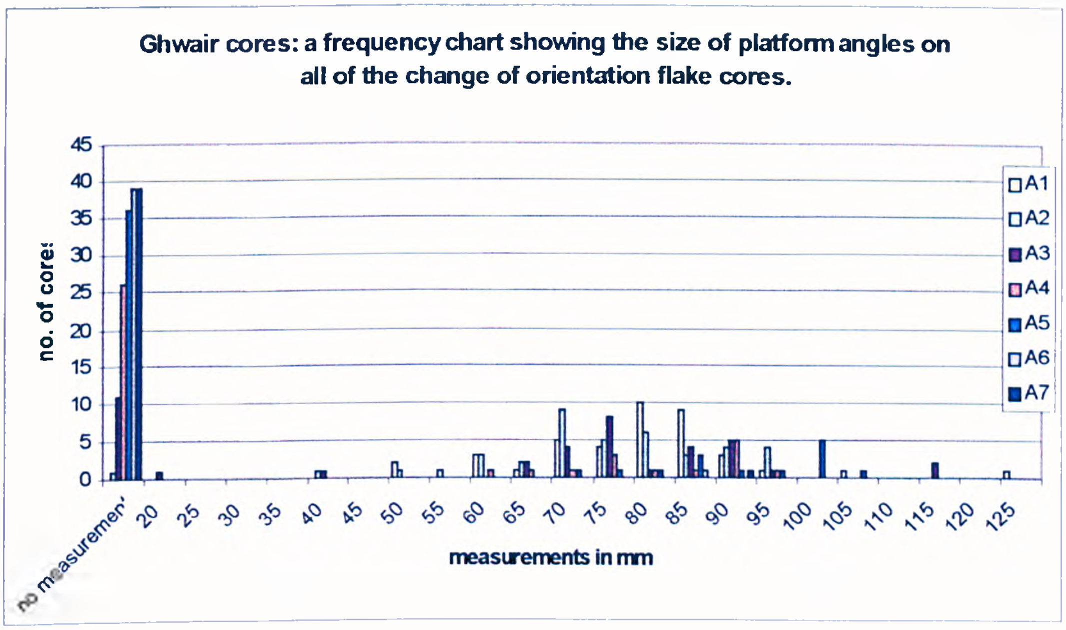
Graph 3



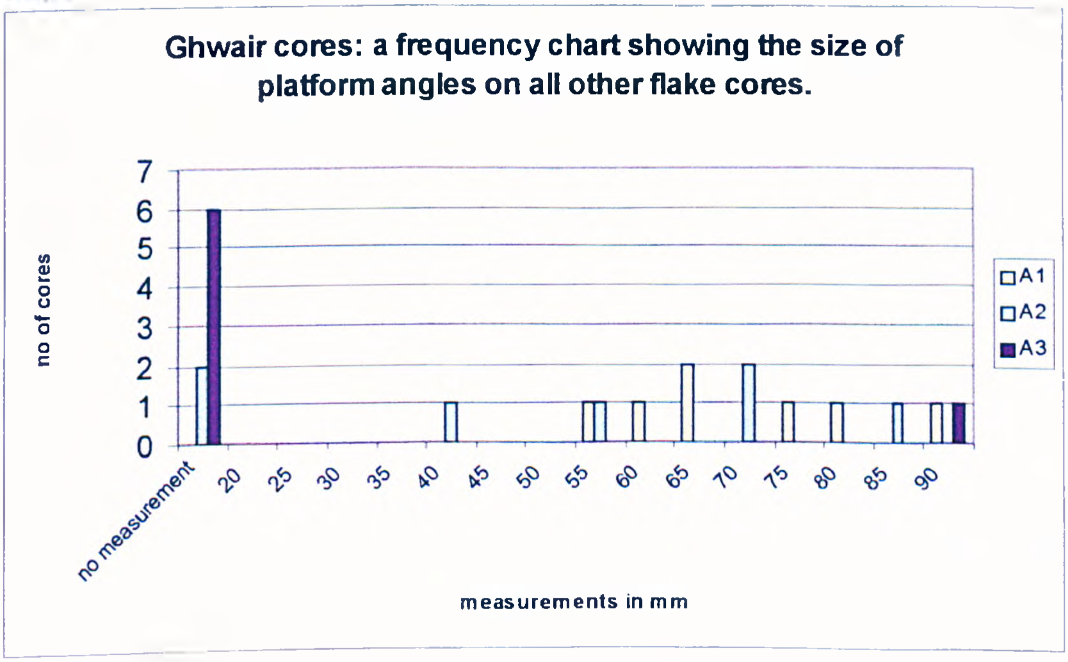
Graph 4



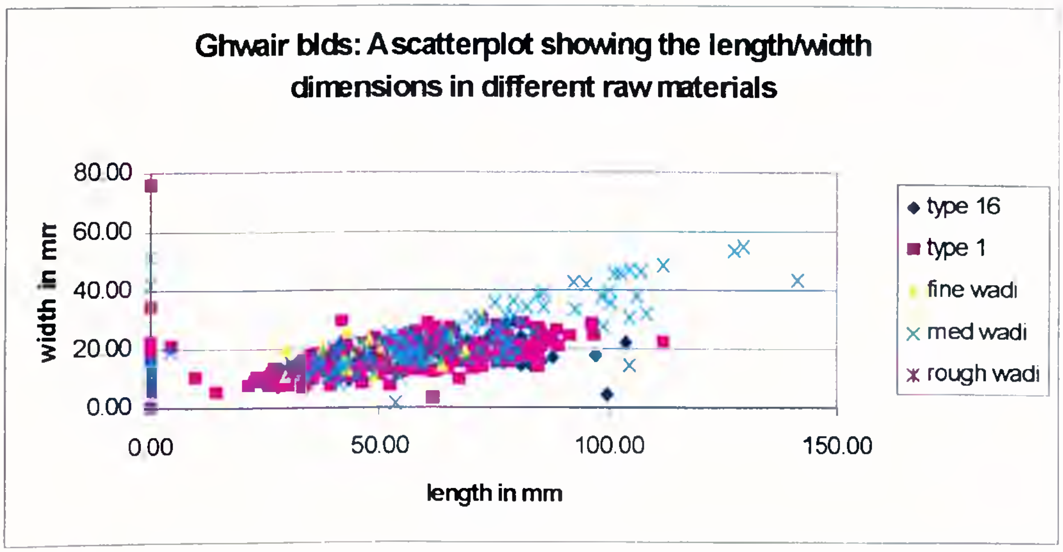
Graph 5



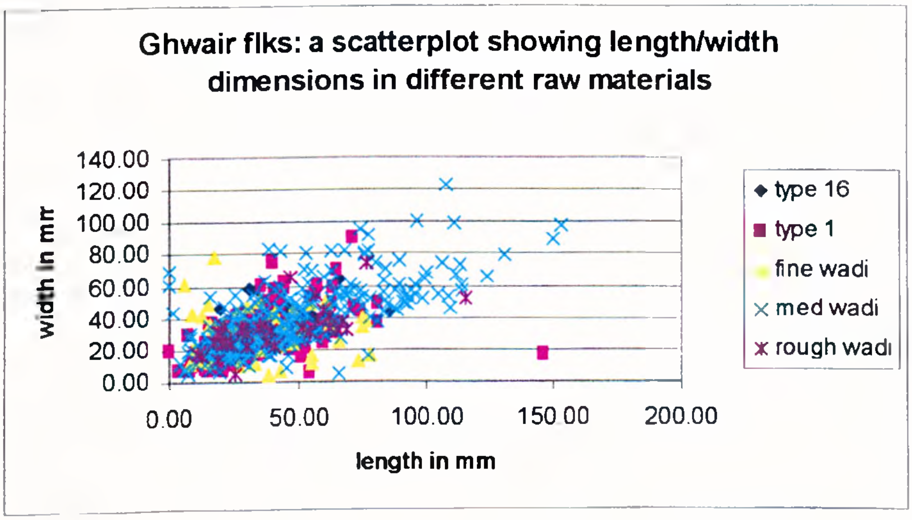
Graph 6



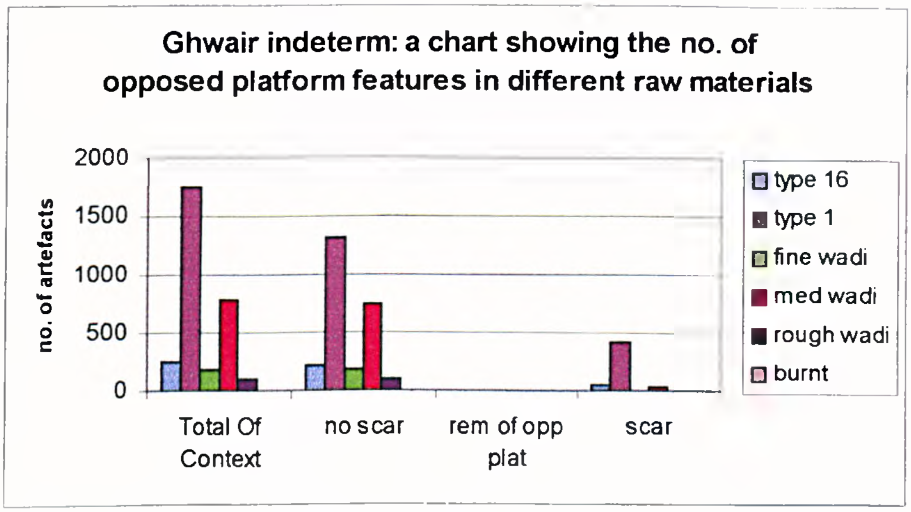
Graph 7



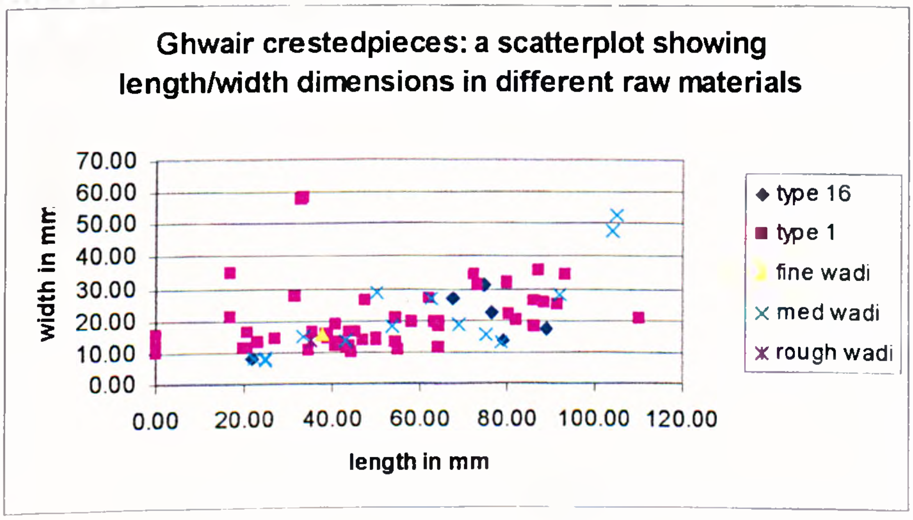
Graph 8



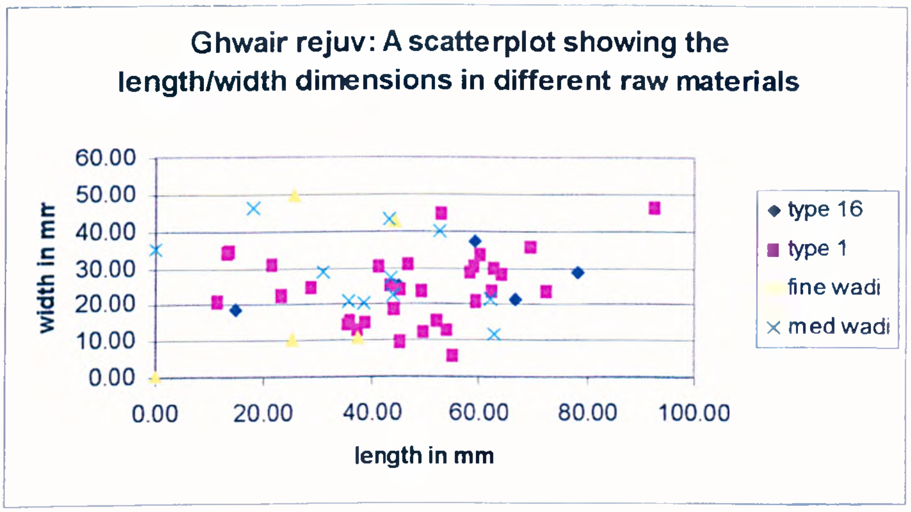
Graph 9



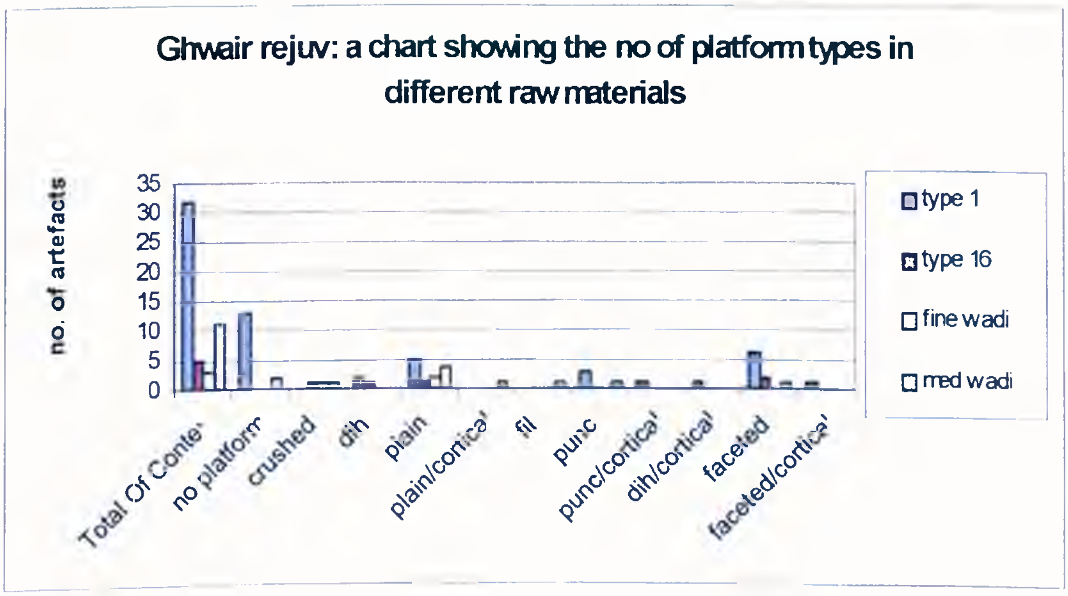
Graph 10



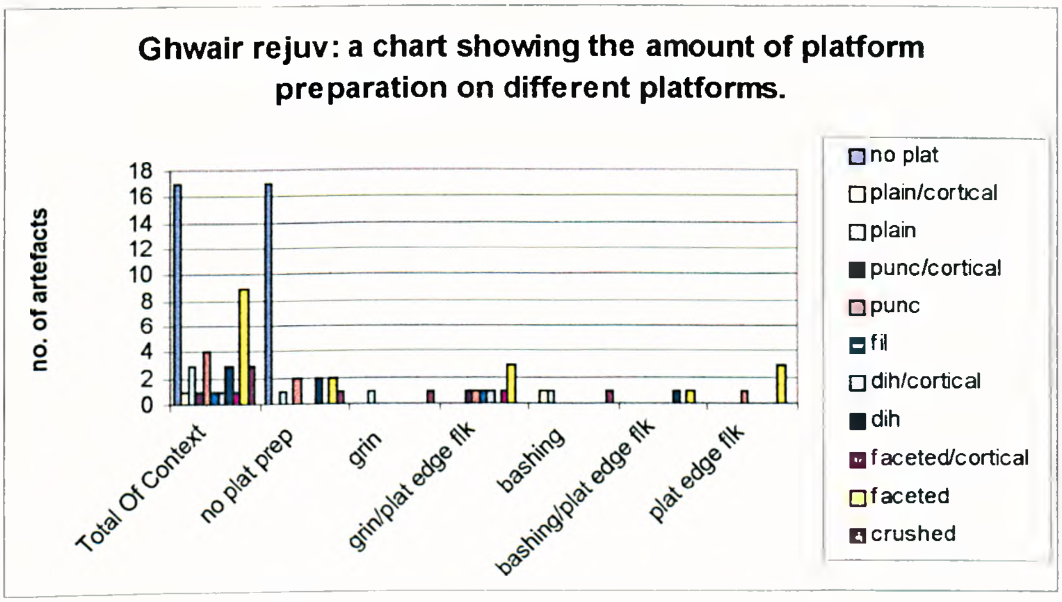
Graph 11



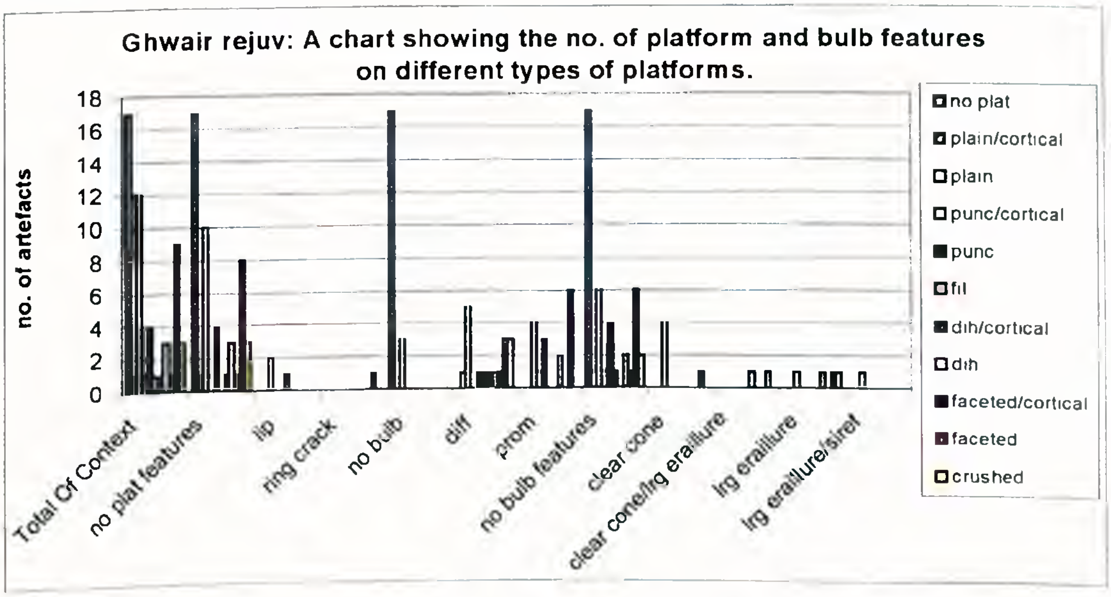
Graph 12



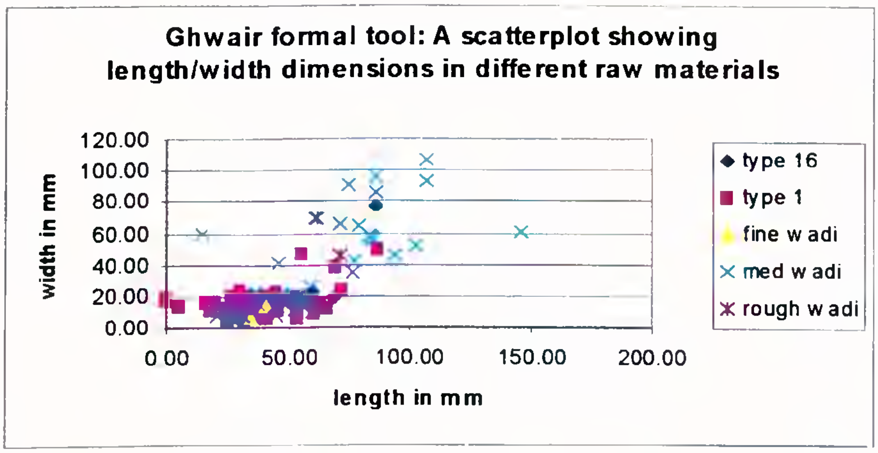
Graph 13



Graph 14



Graph 15



Ghwair formal tool: A scatterplot showing length/width dimensions in different raw materials
width in mm
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.00
50.00
100.00
150.00
200.00
length in mm
type 16
type 1
fine w adi
med w adi
rough w adi

List of Figures: Chapter 5 (Ghwair)

Fig. 1 Naviforms from the Ghwair assemblage. (i) Classic naviform in type 16 raw material. (ii/iii) Variant naviforms with fully and partially cortical backs.

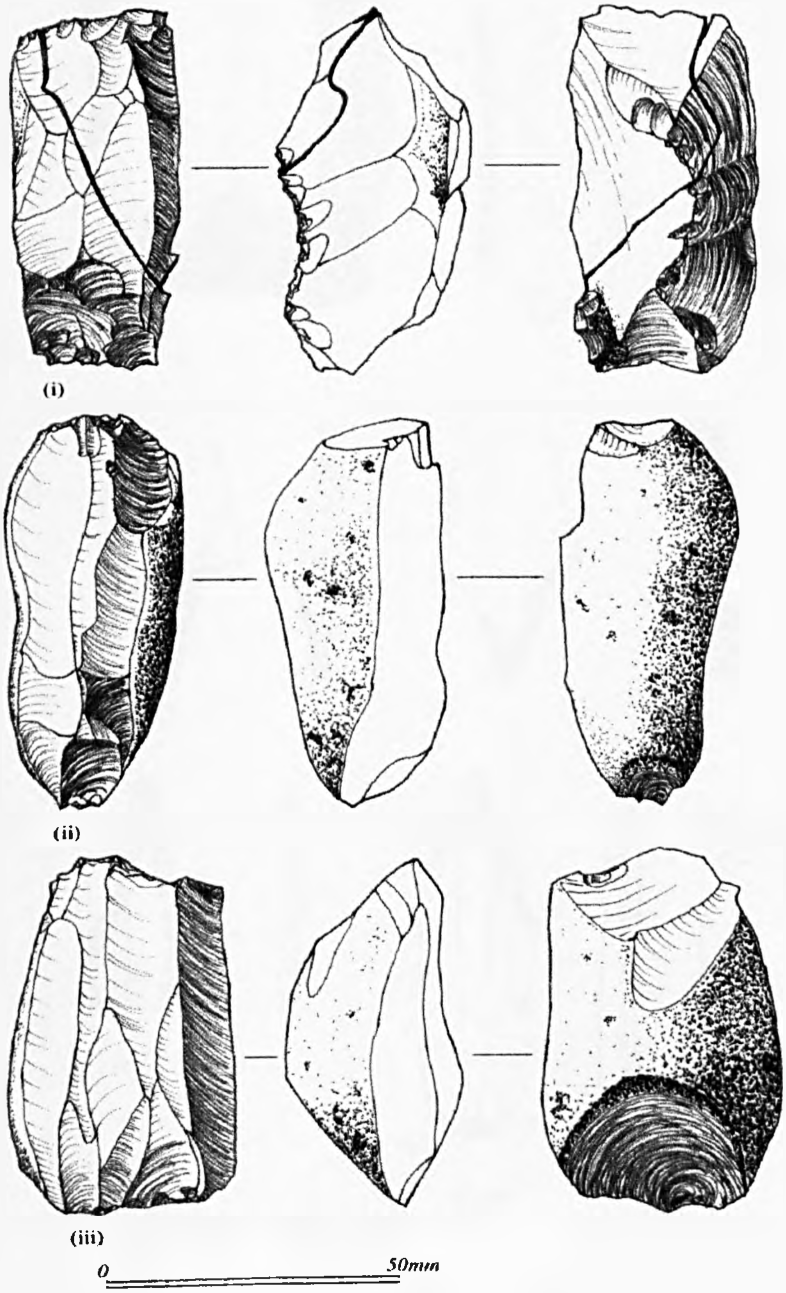
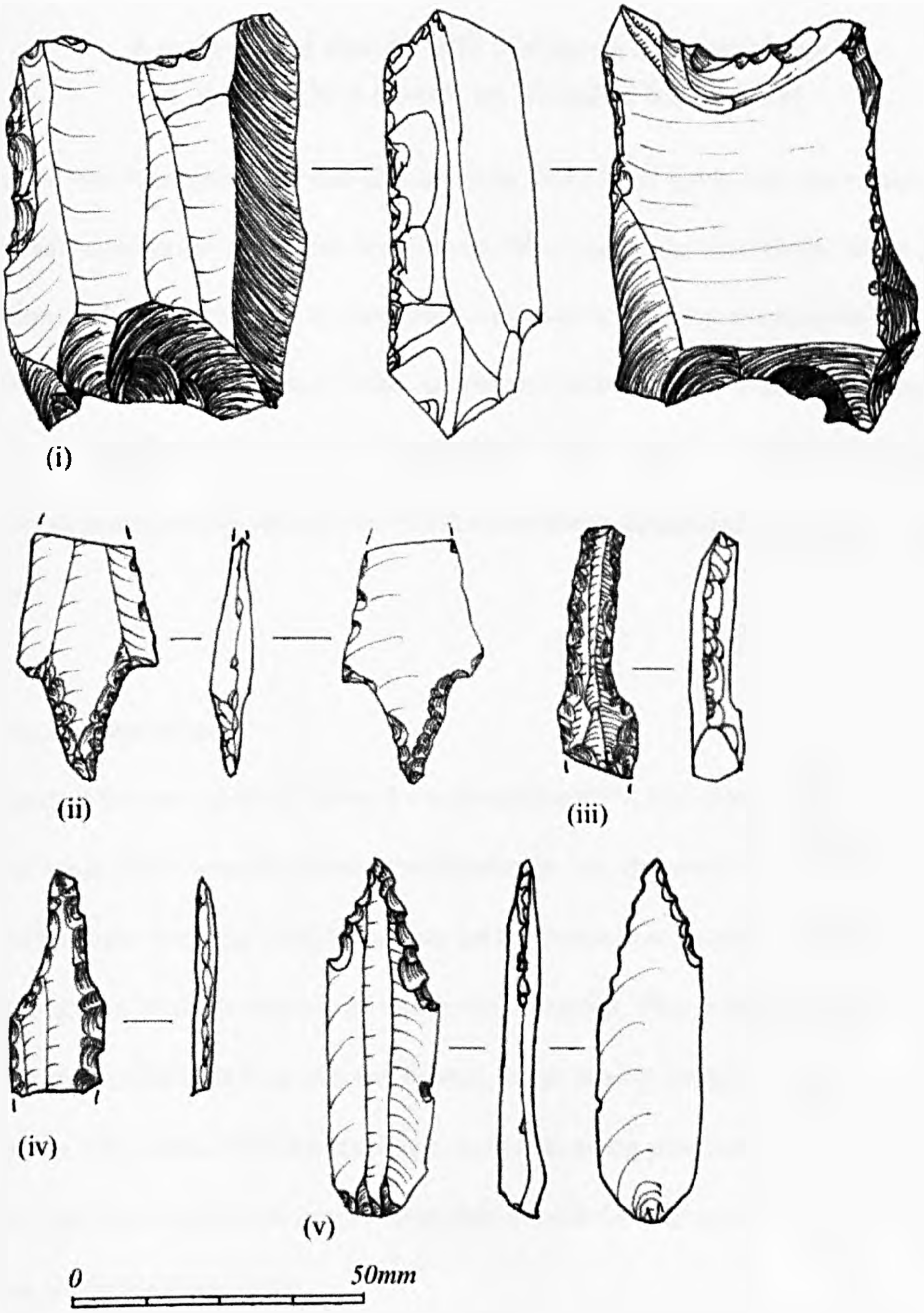


Fig. 2 **Tools from the Ghwair assemblage**. (i)\A naviform core that has been reused as a tool. (ii) Broken Byblos point. (iii) Broken borer. (iv) Broken piercing tool. (v) Piercing tool produced on a blade blank.



Chapter 6

Analysis of the Wadi Fidan A assemblage (Currently known as Wadi Fidan 100)

This chapter has been separated into five sections, three lithic types, site raw material, and summary and conclusion. The three sections on lithic types consist of Core, Blade and Flake. The section on Cores is divided up into type, dimensions, platform preparation and platform angle. The sections on Blades and Flakes are divided into type, dimensions, platform type, platform preparation and platform and bulb features. The summary and conclusion reviews the reduction strategies identified in the WFA assemblage, discussing each stage of the *chaîne opératoire.*

WFA: site raw material

On the basis of the raw material survey I conducted in 1997, it is clear that the raw materials in general use at WFA were the same as at Ghwair. In fact, the wadi cobbles used to produce tools at WFA were from the Wadi Dana area (in the immediate locality of Ghwair) rather than the Wadi Fidan, with the exception of rough wadi material. This is because Fidan is further down stream from Dana and so only the lighter, lower quality, conglomerates were washed that far down. The exotic flint raw materials were also being procured from the same source as Ghwair. So I have organised the raw materials at both Ghwair and Fidan in the same categories, using the same terms.

Due to limited access to the assemblage I have only fully recorded the data on cores, flakes and blades.

WFA: core type

The majority of cores at Wadi Fidan A are blade cores. Most of these are naviform blade cores in type 1 raw material (table 1). These cores are a variant form of naviform (appendix 4) that are often produced without cresting down the back because the flint nodule already provides a suitably shaped back (fig. 1). The other type 1 blade and bladelet cores are single and double platform cores that are possibly exhausted naviforms or are a separate blade core strategy that is not as commonly used as the naviform blade production.
There are only two cores in type 16 and both are naviforms. One is a classic naviform (appendix 4), but the other has been heavily reduced and no crest remains along its back. The sample is too small to assess whether the naviform cores in type 16 utilised the type 1 'variant' method of leaving the backs uncrested.

Flake cores are present in small numbers and are found in all raw materials with the exception of type 16. The largest number is found in rough wadi, but there is no emphasis on the production of any particular type of flake core across the raw materials.

It is clear that type 1 is the preferred raw material. This is unexpected, considering that it is an exotic raw material from an unknown source outside of the Dana, Faynan, Fidan wadi system. However, the people of Wadi Fidan found it necessary to travel as far as the wadi Dana (approx. half days walk) to acquire flint of a reasonable quality. So technically all the flint at Wadi Fidan, excluding rough wadi, is exotic. Most effort put into acquiring raw materials was expended on type 1.

WFA: core dimensions

The naviform cores in type 16 are at the larger end of the scale (graph 1 and 2). They are clearly not as heavily reduced as the type 1 naviform cores. Though type 16 is as exotic and of as high quality as type 1, here it is not being used as often.

The type 1 naviform cores form a distinct cluster of relatively big thin cores between 46.7-65.3mm in length and 18.8-52mm in width. There is another cluster of type 1 blade, bladelet and flake cores. The dimensions of this mixed group are shorter though, generally, the same width as the naviform cores and so it is possible that they may well be exhausted naviforms. The fact that all of blade cores in type 1 and 16 form a cluster on the scatter plot, and that the non-naviform blade cores in type 1 are also included in this cluster (graph 2), seems to represent a relatively standardised practice in blade core production, certainly in terms of the debitage metrics that are removed from these cores.

Only the medium and rough wadi flake cores fall significantly outside the naviform groups. They are much larger and therefore, like one of the type 16 cores, are not being as extensively reduced as cores in type 1.

The dimensions of the Wadi Fidan cores reflect what is happening with the core types. Type 1 is the raw material of choice, and this is being heavily utilized, far more than any other raw material.

WFA: core platform preparation

The most common methods of preparation on all of the cores (both flake and blade cores) are bashing/platform edge flaking and then bashing (table 2). These two methods are the only ones employed by the knappers at Wadi Fidan A when preparing, with the exception of the naviforms, all their flake and blade cores. The naviforms were reduced using bashing/platform edge flaking and bashing; also some grinding was employed, usually in combination with other methods. A relatively consistent level of effort was put into preparing the flake and blade core platforms but there is a sharp increase in preparation witnessed on the naviforms. It is clear that once the naviforms were exhausted and turned into either bladelet or flake cores they stopped using grinding, probably because it was no longer possible to keep the removals a regular shape and size. They were simply using the material up rather than expending time and effort preparing the platforms.

WFA: core platform angle

The inside angle of all core platforms has not provided any useful information. A frequency chart shows that the naviform platform angles get smaller as the cores reduce in length, which is an expected pattern (graph 3). There is no clear correlation between the core dimensions and the platform angle in the cores as a whole because there is no direct relationship between these two attributes in the flake core reduction methods (graph 4). The same can be said for the non-naviform blade cores because, like the flake cores, the platforms are not opposite each other and therefore there is no ongoing relationship between platform angle and core size (graph 5).

WFA: blade type

Type 16 blades and bladelets are few in number but there is a clear preference for blades as opposed to bladelets (appendix 2 table 3). This concurs with the type 16 naviform core size which are relatively large.

The majority of blades and bladelets have been produced in type 1 raw material. Most of these are either broken blade/bladelets or bladelets (table 3). The knappers were particularly interested in the smaller blades coming off the naviform cores in this raw material, which was the opposite from the way they used the type 16 naviform cores and debitage. This is reflected in the tool assemblage, which is dominated by little piercing tools made from broken blade/bladelets and bladelets in type 1.

Fine wadi material is also barely used, but the majority of pieces are blade/bladelets and bladelets, again a similar preference to the debitage in type 1. However, the sample size is small and so this picture could change. All the other raw materials are present only in very small numbers in the blade and bladelet debitage and blanks; the most significant of these is medium wadi. In medium wadi there are only slightly more blade/bladelets and bladelets than blades (over 50mm in length). So in this raw material, there is no clear size preference as can be seen in type 1 and 16. Rough wadi is the least utilized of all the raw materials and the numbers are so low that there is not much distinction between quantity of blades, blade/bladelets and bladelets.

Generally there does not seem to be much separation in the treatment of secondary blades, blade/bladelets and bladelets in type 1. They are present in almost equal numbers in the type 1 raw material and are being retouched in similar proportions to their non-cortical counterparts. This suggests that the knappers at Ghwair were maximising the use of this raw material. In the other raw materials secondary debitage is present in very low numbers, this could indicate a reluctance to use this resource or simply be an effect of the low numbers of debitage in this raw material as a whole.

WFA: blade dimensions

The type 16 blades are generally larger than blades in any other raw material (graph 6). They fit neatly into the upper size range of the naviform cores, which have been produced in type 16 raw material (graphs 1 and 2). So these blades are clearly linked to the type 16 naviform production.

Type 1 blades generally cluster within the size range of type 1 naviform cores, between 60-90mm (graphs 1 and 2). There is a fair amount of overlap of blades at either end of this core range and the larger examples suggest that the type 1 naviform cores did not get much larger than 100mm (graph 6). This picture shows that there is a definite connection between the type 1 blades and the type 1 naviform cores. It is also clear that the knappers at Wadi Fidan A are particularly interested in producing blades that fall between 40-60mm, around the blade, bladelet boundary of 50mm.

Fine wadi blades generally fall below 50mm. The only core in this raw material is a change of orientation flake core so it is not initially clear how the blades were produced. However, this core is about 49mm in length (graph 2) and, therefore, it is feasible that a small number of blades could have come from this core or another similar in size. Generally, they are producing relatively small debitage in this raw material.

The majority of blades in medium wadi range between 30-60mm in length. Two exceptions, are 80 and 119mm in length. There is only one core produced in medium wadi and it is a change of orientation flake core that is 80mm in length. Therefore, it is difficult to connect the bulk of the medium wadi blades to this one core. The most common blade sizes in this raw material cluster together with the majority of the type 1 blades (graph 6) and so it may be possible that medium wadi blades are produced on blades cores that are not present within this excavation trench, but are of a similar size to the type 1 naviform cores. However, there is no evidence to suggest that their form was like the naviform cores, there are no opposed platform scars on the dorsal surface of the blades. Though the medium wadi blade numbers are low, they indicate that this raw material was at least as important for blade production as the type 16 (which is a naviform industry) and the fine wadi raw materials. The extensive use of type 1 raw material possibly influences our perception of what is happening in the other raw materials.

Rough wadi is the least important raw material form blade production. Again, like most of the other raw materials, the majority of these blades fall below 50mm. The exception is a blade that is just over 90mm in length. There are two rough wadi flake cores that range between 40-

65mm in length. The sizes generally match and so it is possible that the rough wadi blades came from the rough wadi flake cores. Only the 90mm blade stands out, but it is possible that this was an early removal, or from a core that was not found in this trench. Whatever the possibilities, the number of rough wadi blades is too low to produce clear results.

WFA: blade platform type

In type 16 raw material punctiform and filiform platforms are most numerous (table 4). This is hardly surprising considering that the small platforms are commonly produced by naviform blade production techniques because a great deal of accuracy is needed to consistently remove such regular blades.

The situation on type 1 platforms is similar to type 16; punctiform is the most important type of platform (table 4). This is linked to the type 1 naviform blade production. Plain platforms are the most important platform after punctiform, but the number is considerably lower. However, it is in this raw material that we have the widest range of platform use, and this may simply be a reflection of sample size.

On fine wadi blades filiform is the most important type of platform (table 4); this could be connected to the general size of the cores and blades (as opposed to the shape and form of the naviform cores). It requires a certain level of accuracy to remove small blades from relatively small cores.

Plain platforms are most common in medium wadi (table 4), but the small platforms (punctiform and filiform) added together almost equal the number of plain. In medium wadi you get a fair number of larger blades as well as small ones. So this mixture of platforms may be the result of less accuracy being required at the initial stages of debitage production because the cores are larger and consequently easier to handle.

It is difficult to discuss the results from rough wadi debitage with great confidence because the sample is small. However, plain platforms appear to be important suggesting that the knappers were less concerned with accuracy in the removal of these blades as when they were using other raw materials. There is certainly no production of the small platforms. I think that this lack of concern was not the result of anything practical because the rough wadi core and blade dimensions do not differ much from the type 1, fine and medium wadi samples. Rather, that this treatment simply reflects the fact that rough wadi is not used often and is not valued as much as other materials.

WFA: blade platform preparation

In type 16 raw material the majority of platforms are punctiform (6 in total) and filiform (6) and these have been prepared largely using grinding/bashing and grinding (table 5). These blades are linked to the type 16 naviform industry and so careful preparation of the platforms is important.

The blades in type 1 have been most commonly produced with punctiform platforms (103 in total) and the most important preparation methods are grinding/platform edge flaking, grinding/bashing and grinding (table 6). Filiform platforms (72 in total) are also important and the majority of preparation consists of grinding/platform edge flaking (table 6). There are a relatively significant number of plain platforms (32 in total) and these have been prepared largely using bashing/platform edge flaking. Here there is a slightly different emphasis in the type of preparation to the punctiform and filiform platforms though generally it remains similar. Overall, the proportions of preparation across the board (with the exceptions of punctiform/cortical and winged) are high, which is unsurprising considering that these blades are the product of type 1 naviform core technology. However, there is a much wider range of preparation method used on platforms in type 1 than in type 16. I believe this is both a reflection of the fact that the type 1 sample is so much larger than the other raw materials and also the relative importance of the type 1 raw material.

In fine wadi, filiform platforms (6 in total) are most common and bashing is the largest proportion of preparation (table 7). However, platform edge flaking is equally important though in partial combination with other methods. It is interesting to see that the majority of platforms are small, but they have not been prepared with the same care and attention as they have in type 1 and 16 raw materials. This suggests that a different process is applied to these blade removals. Just enough effort is put into creating a small platform because the cores were small, but the consistent removal of regular blades is not as important so there is little use of careful preparation to ensure an accurate blow.

The majority of medium wadi blades have been produced with plain platforms (8 in total) and these have been prepared mainly using bashing and platform edge flaking (table 8). The punctiform platforms (4 in total) have largely been prepared using bashing. Here, the knappers used a narrower range of preparation methods than with other materials such as type 1 and 16. The emphasis of the preparation type is closer to that on fine wadi blades, but the levels of preparation are higher than fine wadi (tables 7 and 8). This is interesting because if the platform type and level of preparation on fine wadi blades is linked to the size and nature of the cores, then in medium wadi we would expect there to be less platform preparation as some of the cores are larger and easier to knap. This may be a reflection of the importance of the medium wadi blades or simply be a result of the fact that the sample is bigger than that of the fine wadi blades.

In rough wadi the majority of platforms are plain (4 in total) and the largest number have been prepared using platform edge flaking. With the exception of winged platforms, the general level of preparation is relatively high. However, the number of rough wadi blades is extremely low and so the data may not be presenting a realistic picture.

WFA: blade platform and bulb features

All of the platform and bulb features are found on blades that retain their platforms. So the percentages are taken from the total number of blades with platforms in each raw material. Platform and bulb features are indicators of technique and are commonly associated specifically with hammer type (chapter 5 pg. 77-79). However, other aspects of technique like strength of blow, angle of blow and platform preparation may also have an affect on the presence of platform and bulb features (chapter 5 pg. 77-79). This may particularly be true when the features commonly associated with hammer type give a confused picture.

In type 16, platform features are very low in number, 9.6% of lips are associated with diffuse platforms, suggesting softer hammer techniques (table 10). However, if you assume that lips and diffuse bulbs are indicators of softer hammer and prominent bulbs and ring cracks are indicators of harder hammer, technically 9.6% of the platform features also gives a confused picture and so there is no general indication of any hammer technique in this sample. It is possible that this is the result of the fact that there are so few blades in this raw material.
The picture in type 1 appears somewhat clearer. The ring cracks are found in association with slightly more diffuse rather than prominent bulbs (table 11). However, most of the lips are associated with diffuse platforms and this group makes up the largest number of platform features, possibly suggesting that softer hammer was the technique of choice in this raw material, which is associated with naviform production.

In fine and medium wadi there is only one example each of the platform features, there are none in rough wadi (tables 12 to14). These numbers are too low to analyse with any degree of confidence.

There are significantly more bulb features on blades in most of the raw material categories than there are platform features. However, these are traditionally linked to only harder hammer techniques so it is important to associate these with bulb types.
In type 16 the bulb features are found in association with both prominent and diffuse bulbs in almost equal amounts (table 14). The proportion of clear cones is relatively high, 33% of the total number of blades (including those that have not retained their platforms). The eraillures

tend not to be conclusive indicators of hammer technique so the proportion of clear cones is far more important.

The bulb features on type 1 blades are also related to prominent and diffuse bulbs in almost equal numbers (table 15). So the bulb features do not indicate any particular hammer technique. However, the proportion of clear cones in the total type 1 blade assemblage is not as high as type 16 (only 19.8%).

In fine wadi, there is only one clear cone and it is related to a prominent platform. However, this clear cone only makes up 4.8% of the total fine wadi blade assemblage and on this basis not much can be discerned from it. The medium wadi clear cones are mainly related to diffuse bulbs, so though we do have a relatively consistent pattern, it goes against the standard conventions of what constitutes indications of harder hammer techniques. In this raw material there is a relatively high proportion of clear cones, 37%; much like the clear cones on type 16 blades. Rough wadi blades have more clear cones in association with diffuse bulbs than prominent, again going against some views about hammer type. The proportions of clear cones are the highest of all the raw materials at 50%. However, the numbers of rough wadi blades in general are low so it is difficult to assess whether this picture is an accurate one. The data on platform and bulb features has demonstrated how unclear the picture is on hammer technique. Only the type 1 platform features indicate a suggestion of softer hammer use. Judging the size of bulbs is a rather subjective process, so it is possible that bulb prominence is not particularly useful as an indicator of technique. For this reason I have selected all of the blades with both platform and bulb features present to see if they can help clarify this issue (table 19). There are only examples of related platform and bulb features in type 1, 16 and medium wadi, again sample size has affected the outcome. If these hammer type conventions are correct, we would not expect to see lips with the clear cones. In type 16, two out of three lips are linked to clear cones (tables 10 and 21), which is a relatively high proportion. In type 1 only one out of thirteen lips is associated with a clear cone. Four out of ten ring cracks are associated with clear cones. This suggests that the general picture in type 1 material that we see in the platform features is fairly accurate. Lips and ring cracks are present in almost equal amounts, so the knappers at Wadi Fidan are either using a combination of softer and harder hammer techniques in the type 1 naviform industry, or lips and ring cracks are also linked to other aspects of technique.

On the medium wadi blade there is only one example of a platform feature, which is a lip, and this is associated with a clear cone, giving us a confused picture. However, the sample is also too small to say much about it.

In general, I think that the numbers of blades in all raw materials except type 1 are too low to show a sufficient number of platform and bulb features that can discussed with any confidence. The type 1 blades show that the knappers at Fidan A were possibly using a wide range of hammer stones and possibly other techniques, combining softer or harder hammer techniques

It is possible that combining the data on platform and bulb features across the raw materials may give a clearer picture. The percentages on table 20 have been taken from the total number of blades with platforms. As discussed earlier, the number of clear cones across all of the raw materials is quite high (26%, table 20). Almost a third of the total number of lips are related to clear cones. Given the nature of this concurrence, it is not really possible to discuss the hardness or softness of hammer type. It is not clear whether all cases of clear cones relate to harder hammer and all cases of lips relate to softer hammer. It is likely that the platform features are related to other aspects of technique like angle and strength of the blow and preparation of a platform.

WFA: flake type

The majority of the Wadi Fidan A flake assemblage is in type 1 raw material (50.6% table 21). Medium wadi is the second most important raw material (24.2%). It is clear that medium wadi is a more important raw material in the flake than it is in the blade assemblage, though neither is there a dominance of type 1 in the flake assemblage (tables 3 and 21). Type 16 is the most important raw material outside of type 1 and medium wadi in the flake assemblage. Overall, the majority of flakes in this raw material are not retouched, regardless of whether they retain cortex or not. There are no flake cores in type 16 and it is possible that these flakes were produced as a by-product of naviform core production. As a consequence there is less interest in reusing these flakes as tools.

In type 1, the most important group is secondary flakes. Like type 16, the majority of these flakes are not retouched, though there are proportionally more retouched flakes than in type 16. In this raw material there are a few flake cores, possibly exhausted naviform cores. The flake assemblage is thus likely to reflect a mixture of flakes produced as a by product of the naviform cores that were not extensively reused as tools and flakes that were produced from the type 1 flake cores and treated as tools in their own right.

Fine wadi is the raw material least used for the production of flakes. Only slightly fewer fine wadi flakes have been retouched (3.8%) than have not (4.1%), so proportionally there are relatively high levels of retouch in this raw material (table 21).

In medium wadi, the majority of flakes are flakes without retouch and most of these do not retain cortex (table 21). However, there are a fair number of retouched flakes, which is proportionally more (when compared to the number of unretouched flakes in the same raw material) than the retouched flakes in type 1.

The majority of flakes in rough wadi are plain flakes and flakes with retouch (5.2% table 21). However, secondary flakes and secondary flakes with retouch make up a relatively significant number (3.5%) in relation to the other rough wadi flakes.

Generally, there is a greater contrast between the retouched and unretouched flakes in type 1 and 16 and a smaller separation between the flake debitage and tools in all the other raw materials regardless of the sample size. As some flakes are produced as part of the naviform blade production strategies and others are intended flake products, this will affect the way in which they are treated.

WFA: flake dimensions

The dimensions of flakes in type 16 generally fall below the core lengths in the same material but the maximum flake width is about the same as the type 16 cores (graphs 2 and 7). They are also comparable to about half of the blades in type 16 (that fall below 60mm in length, graph 6). This suggests that these flakes come from the same cores as the type 16 blades. However, it is not clear whether this is the result of naviform core preparation and maintenance or because the flakes were later removed from exhausted naviform cores. There are no exhausted type 16 naviform cores present in this assemblage and the evidence suggested by the flake types, relatively low levels of retouch and proportionally high amounts of cortex on these flakes (table 21), indicates that they were by-products of naviform core preparation and blade production.

The flakes in type 1 are generally shorter than 50mm in length, which is similar to just over half of the type 1 blades (graphs 6 and 7). The widest flakes are of a similar size to the widest type 1, naviform cores (graph 1 and 2). This indicates that these flakes came from the same cores as the blades in type 1. This situation is very similar to that of the type 16 flakes, but here we do have examples of exhausted naviform flake cores, suggesting that the flakes are a mixture of both naviform core preparation and maintenance, and reuse of the naviform cores to produce flakes.

The majority of flakes in fine wadi are similar in length and maximum width to the fine wadi cores (graphs 2 and 7). The lengths of the fine wadi blades also fall within this range (graph 6), and so it is feasible that these blades and flakes come from the same cores.

The only medium wadi core is generally larger and wider than the majority of medium wadi flakes (graphs 2 and 7). However, there are five flakes that are considerably bigger than this core. Though there is a wide range of sizes in the medium wadi flakes, the majority cluster with the type 1 and 16, and fine wadi flakes. This is a similar picture to the medium wadi blades, suggesting that these flakes and blades came from the same cores. However, it is possible that there are cores missing from the assemblage because the only example is much larger than the majority of medium wadi flakes and blades and does not appear to be heavily reduced.

The rough wadi flakes display the widest range of dimensions of all the raw materials (graph 7). The rough wadi blade lengths correspond to the majority of the flakes and cores in this raw material, suggesting that the blades and flakes are from the same cores (graphs 2, 6 and 7). However, there are a few flakes and blades that are significantly larger than the rough wadi cores indicating that either these cores are heavily reduced or that some are missing. As there are a significant number of relatively small rough wadi flakes and the cores are large in relation to other raw materials, I do not think that these are heavily reduced cores.

It is clear that all of the flakes have come from cores in this assemblage with the possible exceptions of medium and rough wadi. It is also interesting to note that all blades and flakes have come from the same cores. Type 1 is the only exception where the flakes have come from reused blade cores.

WFA: platform type

The majority of platforms on type 16 flakes are plain. This differs to the type 16 blades where the smaller platforms dominate and where there is also a smaller range of different platform types than on the flakes (tables 4 and 22).

On type 1 flakes plain platforms are most common, and again this is different to the blades in this raw material as the smaller platforms dominate. There is also a wider range of proportionally important platforms (punctiform, faceted and crushed) on the flakes (unlike the blades).

In fine wadi the majority of platforms are plain, and again, the blade platforms mainly punctiform.

Medium wadi flakes are also mainly produced with plain platforms. However, this is similar to the blade platforms in this material. Similar techniques may have been use for blade and flake production in medium and rough wadi materials; platform preparation and features will help to clarify this.

Rough wadi flake platforms are also mainly plain and this is the same as the blades in this raw material. However, there is a wider range of platforms on the flakes than on the blades in rough wadi. This is probably because rough wadi is proportionally more important in the flake assemblage than in the blade assemblage.

In general, plain platforms are most common throughout the flake assemblage. This is not witnessed on the blades where the most important platform types differ according to raw material.

WFA: flake platform preparation

The majority of flake platforms in type 16 are plain (12 in total) and these have been prepared mainly by platform edge flaking and then bashing/platform edge flaking (table 23). Bashing and platform edge flaking are the most important method of preparation, though grinding is present. More use of grinding is found on type 16 blade platforms but preparation is spread over a wider variety of flake platforms (tables 5 and 23). However, overall, there is proportionally less preparation of the flake platforms than the blades.

On type 1 flakes, *the majority of platforms are plain (36 in total)* and these have been prepared largely by platform edge flaking (table 24). Bashing and platform edge flaking are the most common methods of preparing the other important types of platform (crushed 26 in total, faceted 21 in total, dihedral 15 in total and winged 10 in total). However, we see extensive use of grinding on punctiform (30 in total) and plain/cortical platforms (23 in total). The use of grinding on punctiform platforms reflects what is happening on the type 1 blades with punctiform platforms and it is used to strengthen such a small platform (tables 6 and 24). As cortex is difficult to knap grinding is used on plain/cortical platforms in order to help create a platform. This can also be seen in the blades, though there are far fewer plain/cortical platforms. However, on a general level, there is less use of grinding on the flakes than on the blades. A roughly similar number of flake and blade platforms have been prepared but this total is proportionally lower in the type 1 flake assemblage.

The majority of platforms on fine wadi flakes are plain (16 in total) and these have largely been prepared with platform edge flaking and bashing (table 25). These two methods of preparation are the most common throughout the fine wadi flakes. This situation is similar to the fine wadi blades, the only difference being that grinding is utilized slightly more often (tables 7 and 25). There is a wider range of different platforms being prepared on the flakes but there is proportionally more preparation on the blades in fine wadi. Most platforms on medium wadi flakes are plain (51 in total) and these are most commonly prepared with bashing and platform edge flaking (table 26). These two methods of preparation are the most important throughout the medium wadi flakes. Though the proportions of platform type on the blades are similar to the flakes they are distinguished by a more extensive use of grinding (tables 8 and 26). Overall, the total proportion of preparation on the medium wadi blades is higher than on the flakes.

On the rough wadi flakes, most platforms are plain (21 in total) and these have been prepared using platform edge flaking and bashing (table 27). The same methods have been used to prepare all of the other platforms. This is similar to the way in which the blades have been prepared (table 9). Rough wadi blades have received proportionally more preparation than the flakes, however, the blade sample is very small and so this may not be a completely accurate picture.

In general the patterns of platform preparation on the flakes reflects that of the blades but at a lower level, and there is much less use of grinding. The degree of similarity in preparation is closest between the type 1 flakes and blades of all the raw materials, which is an indication of the importance of this raw material and the distinctive technique, strategy combinations involved in naviform production on the site of Wadi Fidan A. Often a wider variety of flake platforms than blade platforms have been prepared in some way, suggesting that there is less specialization in the production of flakes across all the raw materials.

WFA: flake platform and bulb features

There are only lips on type 16 flakes and these are associated with both prominent and diffuse bulbs (table 28) and consequently the results are unclear.

The pattern of platform features on type 1 flakes is clearer, 5 out of 7 lips are associated with diffuse bulbs and 6 out of 8 ring cracks are associated with prominent bulbs (table 29). This possibly suggests that the knappers at Wadi Fidan A were combining both harder and softer hammer techniques in the production of type 1 flakes. This is similar to the results from type 1 blades.

There is only one lip on the fine wadi flakes and it is associated with a diffuse bulb (table 30). However, the ring cracks are equally associated with prominent and diffuse bulbs. These results are therefore, inconclusive in terms of hammer type.

Again, there is only one lip on the medium wadi flakes and it is associated with a diffuse bulb (table 31). All the ring cracks are associated with diffuse bulbs, and so like fine wadi flakes, the results are inconclusive.

On the rough wadi flakes there are only ring cracks and these are associated with diffuse bulbs and so the results are also inconclusive (table 32).

The bulb features on type 16 flakes are equally inconclusive in relation to hammer type. The same number of clear cones are associated with diffuse and prominent bulbs (table 33).
In type 1 there are an almost equal number of clear cones associated with diffuse and prominent platforms (table 34), contrasting to the relatively clear picture presented by the platform features.

On fine wadi flakes, 11 clear cones are associated with prominent bulbs and 9 with diffuse bulbs (table 35). The results could possibly give an indication of hard hammer technique but the difference between the two groups is too small to be confident about this.

On medium wadi flakes most clear cones are associated with diffuse platforms (table 36) and so the results are inconclusive.
The clear cones on rough wadi flakes are also mainly associated with diffuse platforms (table 37). It is interesting to see that 45.2% of the total flake assemblage have clear cones, this is almost twice the amount on the blades 26%, possibly suggesting that harder hammer is more important in the production of flakes.

Associating platform and bulb features with bulb type has produced little conclusive evidence on the flakes, in much the same way as it did on the blades in relation to hammer type. As the assessment of bulb prominence of diffuse is subjective, I believe it necessary to look at platform and bulb features found on the same flake. As previously discussed, ring cracks and clear cones are often used as indicators of harder hammer and so I would not expect to see lips and clear cones on the same piece (chapter 5, 77).

In type 16, one out of three lips is associated with a clear cone (table 38). As there are no other examples of platform features and the bulbs have provided no conclusive evidence, this result suggests that it is not possible to clearly identify hammer technique.

In type 1 only one out of seven lips are associated with clear cones and five out of eight ring cracks are associated with clear cones (table 38). This suggests that the results from the platform features and bulb types are generally indicative of the use of a combination of harder and softer hammer technique.

In fine wadi 2 out of 4 ring cracks are associated with clear cones (table 38). This in combination with the bulb features and the low number of lips could suggest that harder hammer was commonly used. However, these results are not as clear as those in type 1.
In medium wadi three out of six ring cracks are associated with clear cones (table 38). This result in combination with the low number of lips could suggest harder hammer.

In rough wadi all the ring cracks are associated with clear cones (table 38), possibly indicating the use of harder hammer.

Overall the platform and bulb features in combination indicate that harder hammer was generally the most important method of production in the flake assemblage. It was used to produce fine, medium and rough wadi flakes and a combination of both harder and softer hammer was used to produce type 1 flakes. However, this is only if hammer type is considered to be the main cause of the production of features rather than other aspects of technique. The evidence suggests that at the very least technique was more complicated in the production of type 1 flakes and blades than that used to produce the flakes in other raw materials. This technique (in type 1) also appears to have produced relatively more platform and bulb features both on type 1 flakes and blades than the technique used to produce flakes in other raw materials. The number of flakes that retain their platforms is also much higher than the blades and so the techniques used to produce flakes in fine, medium and rough wadi may well have been similar to that used to produce the blades, however, as it does not produce as many features it does not appear to be possible to make a comparison in the data. Only type 16 remains unclear on both flakes and, therefore, on type 16 blades as the quantity of type 16 debitage that retains platforms is low.

WFA: summary and conclusion

I have identified eight different reduction strategies from the 1989 test trench area. Four are blade production strategies, one is a flake production strategy and three are a combination of both blade and flake reduction strategies.

The only reduction strategy that uses type 16 raw material is naviform, purely for the production of blades. Any flakes produced in this raw material are a by-product of preparing and maintaining the cores. The reduction sequence is fully present as far as the cores, blades and flakes can suggest, however, the early stages of reduction (the earlier stages are represented by blades that retain cortex) are under represented in this area of the site. Other aspects of the debitage, like crested and rejuvenated elements, I am unable to comment on. It is difficult to assess what technique was being used in the production of the blades because there are both harder and softer hammer indicators present but the features are generally few in number and no clear pattern is identifiable. However, because the type 16 naviform industry is so similar to the type 1 naviform industry it is possible that the technique was also similar. The platforms in this blade production industry are generally small and carefully prepared in much the same way as is seen in the type 1 naviform blade production. This strategy is relatively important because care and effort is put into the production of the platforms. However, in terms of quantity, and procurement strategy, it is not much more important than medium and fine wadi raw materials. The only factor which clearly separates the type 16 naviform blade production from the type 1 naviform blade production is that the type 16 cores are used to produce longer blades.

The naviform blade production strategy in type 1 is similar to the type 16 naviforms; however, the earlier stages of reduction are better represented in the blade and flake debitage. The technique indicators suggest a combination of both harder and softer hammers being used to produce the blades, or at the very least, a more complicated strategy than seen in the flakes in the wadi raw materials. Platforms are prepared in much the same way as the type 16 naviforms. This is the most important strategy present in this area of the site. Care and effort is put into the preparation of platforms and the quantity of debitage in this raw material is significantly higher than any other.

The other two blade core strategies in type 1 are single and double platform cores. However, the debitage produced from these cores is indistinguishable from the naviforms and so one can only assume that it is related to the type 1 naviform production and is a feature of the original nodule shape. The reduction sequence is probably similar to the type 1 naviforms and fully present in this trench. The technique is also possibly similar (as far as the cores suggest) and so it is an important reduction strategy in terms of the effort put into preparing the cores, though the quantity of debitage is likely to be low.

The flake production strategies (across the raw materials) are largely made up of change or orientation or irregular flake cores. However, there are a few single and opposed platform flake cores. The change of orientation and irregular cores are very informal strategies where flakes are removed on an *ad hoc* basis according to what the shape of the nodule will allow. The other flake cores, though more formal is shape, are related to this *ad hoc* flake reduction strategy because they are few in number and the technique, as indicated by the debitage, is indistinguishable. The single and opposed platform flake cores probably developed according to the nodule or exhausted blade core shape in much the same way as the irregular and change of orientation flake cores.

The flake production strategy in type 1 utilizes exhausted naviform cores. In this sense it reflects the blade production in type 1. The reduction strategy is fully represented in the debitage, including the earlier stages (earlier reduction stages are represented by flakes that retain cortex). The cores and flakes are present in this trench and are dimensionally similar to the type 1 naviform cores and blades. There is an indication that the techniques used to produce these flakes was similar to the blades in type 1 (a possible combination of both harder and softer hammer) and it is more complicated than the technique seen in the flake assemblage produced in the wadi materials. However, less time is spent on preparing the platforms and the difference in quantity between the flakes in other raw materials is not as great as the difference between the type 1 blades and blades in other raw materials. The type 1 flake industry is clearly not as important as the type 1 blade industry.

There are only flake cores in fine wadi material, but the dimensions of both blades and flakes suggests that the came from the same cores. However, the low number of fine wadi cores could suggest the possibility that there are a few missing from this assemblage. The reduction sequence is fully represented and the earlier stages of reduction are present. The technique indicators on the blades give inconclusive results, but the flakes possibly suggest that harder hammer was used in their production; and as the blades and flakes are related it is possible that harder hammer was used to prepare the blades as well. It is certainly clear that technique in the fine wadi assemblage is simpler than that seen in the type 1 debitage. A little more care and attention is spent on producing blade platforms than flake platforms. However, a wider variety of platforms are prepared on the flakes suggesting there was less specialisation in preparing the flakes. Overall, the effort put into the production of both blades and flakes in fine wadi and the quantity of debitage in this raw material indicates that it is not as important (in terms of debitage production) as both the blades and flakes in type 1.

Both the flakes and blades in medium wadi come from the same cores, but there is only one flake core in this raw material. Therefore, there are cores missing from this trench. The technique is unclear on both flakes and blades. More care and attention is applied to the production of the blades than the flakes, and flake platform production is less specialised. This group of flakes and blades are equally important as the blades and flakes in fine wadi. The blades and flakes in rough wadi are also probably from the same cores. The knappers at Fidan A show a clear size preference for blades and flakes in all other raw materials except rough wadi. The blades and flakes in this raw material range extensively in size and it is clear that the cores, which produced the largest debitage, are not present in this trench. However, the reduction sequence is otherwise fully represented, including much of the earlier stages (that are represented by a significant proportion of secondary flakes and one primary flake). There is an indication of the use of harder hammer especially on the flakes (the number of blades are too low to give an accurate picture). At the very least, the technique is similar to the flakes in other wadi materials and it is simpler than the technique used to produce the type 1 debitage. The level of platform preparation is similar on both the blades and flakes and so there is no a clear distinction between the treatment of blades and flakes as seen in type 1, fine and medium wadi. The quantity and effort in the production of rough wadi debitage suggests that this is the least important strategy in this area of the site.

As we have at least some representation of the fine, medium and rough wadi reduction strategies present in this trench, I do not think the missing portions of the sequence are very far away. It is possible that they have been missed by the edges of the trench by only a few feet. However, we can see a certain level of distinctive distribution because the type 1 and 16 reduction strategies are fully present.

The goals of each reduction strategy can be seen in the tools. Unfortunately, due to restrictions of access I was unable to analyse the formal tools (fig 1). However, the blade and flake debitage does include non-formal tools (retouched debitage). A similar proportion of the total flakes and blades have been retouched (table 39), though this is less than half the debitage in both cases. There is also a fairly consistent proportion of retouched debitage between the raw materials, with the exception of medium wadi flakes (table 39). This indicates that there are no real distinctions in the non-formal tools assemblage between the different raw materials and reduction strategies. However, personal observation of the formal tools in this assemblage indicates that the majority of the type 1 and 16 raw material is reserved for formal tool production. Sickle blades, points, and vast numbers of small piercers are the most common formal-tools found in this assemblage and they are produced in type 1 and 16 materials, which are associated with the naviform industries (fig. 2). It appears that there are two goals of the naviform strategies. The first is to produce longer blades in the earlier stages of reduction, and these are then used as blanks for the points and sickle blades. The second goal is to produce blade/bladelets and bladelets to be used for piercing tools. Simply from observation, it is clear that the piercing tools are clearly the main aim of the tool production at Wadi Fidan A as there is such a high quantity of them in this trench alone. The quantity of piercing tools suggests that they are related to the main craft output of this site.

The next chapter (Chapter 7) will discuss the analysis of the lithic assemblage from Baja. The results discussed in this chapter will be returned to in Chapter 9 where I will make a comparative analysis of all four assemblages.

List of tables: Chapter 6 (WFA)

Table 1

WFA cores (total 32)					
core type	type 16	type 1	fine wadi	med wadi	rough wadi
single plat flk core					6.3%
opp plat flk core		3.1%	3.1%		
irregular flk core		3.1%			
change of orient flk core			3.1%	3.1%	3.1%
single plat bld core		3.1%			
double plat bld core		3.1%			
naviform	6.3%	56.3%			
single plat bldlet core		6.3%			

Table 2

WFA cores (total 32)							
	grinding	bashing	plat edge flk	grin/bashing	grin/plat edge flk	bashing/plat edge flk	grin/bashing/plat edge flk
single plat flk core		3.1%				3.1%	
opp plat flk core						6.3%	
irregular flk core						3.1%	
change of orient flk core		3.1%				6.3%	
total % of flk core plat prep		**6.3%**				**18.8%**	
single plat bld core						6.3%	
double plat bld core		3.1%					
naviform	3.1%	6.3%	3.1%		3.1%	34.4%	12.5%
single plat bldlet core						3.1%	
total % of bld core plat prep	**3.1%**	**9.4%**	**3.1%**		**3.1%**	**43.8%**	**12.5%**

Table 3

WFA blades total 506					
bld type	type 1	type 16	fine wadi	med wadi	rough wadi
sec bld	3.6%	0.6%	0.2%	0.4%	
sec bld rtch	7.9%		0.2%		
bld	5.1%	1.4%	0.2%	1.6%	0.6%
bld rtch	7.9%	1.4%	0.2%	0.4%	0.4%
sec bld/bldlet	7.9%				0.2%
sec bld/bldlet rtch	4.2%				
bld/bldlet	16.4%	1.4%	2.2%	1.2%	0.2%
bld/bldlet rtch	11.9%	0.8%	1.0%	0.6%	0.2%
sec bldlet	3.4%				
sec bldlet rtch	2%				
bldlet	6.9%	0.2%		1.2%	
bldlet rtch	4.4%		0.2%		
prim bld	0.6%				
Total % bld	**82.2%**	**5.8%**	**4.2%**	**5.2%**	**1.6%**

Table 4

WFA blds total 505	type 16	type 1	fine wadi	med wadi	rough wadi
no plat	**1.7%**	**24.6%**	**1.6%**	**1.2%**	**0.4%**
plain/cort		3.4%		0.2%	
plain	0.8%	6.3%		1.6%	0.8%
punc/cort		2.2%			
punc	1.2%	20.4%	0.6%	0.8%	
fil/cort		0.8%			
fil	1.2%	4.3%	1.2%	0.4%	
dih/cort		0.4%			
dih	0.4%	1.4%	0.4%	0.2%	
faceted	0.6%	3.8%		0.2%	
winged		1.2%		0.2%	0.2%
crushed		4.4%	0.4%	0.6%	0.2%
total% with plat	**4.2%**	**48.6%**	**2.6%**	**4.2%**	**1.2%**

Table 5

WFA bld type 16 (total with plat 21)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on plat**
plain total 4		3 (75%)	1 (25%)					**100.0%**
punc total 6	1 (16.7%)			3 (50%)	1 (16.7%)			**83.4%**
fil total 6	2 (33.3%)		1 (16.7%)	1 (16.7%)	1 (16.7%)		1 (16.7%)	**100.0%**
dih total 2		1 (50%)				1 (50%)		**100.0%**
faceted total 3		1 (33.3%)	1 (33.3%)				1 (33.3%)	**100.0%**

Table 6

WFA bld type 1 (total with plat 295)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on plat**
plain/cort total 17	3 (17.6%)			2 (11.8%)		1 (5.9%)		**35.3%**
plain total 32	4 (12.5%)	1 (3.1%)	4 (12.5%)	4 (12.5%)	8 (25%)	6 (18.6%)		**84.4%**
punc/cort total 11	2 (18.2%)	1 (9.1%)	1 (9.1%)	2 (18.2%)		1 (9.1%)		**63.6%**
punc total 103	21 (20.4%)	5 (4.9%)	2 (1.9%)	26 (25.2%)	40 (38.8%)	3 (2.9%)	5 (4.9%)	**99.0%**
fil/cort total 4			1 (25%)	1 (25%)	1 (25%)			**75.0%**
fil total 72	9 (12.5%)	1 (1.4%)	4 (5.6%)	14 (19.4%)	34 (47.2%)	4 (5.6%)	6 (8.3%)	**100.0%**
dih/cort total 2			1 (50%)					**50.0%**
dih total 7	2 (28.6%)		1 (14.5%)	2 (28.6%)	2 (28.6%)			**100.0%**
faceted total 19	1 (5.3%)	1 (5.3%)	8 (42.1%)	1 (5.3%)	4 (21.1%)	1 (5.3%)	1 (5.3%)	**84.2%**
winged total 6		1 (16.7%)		2 (33.3%)				**50.0%**
crushed total 22		7 (31.8%)	2 (9.1%)	1 (4.5%)	2 (9.1%)	1 (4.5%)	1 (4.5%)	**63.6%**

Table 7

WFA bld fine wadi (total with plat 13)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on plat**
punc total 3	1 (33.3%)			1 (33.3%)	1 (33.3%)			**100.0%**
fil total 6		2 (33.3%)	1 (16.7%)	1 (16.7%)				**66.7%**
dih total 2		1 (50%)						**50.0%**
crushed total 2				1 (50%)				**50.0%**

Table 8

WFA bld med wadi (total with plat 21)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on plat**
plain/cort total 1			1 (100%)					**100.0%**
plain total 8		3 (37.5%)	3 (37.5%)			1 (12.5%)		**87.5%**
punc total 4		2 (50%)	1 (25%)	1 (25%)				**100.0%**
fil total 2	1 (50%)			1 (50%)				**100.0%**
dih total 1								**0.0%**
faceted 1				1 (100%)				**100.0%**
winged 1								**100.0%**
crushed 1		1 (100%)						**100.0%**

Table 9

WFA bld rough wadi (total with plat 6)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash /plat edge flk	**total % of prep on plat**
plain total 4		1 (25%)	2 (50%)					**75.0%**
winged total 1								**0.0%**
crushed total 1		1 (100%)						**100.0%**

Table 10

WFA bld type 16 total with plat 21			
platform		lip	ring crack
plain	prom	1 (4.8%)	
	diff		
fil	prom		
	diff		1 (4.8%)
dih	prom		
	diff	1 (4.8%)	
faceted	prom		
	diff	1 (4.8%)	

Table 11

WFA bld type 1 total with plat 295			
platform		lip	ring crack
plain/cort	prom		
	diff	1 (0.3%)	
plain	prom		
	diff	2 (0.7%)	6 (2%)
punc	prom	3 (1%)	2 (0.7%)
	diff	3 (1%)	
fil	prom		
	diff	4 (1.5%)	
winged	prom		2 (0.7%)
	diff		

Table 12

WFA bld fine wadi total with plat 13			
platform		lip	ring crack
punc	prom		
	diff		1 (7.8%)

Table 13

WFA bld med wadi total with plat 21			
platform		lip	ring crack
faceted	prom		
	diff	1 (4.8%)	

Table 14

WFA bld type 16 total with plat 21				
plat	bulb	lrg eraillure	clear cone	lrg erillure/ clear cone
plain	prom		1 (4.8%)	1 (4.8%)
	diff	1 (4.8%)		
punc	prom			
	diff	1 (4.8%)	2 (9.5%)	1 (4.8%)
fil	prom			
	diff		1 (4.8%)	1 (4.8%)
dih	prom		1 (4.8%)	
	diff			1 (4.8%)
faceted	prom			1 (4.8%)
	diff			

Table 15

WFA bld type 1 total with plat 295					
plat	bulb	lrg eraillure	clear cone	lrg erillure/ clear cone	conical
plain/cort.	prom		2 (0.7%)		
	diff	5 (1.7%)	1 (0.3%)	1 (0.3%)	
plain	prom	2 (0.7%)	4 (1.4%)	2 (0.7%)	
	diff	3 (1%)	6 (2%)	2 (0.7%)	1 (0.3%)
	no bulb	1 (0.3%)			
punc/cort.	prom		1 (0.3%)		
	diff	2 (0.7%)			
punc	prom	3 (1%)	5 (1.7%)	4 (1.4%)	
	diff	6 (2%)	10 (3.4%)	5 (1.7%)	
	no bulb	1 (0.3%)			
fil/cort.	prom				
	diff		1 (0.3%)		
fil	prom		3 (1%)		
	diff	9 (3.1%)	15 (5.9%)	2 (0.7%)	
winged	prom		2 (0.7%)		
	diff				
dih	prom			1 (0.3%)	
	diff		2 (0.7%)		
faceted	prom	1 (0.3%)	5 (1.7%)		
	diff	2 (0.7%)	1 (0.3%)		
	no bulb	1 (0.3%)			
crushed	prom		1 (0.3%)		
	diff	4 (1.4%)	2 (0.7%)	1 (0.3%)	
	no bulb	4 (1.4%)			

Table 16

WFA bld fine wadi total with plat 13				
plat	bulb	lrg eraillure	clear cone	lrg erillure/ clear cone
punc	prom		1 (7.7%)	
	diff			
fil	prom			
	diff	3 (23.1%)		
crushed	prom			
	diff			
	no bulb	1 (7.7%)		

Table17

WFA bld med wadi total with plat 21				
plat	bulb	lrg eraillure	clear cone	lrg erillure/ clear cone
plain/cort	prom			
	diff		1 (4.5%)	
plain	prom			
	diff		4 (19%)	1 (4.8%)
punc	prom		1 (4.8%)	
	diff			
fil	prom			
	diff	1 (4.8%)		
dih	prom	1 (4.8%)		
	diff			
winged	prom			
	diff		1 (4.8%)	
dih	prom	1 (4.8%)		
	diff			
facted	prom		1 (4.8%)	
	diff		1 (4.8%)	
crushed	prom	1 (4.8%)		
	diff			

Table 18

WFA bld rough wadi total with plat 6				
plat	bulb	lrg eraillure	clear cone	lrg erillure/ clear cone
plain	prom			
	diff		3 (50%)	
winged	prom		1 (16.7%)	
	diff			

Table 19

WFA blds the platform features and bulb features that appear in the same blade							
platform	bulb	lip/clear cone	lip/lrg eraillure	lip/clear cone/lrg eraillure	ring crack/clear cone	ring crack/lrg eraillure	ringcrack/clearcone/lrg eraillure
type 16 total with plat 21							
plain	prom			1 (4.8%)			
	diff						
fil	prom						
	diff				1 (4.8%)		
dih	prom						
	diff			1 (4.8%)			
type 1 total with plat 295							
plain	prom				1 (0.3%)		
	diff				2 (0.7%)		
punc	prom	1(0.3%)			1 (0.3%)		
	diff		1 (0.3%)				
med wadi total with plat 21							
faceted	prom						
	diff	1 (4.8%)					

Table 20

WFA blds total with plat 356	lip	ring crack	clear cone	lip/clear cone	ring crack/ clear cone	conical
plain/cort	0.3%		1.4%			
plain	0.6%	0.8%	5.6%	0.3%	0.8%	0.3%
punc/cort			0.3%			
punc	1.4%	0.6%	7.6%	0.3%	0.3%	
fil/cort			0.3%			
fil	1.1%		5.9%		0.3%	
winged		0.6%	0.8%			
dih			0.8%	0.3%		
faceted	0.3%		2.5%	0.3%		
crushed			1.1%			
total %	**3.7%**	**2.0%**	**26.0%**	**1.2%**	**1.4%**	**0.3%**

Table 21

WFA flk total 367	type 16	type 1	fine wadi	med wadi	rough wadi
sec flk	2.5%	20.7%	2.2%	3.5%	1.6%
sec flk rtch	0.8%	9.3%	1.9%	2.5%	1.9%
flk	3.5%	12.8%	1.6%	12.0%	2.7%
flk rtch	0.8%	5.7%	1.9%	5.7%	2.5%
prim flk		1.6%	0.3%	0.5%	0.3%
prim flk rtch	0.3%	0.5%			
total %	**15.1%**	**50.6%**	**7.9%**	**24.2%**	**9.0%**

Table 22

WFA flks total 367	type 16	type 1	fine wadi	med wadi	rough wadi
no plat.	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
plain/cort	1.1%	6.0%	0.3%	0.5%	0.5%
plain	3.3%	10.0%	4.4%	13.9%	5.7%
punc/cort		0.3%			
punc	0.8%	8.2%	0.8%	2.2%	0.5%
fil/cort		1.1%			
fil	0.5%	4.6%	0.5%	0.5%	0.8%
dih/cort		0.3%			
dih	0.5%	4.1%	0.8%	1.6%	0.3%
faceted/cort		0.3%			
faceted	0.5%	5.7%	0.5%	1.9%	0.3%
winged/cort		1.1%			
winged	0.5%	2.7%	0.3%	1.4%	0.3%
crushed	0.5%	7.1%	0.3%	1.9%	0.3%
total % with plat	**7.7%**	**51.5%**	**7.9%**	**23.9%**	**8.7%**

Table 23 (All the flakes retain their platforms.)

WFA flks type 16 (total 29)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash /plat edge flk	total % of prep on a plat
plain/cort total 4		1 (25%)	1 (25%)					50.0%
plain total 12	1 (8.3%)		6 (50%)			4 (33.3%)		91.6%
punc total 3	1 (33.3%)		1 (33.3%)					66.6%
fil total 2		1 (50%)		1 (50%)				100.0%
dih total 2	1 (50%)	1 (50%)						100.0%
faceted total 2		1 (50%)						50.0%
winged total 2		1 (50%)	1 (50%)					100.0%
crushed total 2		1 (50%)						50.0%

Table 24

WFA flks type 1 (total 188)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash / plat edge flk	total % of prep on a plat
plain/cort total 23	5 (21.7%)	1 (4.3%)	3 (13%)					39.0%
plain total 36		8 (22.2%)	16 (44.4%)	3 (8.3%)		4 (11.1%)		86.0%
punc/cort total 1								0.0%
punc total 30	6 (20%)	6 (20%)	4 (13.3%)	3 (10%)	5 (16.7%)	1 (3.3%)	1 (3.3%)	86.6%
fil/cort total 4	1 (25%)				1 (25%)			50.0%
fil total 17	1 (5.9%)	2 (11.8%)	2 (11.8%)	2 (11.8%)	1 (5.9%)	4 (23.5%)	3 (17.6%)	88.3%
dih/cort total 1								0.0%
dih total 15		1 (6.7%)	4 (26.7%)		2 (13.3%)	3 (20%)		66.7%
faceted/ cort total 1								0.0%
faceted total 21	1 (4.8%)	1 (4.8%)	8 (38.1%)	1 (4.8%)	4 (19%)	2 (9.5%)		81.0%
winged/ cort total 4		1 (25%)	1 (25%)					50.0%
winged total 10		2 (20%)	2 (20%)			5 (50%)		90.0%
crushed total 26		8 (30.8%)	1 (3.8%)			4 (15.4%)		50.0%

Table 25

WFA fIks fine wadi (total 29)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
plain/cort total 1			1 (100%)					**100.0%**
plain total 16		5 (31.3%)	4 (25%)	1 (6.3%)		2 (12.5%)	1 (6.3%)	**81.4%**
punc total 3	1 (33.3%)	1 (33.3%)		1 (33.3%)				**100.0%**
fil total 2		1 (50%)			1 (50%)			**100.0%**
dih total 3						1 (33.3%)		**33.3%**
faceted total 2			1 (50%)			1 (50%)		**100.0%**
winged total 1						1 (100%)		**100.0%**
crushed total 1								**0.0%**

Table 26

WFA flks med wadi (total 89)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
plain/cort total 3						1 (33.3%)		**33.3%**
plain total 51		9 (17.6%)	14 (27.5%)	1 (2%)		6 (11.8%)		**58.9%**
punc total 8		2 (25%)	1 (12.5%)		1 (12.5%)	1 (12.5%)		**62.5%**
fil total 2	1 (50%)							**50.0%**
dih total 6			4 (66.7%)					**66.7%**
faceted total 7		1 (14.3%)	4 (57.1%)			2 (28.6%)		**100.0%**
winged total 5		2 (40%)	1 (20%)					**60.0%**
crushed total 7		3 (42.9%)	1 (14.3%)			1 (14.3%)		**71.5%**

Table 27

WFA flks rough wadi (total 32)	grin	bash	plat edge flk	grin/ bash	grin/plat edge flk	bash/ plat edge flk	grin/ bash/ plat edge flk	**total % of prep on a plat**
plain/cort total 2						1 (50%)		**50.0%**
plain total 21		5 (23.8)	3 (14.3%)			2 (9.5%)		**47.6%**
punc total 2		1 (50%)				1 (50%)		**100.0%**
fil total 3		3 (100%)						**100.0%**
dih total 1								**0.0%**
faceted total 1						1 (100%)		**100.0%**
winged total 1								**0.0%**
crushed total 1								**0.0%**

Table 28

WFA flk type 16 total 29			
platform	bulb	lip	ring crack
plain	prom	(1) 3.4%	
	diff	(1) 3.4%	
punc	prom	(1) 3.4%	

Table 29

WFA flk type 1 total 188			
platform	bulb	lip	ring crack
plain	prom		(2) 1.1%
	diff	(1) 0.5%	(1) 0.5%
punc	prom	(1) 0.5%	(1) 0.5%
	diff	(1) 0.5%	
fil	prom	(1) 0.5%	(1) 0.5%
dih	diff	(1) 0.5%	
faceted	prom		(2) 1.1%
	diff	(2) 1.1%	
winged	diff		(1) 0.5%

Table 30

WFA flk fine wadi total 29			
platform	bulb	lip	ring crack
plain	prom		(2) 6.9%
	diff	(1) 3.4%	(2) 6.9%

Table 31

WFA flk med wadi total 89			
platform	bulb	lip	ring crack
plain/cort	diff		(1) 1.1%
plain	diff		(4) 4.5%
faceted	diff	(1) 1.1%	(1) 1.1%

Table 32

WFA flk rough wadi 32			
platform	bulb	lip	ring crack
plain	diff		(2) 6.3%

Table 33

WFA flk type 16 total 29				
platform	bulb	lrg eraillure	clear cone	lrg eraillure/ clear cone
plain/cort	diff	(1) 3.4%	(2) 6.9%	
plain	prom		(3) 10.3%	(2) 6.9%
	diff		(3) 10.3%	
punc	prom		(1) 3.4%	
	diff	(1) 3.4%		
dih	prom	(1) 3.4%		
faceted	diff	(1) 3.4%		
winged	diff		(1) 3.4%	
crushed	diff	(1) 3.4%		
	no bulb	(1) 3.4%		

Table 34

WFA flk type 1 total 188					
platform	bulb	lrg eraillure	clear cone	lrg eraillure/ clear cone	conical
winged/ cort	prom		(1) 0.5%		
	diff	(2) 1.1%	(1) 0.5%		
winged	prom		(7) 3.7%		
	diff	(1) 0.5%	(1) 0.5%		
punc	prom	(3) 1.6%	(3) 1.6%	(1) 0.5%	
	diff	(1) 0.5%	(5) 2.7%	(1) 0.5%	
faceted/ cort	diff	(1) 0.5%			
faceted	prom	(1) 0.5%	(2) 1.1%	(1) 0.5%	
	diff	(1) 0.5%	(5) 2.7%	(1) 0.5%	
plain/cort	prom	(2) 1.1%	(2) 1.1%	(1) 0.5%	(1) 0.5%
	diff	(2) 1.1%	(1) 0.5%		
plain	prom		(9) 4.8%	(4) 2.1%	
	diff		(10) 5.3%	(4) 2.1%	
fil/cort	prom		(1) 0.5%		
	diff		(1) 0.5%		
fil	prom	(2) 1.1%	(1) 0.5%		
	diff		(1) 0.5%	(1) 0.5%	
dih/cort	prom	(1) 0.5%			
dih	prom	(2) 1.1%	(2) 1.1%		
	diff	(2) 1.1%	(1) 0.5%		
crushed	prom	(3) 1.6%	(2) 1.1%		
	diff	(4) 2.1%	(1) 0.5%		
	no plat	(5) 2.7%		(1) 0.5%	

Table 35

WFA flk fine wadi total 29				
platform	bulb	lrg eraillure	clear cone	lrg eraillure/ clear cone
plain/cort	prom		(1) 3.4%	
plain	prom		(6) 20.7%	
	diff		(5) 17.2%	(1) 3.4%
punc	diff			(1) 3.4%
fil	diff		(1) 3.4%	
dih	prom		(2) 6.9%	
faceted	prom		(1) 3.4%	
	diff		(1) 3.4%	
winged	prom		(1) 3.4%	
crushed	diff	(1) 3.4%		

Table 36

WFA flk med wadi total 89					
platform	bulb	lrg eraillure	clear cone	lrg eraillure/ clear cone	clear cone/siret
plain/cort	diff		(3) 3.4%		
plain	prom	(1) 1.1%	(10) 11.2%		
	diff	(1) 1.1%	(16) 18%	(3) 3.4%	
	no bulb	(1) 1.1%			(1) 1.1%
punc	prom		(1) 1.1%		
dih	prom		(3) 3.4%		
	diff		(1) 1.1%		
faceted	prom		(4) 4.5%		
	diff		(1) 1.1%		
winged	prom		(2) 2.2%		
	diff		(3) 3.4%		
crushed	diff	(1) 1.1%	(1) 1.1%		
	no bulb	(1) 1.1%			

Table 37

WFA flk rough wadi total 32				
platform	bulb	lrg eraillure	clear cone	lrg eraillure/ clear cone
plain/cort	prom	(1) 3.1%		
plain	prom		(5) 15.6%	(1) 3.1%
	diff	(1) 3.1%	(8) 25%	(1) 3.1%
punc	diff			(1) 3.1%
fil	prom		(1) 3.1%	
faceted	diff		(1) 3.1%	
winged	diff			(1) 3.1%
crushed	no plat	(1) 3.1%		

Table 38

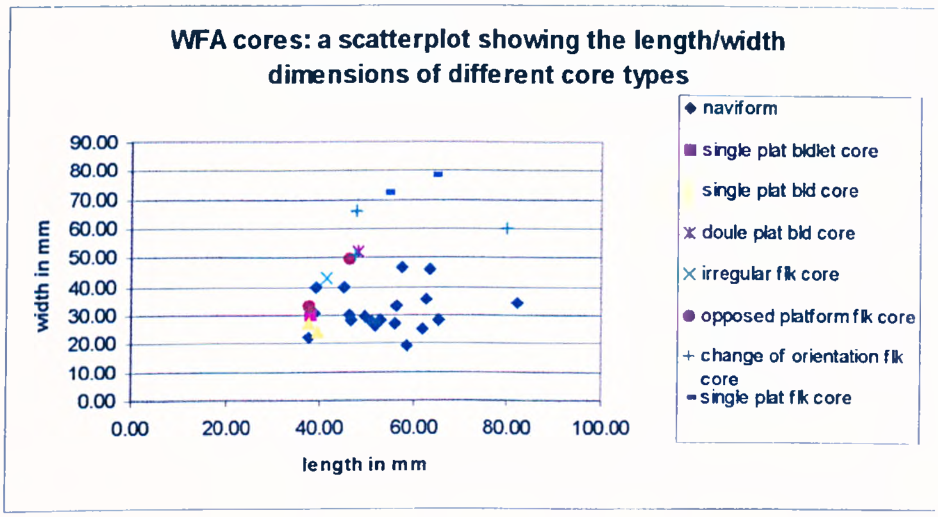
WFA flk platform and bulb features on the same flake						
Plat-form	bulb	lip/clear cone	lip/lrg earillure	ring crack/clear cone	ring crack/lrg eraillure	ring crack/clear cone/lrg eraillure
type 16 total 29						
plain	prom	(1) 3.4%				
type 1 total 188						
plain	prom			(1) 0.5%		
	diff					(1) 0.5%
punc	prom					(1) 0.5%
fil	prom				(1) 0.5%	
	diff		(1) 0.5%			
faceted	prom			(1) 0.5%		
	diff	(1) 0.5%				
winged	diff			(1) 0.5%		
fine wadi total 29						
plain	prom			(2) 6.9%		
med wadi total 89						
plain/cort.	diff			(1) 1.1%		
plain	diff			(1) 1.1%		
faceted	diff			(1) 1.1%		
rough wadi total 32						
plain	diff			(1) 3.1%	(1) 3.1%	

Table 39

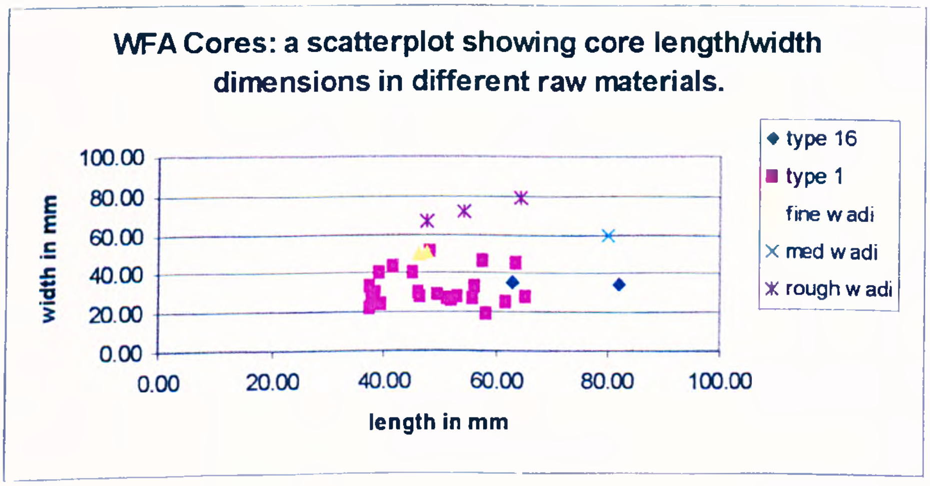
WFA non-formal tools	type 16	type 1	fine wadi	med wadi	rough wadi	total in no.
flakes all	29	188	29	89	32	367
flakes non-formal tools	10	64	14	30	19	137
total non-formal tools %	**34.5%**	**34.0%**	**48.3%**	**33.7%**	**59.4%**	**37.3%**
blades all	31	419	21	27	8	506
blades non-formal tools	12	194	8	5	2	221
total non-formal tools %	**38.7%**	**46.3%**	**38.1%**	**7.4%**	**25.0%**	**43.7%**

List of Graphs: Chapter 6 (WFA)

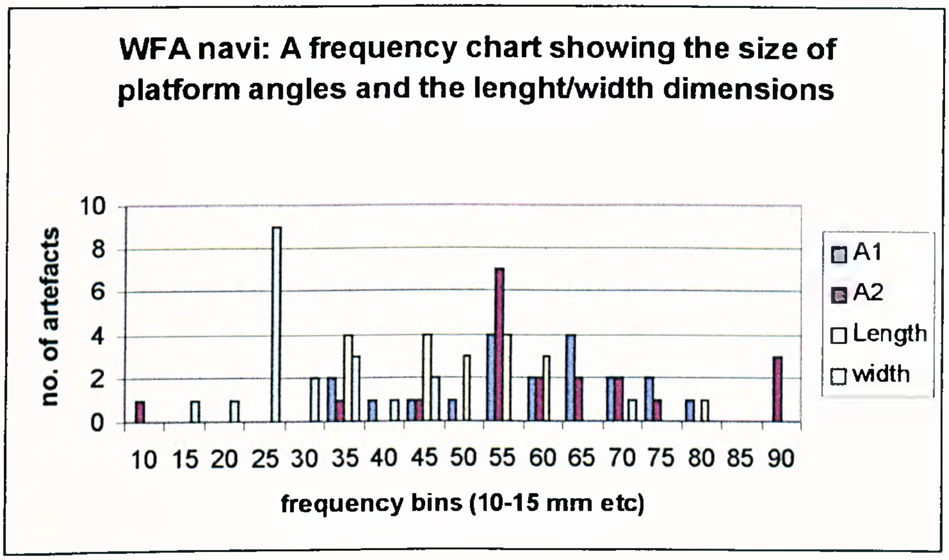
Graph 1



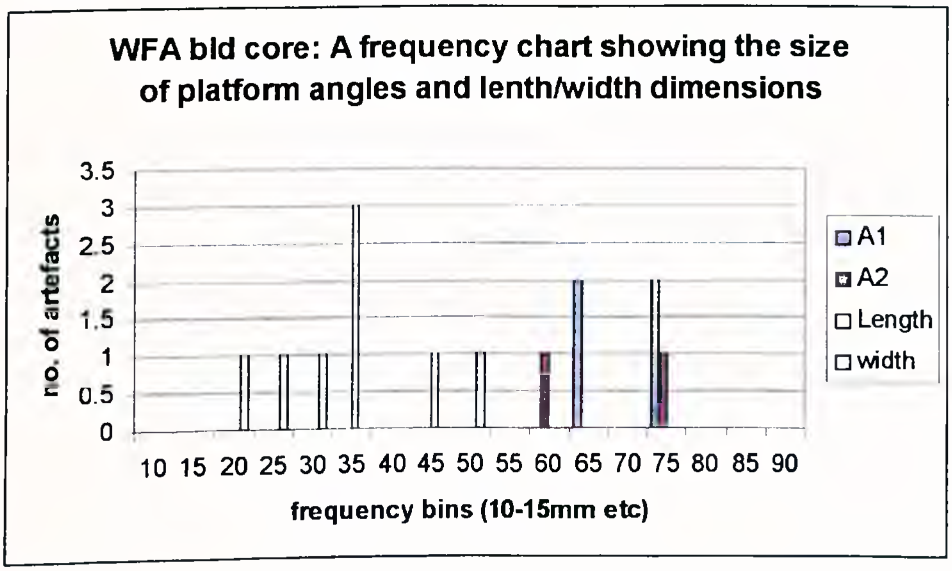
Graph 2



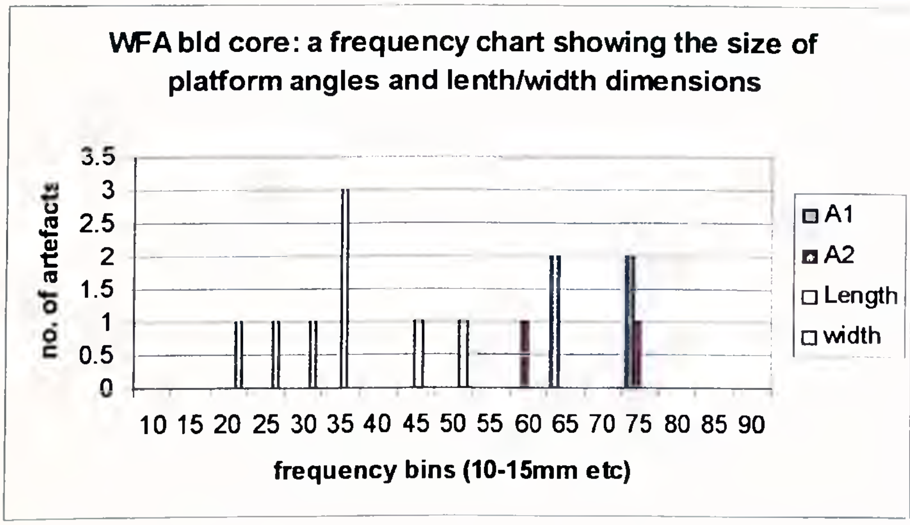
Graph 3



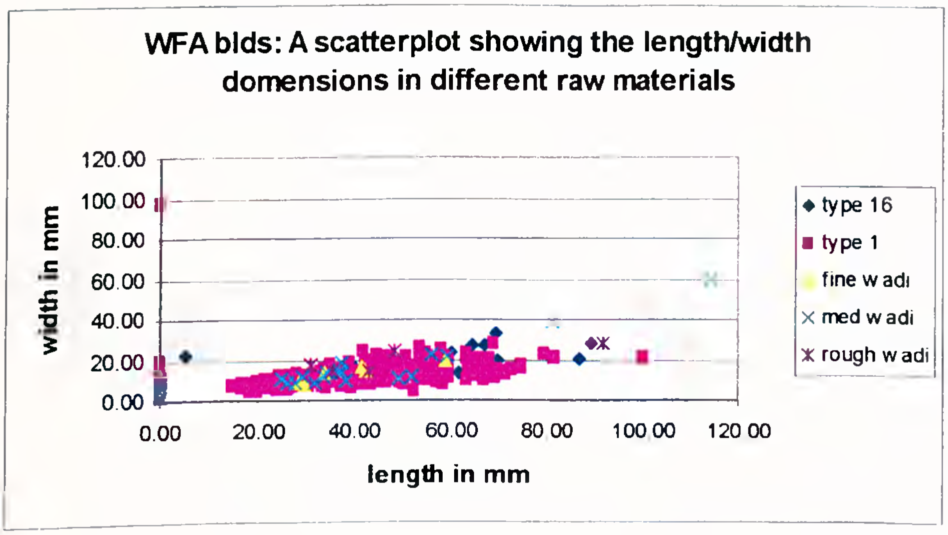
Graph 4



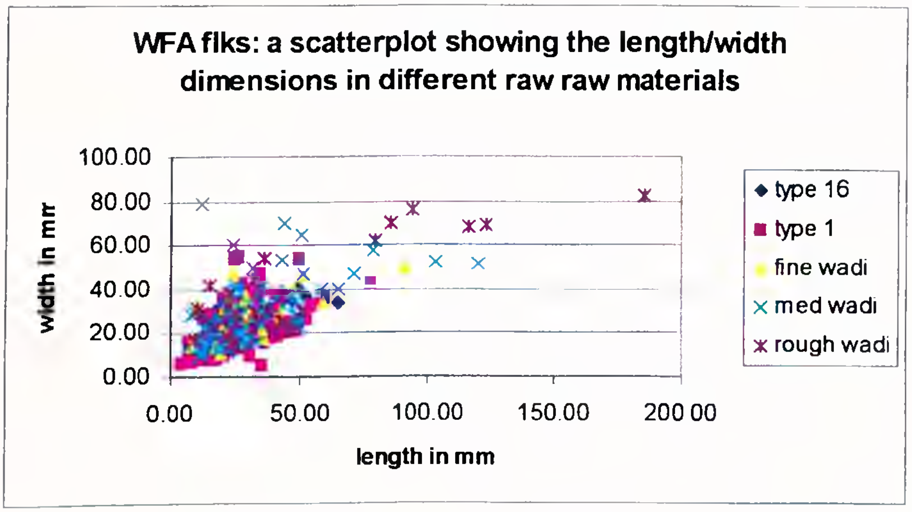
Graph 5



Graph 6



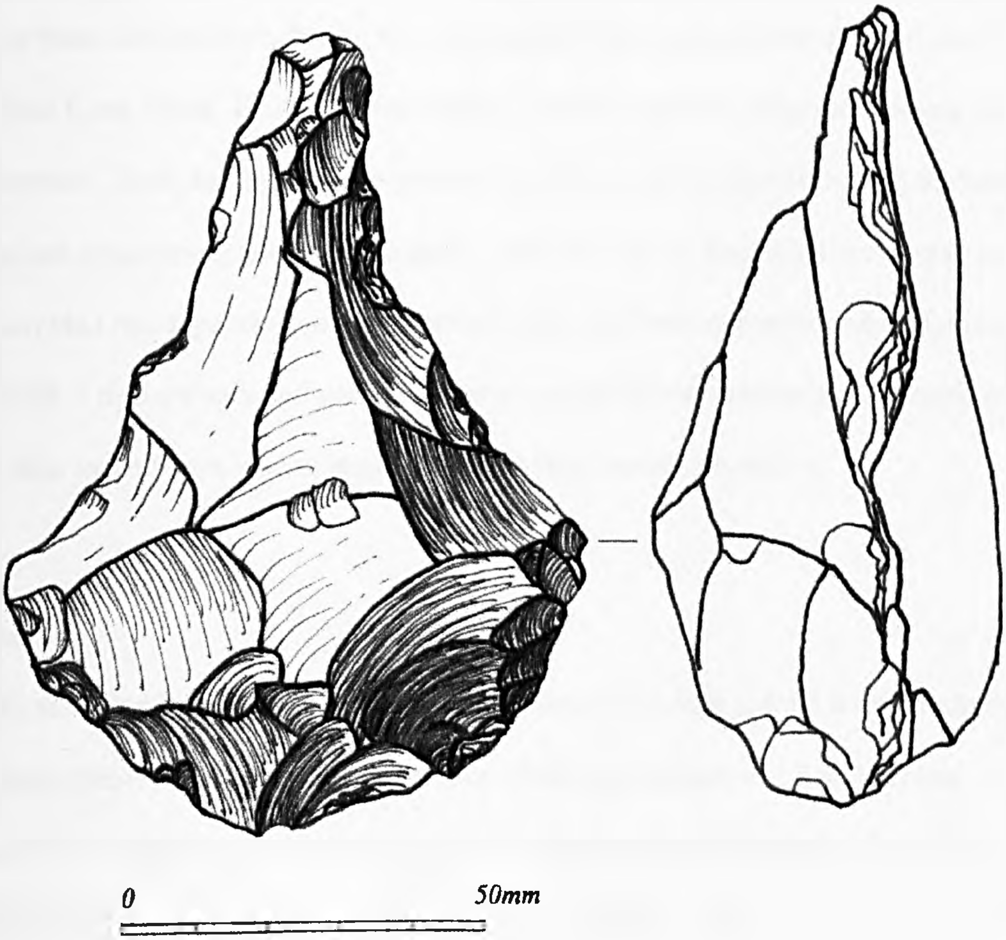
Graph 7



WFA flks: a scatterplot showing the length/width dimensions in different raw raw materials
100.00
80.00
60.00
40.00
20.00
0.00
width in mm
0.00
50.00
100.00
150.00
200.00
length in mm
type 16
type 1
fine wadi
med wadi
rough wadi

List of Figures: Chapter 6 (WFA)

Fig. 1 Example of a core tool from WFA. Time constraints prevented me from analysing and drawing other formal tools.



Chapter 7

Analysis of the Baja lithic assemblage

This chapter has been separated into twelve sections. Nine sections cover lithic types and the other three sections include site, raw material and summary and conclusion. The lithic types include Core, Blade, Flake, Indeterminates, Crested elements, Rejuvenation elements, Overshots, Tools and Spalls. The section on cores is sub-divided into type, dimensions, platform preparation, and platform angle. The six sections from Blade to Overshots are subdivided into type, dimensions, platform type, platform preparation, and platform and bulb features. The Summary and conclusion reviews the different reduction strategies identified in the Baja assemblage, discussing each stage of the *chaîne opératoire*.

Baja: site

Dr H. G. Gebel has suggested that this assemblage from Baja is from a workshop dump context (Gebel *pers. com.* 1998). Analysis of this assemblage will help to refine understanding of the nature of this workshop dump. Due to time constraints, the analysis is based on a sample of roughly 50% of the total assemblage. All of the cores have been recorded, though it is important to note that Gebel removed some of the naviform cores.

Baja: raw materials

The raw materials at this site are very similar to those found at Ghwair (appendix 1), though I do not know where the local sources are. The only exception is that of the baja fine at Baja, it is comparable to the same raw material at Ghwair though the cortex does not indicate that it is wadi rolled (it is soft and powdery). This suggests that the baja fine at Baja did not come from an original source but rather from an area subject to strong water movement. In this case, the term wadi is misleading and so I shall re-name the fine wadi raw material as baja fine raw material.

Medium and rough wadi are wadi rolled and I found similar wadi type raw materials at Ghwair, in wadi beds as far south as Petra, and as far north as Jerash. Therefore, I am assuming that the medium and rough wadi flint came from the closest wadi to the site of Baja. Type 16 is not present in the Baja core assemblage, but type 1 is relatively common. The type 1 raw material at Baja is not found in wadi beds and the cortex is not extensively weathered, consequently there are two possible sources. Either it is exclusively found somewhere close to the Wadi Faynan area and is being imported over long distances from that source, or that there is more than one source for this flint though it still remains less common as the other flint raw materials at Baja.

Baja: core type

It is important to note that as Gebel removed under fifteen naviform cores from this assemblage there are relatively few blade cores present (Gebel *pers. com.* 1998). All are found in baja fine raw material, only one blade core is single platform and the rest are naviform blade cores (table 1). The naviform cores present are a 'variant' type (appendix 4) in the sense that they are not fully crested down the back of the core as the 'classic' naviform is (fig 1). The naviforms removed by Gebel are also of this variant type. This type may be the result of the original nodule shape allowing the knapper to proceed without need for a crest down the back or it may point to the fact that these cores are heavily reduced and have lost their original crests. It is not possible to assess what raw materials those naviforms removed from the assemblage were produced in as I have not personally viewed them.

Flake cores are the most common core type, however, this ratio will be changed by the count of naviform cores that have been removed from this assemblage. The majority of flake cores are produced in type 1 and there is a much wider variety than blade cores. A significant proportion of the flake cores are opposed platform or bipolar in both type 1 and opposed platform and bi-directional in baja fine raw material, however, the most important types are irregular and change of orientation flake cores (table 1). These particular flake cores are also heavily reduced, particularly those in type 1. Medium and rough wadi cores are irregular in form and low in number suggesting that these raw materials are unimportant. There are no cores in type 16 raw material present in this assemblage, though there is type 16 debitage. It is possible that some of the naviforms removed by Gebel are produced in type 16, but the low quantity of debitage and tools in this raw material makes this unlikely.

Baja: core dimensions

The type 1 flake cores cluster together between 20-40mm in length which is unusually small (graph 1and 2). A fair number of these flake cores have opposed platform or bipolar elements some of which have piece esquillée crushing. This is a distinct group of flake cores though it is not clear whether they were used to produce tiny flakes or were used as wedges of some sort (hence the esquillée crushing).

The baja fine cores also cluster in a distinct group between 50-80mm (graph 2). The flake (particularly the opposed platform and bipolar flake cores) and blade cores are generally similar in size. There are also two baja fine change of orientation flake cores that fall in the middle of the type 1 core cluster, however, the width of these two cores are similar to the naviform cores though they are shorter, indicating that they could be exhausted naviform cores. Therefore, as the size, raw material and, in some cases, the form of these flake cores all relate to the naviforms it is possible that the baja fine flake cores are reused naviforms, or at the very least, are produced on preforms of a very similar size to the naviform blade cores. The only medium wadi core is significantly wider than all the other cores, though its length is similar to the majority of cores in type 1 (graph 2).

The two rough wadi flake cores are irregular types (graph 1 and 2) and are similar in size. They fall in between the type 1 and baja fine clusters.

Baja: core platform preparation

All of the cores show preparation on the platforms. Bashing and platform edge flaking are the main methods of preparation, however, grinding is more commonly used on the blade cores (table 2, appendix 3). The difficulty of analysing platform preparation on core platforms arises from the fact that debitage removals tend to remove the focal points of the preparation and it is not in the knappers interest to further prepare a core platform prior to discarding it. Therefore, the picture is incomplete and it is necessary to relate platform preparation on cores to preparation on the debitage.

Baja: core platform angle

There is a suggestion of a correlation between platform angle and length of the naviform cores, however, the relationship is not clear as the numbers are low. The flake cores such as the bipolar, single and opposed platform are also too low in number to demonstrate any clear correlation. There is no direct relationship between platform angle and core size on the more irregular flake cores.

Baja: blade type (appendix 2)

The blade assemblage includes type 16 raw material though there are only three examples. None of these blades have been retouched and two out of the three are blade/bladelets that do not retain any cortex. Unfortunately this sample size is too small to analyse the metrics with any confidence.

Over three quarters of the type 1 blade assemblage are smaller pieces under 50mm in length (bladelets and blade/bladelets, table 3). Just over half of the blades retain cortex. A similar quantity is retouched though most of these do not retain any cortex.

Just over three quarters of the baja fine blades are under 50mm (bladelets and blade/bladelets) and one quarter of the blades retain cortex (table 3). Only 9.7% of the baja fine blades are retouched (this is just over one seventh) and the majority of these blades do not retain any cortex.

Roughly three quarters of the medium wadi blade assemblage is under 50mm in length, much like the blades in type 1 and baja fine (table 3). Just over a third of the blades retain cortex. A little under a half of the medium wadi blades are retouched which is similar to the retouched levels in type 1.

The proportion of rough wadi blades that are under 50mm is lower than type 1, fine and medium wadi (it works out that a ratio of *c.* 4/6 are under 50mm in length). There are also proportionally fewer examples of blades that retain cortex in rough wadi than in the other raw materials (table 3). The blades in this raw material also have the lowest levels of retouch. The low quantity of blades in rough wadi brings into question whether or not the results are meaningful in this raw material.

Type 16 is present in the blade assemblage, though the quantity indicates that it is not an important raw material in this particular assemblage (it may be more important elsewhere on the site). There are no cores in this raw material suggesting that they are missing from the assemblage. Baja fine is the most important raw material for the production of blades and they are related to the baja fine naviform core industry, which is the most common type of blade core. Type 1 and medium wadi are of equal importance for the production of blades after baja fine.

Generally, it is the smaller blade/bladelets and bladelets that are most important in all raw materials. The overall levels of retouch are relatively low (particularly in fine and rough wadi) on the blades in this workshop dump. This may be a result of the nature of this particular context, which is an area of discarded waste and consequently many retouched tools may have been removed. Where there are retouched blanks, it is clear that the knappers favoured debitage that did not retain any cortex.

Baja: blade dimensions

The blades in type 16 are a little longer than the bulk of the Baja blade assemblage (graph 4). However, not much more can be said about the dimensions of these blades, as there are no type 16 cores to compare them with.

The type 1 blades tend to range between 19-40mm in length. The type 1 flake cores are so distinctive and small that there is no evidence to suggest that they were originally blade cores. This means that the type 1 blade cores are missing from this assemblage, either they are some of the naviforms removed by Gebel or they were never deposited in this dump (graphs 1,2 and 4).

The blades in baja fine cover the widest dimensional range from 13 to 57mm in length (graph 4). The naviform cores range between 52-77mm and so the majority of baja fine blades could have come from these cores (graphs 1 and 2). However, it appears that there are some larger blades not present in this assemblage, they will be between 57-77mm in length. There is one blade that is longer than any of the naviform cores (84.3mm), hinting at the full extent of the naviforms before they were reduced.

The medium wadi blades range between 10-51mm in length and the only core in medium wadi (which is a flake core) is 30.4mm in length (graphs 1,2 and 4). It is most likely that the longer blades did not come from this core, though it is possible that this core began life as a blade core and was then reused as a flake core. If the blades did not come from these particular cores then there are missing medium wadi blade cores that were not discarded in this workshop dump.

The blades in rough wadi range between 1.3-23.5mm and are generally relatively small in comparison to many blades in other raw materials (graph 4). The rough wadi flake cores are 43.8 and 45.5mm in length and so it is possible that they were removed from these cores (graphs 1 and 2). However, these are flake cores that are significantly longer than the blades and so it is not possible to argue that blade scars have been obscured on the removal surface by heavy reduction (because you would expect the cores to be either the same size or smaller than the blades). So, there may also be rough wadi blade cores missing from this workshop dump.

The blade dimensions in all raw materials generally cluster together, suggesting that the knappers at Baja had a favoured size range for blades.

Baja: blade platform type

The only platforms on type 16 blades are punctiform and filiform (table 4).

The largest number of platforms on the type 1 blades are plain, but punctiform and filiform are almost as important (table 4).

On baja fine blades, the most important platforms are punctiform and filiform.
On medium and rough wadi blades punctiform is the most important platform type.
It is clear that the smaller platforms are important regardless of the raw material; this is probably linked to the importance of blade/bladelets and bladelets in the Baja blade assemblage.

Baja: blade platform preparation

There are three different methods of preparation used at Baja, often in combination.
In type 16 all of the blade platforms are prepared and grinding is important (table 5).
However, this sample is too small to discuss with much confidence.

The smaller platforms on type 1 blades have the highest levels of preparation and grinding is again relatively important (table 6). The other types of platforms have received lower levels of preparation and there is no use of grinding. However, the sample of type 1 blades is small and so this trend is not clearly demonstrated.

On baja fine blades there are high levels of preparation on the smaller platforms and grinding is an important method of preparation. Other platform types have received lower levels of preparation.
In medium wadi blades there are relatively low levels of platform preparation overall, including the smaller platforms (table 8). Grinding is not utilised on this raw material.
However, the sample is small and so this pattern of data is not clearly demonstrated.

On rough wadi blades there is a low level of preparation on the punctiform platforms and grinding has not been utilised at all on this raw material (table 9). However, the sample is too small to discuss with much confidence.

The knappers at Baja put more time and effort into the preparation of blades in type 1, 16 and baja fine raw materials. They particularly concentrated on the preparation of cores when producing blades with smaller platforms like punctiform and filiform. Medium and rough wadi blades were not prepared as well, despite the fact that the majority of platforms were small like those in the other raw materials. This suggests that careful preparation, (using grinding as well as other methods) was not used because it was absolutely necessary in order to successfully remove a blade with a small platform, but probably because it increased the prospects of effective removals of blades with desired regularity in form.

Baja: blade platform and bulb features

The platform and bulb features occur too infrequently to allow for any conclusive results on hammer type (appendix 3). There is only one platform feature and this is in type 16, a lip in association with a diffuse bulb. However, the research so far has not conclusively demonstrated that lips are simply due to softer hammer technique (Chapter 5, 77-78) and the appearance of the bulb type (prominent or diffuse) is subjective to the analyst.

Large eraillures are not important unless found in association with clear cones which does not happen in this blade assemblage (Chapter 5, 77). Clear cones can be found on only 7.5% of the blade assemblage that still retain their platforms (a total of 64 blades); unfortunately this is a rather low percentage to confidently assess hammer type.

The clear cones are only found on type 1, fine, and medium wadi blades, four of which are associated with diffuse bulbs and one with a prominent bulb. These results are inconclusive and do not indicate any dominant hammer technique. As assessing bulb type is subjective, analysing platform and bulb features that occur in association has helped clarify hammer technique in other assemblages. Unfortunately there are no examples of both platform and bulb features occurring on the same blade in this assemblage. Therefore, it is not possible to make any assessment of hammer technique on the blade assemblage from this workshop dump at Baja. However, this lack of technique indicators is in itself distinctive and will be interesting to compare to other assemblages.

Baja: blade opposed platform scars

Scars on the dorsal surface of the blades can indicate the direction that a previous removal was taken from. In the case of the baja fine blades there are a significant number of opposed platform scars on the dorsal surface. This is unsurprising considering that the naviform cores in the assemblage were produced in baja fine. There are only two other examples of opposed platform scarring on the dorsal surface, one is on a type 16 blade and the other on a type 1 blade. One blade in type 16 is not a significant quantity but, considered in association with the fact that the type 16 blade platforms were prepared in a similar way to the baja fine blades, it hints at the possibility that there is an opposed platform blade industry in type 16 though the cores are not present in the workshop dump to conclusively demonstrate this (the low quantity of type 1 debitage suggests that few or none of the naviform cores removed by Gebel will be in type 16). The type 1 blades have also been prepared in a similar way to the baja fine blades (the debitage quantity suggests that a fair number of the cores removed by Gebel could be in type 1 raw material). There are no opposed platform scars on medium and rough wadi blades and I do not think that it is coincidence that less time is spent on preparing these blade platforms. These scars hint at the fact that the level of effort put into preparing the blade platforms is linked to the use of opposed platform (probably naviform) reduction strategies.

Baja: flake type

Type 16 raw material is not important in the flake assemblage and makes up a similar proportion to the blade assemblage (tables 3 and 15). The main group in this raw material is retouched flakes, however, it is too small a sample to say much about it.

The most important groups in type 1 are flakes and retouched flakes. Half of the type 1 flake assemblage is retouched and the majority of flakes do not retain any cortex. This level of retouch is similar to that on the type 1 blades (tables 3 and 15).

Baja fine is the most extensively utilised raw material for the production of flakes. Very few retain cortex and very few are retouched; much like the baja fine blades (tables 3 and 15). However, baja fine raw material is proportionally more important for the production of blades than for flakes in this assemblage (tables 3 and 15).

In medium wadi, secondary flakes and flakes are the largest groups. There are slightly more flakes that retain cortex than flakes that do not and just under a third of the total are retouched. This differs significantly from the medium wadi blade assemblage where there are fewer with cortex and with retouch (tables 3 and 15). This raw material is also proportionally more important in the flake assemblage than in the blade assemblage.

In the rough wadi flake assemblage, flakes are the largest group. Half of the flakes in this raw material retain cortex but very few flakes are retouched. The rough wadi blades do not retain cortex in such a high proportion though a similar percentage are retouched. However, the rough wadi flakes are proportionally much more important than the blades, though the blade sample is possibly too small to make any meaningful comparisons to the flakes.

Cortex refers to flakes that have been removed in a fully cortical layer of the flint, but it is not clear which raw material produced this type of cortex. This cortex may be from a nodule of flint (the flakes do have tiny flint inclusions) or it may be part of a limestone industry, which was commonly used to produce various artifacts during the PPNB. The knappers at Baja have not bothered to retouch these flakes probably because this is a very poor quality material and difficult to retouch. However, there are a relatively significant number of flakes in this group. Raw materials other than baja fine are more predominant in the flake assemblage than in the blade assemblage. There are fewer cortical flakes in type 1,16 and baja fine raw materials. Type 1 flakes are particularly frequently retouched. Low levels of retouch are found on fine, medium and rough wadi flakes, which were possibly produced using the more localized raw materials. Retouch in general is more common on the blades. It is interesting to note that although baja fine flakes are most important in terms of quantity, the majority of flake cores are found in type 1. However, the flake cores in type 1 are small and so will not produce high quantities of debitage. It is also possible that some of the baja fine flakes are products of blade core reduction and this will even out the ratio between type 1 and baja fine flakes produced on flake cores.

Baja: flake dimensions

The type 16 flakes are much shorter than the blades, however, they are generally similar in width, suggesting that these flakes were produced from exhausted blade cores (graphs 4-5), though there are no cores in this assemblage to support this theory.

The flake lengths in type 1 are generally comparable to the size range of the distinctive type 1 flake cores. The flakes tend to be shorter than the blades and many are much wider (graphs 4-5). However, there is a cluster of flakes at the centre of the type 1 size range that are similar in width to the blades. The similarity in width suggests the possibility that some of these the flakes were removed either as part of the blade core reduction sequence, or from reused exhausted blade cores. However, the flake dimensions also suggest that many flakes were part of an original flake core reduction sequence.

The flakes in baja fine are similar in length to the equivalent blades, but the main cluster of flakes ranges up to 30mm in width, which is twice as wide as the majority of the widest blades (graphs 4-5). These dimensions possibly indicate that the bulk of flakes and blades in baja fine came from different cores. However, the original nodules were similar in size and shape.

The medium wadi flakes mainly cluster within a similar range of lengths to the blades in the same raw material, but the upper widths of the flakes are twice the size of the blades (graphs

4-5). As seen in the baja fine debitage, the flakes and blades in medium wadi are probably not from the same cores though the nodules are a regular size.

The rough wadi flakes display a similar pattern; the flakes are generally shorter but significantly wider than the blades (graphs 4-5). Again suggesting different cores but similar nodules.

The cortical flakes fall within an area of the scatter plot where baja fine flakes are most common (graph 5), suggesting the possibility that this cortex is from a baja fine core if it is not limestone.

The data suggests that the knappers at Baja were reusing blade cores in both type 1 and 16 for flake production. They were also using similarly shaped nodules in all the raw materials except type 16, to produce separate flake and blade cores.

Baja: flake platforms

There is more variety in the flake platforms than the blades. Platforms with cortex are also more common.

The most important platform types on type 16 flakes are plain and filiform. This differs to the blade platforms, which consist of only the smaller types (tables 4 and 16).

The important platforms on type 1 flakes are plain and then crushed. After these two platforms, the smaller platforms are next in significance. This is similar to the pattern of blade platforms though there are fewer crushed platforms (tables 4 and 16).

On baja fine flakes, plain and crushed are the common types of platform; this differs to the blades where the smaller platforms are of greatest importance (tables 4 and 16).

Plain, then punctiform and crushed platforms are most common on medium wadi flakes (table 16) and this differs to the blades where the punctiform platforms are most important (table 4). Plain and punctiform are the most important platforms on rough wadi flakes. This again differs to the blades because the smaller platforms are the most common; there are also no examples of crushed platforms on the blades (tables 4 and 16).

Plain, winged and crushed platforms are found on the flakes produced in cortex (table 16), which is not surprising considering the nature of the raw material (cortex is difficult to knap with a high level of accuracy and so the platforms must be simple or crushed).

Plain platforms are most common throughout the flake assemblage and, with the exception of type 1, this differs to the blade industry where the punctiform and filiform platforms are most important. There is a high level of crushed platforms in the Baja flake industry, hinting at the possibility that there were some differences in technique used to produce blades and flakes.

Baja: flake platform preparation

The preparation of type 16 flake platforms is largely bashing and platform edge flaking (table 17). Grinding is present but the levels suggest that it is not important. The overall levels of preparation are relatively high in comparison to flakes in other raw materials (tables 17-22), though they are lower than the type 16 blades (table 5).

Bashing and platform edge flaking are the most important methods used to prepare the type 1 flake platforms (table 18). Like the type 16 flakes, grinding is present but unimportant. Interestingly, the crushed platforms on type 1 flakes have received proportionally more preparation than the other common platforms (such as plain, punctiform and filiform). In this flake assemblage it is the type 1 flakes that receive the highest level of preparation, which is also higher than the blades in the same raw material (table 6).

On baja fine flakes, bashing and platform edge flaking are the most common methods used to prepare the platforms (table 19). Grinding is also present but again, unimportant. As on the type 1 flakes, crushed platforms have received more preparation then the other common platforms. Overall, there is a relatively high level of preparation on the baja fine flakes though it is lower than the preparation in type 1 and significantly lower than the preparation on baja fine blades (table 7).

Bashing and platform edge flaking are again the main methods of preparing medium wadi flake platforms (table 20). Grinding is present but unimportant, and crushed platforms have received more preparation than the other common platforms. The overall level of preparation on these flakes is relatively low though it is significantly higher than the level of preparation on the equivalent blades (table 8).

On the rough wadi flakes the majority of platforms have been prepared using bashing and platform edge flaking (table 21). Grinding is present but unimportant and the crushed platforms have been prepared more often then the other common platforms.
Overall, the rough wadi flakes have received the lowest level of preparation, lower than the level of preparation seen on the rough wadi blades (table 9).

The flakes produced in cortex are probably part of the baja fine flake assemblage (see flake dimensions) and so should be linked to the pattern of preparation on the baja fine flakes. It is unsurprising that bashing is the only form of preparation on these flakes because cortex is so difficult to knap with any degree of accuracy.

In general, the level of preparation on the flakes is low in comparison to the blades (with the exception of the type 1 flake debitage). A wider range of platforms have been prepared on the flakes; a result of the fact that a wider range of platforms have been produced on the flakes. The type of preparation used on the flakes is consistent throughout the raw materials, this differs to the blades where grinding is utilised in contrasting levels on different types of raw material. Grinding on the flakes has been used in a different way, probably being used to solve problems in the production of many different types of platforms across all the raw materials rather than to increase the prospects of an effective removal on the smaller platforms as seen on the blades in type 1,16 and baja fine. When producing the flake assemblage, the knappers of Baja appear to have concentrated their efforts in preparing the flakes in type 1 and it is in this raw material that we see the widest range and the smallest flake cores, this despite the fact that the majority of flakes are found in baja fine. This picture contrasts to the blade assemblage where baja fine blades have received the most attention. Platforms that were crushed in the flakes assemblage have consistently been better prepared (prior to removal) than plain, punctiform and filiform platforms. However, much of the preparation was bashing and it is difficult to separate the intentional bashing preparation and the unintentional crushing at the point of removal. It is important to bear in mind that some of the flakes in the raw materials associated with the opposed platform blade industries may have been produced as part of the blade reduction sequence. However, the general homogeneity of the flake debitage makes it impossible to identify these flakes.

Baja: flake platform and bulb features

There are too few platform features in the flake assemblage to make an assessment of hammer technique (table 23).

In the flake assemblage, 13.1% show clear cones, which differs to the blade assemblage where only 7.5% show clear cones.

There are no bulb features present on type 16 flakes.

In type 1 four flakes show clear cones in association with prominent bulbs and one shows a clear cone in association with a diffuse bulb (table 24). This indicates the possibility of harder hammer use, which is supported by the fact that one of the flakes with a prominent bulb and a clear cone also shows a ring crack.

All the other raw materials show no clear numerical distinction between the association between clear cones, prominent and diffuse bulbs (tables 25-27). Unfortunately the type 1 flake is the only example of any association between platform and bulb features and so there can be no real assessment on technique using bulb features in any other raw material. The homogeneity of the flake assemblage in terms of preparation and platform type could hint at the possibility that technique was also homogeneous. The prominence of clear cones across all of the raw materials in the flake assemblage (Baja: flake platform type this chapter, 228-229) could suggest the use of harder hammer or at least the use of a more powerful blow.

Baja: indeterminate types

The type 16 indeterminate assemblage is proportionally similar to the blade and flake assemblages in the same raw material; they all are the least important raw material in terms of quantity. The indeterminates are almost equally divided between those with and those without retouch (table 28). The majority of indeterminates retain cortex possibly suggesting that, in this raw material, there is a relationship between the presence of cortex and the fact that they are broken and discarded in a workshop dump. The type 16 blade, flake and indeterminate assemblages are too small to make clear comparisons.

The type 1 indeterminates are about a third retouched and half retain cortex (table 28). There are similar levels of retouch in both the blades and flakes, but only the blades have comparable levels of cortex, and so the majority of type 1 indeterminates are possibly broken blades but also include significant numbers of broken flakes.

Baja fine is the most important raw material in the blades, flakes and indeterminates, however the proportion of baja fine use between the different types of debitage varies significantly. About a third of the baja fine indeterminates are retouched and half retain cortex (table 28). Both the level of retouch and cortex is higher than in the blade and flake assemblages and so it is not clear which is the most common form in the indeterminate assemblage.
Almost half of the medium wadi indeterminates are retouched and under half retain cortex (table 28). Both the levels of retouch and of cortex are similar to the blades and so it is not clear whether broken blades or flakes are most common in the indeterminate assemblage.
About a third of the rough wadi indeterminates are retouched and almost half retain cortex (table 28). This is proportionally similar to the rough wadi flakes suggesting that this indeterminate assemblage is largely made up of flakes.

There is only one example of an indeterminate produced in cortex and it has not been retouched.

Baja: indeterminates dimensions

The lengths on the Baja indeterminates have been broken most often and so the length/width dimensions are meaningless when compared to the blades and flakes. Therefore, it is necessary to compare the width/thickness dimensions with the blades and flakes.

The type 16 indeterminates range between 5.5-32.6mm in width and do not form any focal cluster on the scatter plot (graph 6). The upper sizes of the indeterminates are significantly wider than the flakes and blades (which have a generally similar range of widths, graphs 7-8). Therefore, it is difficult to assess whether these are broken flakes or blades. The quantity of type 16 debitage is also too low to confidently compare the different categories.

The type 1 indeterminates range between 5.9-34.4mm in width (graph 6). These dimensions encompass both the flake and blade width range (graphs 7-8). However, the main cluster of type 1 indeterminates is close to the blade range. The indeterminate thickness also encompasses the flake and blade range. So the dimensions as well as the indeterminate types (this chapter, 233-234) suggest that the type 1 indeterminates are a mixture of flakes and blades.

The baja fine indeterminates range between 5.0 -51.5mm in width and 1.1-14.0mm in thickness (graph 6), which is closest to the flake width/thickness dimensions (graphs 7-8). This suggests that the baja fine indeterminates are largely broken flakes.

The medium wadi indeterminates range between 4.5-43.2mm in width and 1.4-16mm thickness (graph 6). These dimensions are closest to the flakes though it does encompass the blade range (graphs 7-8), and so the majority are probably broken flakes with a fair number of broken blades mixed in.

The rough wadi indeterminates range between 5.5-41.6mm width and 1.3-16.3mm thickness (graph 6). This range is closest to the flake width/thickness dimensions, though it does encompass the blades (graphs 7-8). So the majority are probably broken flakes as the indeterminate types suggest (this chapter, 233-234) but the assemblage does include a few blades.

Baja: indeterminate platform types, preparation and features

The indeterminate assemblage is made up of broken flakes and blades but only159 out of 658 (24.2%) retain platforms and, therefore, cannot provide much useful information regarding platform type, platform preparation, platform and bulb features. It is also not necessary to analyse these because the information is provided elsewhere in the sections on Baja blades and flakes (this chapter pg 222-225, 230-234).

Baja: crested element types

The sample of crested elements from this dump is relatively small, 15 in total. It is baja fine followed by type 1 which are the most common raw materials (table 29), and it is in these two raw materials that we see the widest variety of cores. As the number of crested elements is so low in each individual raw material, I shall consider the sample as a whole. The majority of the crested element assemblage retains cortex, this is unsurprising given the nature of a crested element. Only 33.4% of this assemblage is retouched indicating that crested elements were not particularly favoured as tools by the knappers at Baja.

Baja: cresting type

The crested element is small and so it is necessary to analyse the cresting type in the assemblage as a whole rather than in individual raw materials.

The majority of this assemblage is crested rather than ridge refreshed (appendix 4 and table 30). This represents specific maintenance of the core removal surface rather than ridge refreshing as part of the removal process.

Baja: crested element dimensions

There are two kinds of crested element, crested pieces and crested indeterminates. The crested pieces are clearly flakes and the length is complete. The crested indeterminates are all broken blades and blade/bladelets, though their width is complete. And so it is possible to compare the lengths of the crested pieces, but only the widths of the crested indeterminates, to flakes and blades.

Only three raw materials were used to produce the crested pieces, type 1, medium and rough wadi. It is interesting to note that there are no crested pieces in baja fine, the raw material from which the majority of the blade cores have been produced. The crested pieces range between 12.5-28.3mm in length, which falls comfortably within the flake range of lengths (graphs 5 and 9). This suggests that these pieces are probably removed from flake cores. However, they are part of ongoing maintenance rather than initial cresting to prepare removal surfaces, as the majority of crested pieces are significantly smaller than the larger flakes. The crested indeterminates are all broken blades or blade/bladelets and these have been produced in all five raw materials. The type 16 crested indeterminate is 14.2mm wide and this is wider and, therefore, possibly longer than the largest blade in the same raw material (graphs 7 and 10). Therefore, this is possibly an initial crested blade. However, it is clear that significant proportions of the debitage in type 16 (including the cores) are missing from this workshop dump and as the record is incomplete it is not possible to conclude whether the type 16 crested indeterminate is initial or not.

The type 1 crested indeterminate falls within the width range of the type 1 blades and, therefore, is possibly not any longer than the longest type 1 blade, thus making it non-initial (graphs 7 and 10).

The baja fine indeterminates range between 6.9-18.4mm in width and these fall within the width range of the baja fine blade (graphs 7 and 10). Therefore, these crested indeterminates are part of ongoing maintenance and not initial.
The only rough wadi crested indeterminate falls within the rough wadi blade dimensions and so is not initial.

The initial crested blades and flakes are not present in this assemblage, suggesting that they have either been removed for a specific purpose (crested elements are robust and can make useful tools) or they were never present in the assemblage and the initial stages of reduction occurred elsewhere. If the initial crested blades were removed as tools it may explain why there are such low levels of retouch on the remaining crested elements. There are also low levels of ridge refreshing crested blades (where the cresting is only down one side of the dorsal ridge); these are a feature of ongoing core removal surface maintenance. Again, these have either been removed as tools or were never deposited in this dump.

Baja: crested element platform type, preparation and features

The crested element assemblage is too small to provide useful information on platform types, platform preparation, and platform and bulb features.

Baja: rejuvenation element type and raw materials

The majority of the rejuvenation elements are in baja fine raw material and are probably related to the naviform blade production (table 31). Over half of the rejuvenations do not retain cortex and, therefore, are not part of core maintenance at the initial stages of reduction. The rejuvenation pieces tend to be robust and a significant number (66.7%) have been reused as tools. All of the rejuvenations are platform edge/removal surface rejuvenations, which is unusually limited given the many different ways in which you can rejuvenate a core. It is possible that there are rejuvenations missing from this assemblage (they could have been removed to be used as robust tools or were never deposited in this dump).

Baja: rejuvenation dimensions

The dimensions of rejuvenations cannot provide much useful information because they tend to be quite irregular in shape and form.

Baja: rejuvenation platform type, preparation and features

The rejuvenation sample is too small to provide useful information on platform types, platform preparation, and platform and bulb features.

Baja: overshot

There is only one overshot in this debitage assemblage, it is in type 1 and is from a single platform blade core; unfortunately there are no type 1 blade cores to make a comparison with. The width of the overshot (10.9mm) is comparable to the middle of the blade width range (graph 7) and so the overshot possibly occurred at a mid point in the reduction sequence, though without any cores it is difficult to assess this. There are several possibilities for what may then have happened to the core after this mistake was made. The blade core could have been rejuvenated and further used to produce blades, or rejuvenated and further used for the production of flakes (there are several examples of type 1 single platform flake cores), or the blade core could have simply been discarded after the overshot occurred. However, if this was so, it was not discarded in this workshop dump because there are no examples of overshot type 1 single platform blade cores present.

Only one example of overshot is extremely low quantity, particularly as this context is a dump for discarding waste. I would expect to see a few overshots relating to the naviform core industry in baja fine, type 1 and 16 because the production of long thin blades lends itself to this type of mistake. Consequently either the knappers at Baja were extremely efficient and produced few overshots or the overshots (which are particularly robust) have been removed and possibly used as tools; or knapping occurred elsewhere and not all the waste was deposited in this dump.

Baja: overshot platform type, preparation and features

One example cannot provide any useful information on platform type, preparation and platform/bulb features.

Baja: formal tool type

The term formal tool refers to a tool form that re-occurs either in the assemblage or throughout the southern Levant in general (appendix 5 and fig 2). Unfortunately, as Gebel removed some of the formal and non-formal tools and as I do not know the exact counts and raw material breakdown of these tools, the results produced on tools in this thesis may be unrepresentative of the total tool count from the assemblage as a whole.

The majority of tools are found in baja fine (table 32), the raw material used in the naviform blade industry. Tools like the piercers are produced on broken blades, blade/bladelets and bladelets and these are the most common tools in baja fine raw material. The broken point in type 1 and the secondary retouched burin in type 16 are the only other formal tools made on blade blanks. These could possibly be linked to the possible naviform core industries in type 1 and 16 that the blade debitage hints at. The most common tool type are burins; these are found in all raw materials except rough wadi. Only a hammer stone produced from a wadi cobble is found in rough wadi, there are no knapped formal tools produced in this raw material. In fact, rough wadi is also rarely used for non-formal tools. This is related to the low quality of the flint, which makes it liable to break in a more unpredictable manner than with the other raw materials.

The overall number of formal tools is extremely low, only 3.2% of the total tool assemblage (this includes the non-formal tools, table 33). The formal tools removed by Gebel will change this percentage. However, it is possible that formal tools were also removed by the knappers themselves prior to the depositing of this assemblage in a dump.

Baja: formal tool dimensions

The dimensions of all formal tools produced on blanks are comparable to the debitage dimensional range (graphs 4,5 and 11). The only exceptions are the indeterminate flake/core/tools in both type 1 and baja fine. It is interesting to note that the dimensions of the core tools in type 16 are comparable to the smaller type 16 debitage, the opposite of the type 1 and baja fine indeterminate flake/core/tools. It is clear that no larger pieces of debitage (including cores) in type 16 were deposited up in this dump. This may suggest that type 16 core reduction did not occur in the same place as the industries represented in this workshop dump, though some of the debitage and tools found their way into this dump.

Baja: spall

There is only one example of a spall in this assemblage. It was produced in medium wadi and was retouched though previous retouch from the burin edge is still visible (appendix 5). There is a disparity between the lack of burin spalls and the relative importance of burins in the formal tool assemblage. This suggests that spalls are missing from this dump, possibly removed to be used as tools elsewhere. It is, therefore, possible that the main use of the burins was as cores to produce spalls rather than as formal tools.

Baja: summary and conclusion

There are possibly three blade and two flake reduction strategies evident in this assemblage. The blade reduction strategies are naviforms, and a single platform blade core in baja fine and a missing opposed platform blade industry in type 1, and 16. There are also missing blade industries in medium and rough wadi though they are unlikely to be opposed platform. The naviform strategy is the most formal reduction represented in the assemblage. The baja fine naviforms present in the assemblage (not including those removed by Gebel) are *'variant'* in the sense that they are not fully crested down the back of the core as *'classic'* naviforms are (Chapter 5, 2). However, this may be due to the fact that they are heavily reduced rather than being due to original flint nodule shape (as is seen in Chapter 5, 63). There are major elements of the debitage associated with the naviforms that appear to be missing. For example, initial crested blades, ridge refreshing crested blades, rejuvenation elements, overshots, type1 and 16 blade cores, and also the number of cortical flakes and blades are low. These are all debitage types which are produced both in the initial stages of reduction and ongoing core maintenance and use. There is a significant contrast between the quantity of blades in different raw materials (baja fine is the most common, table 3) and this contrast cannot be seen in the proportions of non-formal tools produced on blade blanks in different raw materials (table 34). It is, therefore, clear that some of the non-formal blade tools have been separated from the assemblage both by Gebel and possibly by the knappers in antiquity. Considering the quantity of baja fine blades, the low number of formal tools in this raw material is also suspect suggesting that an unknown quantity are not present, again removed by Gabel and possibly the original knappers. Therefore, the reduction sequence is clearly incomplete throughout all stages.

The knappers at Baja were particularly interested in the smaller blade/bladelets and bladelets as these make up the bulk of the naviform assemblage products. This is probably related to the production of piercing tools, which are made on these kinds of blanks. However, it is important to bear in mind that many tools have been removed from this assemblage and, therefore, many large blades may have been removed rather than broken up. A lot of effort was put into preparing and isolating small platforms in the naviform industry in order to efficiently remove regular blades. Unfortunately, hammer technique cannot be assessed from the debitage, as there are an unusually low number of platform and bulb features present (this chapter, 223-224). Naviform opposed platform reduction is the most important strategy in the production of blades and baja fine is the only raw material clearly associated with it, though there are indications that type 1 and 16 are also associated.

There is only one single platform blade core and it has been produced in baja fine raw material. Therefore, it is not possible to separate out which part of the baja fine debitage is associated with this type of core. The only overshot indicates that single platform blade cores were also produced in type 1, but I do not think that this is an important blade production strategy.

All type 16 cores are missing but the debitage suggests that there was a blade core (possibly opposed platform) reduction strategy in this raw material. Some crested blades, rejuvenation pieces and larger tools are also missing. These are effectively the earlier stages in the reduction sequence. This and the low percentage of debitage essentially indicate that elements of the type 16 blade reduction strategy were added to this assemblage having probably been reduced elsewhere. In the context of this workshop dump this is the least important method of blade production when we consider quantity of debitage. However, platform preparation was as time consuming as in the baja fine naviform blade production and so the type 16 blade production clearly had some importance.

The medium wadi blade cores are also missing from this dump and the debitage gives no clues as to what type of blade cores they may have been. The medium wadi debitage suggests that the flake core could have begun life as a blade core (there is no evidence for this in the core itself). Some elements of the debitage are not present, for example, the initial crested blades and possibly some rejuvenation elements. Though the medium wadi blade reduction sequence is incomplete, more is present than the type 1,16 and baja fine blade industry. Therefore there is insufficient evidence to suggest that the blade cores in this wadi raw material were reduced elsewhere as seen in the type 16 raw material.

The rough wadi blades are generally smaller than the flake core in rough wadi. This suggests that the flake core is not an exhausted blade core and that the cores that these blades came from are missing. There is only one crested indeterminate (broken blade) and no rejuvenations in this raw material but most of the blade debitage is present. Therefore, it is possible that either the rough wadi blades were produced elsewhere or the cores and a few pieces of debitage have been removed. I believe that it is less likely that rough wadi blades were produced elsewhere as the rough wadi blade and flake reduction sequence is not as incomplete as the 16 reduction strategies; in fact it is more closely comparable to the medium wadi blade industry. This assemblage does include a hammer stone in rough wadi and it is possible that the blade cores could have been reused in a similar way and discarded elsewhere.

The reduction strategy in rough wadi is the least important for the production of blades both in terms of quantity and effort put into preparation. This is unsurprising given the nature of the raw material.

Though there are many different types of flake cores, they can be separated into two strategies. One is the reuse of exhausted blade cores and the other is the production of dedicated flake cores.

There are no examples of type 16 flake cores but the debitage dimensions suggests that they were either produced from exhausted blade cores or were part of the opposed platform blade core reduction sequence. The flake reduction sequence is missing in similar proportions to the type 16 blade reduction sequence. All of the informal tools on flake blanks are missing, which is unsurprising bearing in mind that Gebel removed a number of formal and non-formal tools (though this raw material may not have been used for the production of non-formal tools, as I do not know the raw material breakdown of the tools Gebel removed (table 34)) and it is not possible to attribute any crested elements or rejuvenations to any type 16 flake cores because we do not know the form of the cores. If these flakes are from flake cores (and not blade cores) they were reduced elsewhere and a few elements of the reduction sequence were added to this assemblage.

The type 16 flakes were relatively well prepared in comparison to the equivalent blades, but the preparation was used simply to create platforms and not to strengthen and refine them, as is the case on the blades. Unfortunately, technique cannot be assessed from features on the debitage. The treatment of flake platforms was homogeneous throughout all the raw materials. However, there are no examples of crushed platforms, unlike the flakes in the rest of the assemblage, and so hammer type, or other aspects of technique, may have differed to that applied to flake reduction in other raw materials (this might support the argument that the type 16 flakes were produced as part of the blade core reduction sequence). This was the least important strategy for the production of flakes certainly in this dump context; it may have had greater importance elsewhere on the site.

All of the type 1 flake cores are these unique 'wedge like' tiny cores, the bipolar examples showing piece esquillée crushing. This is a relatively informal strategy given the number of different forms of these cores. The type 1 reduction sequence appears to be relatively incomplete in the debitage. Though there are consistent proportions of type 1 blades, flakes and indeterminates, the initial stages of flake removal are under represented by both cortical flakes and initial crested elements (however, crested elements and rejuvenations will not necessarily be produced from irregular flake cores). Non-formal flake tools are present in relatively significant numbers. Type 1 is the most common raw material in core assemblage, but it is not in the debitage (tables 1,3,15 and 28). The small size of the type 1 flake cores will explain why there is so little debitage in this raw material.

The preparation of type 1 flake platforms is typical of the total flake assemblage, though they are the most extensively prepared flake platforms. Proportionally more flakes have been prepared than the equivalent blades, but it is general preparation used in order to create platforms rather than to refine and strengthen them as seen on the blades. The reason for this high level of preparation is probably explained by the fact that it is difficult to create platforms on such small cores. There are some suggestions that harder hammer was used to produce these flakes; the unusually high level of crushed platforms supports this. The type 1 flake assemblage is not an important strategy, in terms of quantity, despite the high levels of preparation on the platforms. However, the nature of the cores indicates that it is a distinct reduction strategy, the purpose of which is not clear. Some of the cores with piece esquillée crushing suggest that it is the cores that are the aim of the strategy (as wedges), however, the significant proportion of non-formal tools in this raw material suggest that the debitage is the most important product of this strategy.

The flake cores in baja fine are possibly exhausted naviform blade cores as indicated by the debitage metrics (Baja chapter, 227-228). Again, the strategy is informal given the number of different types of flake core. The reduction sequence appears to be complete and includes the non-formal flake tools. Platform preparation is typical of the flake assemblage. Hammer technique is unclear, but the high level of crushed platforms and the similarity to type 1 flakes could indicate the use of harder hammer. In terms of debitage quantity, this is the most important flake production strategy.

The core in medium wadi appears to be a dedicated flake core, though the debitage hints that this core and others like it may be exhausted blade cores. The reduction sequence is basically present and the proportions of medium wadi debitage are consistent in each category. Platform preparation is typical of the flakes. This preparation and the importance of crushed platforms, may relate the medium wadi flake strategy to the harder hammer technique seen on the type 1 flakes. This is not an important flake production strategy, either in terms of quantity or the relative level of effort put into platform preparation.

The rough wadi debitage indicates that the core, in the same raw material, is a dedicated flake core. The reduction sequence is essentially present, including the non-formal flake tools. Formal tools were not necessarily produced in this raw material, due to the flint quality. Platform preparation is again typical of the flakes, but the lowest proportion of platforms has been prepared in this raw material. Crushed platforms are also proportionally important and so were probably produced using a similar technique to the type 1 flakes. This is the least important flake production strategy, both in terms of debitage quantity and effort put into preparation.

The term 'workshop dump' is very general and can suggest many things. For example, it could contain the debris from a primary knapping event, where the majority of the total reduction sequence is present in the assemblage. Another example is a dump that contains the debris from core reduction and does not include the initial stages of the reduction sequence but is otherwise generally complete. The workshop dump at Baja that produced the assemblage analysed in this thesis is not like any of the above examples. It is far more eclectic and does not represent any complete reduction sequence. The initial stages of knapping are not present at all, and so the dump largely consists of the latter stages of the reduction sequence. Tools are important in the assemblage and so this dump in not purely made up of primary knapping waste but represents waste from several different activities. The nature of the debitage, particularly that in type 16 raw material, indicates that dump contains waste from more than one knapping episode and in the case of type 16 raw material it may also be spatially discreet. The type 1 'wedge like' cores show that there are also distinctive forms of knapping occurring. There are missing elements of the reduction sequence that have either been specifically selected out for use or simply discarded elsewhere or both. The high level of tools also represents craft and domestic activities and this is supported by the fact that the dump also contained animal bones, kitchen waste and general settlement garbage (Gebel *pers. com.* 2003).

The general eclectic nature of this workshop dump will make it easier to compare it to other assemblages because it represents a cross section of the lithic technology at Baja rather than a discrete single knapping episode.

The next chapter (Chapter 8) will discuss the analysis of the lithic assemblage recovered from the site of Wadi Fidan A. The results discussed in this chapter will be returned to in Chapter 9 where I make an analytical comparison all four lithic assemblages.

List of Tables: Chapter 7 (Baja)

Table 1

Baja Cores total 36	type 1	Baja fine	med wadi	rough wadi
single plat flk core	8.3%			
bipolar flk core	8.3%			
bi-directional flake core		2.8%		
opp plat flk core	2.8%	2.8%		
change of orient flk core	16.7%	2.8%		2.8%
irregular flk core	25.0%	5.6%	2.8%	2.8%
irregular flk core on a flk	2.8%			
single plat bld core		2.8%		
naviform		11.1%		
Total %	**63.9%**	**27.9%**	**2.8%**	**5.6%**

Table 2

Baja cores total 36	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	Total percentage of preparation on the core type
single plat flk core total 3						(3) 100%		**100%**
bipolar flk core total 4						(4) 100%		**100%**
opp plat flk core total 2						(1) 50%	(1) 50%	**100%**
change of orient flk core total 7		(1) 14.3%	(2) 28.6%			(3) 42.9%	(1) 14.3%	**100%**
irregular flk core total 11		(1) 3%				(9) 81.8%	(1) 3%	**100%**
irregular flk core on a flk total 1						(1) 100%		**100%**
single plat bld core total 1					(1) 100%			**100%**
Naviform total 4					(1) 25%		(3) 75%	**100%**

Table 3

Baja bld total 104	type 16	type 1	baja fine	med wadi	rough wadi	**Total %**
prim bld			2.0%			**2.0%**
prim bld rtch						
sec bld	1.0%	2.0%	2.9%	1.0%		**6.9%**
sec bld rtch				1.0%		**1.0%**
bld			6.7%		2.0%	**13.4%**
bld rtch			2.9%	1.0%		**3.9%**
prim bld/bldlet						
prim bld/bldlet rtch			2.0%			**2.0%**
sec bld/bldlet		2.0%	6.7%		1.0%	**9.7%**
sec bld/bldlet rtch		2.0%		1.0%	1.0%	**4.0%**
bld/bldlet	2.0%		23.1%	2.9%	1.0%	**29.0%**
bld/bldlet rtch		4.5%	4.8%	2.0%		**11.3%**
sec bldlet		1.0%	2.0%	2.0%		**5.0%**
sec bldlet rtch						
bldlet		2.0%	10.6%	2.0%		**14.6%**
bldlet rtch				1.0%	1.0%	**2.0%**
total %	**3.0%**	**13.5%**	**63.7%**	**13.9%**	**6.0%**	

Table 4 (Percentages are taken from the total number of blades that retain their platforms.)

Baja bld total with plat 67	type 16	type 1	baja fine	med wadi	rough wadi
plain/cort				1.5%	
plain		4.5%	4.5%	1.5%	1.5%
punc	1.5%	3.0%	25.4%	10.4%	3.0%
fil/cort			3.0%		
fil	1.5%	3.0%	25.4%	3.0%	
dih			1.5%		
faceted		1.5%			
crushed			1.5%	3.0%	

Table 5 (The total percentage of preparation is taken from the total number of each platform type and not from the total blades in each raw material that retains their platform.)

Baja bld type 16 total with plat 2	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total %**
punc total 1	(1) 100%							**100.0%**
fil total 1							(1) 100%	**100.0%**

Table 6

Baja bld type 1 total with plat 8	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	total %
plain total 3			(1) 33.3%					**33.3%**
punc total 2	(2) 100%							**100.0%**
fil total 2			(1) 50%	(1) 50%				**100.0%**
faceted 1								**0.0%**

Table 7

Baja bld baja fine total with plat 41	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	total %
plain total 3				(1) 33.3%	(1) 33.3%			**66.6%**
punc total 17	(1) 5.9%		(1) 5.9%	(13) 76.5%			(1) 5.9%	**94.2%**
fil/cort total 2		(1) 50%			(1) 50%			**100.0%**
fil total 17	(3) 17.6%	(1) 5.9%	(3) 17.6%	(1) 5.9%	(3) 17.6%	(1) 5.9%	(5) 29.4%	**99.9%**
dih total 1								**0.0%**
crushed total 1		(1) 100%						**100.0%**

Table 8

Baja bld med wadi total with plat 13	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	total %
plain/cort total 1								**0.0%**
plain total 1			(1) 100%					**100.0%**
punc total 7		(1) 14.3%						**14.3%**
fil total 2								**0.0%**
crushed total 2								**0.0%**

Table 9

Baja bld rough wadi total with plat 3	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	total %
plain total 1			(1) 100%					**100.0%**
punc total 2		(1) 50%						**50.0%**

Table 10

Baja bld type 16 total with plat 3			
plat	bulb	lip	ring crack
punc	diff	(1) 33.3%	

Table 11

Baja bld type 16 total with plat 3				
plat	bulb	lrg eraillure	clear cone	siret/clear cone
fil	diff	(1) 33.3%		

Table 12

Baja bld type 1 total with plat 14				
plat	bulb	lrg eraillure	clear cone	siret/clear cone
plain	diff			(1) 7.1%
faceted	diff		(1) 7.1%	

Table 13

Baja bld baja fine total with plat 64				
plat	bulb	lrg eraillure	clear cone	siret/clear cone
fil	diff		(1) 1.6%	
dih	diff		(1) 1.6%	

Table 14

Baja bld med wadi total with plat 17				
plat	bulb	lrg eraillure	clear cone	siret/clear cone
plain/cort	diff	(1) 5.9%		
punc	prom		(1) 5.9%	

Table 15

Baja flks total 221	type 16	type 1	baja fine	med wadi	rough wadi	cortex	**total %**
prim flk			0.5%	0.9%	1.4%	2.3%	**2.8%**
prim flk rtch				0.5%			**0.5%**
sec flk	0.5%	3.2%	9.0%	7.2%	3.4%		**23.3%**
sec flk rtch		3.6%	4.5%	5.0%	0.5%		**13.6%**
flk		4.5%	27.6%	8.6%	5.0%		**45.7%**
flk rtch	1.8%	4.1%	4.1%	2.3%			**12.3%**
total %	**2.3%**	**15.4%**	**45.7%**	**24.5%**	**10.5%**	**2.3%**	

Table 16

Baja flks total with plat 221	type 16	type 1	baja fine	med wadi	rough wadi	cortex
plain/cort		0.5%	0.9%	0.5%	0.5%	0.5%
plain	0.9%	5.9%	12.2%	6.3%	4.1%	0.5%
punc/cort			0.5%			
punc	0.5%	1.8%	6.3%	5.4%	3.2%	
fil/cort			0.5%	0.5%		
fil	0.9%	0.9%	5.4%	1.8%		
dih/cort			0.5%	0.5%		
dih		1.4%	2.7%			
faceted/cort			0.5%			
faceted		0.5%	2.7%	2.7%	0.5%	
winged/cort			0.5%			
winged		0.5%	3.2%	1.4%	0.5%	0.5%
crushed/cort						0.5%
crushed		4.8%	10.0%	5.0%	1.8%	0.5%

Table 17

Baja flk type 16 total with plat 5	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on the plat**
plain total 2			(1) 50%					**50.0%**
punc total 1					(1) 100%			**100.0%**
fil total 2		(1) 50%						**50.0%**

Table 18

Baja flk type 1 total with plat 34	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on the plat**
plain/cort total 1			(1) 100%					**100.0%**
plain total 13		(1) 7.7%	(7) 53.8%					**61.5%**
punc/cort total 1								**0.0%**
punc total 4			(1) 25%				(1) 25%	**50.0%**
fil total 2			(1) 50%		(1) 50%			**100.0%**
dih total 3			(1) 33.3%					**33.3%**
faceted total 1						(1) 100%		**100.0%**
winged total 1			(1) 100%					**100.0%**
crushed total 9		(5) 55.6%	(2) 22.2%			(1) 11.1%		**88.9%**

Table 19

Baja flk baja fine total with plat 101	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on the plat**
plain/cort total 2			(1) 50%					**50.0%**
plain total 27		(3) 11.1%	(7) 25.9%		(1) 3.7%	(2) 7.4%	(1) 3.7%	**51.8%**
punc/cort total 1	(1) 100%							**100.0%**
punc total 14		(1) 7.1%	(4) 25.6%		(2) 14.3%			**47.0%**
fil/cort total 1					(1) 100%			**100.0%**
fil total 12		(1) 8.3%	(2) 16.7%	(1) 8.3%	(3) 25%	(2) 16.7%		**75.0%**
dih/cort total 1								**0.0%**
dih total 6		(1) 16.7%	(1) 16.7%			(1) 16.7%		**50.1%**
faceted/cort total 1			(1) 100%					**100.0%**
faceted total 6		(2) 33.3%	(1) 16.7%			(1) 16.7%		**66.7%**
winged/cort total 1								**0.0%**
winged total 8		(1) 12.5%	(3) 37.5%	(1) 12.5%		(1) 12.5%		**12.5%**
crushed total 22		(13) 59.1%	(3) 13.6%	(1) 4.5%		(1) 4.5%		**81.7%**

Table 20

Baja flk med wadi total with plat 53	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on the plat**
plain/cort total 1								**0.0%**
plain total 14		(1) 7.1%	(2) 14.5%			(1) 7.1%		**28.5%**
punc total 12	(2) 16.7%		(2) 16.7%			(2) 16.7%		**50.1%**
fil/cort total 1	(1) 100%							**100.0%**
fil total 4		(2) 50%						**50.0%**
dih/cort total 1		(1) 100%						**100.0%**
faceted total 6		(1) 16.7%	(2) 33.3%			(1) 16.7%		**66.7%**
winged total 3		(1) 33.3%	(1) 33.3%					**66.7%**
crushed total 11	(1) 9.1%	(4) 36.6%	(1) 9.1%	(1) 9.1%		(2) 18.2%		**82.0%**

Table 21

Baja flk rough wadi total with plat 23	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on the plat**
plain/cort total 1							(1) 100%	**100.0%**
plain total 9		(1) 11.1%		(1) 11.1%		(1) 11.1%		**33.3%**
punc/cort total 1								**0.0%**
punc total 7						(1) 14.3%	(1) 14.3%	**28.6%**
faceted total 1								**0.0%**
winged total 1								**0.0%**
crushed total 4		(1) 25%		(1) 25%				**50.0%**

Table 22

Baja flk cortex total with plat 5	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	**total % of prep on the plat**
plain/cort total 1		(1) 100%						**100.0%**
plain total 1								**0.0%**
winged total 1								**0.0%**
crushed/ cort total 1								**0.0%**
crushed total 1		(1) 100%						**100.0%**

Table 23

Baja flks type 1 total 34			
plat	bulb	lip	ring crack
plain	prom		(1) 2.9%
Baja flks baja fine total 101			
plain	prom	(1) 1%	

Table 24

Baja flks type 1 total 34					
plat	bulb	clear cone	lrg eraillure	siret	siret/lrg eraillure
plain	prom	(3) 8.8%			
	diff	(2) 5.9%			
punc	diff			(1) 2.9%	
winged	prom	(1) 2.9%			
crushed			(1) 2.9%		

Table 25

Baja flks baja fine total 101					
plat	bulb	clear cone	lrg eraillure	siret	siret/lrg eraillure
plain	prom	(3) 3%			
	diff	(6) 5.9%	(1) 1%	(1) 1%	(1) 1%
punc	diff	(1) 1%		(1) 1%	
dih	diff	(1) 1%			
faceted	prom	(1) 1%			
	diff	(1) 1%			
winged	prom	(4) 4%			
crushed	diff		(1) 1%		
	no plat		(3) 3%		

Table 26

Baja flks med wadi total 53					
plat	bulb	clear cone	lrg eraillure	siret	siret/lrg eraillure
plain	prom	(1) 1.9%			
punc	diff	(1) 1.9%			
faceted	prom	(1) 1.9%			
winged	prom	(1) 1.9%			
crushed	diff	(1) 1.9%			

Table 27

Baja flks rough wadi total 23					
plat	bulb	clear cone	lrg eraillure	siret	siret/lrg eraillure
winged	diff	(1) 4.3%			

Table 28

Baja indeterm total 658	type 16	type 1	baja fine	med wadi	rough wadi	cortex	**total %**
prim indeterm	0.2%	0.5%	1.1%	0.5%	0.8%	0.2%	**3.1%**
prim indeterm rtch	0.2%	0.8%	0.5%	0.5%	0.2%		**8.5%**
sec indeterm	0.6%	3.6%	9.7%	7.6%	0.9%		**22.4%**
sec indeterm rtch	0.8%	5.2%	6.7%	5.6%	1.8%		**20.1%**
indeterm	0.5%	2.0%	13.7%	9.4%	2.6%		**28.2%**
indeterm rtch	0.2%	7.4%	5.0%	10.2%	0.3%		**23.1%**
total %	**2.5%**	**19.5%**	**36.7%**	**33.8%**	**6.6%**	**0.2%**	

Table 29

Baja crested total 15	type 16	type 1	baja fine	med wadi	rough wadi	**total %**
sec crest pieces				13.3%	6.7%	**20.0%**
sec crest pieces rtch		6.7%				**6.7%**
crest pieces						
crest pieces rtch		6.7%				**6.7%**
sec crest indeterm	6.7%	13.3%	26.7%			**46.7%**
sec crest indeterm rtch					6.7%	**6.7%**
crest indeterm			6.7%			**6.7%**
crest indeterm rtch			13.3%			**13.3%**
total %	**6.7%**	**26.8%**	**46.7%**	**13.3%**	**13.4%**	

Table 30

Baja crested type 16 total 1	crested	ridge refreshing	unclear
sec crest piece	(1) 100%		
Baja crested type 1 total 3			
sec crest piece rtch	(1) 33.3%	(1) 33.3%	
sec crest indeterm	(1) 33.3%		
Baja crested baja fine total 3			
sec crest indeterm	(3) 42.9%	(1) 14.3%	
crest indeterm rtch	(3) 42.9%		
Baja crested med wadi total 2			
sec crest piece	(1) 50%	(1) 50%	
Baja crested rough wadi total 2			
sec crest piece	(1) 50%		
sec crest indeterm rtch		(1) 50%	
total number	**11**	**4**	**0**

Table 31

Baja rejuv total 15	type 16	baja fine	med wadi
sec rejuv		26.7%	
sec rejuv rtch	6.7%	13.3%	
rejuv		6.7%	
rejuv rtch		26.7%	20.0%
total %	**6.7%**	**73.4%**	**20.0%**

Table 32

Baja tool total 13	type 16	type 1	baja fine	med wadi	rough wadi	**total %**
prim core tool	15.4%					**15.4%**
sec indeterm flk/core/tool			7.7%			**7.7%**
indeterm flk/core/tool		7.7%				**7.7%**
hammer stone					7.7%	**7.7%**
sec burin rtch	7.7%			7.7%		**15.4%**
burin		7.7%				**7.7%**
burin rtch			7.7%	7.7%		**15.4%**
broken point		7.7%				**7.7%**
sec piercing tool			7.7%			**7.7%**
piercing tool			7.7%			**7.7%**
total %	**23.1%**	**23.1%**	**30.8%**	**15.4%**	**15.4%**	

Table 33

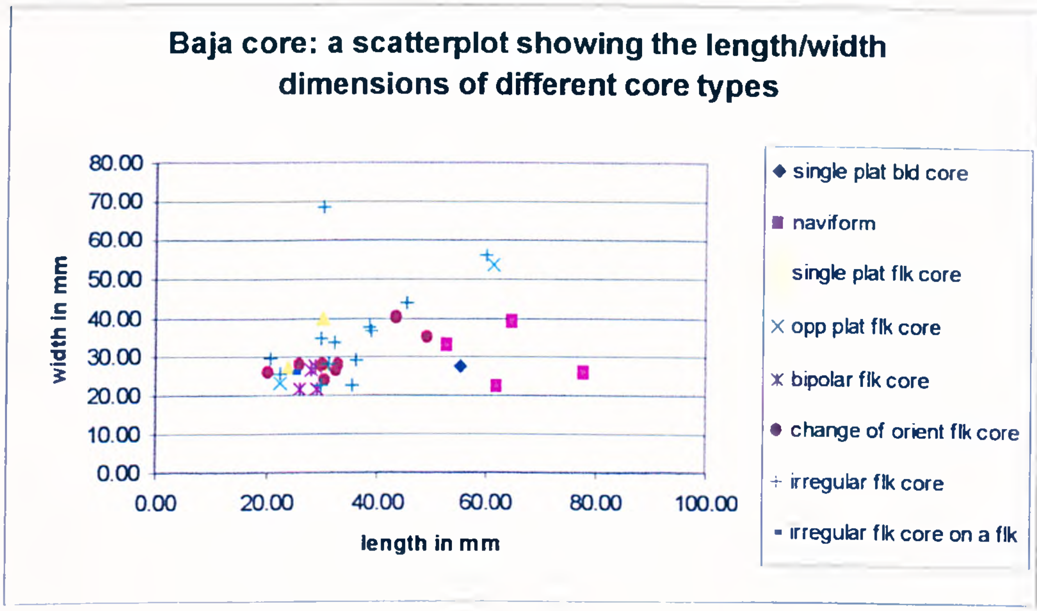
Baja tool total 410	
non formal	96.8%
formal	3.2%

Table 34

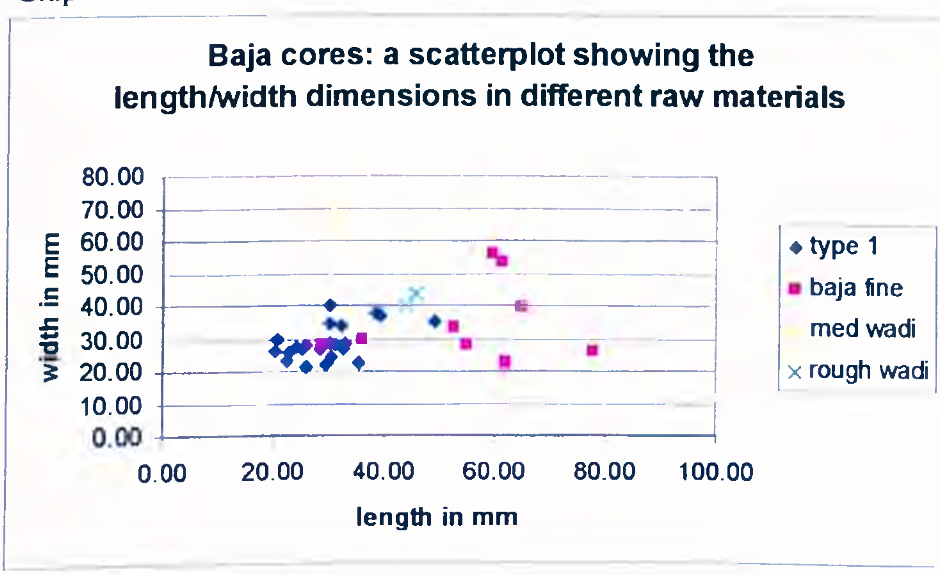
Baja tools fromal/nonformal total 410	type 16	type 1	baja fine	med wadi	rough wadi	**total %**
formal tools	0.7%	0.7%	1.0%	0.5%	0.2%	**2.9%**
blade tools		1.7%	2.2%	1.5%	0.2%	**5.6%**
flake tools	1.8%	4.1%	4.6%	3.9%	0.2%	**14.6%**
indeterm tools	1.7%	22.0%	23.4%	23.4%	3.7%	**74.2%**
crest tools	0.2%	0.5%	0.5%		0.2%	**1.4%**
rejuv tools	0.2%		1.5%	0.7%		**2.4%**
spall rtch				0.2%		**0.2%**
total %	**4.6%**	**29.0%**	**33.2%**	**30.2%**	**4.6%**	

List of Graphs: Chapter 7 (Baja)

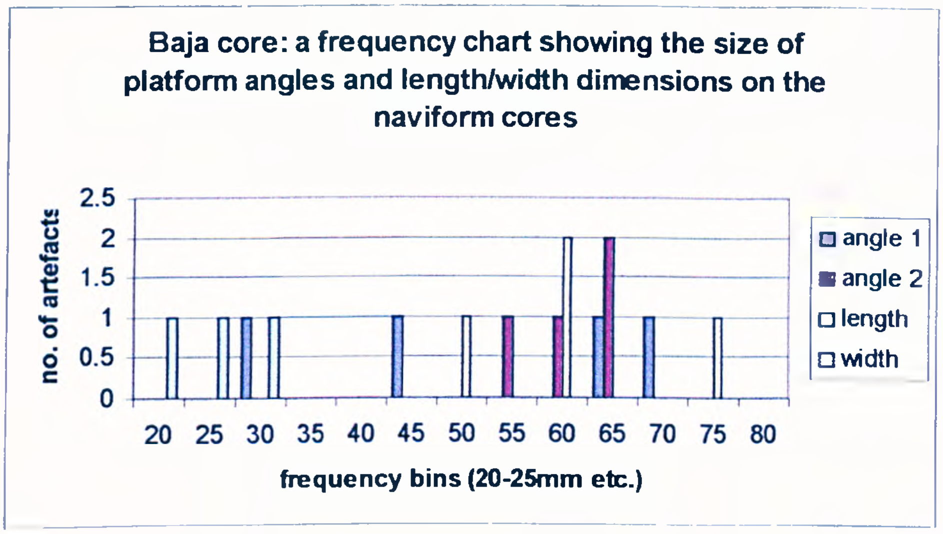
Graph 1



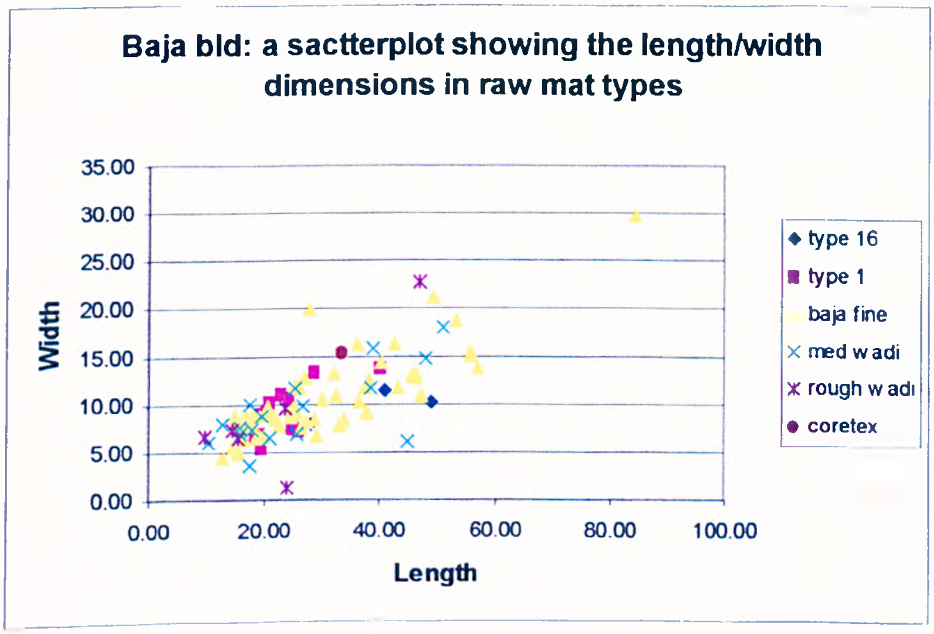
Graph 2



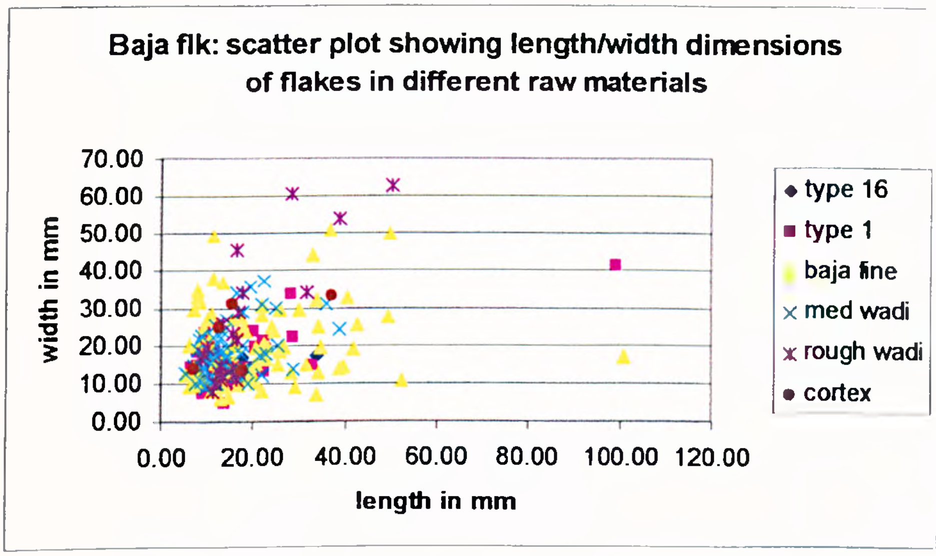
Graph 3



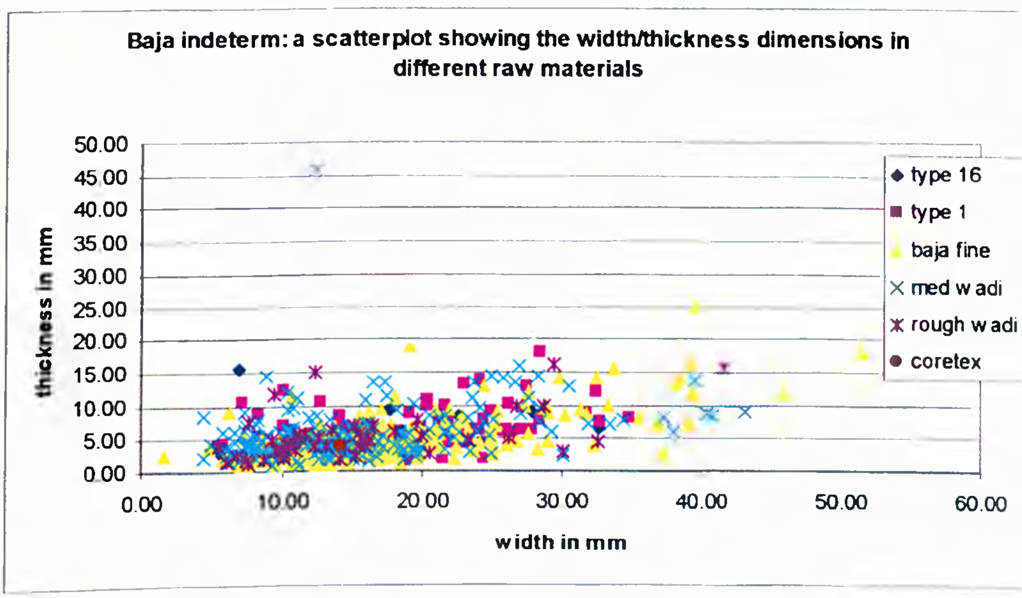
Graph 4



Graph 5

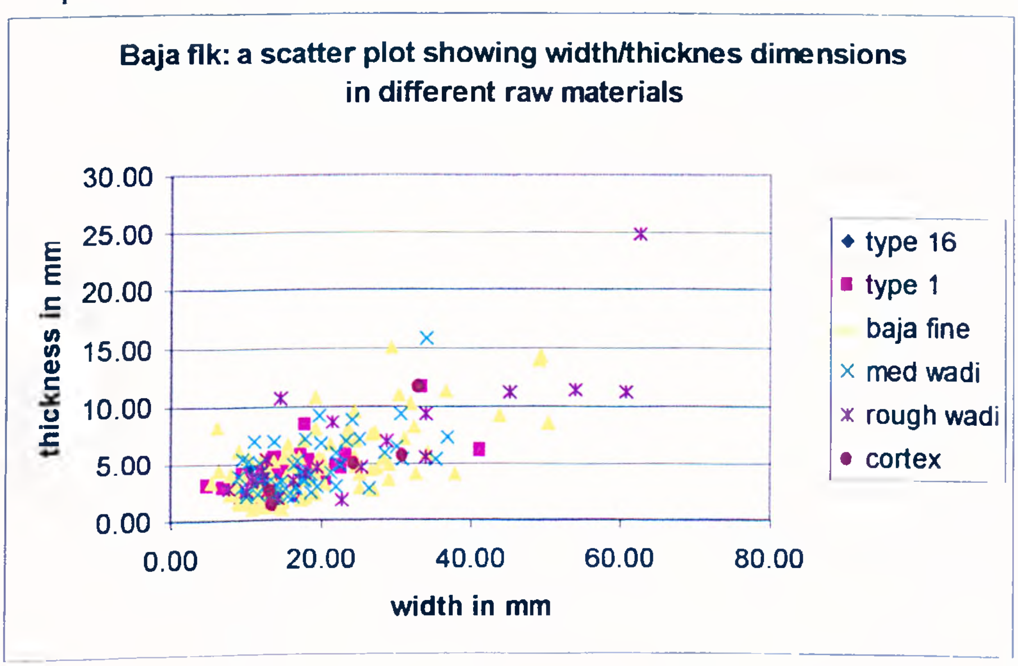


Graph 6

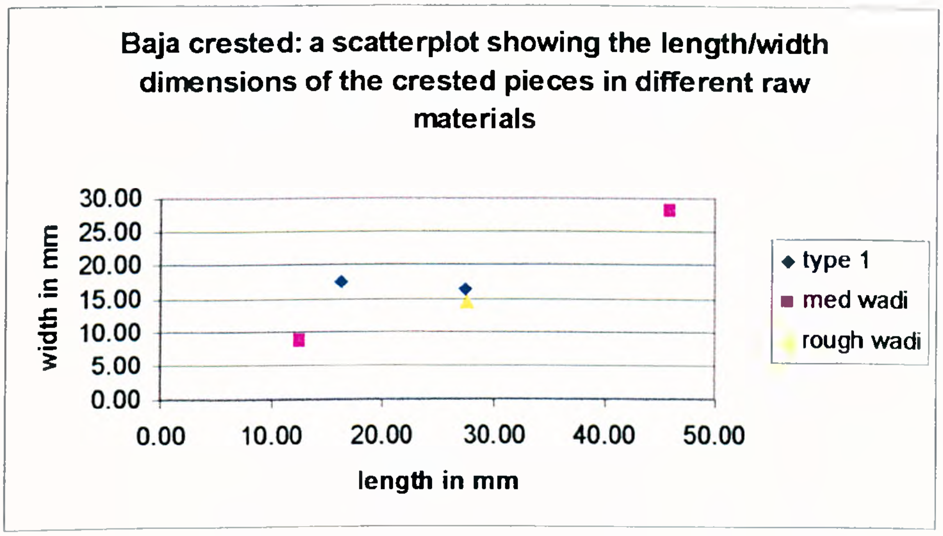


Graph 7

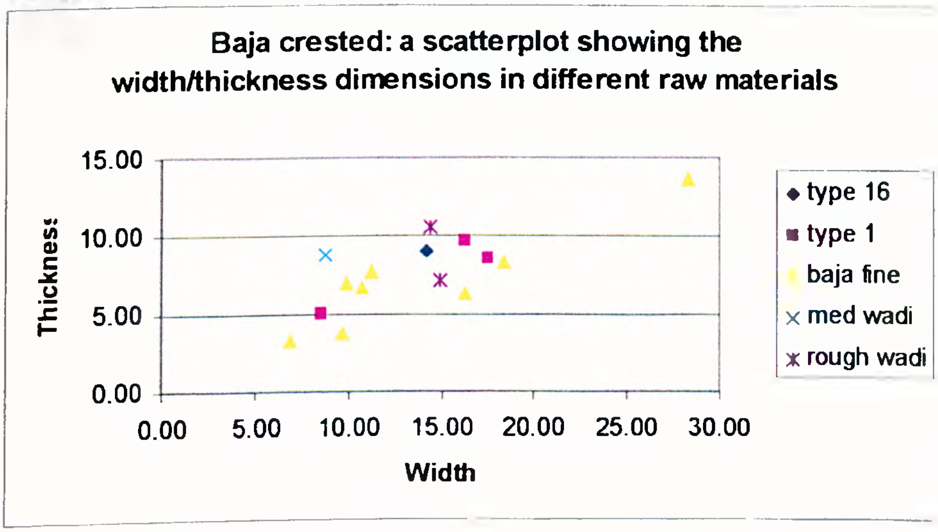
Graph 8



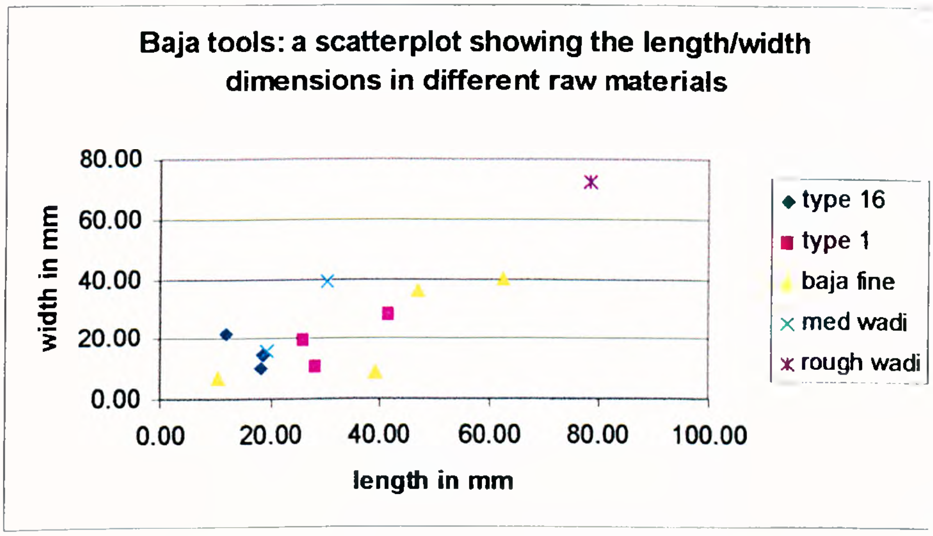
Graph 9



Graph 10



Graph 11



Baja tools: a scatterplot showing the length/width dimensions in different raw materials
80.00
60.00
40.00
20.00
0.00
width in mm
0.00
20.00
40.00
60.00
80.00
100.00
length in mm
type 16
type 1
baja fine
med wadi
rough wadi

List of Figures: Chapter 7 (Baja)

Fig. 1 Variant naviforms from the Baja assemblage. (i) Heavily reduced variant naviform. (ii/iii) Variant naviforms with partially cortical backs.

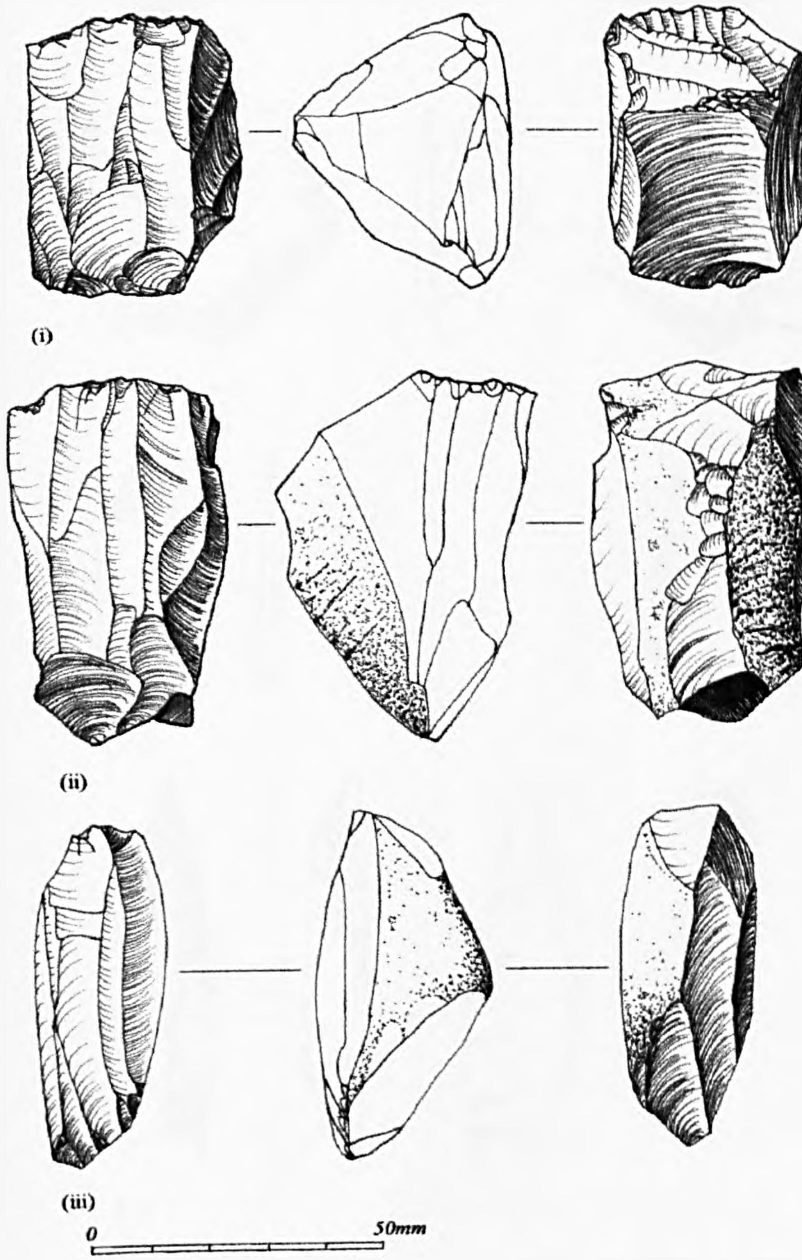
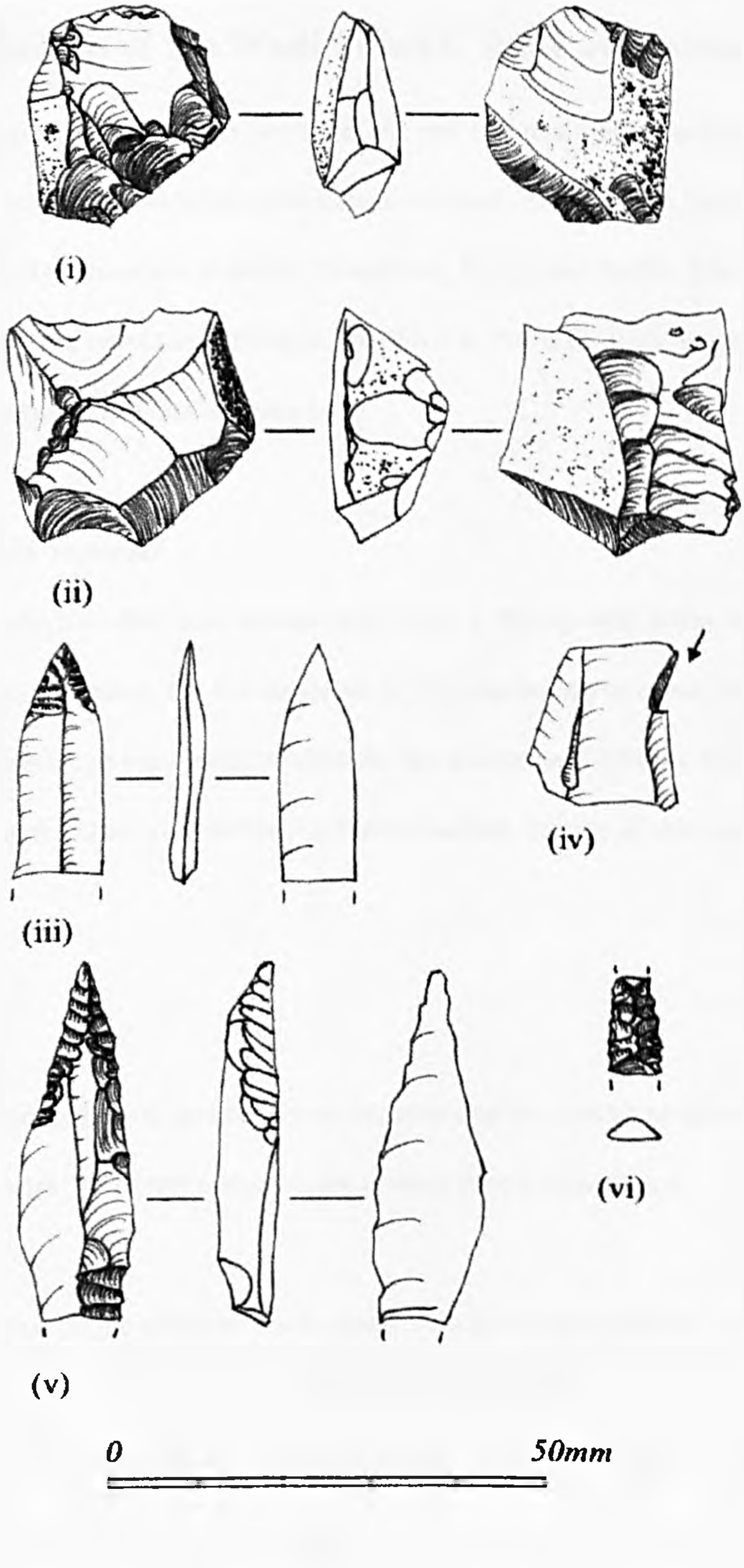


Fig. 2 **Tools from the Baja assemblage.** (i/ii) 'Wedge like' flake cores/tools. (iii) Broken point. (iv)Burin produced from a broken blade blank. (v/vi) Broken piercing tools.



Chapter 8

Analysis of the Wadi Fidan C lithic assemblage

This chapter is separated into eleven sections, site and raw material, nine lithic types and summary and conclusion. The lithic types consist of Core, Blade, Flake, Indeterminates, Crested elements, Rejuvenation elements, Overshots, Tools, and Spalls. The Summary and conclusion reviews the reduction strategies identified in the WFC lithic assemblage, discussing each stage of the *chaîne opératoire*.

WFC: site and raw material

Wadi Fidan C is of a later date than Ghwair and Fidan A, falling well within the PPNC or later in the 6th mbc. However, the raw materials in this assemblage are similar to those found in the Ghwair assemblage and clearly come from the area around Ghwair. Fidan C is situated close to Fidan A and so the raw materials in the immediate locality of the site are low quality conglomerates.

WFC: core type

There is a wide range of blade and flake core types and some core types occur in more than one raw material type. Naviform cores are not present in this assemblage.

In total there are four single platform blade cores. Two are single platform pyramidal blade cores, one in type 16 (fig. 1) and the other in medium wadi (table 1). There is a third single platform blade core in medium wadi but this does not have a pyramidal form and has a cortical back and base. The fourth single platform blade core is in type 1 material, but the removal surfaces indicate that it was once an exhausted bi-directional blade core and is missing one of the main platforms. Bi-directional means that blade removals were taken from opposing platforms on either side of the core, (so essentially there are two unidirectional blade removal surfaces on opposite sites of the core).

The final blade core is an opposed platform core in fine wadi with a fully cortical back, one of the platforms has not been prepared at all and the cortex is used as a natural platform. This could be considered similar to the variant naviforms (on the other three sites) with cortical backs. However, the fact that one of the platforms is the natural cortex suggests that the preform of this core was probably not a biface or even a partial biface as the variant naviform cores originally were. This opposed platform core preform was probably a wadi cobble with a single flake removed in order to create the first, modified platform (so essentially this opposed platform core began life as a single platform core).

The single platform flake core is in fine wadi (table 1); it is heavily reduced and is almost pyramidal in form. The removal surface does not quite run 360 degrees around the platform and it has a cortical back.

There is one change of orientation/bipolar flake core and one change of orientation flake core in rough wadi (table 1). The change of orientation/bipolar flake core has been formed by isolated change of orientation knapping, occurring at either end of the core nodule.

The irregular flake core with bi-directional elements in type 1 raw material shows evidence of being an exhausted bi-directional bladelet core (table 1). There are two bi-directional removal surfaces remaining with some evidence of previous bladelet removals.

The majority of cores are found in type 1, fine, medium and rough wadi raw materials and so these are probably more important than type 16. The most formal type of core is the single platform pyramidal blade core, though the majority of blade cores are single platform. The flake core types are very general and there are no two alike, though there is some evidence of reusing a bi-directional blade core in type 1 as a flake core. There is almost an equal ratio of blade to flake cores a 5:4 (table 1).

WFC: core dimensions

Unfortunately, the core sample size is small and there is only one of each type (with the exception of pyramidal blade cores) so the dimensions cannot provide much useful information. The majority of cores are generally the same width and, length, and range between 20 and 50mm. The dimensions do not show any distinct differences between flake and blade cores.

WFC: core platform preparation

The majority of platform preparation is bashing, platform edge flaking and grinding are used very little (table 2). Generally, there is little effort put into preparing the core platforms.

WFC: platform angle

The Wadi Fidan C core sample is small and the cores vary greatly in form so I do not think that platform angle will provide any useful information, particularly as the platform angle on cores from Ghwair and Wadi Fidan A have also failed to provide much useful information even despite greater numbers.

WFC: blade type

Type 16 is the least important raw material in the blade assemblage and this is reflected generally in the core assemblage (if you include the flake cores). The largest single group are blade/bladelets, these and the bladelets make up the majority of the type 16 blades (table 3). Not many have been retouched and proportionally fewer retain cortex than all of the other raw materials in the blade assemblage.

Type 1 is the most important raw material in the blade assemblage; this is not clear in the core assemblage probably because the sample is small. The majority of the type 1 blade assemblage is smaller blade/bladelets and bladelets, similar to the type 16 blade assemblage (table 3). Just over half of the type 1 blade assemblage is retouched, which is significantly greater than in the type 16 blades assemblage. The majority of blades do not retain cortex, though again, proportionally more do than the type 16 blades.

Fine and medium wadi blades are almost equal in quantity and so are probably equal in importance after type 1. In fine wadi, the largest individual group is blade/bladelets but the smaller pieces are of a similar quantity to the larger blades (table 3). This is different to what is occurring in type 1 and 16 materials where there is an emphasis on smaller pieces. The majority of fine wadi blades are not retouched and a quarter retain cortex, proportionally more than the type 1 and 16 blades.

In medium wadi, the largest single group are bladelets (table 3). However, the majority are larger blades. This is the opposite of what is occurring in type 1 and 16, fine wadi seems to be the middle ground. Most medium wadi blades have not been retouched. About a quarter retains cortex, this is similar to the proportion of fine wadi blades.

There is no single largest group in rough wadi. As in medium wadi, most are larger blades. Over half are retouched, which is similar in proportion to the type 1 blade assemblage. Just under half retain cortex, this is the largest proportion of all the raw materials.

Rough wadi and type 1 are the most important raw materials for blade tool use, and in the case of rough wadi this is so regardless of cortex retention. However, the quantity of blades in type 1 certainly marks it out as the most important raw material for blade production, however, rough wadi is less important than fine and medium wadi.

WFC: blade dimensions

The blade dimensions do not show any distinctions between raw materials; they cluster together with the majority falling between 20-60mm (graph 3). This is generally similar to the dimensional range of all the blade cores (graph 1). Therefore, it is entirely possible that the blade debitage has been produced by all the blade cores present in the assemblage, obviously divided according to the relevant raw materials. There are a few larger blades (up to 80mm) and these could roughly indicate the original length of the blade cores before they were heavily reduced. However, there are no blade cores in rough wadi (table 1) and yet the longest blade is found in this raw material. It is possible that the flake cores in rough wadi began life as blade cores, especially the change of orientation/bipolar flake core, which could particularly lend itself to blade production. It is equally possible, however, that the blade cores in rough wadi are missing and not present in this trench.

WFC: blade opposed platform scars

It is interesting to note that none of the blade debitage in all raw materials retains opposed platform scars on their dorsal surfaces. This is entirely expected as far as the single platform and bi-directional blade production strategies are concerned. However, the opposed platform blade core in fine wadi should have produced some evidence of opposed platform scarring on the blades removed from its removal surface. This suggests that some fine wadi blade debitage is not present in the assemblage or that this particular core was reduced in a manner that produced a minimal number of blades with dorsal opposed platform scarring. It is not difficult to imagine these two scenarios as there is only one example of this type of core; suggesting that it was not an important reduction strategy, especially as the majority cores at WFC (including those in fine wadi) are single platform.

WFC: blade platform type

In type 16, the largest group of platforms are crushed platforms (table 4). Plain, punctiform and filiform are present in very low numbers. However, there are only six blades in type 16 and so not much can be said about this category.

Type 1 blades have the widest range of platforms; this is unsurprising considering this is the largest sample of blades. Plain platforms are most important, followed by punctiform, filiform and crushed (table 4).

On fine wadi blades, the most important platform is plain (table 4). There are also two examples of filiform and crushed platforms.

In medium wadi blades, the largest number of platforms is crushed platforms, closely followed by plain (table 4). There are two examples of punctiform and one of filiform. Rough wadi has the widest range of platforms after type 1 and the most important are plain (table 4).

It is clear that plain and then crushed platforms are most common on the Wadi Fidan C blades. However, the smaller platforms are present in very low numbers, with the exception of type 1 where they are relatively important. The type 1 raw material associates these blades with the bi-directional blade core production strategy.

WFC: blade platform preparation

Bashing and platform edge flaking are the two methods used to prepare the type 16 blade platforms (table 5). However, the sample of type 16 blades that retain their platforms is too small to analyse in detail.

The majority of platform preparation on the type 1 blades is bashing and platform edge flaking (table 6). A very small amount of grinding has been used largely on the smaller platforms. Overall, relatively high levels of preparation have been used.

The sample of fine wadi blades that retain platforms is too small to analyse with any degree of accuracy. However, it is interesting to see that there is no preparation on the plain platforms, unlike plain platforms on blades in all the other raw materials (table 7).

Bashing and platform edge flaking are the most important methods of preparation on medium wadi blades (table 8). There is very little use of grinding, less than on the type 1 blades. Overall, there are relatively low levels of preparation on medium wadi blades.

The sample size of rough wadi blades that retain their platforms is too small to be analysed. However, bashing and platform edge flaking are the methods in which they have been prepared (table 9).

In general, these blades have not been extensively prepared, though there has been marginally more effort put into the preparation of the type 1 blades. It is interesting to see that the type and level of platform preparation on the blades reflects that which is seen on the cores.

WFC: blade platform and bulb features

The platform features are too low in number to be able to make an assessment of hammer technique; there are only two examples, one lip and one ring crack, both on type 1 blades. The bulb features do not provide much more information, though 26.7% of blades have clear cones. In type 16 there are too few bulb features to assess (table 10). In type 1 there are an equal number of clear cones associated with prominent and diffuse bulbs (table 11). Most clear cones are associated with diffuse bulbs in fine wadi (table 12). In medium wadi there are too few clear cones to assess (table 13). The clear cones on rough wadi blades are equally associated with diffuse bulbs as they are with prominent bulbs.

The results so far show no clear indications of hammer type in the Wadi Fidan C blade assemblage. Assessing bulb type is subjective to the observer, so it is possible that platform and bulb features in association with each other will give a more accurate picture. The problem is that at WFC there is only one example of this, a ring crack on the same blade as a clear cone. This hints at harder hammer, which would not be surprising considering the extensive use of bashing on most of the blades. However, one example is simply too small a number to be able to discuss hammer technique with any confidence.

WFC: flake type

The flake assemblage is more important than the blades in terms of quantity, there are only 75 blades and 230 flakes.

Under a quarter of the type 16 flakes retain cortex, but all of these have been retouched (table 15). In total, just over half of the type 16 flakes are retouched, which is proportionally more than the flakes in other raw materials.

Under a third of the flakes in type 1 have been retouched and a third retain cortex (table 15). The majority of the secondary flakes have been retouched, but the majority of flakes without cortex have not.

Fine wadi flakes are proportionally similar to the flakes in type 1. Under a third have been retouched and just over a third retain cortex (table 15). Again, the majority of flakes with cortex have been retouched and the majority without cortex have not.

In medium wadi the pattern is similar, though just under half are retouched which is proportionally more than type 1, 16 and fine wadi (table 15). Over a third retain cortex and the majority of these are retouched. The majority of flakes without cortex are not retouched. The same can be said of rough wadi flakes, most of the flakes with cortex are retouched and most without are not. However, less than a quarter of the rough wadi flakes are retouched and this is proportionally less than all of the flakes in other raw materials. On the type 1, fine, medium and rough wadi flakes, it was either necessary to retouch the secondary flakes in order to use them in the same manner as the flakes without cortex, or they were used for an entirely different purpose.

The most important raw material in the flake assemblage is medium wadi, unlike the blades where type 1 is most important. Type 16 remains the least important for the production of both blades and flakes. In type 16, proportionally more of the flakes have been retouched than the blades. In all of the other raw materials, the levels of retouch are similar. However, in type 1 there are proportionally few blades that retain cortex than flakes.

WFC: flake dimensions

The majority of flakes in all raw materials tend to cluster between 10-50mm in length (graph 4). Type 1, medium and rough wadi extend out from this general cluster, up to 80mm in length (there are two examples which are about 110mm in length). The flakes are generally similar in length to the blades in all raw materials, which is unsurprising considering that both the blade and flake cores are also very similar in size. There are a few examples of medium wadi flakes that are much larger than the medium wadi blades. There are no rough wadi blade cores, but the general similarity of blade and flake debitage sizes suggests that they either came from the same, or similar sized cores. The homogeneity of blade and flake dimensions indicates that the core size was related to homogeneity in nodule size. There is a possibility that one type of core was reused as another, ensuring that blades and flakes are similar, but this cannot be clarified because there are generally so few cores. If cores were reused you would generally expect them to get shorter though this may not necessarily be reflected in the debitage.

WFC: flake platform type

The largest group of platforms on type 16 flakes are plain, unlike the blades (table 4 and 16). There is a wider range of platforms on the flakes than on the blades, and the smaller platforms are proportionally less important on the flakes.

The most important type of platform on type 1 flakes is plain, which is similar to the type 1 blades (table 4 and 16). The range of platforms is more extensive on the flakes than on the blades, and the smaller platforms are less important on the flakes.

The same pattern can be found on the fine wadi flakes. Plain platforms are most common, as is found with the blades (table 4 and 16). There is a wider range of platforms on the flakes and the smaller platforms are less important than on the blades.

On medium wadi flakes, plain platforms are most common, unlike the blades (table 4 and 16). There is a wider range of platforms on the flakes and the smaller platforms are found in similar proportions to the blades.

The most important platform on rough wadi flakes is plain, which is similar to the blades. Again, there is a wider range of platforms, and the smaller platforms are not as important on the flakes.

The platform types are generally similar on blades and flakes; smaller platforms are most common on both type 1 blades and flakes, though they have a greater importance in the production of blades. Plain platforms are clearly the most important platform when producing flakes in any raw material. There is evidence of more crushing on the blades, possibly because they have more examples of punctiform and filiform platforms that are smaller impact areas and are more easily damaged by the strike.

WFC: flake platform preparation

The preparation on type 16 flake platforms is largely bashing and platform edge flaking (table 17). Overall there are relatively high levels of preparation on all of these flakes.

On the type 1 flake platforms, bashing and platform edge flaking are the most important methods of preparation (table 18). Grinding is used relatively often (particularly on the smaller platforms) in comparison to all the other flakes in different raw materials. The overall amount of preparation is high though it is lower than on the type 1 blades.

On fine wadi blades, the most important type of preparation is bashing and platform edge flaking (table 19). There is a very small amount of grinding on the smaller platforms, though it is not significant. Overall, there are relatively high levels of preparation on these platforms.

The most common types of preparation on medium wadi blades are bashing and platform edge flaking (table 20). There is very little use of grinding and overall there are relatively low levels of platform preparation.

Bashing and platform edge flaking are the most important methods of preparation on the rough wadi flakes (table 21). Overall there are relatively low levels of platform preparation.

It is clear there is generally more preparation on both type 1, 16 and fine wadi flakes and blades. In type 1 grinding is more important in both debitage assemblages. Bashing and platform edge flaking are the most important methods of preparation in both the flake and blade assemblages.

WFC: flake platform and bulb features

The association of platform features and bulb types on the flake assemblage presents an inconclusive picture in most of the raw materials (tables 22-31), therefore, applying Ohnuma and Bergman's theory on hammer type (Ohnuma and Bergman 1982) is contentious (Chapter 5, 13-14). I shall not take into account the prominence or diffuse nature of the bulb here because judging this is subjective to the analyst and the data platform and bulb features on the WFC flakes is very confused. There are only 3 lips and two ring cracks found on type 16 flakes. However, both ring cracks are found in association with two of the three lips (table 22). The ratio of lips to ring cracks is very close on type 1 flakes (6:5 table 23) and on medium wadi flakes (1:3 table 25), especially considering that there are 75 medium wadi flakes. The ratio of lips to ring cracks is even closer on rough wadi flakes (3:3 table 26). Only on fine wadi flakes is there a significant difference; in this instance there are four ring cracks but no lips (table 24). As a consequence of the above, and with the exception of fine wadi flakes (which suggest the use of harder hammer), this data is too ambiguous to apply Ohnuma and Bergman's theory on the association of platform features with hammer type (Ohnuma and Bergman 1982).

The addition of clear cones may help to clarify this data. The lowest proportion of clear cones is found on type 16 flakes (28.6%) and one lip is found in association with a clear cone (table 32), therefore, the results are not sufficiently conclusive to suggest any hammer type. This data, in addition to the inconclusive data on type 16 flake platform features, brings into question the validity of utilising platform and bulb features as indicators of simply hammer technique.

The proportion of type 1 flakes that have clear cones is higher than that of type 16 flakes (41%), and only one lip (out of 6) is found in association with a clear cone (table 32). However, the high number of lips suggests that either a combination of harder and softer hammer was used or that something different was occurring in the technique applied to the production of type 1 flakes than in the production of the rest of the debitage assemblage. In the fine wadi flake assemblage, 33.3% show clear cones (table 29). This is not the highest proportion of clear cones, but because these flakes also do not have any lips, the data suggests that harder hammer was the technique of choice. This is of course, only if platform and bulb features are simply an indication of hammer type (which has been demonstrated not to be true in the rest of the flake debitage). It is certainly clear that the aspect of technique relating to strike factors, applied to fine wadi flakes differs to the type 1 flakes.

The highest proportion of clear cones is found on medium wadi flakes (60% table 30), and all three ring cracks are associated with clear cones (table 32). As there is only one lip, this data either suggests that harder hammer was applied to their production, or that the aspect of technique relating to strike factors was similar to that applied to the fine wadi flake assemblage.

In the rough wadi flake assemblage, 55.3% of flakes have clear cones (table 47). This is by no means the lowest proportion of clear cones. However, as one out of three lips is associated with a clear cone and the ratio of lips to ring cracks is equal, it is unclear what hammer type was used. Certainly the general pattern of features differs significantly from the type1, fine and medium wadi flake assemblages.

WFC: indeterminate type

The majority of indeterminates are in type 1 raw material, and the least are fine wadi (table 33). Most indeterminates are retouched and do not retain any cortex. Only 21.6% retain cortex, and half of them are retouched.

WFC: indeterminate dimensions

Only the width and thickness dimensions are complete on the indeterminates and so I shall compare these dimensions with the blades and flakes (graphs 5-7). The majority of the indeterminates are between 10-20mm in width and up to 10mm in thickness. These dimensions are generally similar to the blade width and thickness, suggesting that the majority of indeterminates in all raw materials are blades.

WFC: indeterminate platform types

The blade and flake platforms are very similar in type and so it will not be possible to distinguish between broken blades and flakes using this information. The total number of indeterminates that retain their platforms is also very low (25 pieces).

WFC: indeterminate platform preparation

As the total number of indeterminates with platforms is very low, the total percentage of preparation per platform type will not be very useful and so it is best to look in detail at the type of preparation and whether or not this corresponds to the blade assemblage.
Type 16 indeterminate that retains a platform (there is only one example, it has a plain platform) has been prepared using bashing preparation (table 34). This corresponds to the type 16 blades; however, the indeterminate and blade samples are too small to make any serious comparisons.

The sample of type 1 indeterminates that retain their platforms is somewhat larger (table 35). Grinding preparation is used more often than on indeterminates in other raw materials, especially on the smaller platforms, and the overall level of preparation is relatively high. This situation is very similar to that found on type 1 blades.

The only fine wadi indeterminate that retains a platform (punctiform) has been prepared using grinding/bashing (table 36). This could be construed as similar to the fine wadi blades; however, the indeterminate sample is too small to make comparison viable.

There is very little use of grinding on the medium wadi indeterminates that retain their platforms (table 37) and there is also generally lower levels of preparation than on type 1 indeterminates (tables 37 and 35). Again this corresponds to the data on the equivalent type 1 blades.

The rough wadi indeterminates (that retain platforms) have been prepared using very little grinding (table 38) and there are generally lower levels of overall preparation than on type 1 and medium wadi indeterminates (tables 38, 37 and 35). However, the blade sample is too low to compare overall levels of preparation, but the type of preparation is similar.

WFC: indeterminate platform features

The platform and bulb features on the indeterminates are very low indeed; this is because there are no other indeterminates that retain part of their proximal ends other than the 25 pieces that retain their platforms. Therefore, the percentage of platform and bulb features in each raw material appears deceptively high because they are taken out of a total of only 25 (tables 39-47). This makes it impossible to compare to the blades because the overall percentage of features on indeterminates is higher than the both the blades and the flakes (despite the indeterminates probably being broken blades). It is also not possible to compare the combinations of features because the platform features on the blades are extremely low. This suggests that either different aspects of technique relating to strike factors have been applied to the indeterminates than to the blades across all raw materials, or (as I think is the case) the small sample of indeterminates retaining their proximal ends is corrupting the data. The total number of features on the indeterminates overall is also too low to make any attempt at applying Ohnuma and Bergman's theory to assess hammer type (Ohnuma and Bergman 1982).

WFC: crested elements[3]

There is only one crested blade in the Wadi Fidan C assemblage. It was produced in type 1 raw material and it retains cortex. However, it is probably not an initial crested blade because (it is 64.1mm in length) there is one blade that is longer (graph 3). The cresting is bifacial down the dorsal ridge (Chapter 5, 28) and it has been reused as a tool. The raw material and dimensions associate this crested blade with the bi-directional blade production strategy hinted at by the cores.

WFC: rejuvenation[3]

The majority of rejuvenation is occurring in type 1 raw material (table 48), which is associated with the debitage that has received the most extensive preparation. The blade core in type 1 is an exhausted bi-directional core and requires more platform rejuvenation than single platform blades cores. This is reflected in the fact that the majority of rejuvenation pieces are rejuvenating the platforms or platform edge (table 49). The only other opposed platform core is produced in fine wadi, the two rejuvenations in this raw material are also related to the platforms (table 49). The rejuvenation in rough wadi is questionable, it either rejuvenated a removal surface or it is simply a large flake (table 49). The majority of the rejuvenations do not retain cortex, suggesting that they were removed later on in the reduction

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[3] The analysis of the Ghwair assemblage made it clear that the platform production on relatively uncommon and distinctive debitage like crested blades and rejuvenation pieces is not related to the platform production on the bulk of the assemblage. Therefore, the analysis of the platforms does not provide particularly useful information.

sequence (table 48). Only about half of the rejuvenations are retouched and so these pieces were not particularly favoured as tools (a rejuvenation can be used as a robust tool, table 48).

WFC: overshot

There are only two broken overshots. They are both in type 1 raw material and the morphology of removal scars on their surfaces suggests that they are related to the bi-directional blade core reduction strategy.

WFC: tools

Unfortunately there are very few formal tools in this assemblage, but the majority of tool types are burins and the other is a piercing tool (table 50). There does not appear to be any particular association between burin tool type and raw material, however, all the tools have been produced on blade/bladelet blanks. The term burin/retouch (table 50) means that, aside from the burination, there has been further retouch. These two particular transverse burins are blades that have been truncated across their width by the burination removal. This is obviously a specific tool form, though there is no correlation with raw material type. Formal tool production was either not important or did not occur in this particular area. Non-formal tool production was relatively important, consisting of 49.2% of the total debitage assemblage.

WFC: tool dimensions

It is not possible to relate these formal tool types to the debitage and cores because there are so few and the retouch has masked the original blank size.

WFC: spall

There is only one spall in this assemblage. It has been produced in type 16 raw material and removes an abruptly retouched edge from a tool. This suggests that at least in type 16, there is tool maintenance or reuse of tools occurring in this trench.

WFC: summary and conclusion

Blade production strategies

There are three blade reduction strategies present in this assemblage, and they are not all specifically related to raw material. These consist of, single platform, opposed platform (not naviform) and bi-directional blade production strategies.

The single platform blade cores in medium wadi and the single platform pyramidal blade cores in type 16 are either part of the same reduction strategy or are closely related strategies. This can be seen in the similarity of the core morphology and dimensions, and in the blade debitage dimensions, preparation and features. The reduction sequence of the single platform blade production strategy is incomplete in this assemblage. Both the early stages and parts of the later reduction stages are not present. The debitage shows no distinction in the application of technique to single platform cores in different raw materials (further supporting my suggestion that these cores are part of the same single platform strategy), plain platforms are the most important platform type and the overall level of preparation is generally high, though grinding is utilized less than in the bi-directional blade production strategy. There are no platform features on the type 16 and medium wadi blades though there is one ring crack on a medium wadi indeterminate. This suggests that whatever is occurring when the knappers are striking the cores, it is producing a very low number of platform features. However, the proportion of clear cones differs between type 16 and medium wadi blades, this is possibly related to the difference in raw materials rather than a deliberate change in technique (especially as there is a similarity in the platform features). A significant number of crushed platforms on blades in type 16 and medium wadi blades suggest that a heavy or forceful blow was often being used. This is possibly the reason why plain platforms, and not smaller platforms, are most common as it is difficult to consistently strike close to the edge of the core platform when using greater force. Two out of the four formal tools have been produced from this single platform blade production strategy and 43.8% of the blade and indeterminate are in type 16 and medium wadi materials, suggesting that this strategy is important for the production of both formal and non-formal tools. The quantity of cores would suggest that this is the most commonly utilized reduction strategy, however, the type 16 and medium wadi debitage only makes up 27.7% of the blade and indeterminate assemblages. Also a lower level of effort was put into the preparation of platforms than is seen in the bi-directional blade production strategy, therefore, this is not the most important blade production strategy.

The opposed platform blade production strategy in fine wadi has only one example of a core, and this example is not carefully prepared. In fact one of the core platforms has not been prepared at all and fully cortical blades are used to begin a removal surface rather than a crested blade. The fine wadi blade debitage does not have many examples of opposed platform scars on dorsal surfaces, and this, coupled with the low level of core preparation, leads me to consider that this as an expediently opposed platform strategy. The second platform is not systematically utilized in the same way as on a naviform core for example.

The reduction sequence of the opposed platform strategy is complete in the assemblage, the early stages are represented (by cortical blades) and there are a few rejuvenations in fine wadi material indicating the later core maintenance stages. The completeness of this opposed platform blade production strategy makes it distinct from the single platform blade production strategy. However, technique is not distinct from the single platform strategy. Plain platforms are the most common platform type and platform preparation is also similar to other blade production strategies in wadi raw materials, which demonstrate generally high levels of overall preparation with less use of grinding than is seen on type 1 blades. There are no platform features on fine wadi blades and indeterminates, and very few clear cones, which is very similar to the single platform blade strategy debitage. No formal tools have been produced in fine wadi material, 40% of the fine wadi blade and indeterminate assemblages, which again, is a very similar proportion to the single platform strategy debitage. The opposed platform blade production strategy is the least important blade production strategy because the lowest proportion of blade and indeterminate debitage (13.4%) is in fine wadi material and the effort put into platform preparation is no greater than that applied to the single platform blade cores. This strategy also does not involve extensive core preparation prior to reduction.

The bi-directional blade production strategy is associated with type 1 raw material. This raw material is intensively utilized and the bi-directional cores have been reused either as change of orientation flake cores or as a single platform blade cores. The initial and early stages of this reduction sequence are not present in the assemblage, because the crested blade is not initial and there are only a very few cortical flakes (which could have come from a cortical area of the core later on in the reduction sequence). Otherwise, the later stages of core reduction and maintenance are fully represented in the assemblage. The technique applied to this bi-directional blade strategy is distinct from all the other blade production strategies. Though plain platforms are common, the smaller punctiform and filiform are also important and so is the use of grinding, especially on these small platforms. There are also more platform features in type 1 blades and indeterminates (though the number remains very low). Two out of the four formal tools are produced in type 1 raw material (both have been made on blade blanks), 64.6% of the blade and indeterminate assemblages have been retouched. Therefore, the bi-directional blade strategy is important for the production of both formal and non-formal tools, possibly more important than any other blade strategy. The debitage from this bi-directional blade strategy makes up 42.9% of the blade and indeterminate assemblages and greater effort has been put into the preparation of platforms than in any of the other blade production strategies. This evidence indicates that this is the most important strategy for the production of blades.

There are no rough wadi blade cores in the WFC assemblage and the quantity, morphology and dimensions of the rough wadi blades suggest that they are elongated flakes produced as part of the rough wadi flake production strategy.

Flake production strategies

There are three, possibly four flake production strategies present in the WFC assemblage. One reuses exhausted bi-directional blade cores, two are dedicated flake core strategies and there is only debitage to indicate the presence of the fourth. A portion of the flake assemblage will have been produced as part of blade production strategies; however, it is difficult to distinguish these from the bulk of the flake assemblage. Though there are fewer flake cores than blade cores, the quantity of flake debitage is greater than the blades (230 flakes: 112 blades and indeterminates), suggesting that the flake debitage is the main production aim of the lithic technology. This is unsurprising considering the late Neolithic date of the site. Despite flake production having such importance, flakes do not appear to have been used as blanks for formal tools.

There are no flake cores in type 16 material and only low numbers of flake debitage in this raw material. The technique applied to this debitage is closely related to the type 16 blade debitage. This evidence suggests that the type 16 flake debitage was produced as part of the single platform blade reduction strategy.

The single platform flake core in fine wadi is part of a dedicated flake core strategy. The core itself is almost pyramidal, suggesting that it is closely related to the single platform blade core strategy. The reduction sequence is complete in the WFC assemblage, including some cortical flakes representing the early stages and platform rejuvenations (which could be from both the single platform flake and blade production strategies) representing later core maintenance stages. Technique is similar to the flake reduction strategies in medium and rough wadi. Plain platforms are most common and there are relatively high levels of overall preparation though not of grinding. The proportion of platform features differ between all flake production strategies, however, the fine wadi flakes are not as distinct from medium and rough wadi flakes as the type 1 flakes are. Bulb features vary between flakes in all the different raw materials, no one strategy stands out as it does with platform features. This suggests that technique applied to the single platform, medium wadi and change of orientation flake production strategies differs in certain areas though they do share many similarities. Non-formal tools make up 28.6% of the fine wadi flake assemblage. This is relatively low in comparison to type 1 and medium wadi flakes suggesting either that the main goal of this reduction sequence was to produce flakes that would not be retouched or that for every tool blank a high number of by-products were produced. The single platform flake production strategy has produced the lowest quantity of debitage and the effort put into platform preparation is not distinct from the other flake strategies using wadi materials. This suggests that this strategy is the least important for the production of flakes.

The irregular flake core with bi-directional elements in type 1 raw material is part of an irregular flake production strategy that reuses bi-directional blade cores. Indicating the intensive use of the type 1 raw material. The debitage indicated that the reduction sequence of this strategy is complete in the assemblage, cortical flakes are present and rejuvenations were probably not produced by an irregular flake reduction strategy. The technique applied to this reduction strategy distinguishes from the other flake production strategies in much the same way that the bi-directional blade production strategy was also distinct. Though plain platforms are the most common platform type on type 1 flakes, smaller punctiform and filiform platforms are more common than on flakes in other raw materials. The level of overall preparation is high across all the flakes, but the level of grinding is higher on type 1 flakes (especially on those with small platforms). The combination of strike factors on type 1 flakes is also distinct from the rest of the flake assemblage. There are a significantly higher number of platform features than on flakes in other raw materials, and this proportion is also higher than on the type 1 blades. This suggests that certain aspects of technique relating the strike produced more platform features, in both the type 1 blade and flake strategies, than in all other reduction strategies. However, the technique applied to all flake production strategies also produced more platform and bulb features that that applied to blade production. Half of the type 1 flake assemblage is retouched (52.5%) suggesting that one of the main goals of this reduction sequence is to produce non-formal tools. The type 1 flakes are the second largest group of flakes after those in medium wadi, so it is clear that these are not simply by-products of the blade core reduction. More effort has been put into the preparation of the core platforms than in any other flake reduction strategy and the highest proportion of flake debitage has been used for non-formal tool production in this strategy. Therefore, the irregular flake reduction strategy in type 1 raw material is possibly the most important strategy for the production of flakes.

There are no medium wadi flake cores present in the WFC assemblage, therefore, it is the quantity and features of the medium wadi flake debitage that indicates that this is a separate strategy from the single platform blade production. The medium wadi flake reduction sequence is probably fully present. Cortical flakes are present representing the early stages of reduction. As we do not know the original morphology of the cores, it is difficult to assess whether any core maintenance debitage might have been produced, this is what I am referring to when I say that the reduction sequence is probably complete. This either means that the cores were removed after the knapping process was completed or that the excavation of the site has affected the recovery of this assemblage. I consider the latter to be the more likely case as it is less probable that the knappers only removed cores in wadi raw materials; particularly as the cores are not as intensively used as those in type 1 and cores do not appear to be used as tools at this site. Technique is similar to that applied to the single platform flake cores. Plain platforms are the most common platform type and, though the level of grinding is lower than on type 1 flakes, the overall level of preparation is high. The proportion of platform features is not as distinct as on type 1 flakes. The medium wadi flake debitage was important for the production of non-formal tools, 45.8% are retouched. This is reflected in the formal tool category, where type 1 and medium wadi are the two raw materials from which the formal tools have been made (though they were made on blade rather than flake blanks). However, there were more by-products produced for each tool in the medium wadi flake strategy than there were in the type 1 irregular flake strategy. The largest group of flake debitage is in medium wadi, supporting the view that these flakes were not produced as part of a blade production industry. However, this is not necessarily the most important flake production strategy because both the production of tools and the effort put into platform preparation was less than on the type 1 flakes.

The change of orientation and change of orientation/bi-directional (appendix 4) flake cores are probably part of the same reduction strategy. This is demonstrated by the raw material, core morphology and flake debitage. The reduction sequence is complete in the WFC assemblage, including a few primary flakes. The nature of the change of orientation reduction method is one where the core is continuously maintained with each flake removal. Therefore, this strategy will not produce separate rejuvenation pieces. Technique is again much like that applied to the single platform and medium wadi flake production strategies. Plain platforms are most common, generally high levels of preparation (though not of grinding) and platform features do not stand out in the way they do on type 1 flakes. Only 19.6% of the rough wadi flakes are retouched, suggesting that either the goal of this reduction strategy was to produce flakes that would not be retouched or that there were high levels of by-products for every tool produced. The quantity of rough wadi flakes suggests that it was a marginally more important strategy than fine wadi single platform flakes though less important than medium wadi flakes. Certainly technique does not distinguish it from these other two strategies. The effort put into platform preparation and the level of tool use clearly place the change of orientation flake production strategy as less important than the irregular flake core production strategy in type 1 material.

Flake production is more common at WFC than blade production, which is typical of the PPNC/6th mbc. However, it is clear that blades still retain an important role, not least for the production of formal tools. All the different reduction strategies do not appear to culminate in the production of any specific formal tool, it seems that non-formal tools are more important and produced in all raw materials, though in differing proportions. In both the blade and flake production strategies the greatest time and effort is put into those strategies that use type 1 raw material; the intensive use of type 1 (reusing the bi-directional blade cores for both single platform blade and irregular flake cores) indicates the level of importance this raw material held for the knappers at Wadi Fidan C.

In the next chapter (Chapter 9) I shall make a comparison of the lithic assemblages from all four sites of Ghwair 1, Wadi Fidan A, Baja and Wadi Fidan C. I will also make some conclusions on the nature of the networks of information sharing occurring within this locality over the duration of the PPNB and the PPNC/6thmbc.

List of tables: Chapter 8 (WFC)

Table 1

WFC core type total 9	type 16	type 1	fine wadi	med wadi	rough wadi
single plat flk core			11.0%		
change of orient/bipolar flk core					11.0%
change of orient flk core					11.0%
irregular flk core (bidirectional elements)		11.0%			
single plat bld core				11.0%	
single plat bld core (exhausted bidirectional core)		11.0%			
single plat pyramidal bld core	11.0%			11.0%	
opp plat bld core			11.0%		

Table 2

WFC core type total 9	plat edge flk	bashing	bash/plat edge flk	grin/bash
single plat bld core				
single plat pyramidal bld core		11.0%		
single plat (originally bipolar) bld core			11.0%	11.0%
opp plat bld core	11.0%	11.0%		
single plat flk core				
change of orient/ bipolar flk core		11.0%		
change of orient flk core		11.0%		
irregular flk core (bipolar elements)		11.0%		

Table 3

WFC bld total 75	type 16	type 1	fine	med	rough
prim bld			1.4%		
sec bld	1.4%		1.4%	2.7%	2.7%
sec bld rtch		4.1%		1.4%	1.4%
bld		5.5%		1.4%	2.7%
bld rtch	2.7%	9.6%	5.4%	4.1%	
sec bld/bldlet		1.4%	1.4%		
sec bld/bldlet rtch		1.4%			1.4%
bld/bldlet	4.1%	6.8%	6.5%	1.4%	
bld/bldlet rtch		6.8%			2.7%
sec bldlet		2.7%			
sec bldlet rtch					
bldlet	1.4%	6.8%	1.4%	5.5%	
bldlet rtch		4.1%			1.4%
total %	**9.2%**	**49.2%**	**17.5%**	**16.5%**	**12.3%**

Table 4

WFC blds total 75	type 16	type 1	fine wadi	med wadi	rough wadi
no plat	1.3%	0.5%	5.3%	1.3%	2.7%
plain/cort			1.3%		
plain	1.3%	13.3%	4.0%	4.0%	4.0%
punc	1.3%	8.0%		2.7%	1.3%
fil	1.3%	9.3%	2.7%	1.3%	1.3%
dih		2.7%			
faceted		4%			1.3%
crushed	2.7%	5.3%	2.7%	5.3%	1.3%

Table 5

WFC bld type 16 (total with plat 5)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total% of prep on the plat**
plain (total 1)						(1) 100%		**100.0%**
punc (total 1)		(1) 100%						**100.0%**
fil (total 1)						(1) 100%		**100.0%**
crushed (total 2)		(2) 100%						**100.0%**

Table 6

WFC bld type 1 (total with plat 32)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total% of prep on the plat**
plain (total 10)		(1) 10%	(6) 60%	(1) 10%		(2) 20%		**100.0%**
punc (total 6)		(1) 16.7%		(2) 33.3%		(2) 33.3%		**83.3%**
fil (total 7)		(2) 28.6%		(1) 14.3%	(3) 42.9%		(1) 14.3%	**100.0%**
dih (total 2)			(1) 50%				(1) 50%	**100.0%**
faceted (total 3)			(2) 66.7%				(1) 33.3%	**100.0%**
crushed (total 4)		(1) 25%	(1) 25%			(1) 25%		**75.0%**

Table 7

WFC bld fine wadi (total with plat 8)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total% of prep on the plat**
plain/cort (total 1)	(1) 100%							**100.0%**
plain (total 3)								**0.0%**
fil (total 2)	(1) 50%			(1) 50%				**100.0%**
crushed (total 2)		(2) 100%						**100.0%**

Table 8

WFC bld med wadi (total with plat 11)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total% of prep on the plat**
plain (total 3)			(1) 33.3%		(1) 33.3%			**66.7%**
punc (total 2)								**0.0%**
fil (total 1)		(1) 100%						**100.0%**
crushed (total 4)		(2) 50%				(1) 25%		**75.0%**

Table 9

WFC bld rough wadi (total with plat 7)	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total% of prep on the plat**
plain (total 3)		(1) 33.3%						**33.3%**
punc (total 1)		(1) 100%						**100.0%**
fil (total 1)		(1) 100%						**100.0%**
faceted (total 1)						(1) 100%		**100.0%**
crushed (total 1)		(1) 100%						**100.0%**

Table 10

WFC blds type 16 total 6				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	prom		(1) 16.7%	
fil	diff	(1) 16.7%		
crushed	no bulb	(2) 33.3%		

Table 11

WFC blds type 1 total 36				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	prom	(1) 2.8%	(3) 8.3%	
	diff	(1) 2.8%	(3) 8.3%	
punc	diff			(1) 2.8%
fil	prom		(1) 2.8%	
	diff	(2) 5.6%	(1) 2.8%	
faceted	prom	(1) 2.8%		
crushed	diff	(2) 5.6%		
	no bulb	(1) 2.8%		

Table 12

WFC blds fine wadi total 12				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain/cort	diff		(1) 8.3%	
plain	prom			(1) 8.3%
	diff		(2) 16.7%	
crushed	diff	(2) 16.7%		

Table 13

WFC blds med wadi total 12				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	diff		(1) 8.3%	
punc	prom		(1) 8.3%	
crushed	no bulb	(1) 8.3%		

Table 14

WFC blds rough wadi total 9					
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone	conical
faceted	prom		(1) 11.1%		
plain	prom		(1) 11.1%		
	diff		(2) 22.2%		
crushed	diff				(1) 11.1%

Table 15

WFC flks total 230	type 16	type 1	fine wadi	med wadi	rough wadi
prim flk		0.4%	0.4%	2.2%	1.3%
prim flk rtch		0.4%	0.4%	0.4%	
sec flk		1.7%	2.6%	1.7%	4.8%
sec flk rtch	1.3%	5.7%	2.6%	7.4%	3.0%
flk	2.2%	10.4%	7.8%	13.0%	9.6%
flk rtch	2.6%	7.8%	1.3%	6.5%	1.7%
total %	**6.1%**	**26.4%**	**15.1%**	**31.2%**	**20.4%**

Table 16

WFC flk total 230	type 16	type 1	fine wadi	med wadi	rough wadi
plain/cort.	0.4%	0.9%	0.4%	1.7%	0.9%
plain	3.5%	8.7%	9.1%	14.8%	10.9%
punc	0.4%	3.5%	1.7%	2.1%	1.3%
fil/cort.		0.9%			
fil	0.4%	1.7%	0.4%	1.3%	0.4%
dih	0.4%	2.6%	0.9%	3.5%	0.9%
faceted		1.3%		2.6%	2.6%
winged/cort.			0.4%		
winged	0.4%	3.0%	0.9%	1.7%	1.3%
crushed	0.4%	3.9%	1.7%	3.5%	1.3%

Table 17

WFC flk type 16 total 14	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/ plat edge flk	total % of prep on a plat
plain/cort (total 1)			(1) 100%					**100.0%**
plain (total 8)		(1) 12.5%	(4) 50%			(1) 12.5%		**75.0%**
punc (total 1)							(1) 100%	**100.0%**
fil (total 1)		(1) 100%						**100.0%**
dih (total 1)								**0.0%**
winged (total 1)						(1) 100%		**100.0%**
crushed (total 1)		(1) 100%						**100.0%**

Table 18

WFC flk type 1 total 61	grin	bash	plat edge flk	grin/ bash	grin/plat edge flk	bash/ plat edge flk	grin/ bash/ plat edge flk	total % of prep on a plat
plain/cort (total 2)								0.0%
plain (total 20)		(3) 15%	(9) 45%	(1) 5%	(1) 5%	(5) 25%		95.0%
punc (total 8)	(1) 12.5%		(2) 25%	(1) 12.5%	(1) 12.5%		(2) 25%	87.5%
fil/cort (total 2)	(1) 50%					(1) 50%		100.0%
fil (total 4)		(1) 25%	(1) 25%	(1) 25%			(1) 25%	100.0%
dih (total 6)		(1) 16.7%	(1) 16.7%			(3) 50%		83.4%
faceted (total 3)						(1) 33.3%		33.3%
winged (total 7)		(3) 42.9%	(1) 14.3%			(1) 14.3%		71.5%
crushed (total 9)		(5) 55.5%				(3) 33.3%		88.9%

Table 19

WFC flk fine wadi total 36	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash /plat edge flk	total % of prep on a plat
plain/cort (total 1)								0.0%
plain (total 21)		(1) 4.8%	(9) 42.9%			(4) 19%		66.7%
punc (total 4)	(1) 25%	(2) 50%						75.0%
fil (total 1)	(1) 100%							100.0%
dih (total 2)		(1) 50%						50.0%
winged/ cort (total 1)		(1) 100%						100.0%
winged (total 2)						(2) 100%		100.0%
crushed (total 4)		(1) 25%	(1) 25%			(2) 50%		100.0%

Table 20

WFC flk med wadi total 75	grin	bash	plat edge flk	grin/ bash	grin/ plat edge flk	bash/ plat edge flk	grin/ bash/ plat edge flk	**total % of prep on a plat**
plain/cort (total 4)	(1) 25%							**25.0%**
plain (total 34)		(8) 23.5%	(9)26.5%			(8)23.5%	(1) 2.9%	**76.4%**
punc (total 5)	(1) 20%	(2) 40%				(1) 20%		**80.0%**
fil (total 3)		(1) 33.3%						**33.3%**
dih (total 8)		(5) 62.5%				(1)12.5%		**75.0%**
faceted (total 6)		(2) 33.3%	(2)33.3%			(1)16.7%		**83.3%**
winged (total 4)			(2) 50%			(2) 50%		**100.0%**
crushed (total 8)	(1) 12.5%	(3) 37.5%	(1)12.5%			(1)12.5%		**75.0%**

Table 21

WFC flk rough wadi total 47	grin	bash	plat edge flk	grin/ bash	grin/ plat edge flk	bash/plat edge flk	grin/ bash/ plat edge flk	**total % of prep on a plat**
plain/cort (total 2)						(1) 50%		**50.0%**
plain (total 25)		(5) 20%	(5) 20%			(1) 4%		**44.0%**
punc (total 3)		(3) 100%						**100.0%**
fil (total 1)								**0.0%**
dih (total 4)		(4) 100%						**100.0%**
faceted (total 6)		(2) 33.3%						**33.3%**
winged (total 3)		(2) 66.7%						**66.7%**
crushed (total 3)	(1) 33.3%	(1) 33.3%						**66.7%**

Table 22

WFC flks type 16 total 14				
plat	bulb	lip	ring crack	lip/ring crack
plain	prom			(2) 14.3%
winged	prom	(1) 7.1%		

Table 23

WFC flks type 1 total 61			
plat	bulb	lip	ring crack
plain	prom	(2) 3.3%	(2) 3.3%
	diff	(1) 1.6%	(2) 3.3%
punc	diff	(1) 1.6%	
fil	diff	(1) 1.6%	(1) 1.6%
winged	diff	(1) 1.6%	

Table 24

WFC flks fine wadi total 36			
plat	bulb	lip	ring crack
plain	prom		(2) 5.6%
	diff		(1) 2.8%
punc	diff		(1) 2.8%

Table 25

WFC flks med wadi total 75			
plat	bulb	lip	ring crack
plain	diff	(1) 1.3%	(1) 1.3%
	no bulb		(1) 1.3%
dih	diff		(1) 1.3%

Table 26

WFC flks rough wadi total 47			
plat	bulb	lip	ring crack
plain	prom	(1) 2.1%	
	diff	(1) 2.1%	(1) 2.1%
dih	diff	(1) 2.1%	
winged	prom		(2) 4.3%

Table 27

WFC flks type 16 total 14				
plat	bulb	lrg eraillure	clear cone	lrg eaillure/ clear cone
plain	prom	(1) 7.1%	(1) 7.1%	
punc	diff			(1) 7.1%
fil	diff		(1) 7.1%	
winged	prom			(1) 7.1%
crushed	diff	(1) 7.1%		

Table 28

WFC flks type 1 total 61				
plat	bulb	lrg eraillure	clear cone	lrg eaillure/ clear cone
plain	prom	(1) 1.6%	(5) 8.2%	(2) 3.3%
	diff	(2) 3.3%	(5) 8.2%	(2) 3.3%
punc	diff	(3) 4.9%		
fil/cort	diff	(1) 1.6%		
fil	prom			(1) 1.6%
	no bulb	(1) 1.6%		
dih	prom	(1) 1.6%		(1) 1.6%
	diff		(2) 3.3%	
faceted	prom	(1) 1.6%		
	diff	(1) 1.6%		
winged	prom		(4) 6.6%	
	diff	(1) 1.6%	(1) 1.6%	
crushed	prom		(1) 1.6%	
	diff	(3) 4.9%	(1) 1.6%	
	no bulb	(1) 1.6%		

Table 29

WFC flks fine wadi total 36				
plat	bulb	lrg eraillure	clear cone	lrg eaillure/ clear cone
plain/cort	no bulb	(1) 2.8%		
plain	prom		(1) 2.8%	(1) 2.8%
	diff		(4) 11.1%	
	no bulb			(1) 2.5%
punc	prom		(1) 2.8%	
	diff		(2) 5.6%	
dih	diff		(1) 2.5%	
winged	prom		(1) 2.8%	
crushed	diff	(1) 2.5%		
	no bulb	(1) 2.5%		

Table 30

WFC flks med wadi total 75				
plat	bulb	lrg eraillure	clear cone	lrg eaillure/ clear cone
plain/cort	prom		(2) 2.7%	
	diff		(1) 1.3%	
plain	prom	(1) 1.3%	(11) 14.7%	(2) 2.7%
	diff	(1) 1.3%	(7) 9.3%	(3) 4%
	no plat		(1) 1.3%	
punc	prom		(1) 1.3%	
	diff		(2) 2.7%	
fil	diff		(1) 1.3%	
dih	prom		(2) 2.7%	
	diff		(3) 4%	(1) 1.3%
faceted	prom		(1) 1.3%	
	diff		(2) 2.7%	(1) 1.3%
winged	prom		(2) 2.7%	
	diff		(1) 1.3%	
crushed	diff	(4) 5.3%	(1) 1.3%	

Table 31

WFC flks rough wadi total 47				
plat	bulb	lrg eraillure	clear cone	lrg eaillure/ clear cone
plain/cort	diff		(1) 2.1%	
plain	prom		(4) 8.5%	
	diff	(1) 2.1%	(8) 17%	(2) 4.3%
	no bulb	(1) 2.1%		(1) 2.1%
punc	prom		(1) 2.1%	(1) 2.1%
	diff		(1) 2.1%	
fil	diff	(1) 2.1%		
dih	prom		(1) 2.1%	(1) 2.1%
faceted	prom	(1) 2.1%	(2) 4.3%	
	diff	(1) 2.1%	(1) 2.1%	
winged	prom		(2) 4.3%	
crushed	no bulb	(1) 2.1%		

Table 32

WFC flks platform and bulb features on the same flake						
plat	bulb	lip/lrg eraillure	lip/clear cone	ring crack/lrg eriallure	ring crack/ clear cone	lip/ring crack/lrg eraillure
type 16 total 14						
plain	prom					(1) 7.1%
fil	diff				(1) 7.1%	
winged	prom		(1) 7.1%			
type 1 total 61						
plain	prom		(1) 1.6%	(2) 3.3%		
	diff	(1) 1.6%		(1) 1.6%	(1) 1.6%	
punc	diff	(1) 1.6%				
winged	diff	(1) 1.6%				
fine wadi total 36						
plain	prom				(2) 5.6%	
	diff				(1) 2.8%	
punc	diff				(1) 2.8%	
med wadi total 75						
plain	diff			(1) 1.3%		
	no bulb				(1) 1.3%	
dih	diff				(1) 1.3%	
winged	prom				(1) 1.3%	
rough wadi total 47						
plain	diff		(1) 2.1%			
winged	prom				(1) 2.1%	

Table 33

WFC indeterm total 37	type 16	type 1	fine wadi	med wadi	rough wadi
sec indeterm				8.1%	2.7%
sec indeterm rtch	2.7%		2.7%		5.4%
indeterm		2.7%		8.1%	13.5%
indeterm rtch	8.1%	29.7%	5.4%	10.8%	
total %	**10.8%**	**32.4%**	**8.1%**	**27.0%**	**21.6%**

Table 34

WFC indeterm type 16 total with plat 1	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash /plat edge flk	**total % of prep on a plat**
plain (total 1)		(1) 100%						**100%**

Table 35

WFC indeterm type 1 total with plat 8	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
plain (total 1)					(1) 100%			**100%**
punc (total 2)	(1) 50%				(1) 50%			**100%**
fil (total 3)			(1) 33.3%	(1) 33.3%	(1) 33.3%			**100%**
dih (total 2)		(1) 50%						**50%**

Table 36

WFC indeterm fine wadi total with plat 1	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
punc (total 1)				(1) 100%				**100%**

Table 37

WFC indeterm med wadi total with plat 7	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
plain/cort. (total 1)								**0%**
plain (total 4)		(1) 25%	(1) 25%			(1) 25%		**75%**
dih (total 1)		(1) 100%						**100%**
crushed (total 1)								**0%**

Table 38

WFC indeterm rough wadi total with plat 8	grin	bash	plat edge flk	grin/bash	grin/plat edge flk	bash/plat edge flk	grin/bash/plat edge flk	**total % of prep on a plat**
plain (total 6)		(4) 66.7%	(1) 16.7%			(1) 16.7%		**100%**
punc (total 1)				(1) 100%				**100%**
winged (total 1)								**0%**

Table 39

WFC indeterm type 1 total with plat 8			
plat	bulb	lip	ring crack
plain	diff	(1)12.5%	
fil	diff	(1) 12.5%	

Table 40

WFC indeterm med wadi total with plat 7			
plat	bulb	lip	ring crack
plain	diff		(1) 14.3%

Table 41

WFC indeterm rough wadi total with plat 8			
plat	bulb	lip	ring crack
plain	prom	(1) 12.5%	
	diff		(1) 12.5%

Table 42

WFC indeterm type 16 total with plat 1				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	diff	(1) 100%		

Table 43

WFC indeterm type 1 total with plat 8				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
punc	diff		(2) 25%	
fil	diff	(1) 12.5%	(2) 25%	
dih	diff		(1) 12.5%	(1) 12.5%

Table 44

WFC indeterm fine wadi total with plat 1				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
punc	diff		(1) 100%	

Table 45

WFC indeterm med wadi total with plat 7				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	diff	(1) 14.3%	(1) 14.3%	(1) 14.3%
dih	prom		(1) 14.3%	

Table 46

WFC indeterm rough wadi total with plat 8				
plat	bulb	lrg eraillure	clear cone	lrg eraillure/clear cone
plain	prom		(1) 12.5%	
	diff		(2) 25%	(1) 12.5%
punc	conical	(1) 12.5%		
winged	prom		(1) 12.5%	

Table 47

WFC indeterm plat and bulb features on the same piece			
plat	bulb	lip/lrg eraillure	ring crack/clearcone/lrg eraillure
type 1 total with plat 8			
fil	diff	(1) 12.5%	
rough wadi total with plat 8			
plain	diff		(1) 12.5%

Table 48

WFC rejuv total 10	type 16	type 1	fine wadi	med wadi	rough wadi
sec rejuv		10.0%			
sec rejuv rtch					
rejuv		20.0%	10.0%		10.0%
rejuv rtch		40.0%	10.0%		
total %		**70.0%**	**20.0%**		**10.0%**

Table 49

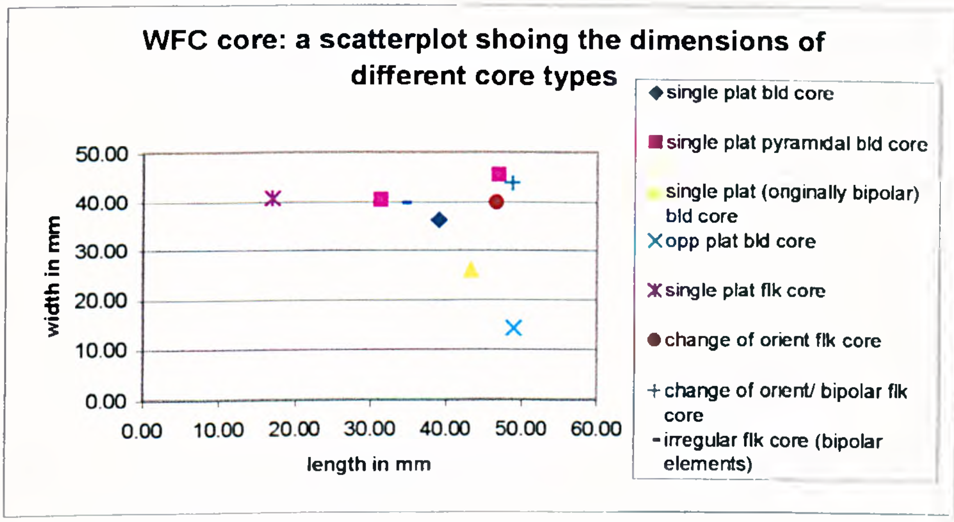
WFC rejuv total 10	type 16	type 1	fine wadi	med wadi	rough wadi
plat rejuv		10.0%	20.0%		
plat edge rejuv		20.0%			
plat edge rejuv/rem surf rejuv		20.0%			
rem surf rejuv		10.0%			10.0%
ski spall		10.0%			

Table 50

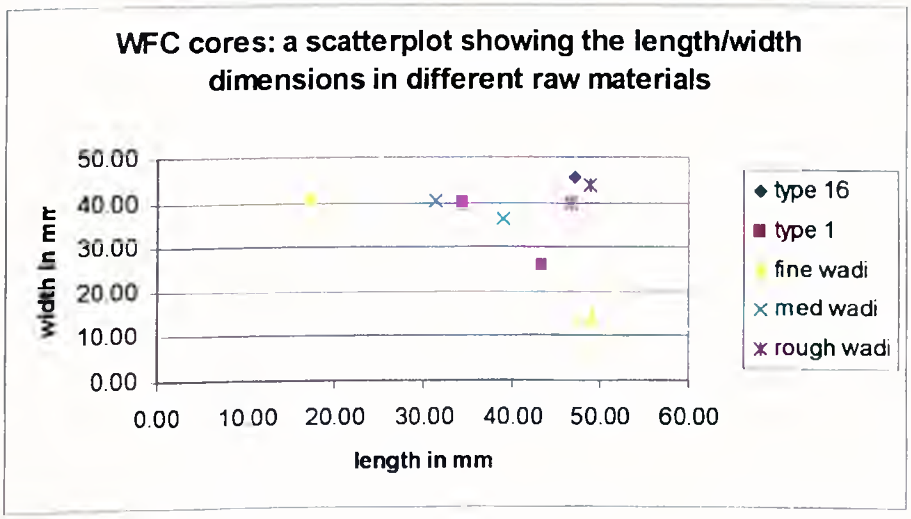
WFC tool total 181 (including non-formal tools)	type 16	type 1	fine wadi	med wadi	rough wadi
piercing tool		0.6%			
sec transverse burin rtch		0.6%			
burin				0.6%	
transverse burin rtch	0.6%				

List of graphs: Chapter 8 (WFC)

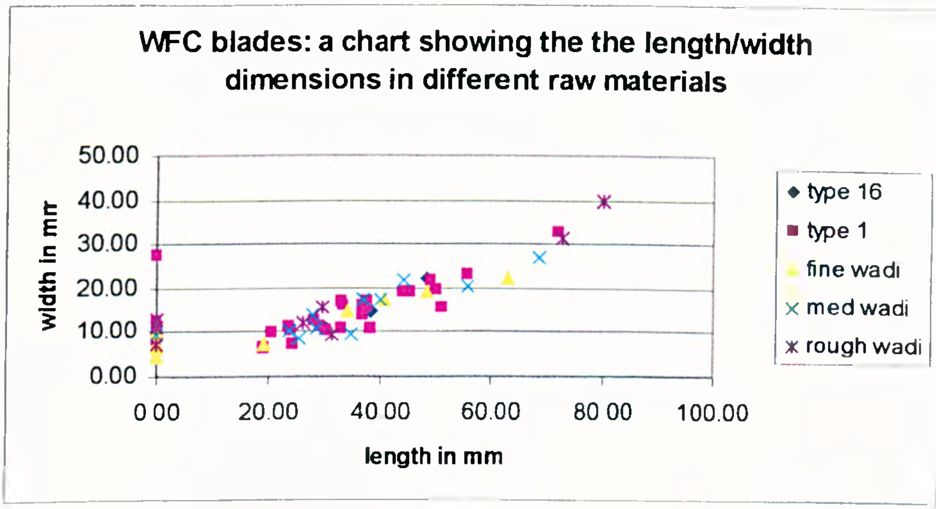
Graph 1



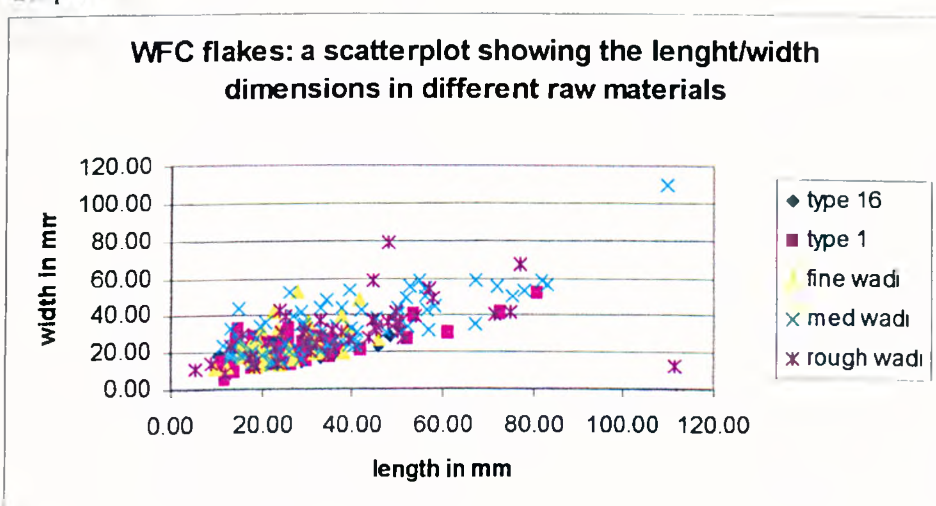
Graph 2



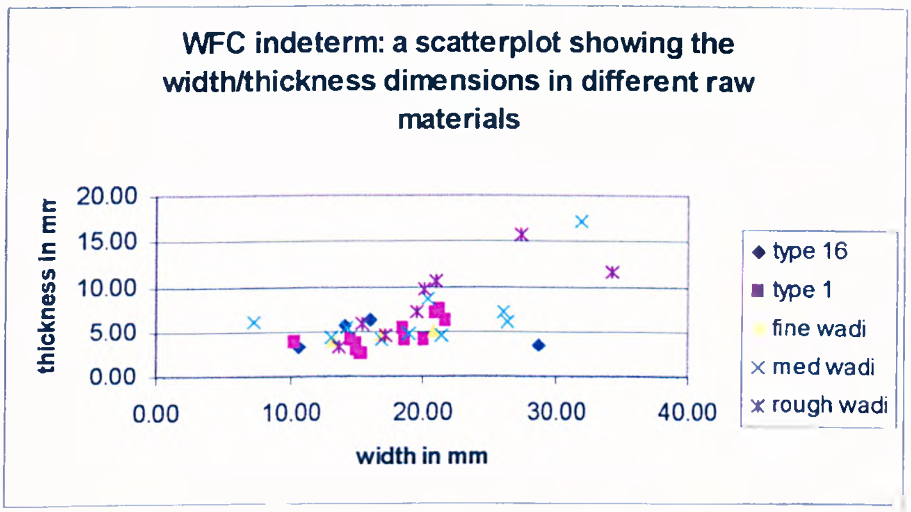
Graph 3



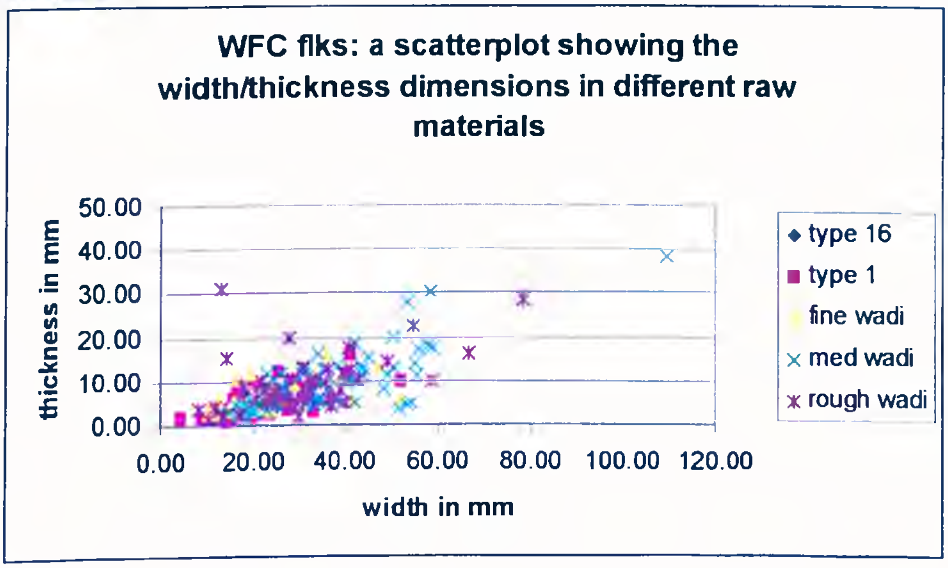
Graph 4



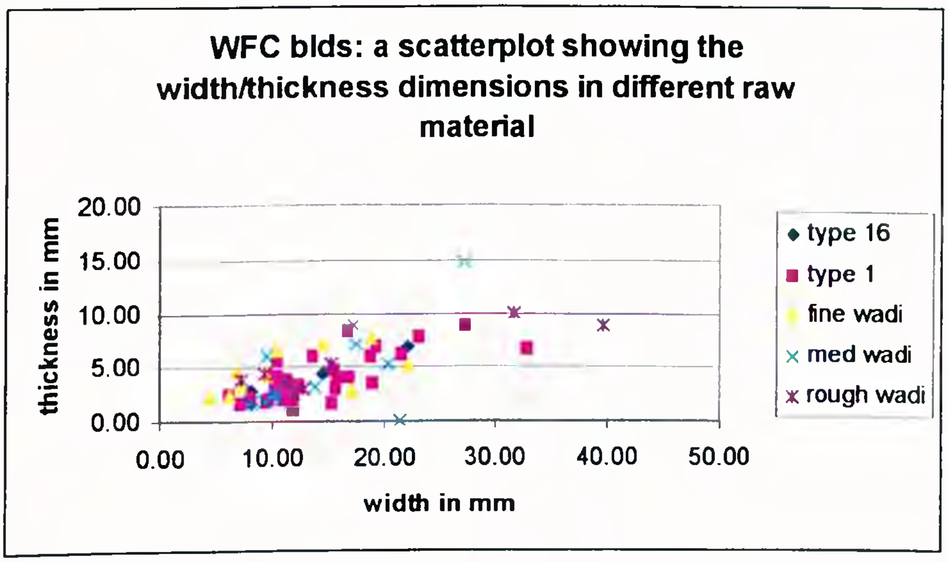
Graph 5



Graph 6



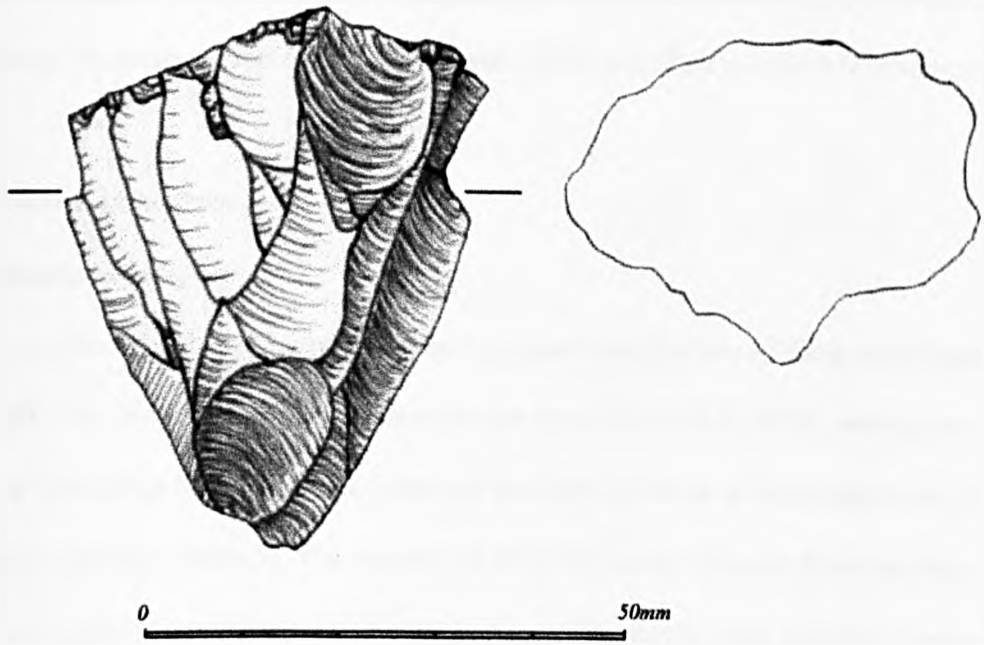
Graph 7



WFC blds: a scatterplot showing the width/thickness dimensions in different raw material
20.00
15.00
10.00
5.00
0.00
thickness in mm
0.00
10.00
20.00
30.00
40.00
50.00
width in mm
type 16
type 1
fine wadi
med wadi
rough wadi

List of figures: Chapter 8 (WFC)

Fig. 1 Pyramidal blade core in type 16 raw material.



Chapter 9

Comparative analysis of all four assemblages

In this chapter I shall be making a comparison of the lithic technology, between the four sites, strategy by strategy, beginning with Ghwair, WFA and Baja and then finishing with WFC.

Naviform industries

Reduction strategies

The naviform blade production strategy is a significant feature of the assemblages at all three PPNB sites. However, the naviform cores are most common at WFA, making up 62.5% of all cores (including flake cores), and they are the least common at Baja making up 11.4% of the core assemblage (table 1). The number of naviform cores removed from the Baja assemblage is low (under 15) and therefore, the percentage of naviform cores will not change significantly. At Ghwair and WFA the naviforms can be found in 'classic' and 'variant' forms (Chapter 5, 63-64) and at Baja only in 'variant' form (including the naviforms removed by Gebel). However, a significant proportion of the naviform cores have been removed from the Baja assemblage and these may not be of the 'variant' form. The 'variant' nature of the naviforms present in the Baja assemblage is possibly due to the fact that they are heavily reduced rather than resulting from the exploitation of a specific nodule shape as can be seen at Ghwair and WFA. The 'classic' naviforms at both Ghwair and WFA are generally of a similar size, but the 'variant' naviform dimensions differ between Ghwair, WFA and Baja (graph 1). At WFA they are smaller than they are at Ghwair and Baja, and there is less dimensional variation despite there being seventeen 'variants' at WFA and only thirteen at Ghwair (the number of naviform cores at Baja can not be compared because many were removed by the excavator). Other than the dimensions of the 'variant' naviform cores, both naviform core types are similar at each of the PPNB sites and their reduction strategies are indistinguishable in the debitage. There may be differences at the preform stages but these are not present in all of the assemblages.

At Ghwair and WFA the 'variant' naviforms are produced in the exotic type 1 material and 'classic' in the exotic type 16 raw material. At Baja the naviforms (which are all 'variant') have been produced in baja fine raw material, which is similar to fine wadi found in the vicinity of Ghwair (appendix 1). There are possibly type 1 and 16 naviform (or at least opposed platform) cores being produced at Baja as well (Chapter 7, 224-225), however, the evidence to hint at this is in the debitage only (there are no type 1 and 16 naviform cores in the Baja assemblage). It is simplest to compare Ghwair and WFA because the knappers at WFA are using the same raw materials as those used at Ghwair. The raw materials being used at Baja are similar but it cannot be said that they are the same because Ghwair and WFA are within half a days walk of each other (c.15km as the crow flies) but Baja is c. 25km away from Ghwair as the crow flies and further if you take into consideration the detours needed to avoid difficult terrain (therefore, it is probably a little over a days walk). Type 16 is the least commonly used raw material for naviform production of the two at both Ghwair and WFA, but it is marginally more important at Ghwair (table 2).

Reduction strategy goals

At Ghwair, 73.6% of the complete type 1 and 16 assemblage is non-formal tools and 1.8% is formal tools, this is a significant total of 75.4%. It is important to note that some formal tools have been removed from this assemblage and so this percentage will increase. However, it is clear that the knappers at Ghwair are retouching almost all the debitage in these two raw materials, and so it appears that one of the main goals of this naviform reduction strategy is possibly to produce general unspecialised tools. Though the formal tools are low in number, it is possible that specific types of tool may have been an important production goal of the reduction sequence, certainly one of the main goals of producing regular naviform blades across the PPNB in general was to use these as blanks for point production. The problem with certain types of formal tools is that they are produced for a specific purpose, to be used in specific circumstances, often away from the knapping area, for example points. From what is present in the assemblage, the most common formal tool type are piercers, however, I do not think that these are the main goal of the reduction sequence because you do not see the concentrations of piercing tools that you do at WFA. Therefore, I think that tool production at Ghwair, though extensive, was not particularly specialised.

Due to restrictions of access to the WFA assemblage, I have only counts of the formal tools and no raw material data, and I have only the non-formal tool data on blade and flake blanks. In type 1 and 16 materials, 42% of the blades and flakes are non-formal tools. This is considerably lower than the 86% retouched blade and flake blanks at Ghwair. This picture is consistent throughout the two assemblages; proportionally more of the Ghwair assemblage are non-formal tools (table 5[4]). Though there are more non-formal tools at Ghwair, the formal tools are proportionally more important at WFA. Of the total WFA assemblage, 24.3% are formal tools, as opposed to 2.1% at Ghwair (though a few formal tools have been removed

[4] It has been necessary to look at the Ghwair and WFA assemblage as a whole as I did not have raw material data on the WFA assemblage except in the core, blade and flake categories)

from the Ghwair assemblage, however, this is insufficient to account for the discrepancy with the high percentage at WFA). At WFA, 93.3% of the formal tool assemblage is piercing tools, which differs significantly to the 38.8% of piercing tools at Ghwair. From personal observation, it is clear that the piercing tools are produced on bladelets and broken blades in type 1 and 16 materials. The relatively low number of non-formal tools and the extremely high number of piercing tools suggests that the main goal of the naviform reduction strategy at WFA was to produce piercing tools. This is reflected in the naviform core size, the type 1 'variants' are the most common naviform at WFA and their smaller sizes are ideal for producing small blades and bladelets, which are the preferred blank types for the production of piercing tools. The larger size of naviform cores at Ghwair is reflected in the blade assemblage and the importance of points (points tend to be made on blade rather than bladelet blanks) in the formal tool assemblage. The goals of the naviform strategies at WFA may be the result of a more intensive craft production that specifically uses piercing tools, than at Ghwair. Certainly at WFA, a high percentage of knapping was focused on naviform production (judging from high naviform to non-naviform ratio), which was intensive and demonstrates a high proportion of the product was specialisation.

At Baja, 23.7% of type 1,16 and baja fine blades and flakes are non-formal tools (and 28.1% of the total debitage in these raw materials are non-formal tools), though these figures are possibly not fully representative due to the number of tools removed by Gebel. The flakes in these materials are more important for non-formal tool production (8.7%) than the blades (3.9%). Only 2.4% of the total debitage in these three raw materials are formal tools. This is much lower than at Ghwair and WFA, though, again this figure may not be fully representative due to the tools removed by Gebel. The type 1 and 16 materials at Baja are used to produce a range of formal tools that is a mixture of core tools and smaller tool types like points and piercers. The use of baja fine material is much more comparable to type 1 and 16 raw material at Ghwair and WFA, blade and bladelet blanks are used to produce mainly the smaller tool types like points and pierces. At Baja there is generally much less emphasis on the production of both formal and non-formal tools than at Ghwair and WFA (as the assemblage stands at the moment) and so the main goal of this reduction sequence was not necessarily to produce retouched tools, or there was a greater willingness to produce a higher proportion of waste products to each tool, particularly in the blade assemblage. The fact that there is no specific formal tool that is more common than the others at Baja, suggests that there is far less specialisation in the final stages of the naviform reduction sequence (tool production), again this verdict may change with the inclusion of the formal tools removed by Gebel. These results may also be partly due to the nature of the context from which the Baja assemblage came. Both formal and non-formal tools have been removed, and added to this workshop dump and so this context does not necessarily reflect the goals of the naviform strategy seen on the site as a whole.

Reduction sequences

The latter stages of the reduction sequence from the Ghwair naviform cores (in both raw materials) are generally present in the assemblage. However, there are low proportions of fully cortical blades and flakes (1.5% of the total type 1and 16 blade and flake assemblage) and the longest crested blades (longer than the longest blade) are also missing from the assemblage. This indicates that the earlier stages of the reduction sequence are not represented in the assemblage, however, the later stages of reduction and maintenance did occur in this area of the site. It is important to note here, that the partially cortical blades and flakes in the naviform associated raw materials from all the PPPNB sites work out at roughly 30% in each assemblage, this is because the 'variant' naviform cores retain relatively high levels of cortex after the preform stages and the naviform reduction strategies are the similar on all three sites. Considering that type 1 and 16 raw materials are exotic, it is entirely plausible that the preforming stage occurred close to the raw material source before being transported to Ghwair.

The naviform reduction sequence at WFA is similarly represented as far as can be seen in the blade and flake debitage (I was unable to analyse the other aspects of debitage). There is a similar low proportion of fully cortical blades and flakes (1%) in type 1 and 16. The debitage clearly indicates that it was the later stages of reduction and core maintenance occurring in this area of the site, in much the same way as it did at Ghwair. The evidence from Ghwair suggests that preforming possibly occurred close to the raw material source and as type 1 and 16 at WFA is the same raw material as that found at Ghwair, it is possible they were also preformed at the same source.

At Baja the reduction sequence of baja fine naviform cores is incomplete at many stages. Some expected formal tools, overshots, rejuvenation and crested elements are not present in the assemblage, and there are low proportions of fully cortical blades and flake debitage (3%). Parts of the reduction sequence of the type 1 and 16 cores are absent in much the same way as baja fine. Though in this case the cores themselves are also missing (either removed in antiquity or removed by the excavator), however, there are other types of cores in type 1. This dump at Baja consists largely of some of the debitage from the later stages of naviform core reduction sequences in baja fine material, but also some debitage from separate knapping episodes, which produced the blades in type 1 and 16. In the case of the type 16 opposed platform blade industry, the knapping episode may also be spatially discreet. The similarity to Ghwair and WFA is that it is the later stages of the reduction sequences that are represented, but the difference is that at Ghwair and WFA, the later stages of the reduction sequence is generally complete. This may be a reflection of the different assemblage contexts; layers of room fills at Ghwair and WFA and a workshop dump at Baja.

Technique

On a general scale, the most common naviform blade platform types found on the three PPNB sites are similar, including plain, punctiform and filiform. However, there are some differences in the specific proportions of each platform type (table 7). At Ghwair there is an almost equal use of plain, punctiform and filiform platforms. At WFA, the only type 16 blades that retain platforms are punctiform and filiform. However, the type 1 blades do commonly use plain platforms in similar proportions to Ghwair, but there is a more extensive use of punctiform platforms at the expense of filiform. This suggests that there is a more specialised approach to the use of smaller platforms at WFA than at Ghwair and at Baja. At Baja we see the lowest proportions of plain platforms, on the baja fine blades, of all three sites. Overall, there is a much more extensive use of the smaller platforms on baja fine blades than can be seen on either of the other PPNB sites.

The flakes in the naviform associated raw materials are largely produced by flake reduction strategies as well as part of the naviform strategies, and so I shall discuss the technique associated with the flakes in the section on flake reduction strategies later in this chapter. In general, it is the smaller platforms (punctiform and filiform) that have been most intensively prepared on the naviform related blade debitage; these same platforms have also received the highest levels of grinding preparation. The only exception is the WFA type 16 blades where all platforms have received high levels of preparation, however, the levels of grinding remain highest on the smaller platforms in much the same way as they do on the rest of the naviform related blade debitage from Ghwair, WFA and Baja. Looking at the specific percentages of preparation on these platforms (both levels of total preparation and levels of grinding) it is clear that they are similar across all three PPNB sites; ranging roughly between 80-100% (table 9). It is the intensive use of grinding that is the clearest differentiation of technique between naviform and naviform related strategies and non-naviform related strategies.

The platform and bulb features relating to the naviform debitage on each PPNB site would suggest, if we use the conventional classification system (chapter 5, 77), the combination of both the use of harder and softer hammer at Ghwair and WFA and an unclear hammer type at Baja. However, my results have demonstrated that platform and bulb features cannot be simply attributed to hammer type. There are many other aspects to technique, and the data from Ghwair and WFA suggests distinctive combinations of strike factors occurring that result in these patterns. When comparing the specific percentages of platform and bulb features between all three PPNB sites, some similarities carry through. There are comparably low levels of lips on all three sites (table 3). There are also comparable levels of ring cracks at Ghwair and WFA, but none at Baja. The clear cones differ on each site; however, it is WFA that stands out the most with much higher levels of clear cones. The percentage difference between all of the features on all three PPNB sites is very small with the exception of WFA clear cones, suggesting that (despite there being no ring cracks at Baja) the techniques applied to Ghwair and Baja naviform production is similar, but at WFA it is slightly different. This is possibly related to the relatively specialised tool production a WFA that makes the naviform industry distinct from that at Ghwair and Baja.

Importance of the strategies

The importance of any reduction strategy can be suggested by a number of things, for example, the quantity of debitage and blanks produced from the strategy and the effort put into producing the debitage.

The naviform strategy in type 16 material at Ghwair is relatively unimportant in terms of the quantity of debitage, but time and effort has been put into the reduction technique. Therefore, this blade production strategy is important, but not as important as the naviform production in type 1.

The largest quantity of debitage has been produced in type 1 material at Ghwair, though this includes both the naviform industry and the exhausted naviform flake core debitage. Type 1 naviforms are certainly the most important blade production strategy, both in terms of the quantity of debitage and the effort put in-to technique.

At WFA the type 16 naviform strategy is less important than at Ghwair because there is proportionally less debitage in this raw material and, therefore, the type 1 naviform strategy is more significant. However, the naviform strategies as a whole are far more important in relation to the entire assemblage at WFA than at Ghwair. Naviforms make up 62.5% of the core assemblage at WFA (as opposed to 25.4% at Ghwair) and the largest proportion of the debitage is associated with the naviform industries. Time and effort has also been put into the reduction technique at WFA as has been done at Ghwair. This emphasis on naviform production at WFA is reflected in the goals of the naviform reduction strategy, which differs to that at Ghwair.

At Baja the important strategy for blade production is the naviform industry in baja fine material, both in terms of debitage quantity and effort put into technique (core quantity is meaningless as many naviform cores were removed). The possible opposed platform blade industry in type 1 and 16 are insignificant because the quantity of debitage is so low (the type 1 and 16 blade industries are labelled opposed platform because there are no cores to demonstrate that they are naviform). The importance of the naviform and opposed platform blade core strategies are, overall, proportionally less important in the Baja assemblage than they are at Ghwair and WFA. However, this may be a feature of the type of context from which this assemblage came. Some naviform products were removed from this workshop dump at Baja, others in type 1 and 16 were added, and so the relative importance of the naviform industries may differ on the site of Baja as opposed to in the workshop dump.

Non-naviform blade industries

It is difficult to compare the non-naviform blade core strategies between the three sites because the form of many of these cores are simply a response to restrictions of the raw material nodule or previous knapping, rather than separate blade production strategies. At Ghwair the opposed platform and double platform bladelet cores are in type 1 material and are clearly related to the naviform strategy. The debitage from these cores are indistinguishable from the bulk of the type 1 debitage and the cores themselves are irregular and similar in size to the 'variant' naviforms.

The medium wadi debitage at Ghwair indicates that there was an expediently opposed platform blade production strategy produced in this raw material, it was possibly a naviform strategy but this cannot be demonstrated without evidence from the cores. The cores themselves are missing from the assemblage and so all information about them is derived from the blade debitage. However, it is distinctive from the debitage produced by the naviform industries because a large proportion of the medium wadi blades are longer than the type 1 and 16 blade debitage, there are fewer opposed platform dorsal scars (suggesting that the cores were only expediently opposed platform) and the technique applied to these blades differed to that of the type 1and 16 blades. The goals of this opposed platform strategy in medium wadi are not clear. The widest range of formal tools were produced in this raw material, though not necessarily on blade blanks, and the majority of debitage has been made into non-formal tools. Clearly producing tools in this raw material is important in much the same way as it is in type 1 and 16 at Ghwair. However, there is less specialisation in medium wadi tool production than in the raw materials associated with the naviform industries at

Ghwair and WFA. Technique applied to the medium wadi blade industry partially differs to that applied to the naviform industry. The knappers were most commonly removing larger blade platforms from these cores (punctiform and filiform are not as common) and were spending less time preparing them (less grinding is utilized), however, the platform and bulb features indicate that technique relating to strike factors and/or hammer type was similar to that applied to the naviform industries in type 1 and 16. This opposed platform blade production strategy in medium wadi is distinctive and cannot be found at either WFA or Baja. It cannot be related to the possible opposed platform blade production strategy in type 1 at Baja because there is not the dimensional distinction between the type 1and baja fine blades (which are associated with the naviform industry) at Baja that can be seen between the type 1 and medium wadi blades at Ghwair.

At WFA the single platform blade and bladelet cores and the double platform blade core have been produced in type 1 and are responses to the limitations imposed by raw material and previous removals. As at Ghwair, these cores are related to the naviform industry because they are produced in the same raw material as the 'variant' naviform cores, which are themselves a response to the raw material shape, these cores are also dimensionally similar to the naviform 'variants' and the debitage removals are indistinguishable from the rest of the type 1 debitage.

There are a limited number of medium wadi blades at WFA though there are no medium wadi blade cores in this assemblage. The debitage indicates that they are not from opposed platform cores, unlike the medium wadi blades at Ghwair, and the techniques applied to this debitage is similar to that applied to the medium wadi flake industry. It is possible that this strategy is related to the medium wadi flake industry because the blade debitage is not distinctive in the way that medium wadi blades at Ghwair are.

At Baja the single platform blade core in baja fine is related to the baja fine naviform industry in much the same way as the single and double platform blade cores at Ghwair and WFA. The raw material is the same, the core is directionally similar to the naviform cores and the debitage is indistinguishable from the naviform debitage. Apart from the missing type 1 and 16 opposed platform (possibly naviform) blade cores there are missing blade cores in medium and rough wadi. However, the blade debitage in these raw materials have been produced in much the same way as the flake debitage in the same raw materials, and so are possibly related to the flake production strategy. This is similar to the medium wadi blade debitage at WFA.

Flake industries: exhausted naviform flake cores

Reduction strategies

At Ghwair and WFA two different strategies of flake production can be identified. The first is the reuse of exhausted naviform cores for flake production and the other is a dedicated flake core strategy. At Baja there are these two types of strategies, but the dedicated flake cores can be separated into two different types. Reused blade cores are not as common as dedicated flake cores on all three sites, though they are most numerous at Ghwair (table 11). The reuse of blade cores or dedicated flake cores tends to be related to raw material at all three sites. At Ghwair and WFA the reused blade cores are produced in type 1 and 16 materials. The major difference of reuse between Ghwair and WFA is that at Ghwair they are turning their type 1 naviforms into flake cores earlier on in the reduction sequence than they are at WFA. The result being that fewer naviforms are reused as flake cores at WFA as they have become too small.

The exhausted naviform flake cores at Ghwair come in a range of different core types and are all produced in type 1 and 16 raw materials (because they are exhausted naviform cores). The different core types, single and double platform, irregular and change of orientation flake cores, are all related to the same strategy and are simply responses to limitations imposed by nodule shape and previous removals. However, it is clear that the knappers at Ghwair favoured the change of orientation core reduction method whenever possible. Though this was not necessarily to maximize flake production across the flake industries as change of orientation flake cores in medium wadi are not heavily reduced.

Flake cores in general are not as common in the WFA assemblage (table 12). The exhausted naviform flake cores are only found in type 1 material and they are made up of opposed platform and irregular flake cores that are clearly related to the naviform shape. There are no flake cores in type 16 suggesting that the flake debitage in this raw material is part of the naviform reduction strategy. It is possible that the knappers at WFA were not as interested in using the change of orientation reduction strategy as they are at Ghwair.

At Baja the exhausted naviform flake cores are found in baja fine material. It is possible that the type 16 flake debitage was produced from either flake cores that were exhausted opposed platform (possibly naviform) blade cores, or that these flakes were produced as by-products of the blade reduction sequence. There is a wide range of baja fine flake core types all, of which can be related to the original naviform cores. There is no clear preference for change of orientation reduction methods that can be seen at Ghwair. However, it is difficult to relate the Baja exhausted naviform flake cores to the equivalent WFA flake cores because there is a greater range of baja fine core types. At WFA there are only opposed platform and irregular exhausted naviform flake cores and the original naviform type can be traced in these flake core forms. It appears that the flake production in the naviform related raw materials is most formalized at Ghwair. Though change of orientation produces an ultimately irregular shaped core, the reduction methodology is consistent and repetitive.

Reduction strategy goals

The type 1 and 16 flake industry at Ghwair is unimportant for the production of formal tools; by far the majority of formal tools types are produced on either naviform blade blanks or are core tools. Therefore, the goal of this flake production strategy is to produce non-formal tools as 85.9% of the type 1 and 16 flake assemblage has been retouched. It is interesting to see that there is no specialisation in the final stages of this strategy, but there is some formalization of the cores at the other end of the reduction sequence.

Non-formal tools are less common in the type 1 flake assemblage at WFA making up only 34%. Like Ghwair, the majority of the formal tools have not been made on flake blanks (I do not have any raw material data for the WFA tools). Therefore, the goals of this strategy are possibly to produce flake debitage that will not be retouched.

At Baja as very few tools have been made on type 16 flake blanks this might be a further indication that these flakes are a by-product of opposed platform blade production. However, it is possible that Gebel removed some of the type 16 flake tools.

Only 8.6% of the baja fine flakes have been retouched, which is lower than both WFA and Ghwair, again possibly the result of Gebel's actions. There is only one example of a formal tool (burin) produced on a baja fine flake blank, and so this strategy is also not important for the production of formal tools. This suggests that the main goal of the exhausted naviform flake core strategy is to produce flake debitage that will not be retouched rather than tools, much like that at WFA. However, the context at Baja is a dump and so tools may have been removed from the assemblage, both by Gebel and possibly in antiquity or were never deposited in this context. This assemblage may not reflect the goals of the flake production strategy in baja fine on the site as a whole.

Reduction sequences

At both Ghwair and WFA, the reduction sequence of the exhausted naviform flake cores is fully present in the assemblage. At Baja, the reduction sequence of the exhausted naviform flake cores is also fully present, but the type 16 flake cores are missing (if this is a flake production strategy) and various stages of the reduction sequence are either partially or fully missing in much the same way as the Baja type 16 blade reduction sequence. Therefore, the complete reduction sequence of exhausted naviform flake cores was carried out within the area of excavation at Ghwair, WFA and Baja (in baja fine material). However, the reduction sequence of the type 16 debitage at Baja was reduced elsewhere and the debitage only partially added to the workshop dump assemblage, this is regardless of whether the type 16 flake debitage was part of exhausted naviform flake or opposed platform blade production strategies.

Technique

The general similarity in common platform types seen on the naviform blades between the three PPNB sites cannot be seen as clearly on the flake debitage produced by the exhausted naviform flake core strategies. However, plain platforms are consistently common throughout all three sites (table 8). They are least common on type 1 flakes at WFA and on baja fine flakes at Baja, it is also in these two raw materials, at these two sites, that the smaller platforms are most common, particularly at Baja. The low number of punctiform and filiform platforms at Ghwair is probably the result of the fact that change of orientation flake cores are more common at this site, smaller platforms tend to be produced accidentally in this reduction strategy. It would appear that, like on the naviform related blades, smaller platforms are most extensively used at Baja in the baja fine raw material. Though WFA appears most similar to Baja when using plain and small platforms on flakes, there are some similarities with Ghwair in the use of faceted platforms, almost as if WFA is somewhere in-between Ghwair and Baja. Therefore WFA and Baja have a closer relationship when using platforms in the flake industry that are extensively related to the naviform blade industry, but WFA also has a closer relationship with Ghwair in the use of faceted platforms that are more extensively used in the flake industry. This is a more complex pattern of relationships between the three sites than is presented by the naviform blade platforms though the use of smaller platforms on the blades at WFA and Baja is possibly reflected by the flake debitage in naviform related raw materials.

This relationship between WFA and Baja can also be seen in the levels of platform preparation. Overall levels of platform preparation are generally high on the exhausted naviform flake core debitage, though they are, overall, slightly lower at Baja than it is at WFA and Ghwair (table 10). However, levels of grinding are consistently high on the smaller punctiform and filiform platforms at WFA and Baja. This is possibly due to the fact that high levels of grinding are necessary to develop such small isolated platforms. However, at Ghwair the smaller platforms (though not common) have been prepared using significantly lower levels of grinding than at WFA and Baja (0% on type 16 punctiform flake platforms, 16.7% on type 1 punctiform platforms and 6.7% on filiform platforms). Again, the relationship between WFA and Baja is closer in its approach to the production and preparation of smaller platforms.

Using conventional theories on hammer technique (chapter 5, 77), the platform and bulb features on each site would suggest the use of harder hammer at Ghwair and Baja and a combination of harder and softer hammer at WFA in the production of debitage from exhausted naviform flake cores. However, hammer type is only one aspect of technique that results in the production of platform and bulb features. It is clear that generally, on all three sites, there are more features, particularly clear cones (table 3) than there are on the equivalent blade debitage. WFA again stands out, as it did in the blade debitage (though for different reasons), because there are more lips here than at Baja and Ghwair. The baja flakes have fewer features overall to a greater degree than is seen in the blades and so what is happening at Baja is not necessarily the same as is happening at Ghwair. Therefore, some aspects of technique relating to strike factors are possibly similar, but other aspects are subtly different on all three sites and so the combinations of strike factors at WFA do not stand out as much as they do in the naviform blade strategy.

Importance of the strategies

Type 16 raw material at Ghwair is significantly less utilized than type 1 both in the flake and blade assemblages. By putting type 1 and 16 flakes together it is clear that this is a significant strategy making up 42.3% of the flake assemblage. However, the effort put into preparing these flakes does not single them out from the rest of the flake assemblage and so the exhausted naviform flake cores are not necessarily the most important flake production strategy.

At WFA, more effort is put into the preparation of type 1 flake platforms than at Ghwair singling them out from the rest of the assemblage, and as the type 1 flakes also make up half of the total flake assemblage, this is clearly the most significant flake production strategy. However, flake production strategies in general are less important, in relation to the blades, at WFA than they are at Ghwair.

At Baja there are questions as to whether the type 16 flakes are part of a flake production strategy at all, though the numbers are so low they are probably not important in this workshop dump context. The baja fine flake strategy is, proportionally, marginally more important than the exhausted naviform flake core strategy at Ghwair, but it is not the most significant flake production strategy at Baja. However, the dump context of the Baja assemblage may not necessarily reflect production and use of lithic production strategies across the site.

Dedicated flake cores

Reduction strategies

The dedicated flake cores at Ghwair are found in fine, medium and rough wadi raw materials. A few of these cores are single and double platform and multiple orientation flake cores but the majority (87.5% of the flake cores in wadi materials) are change of orientation flake cores. However, because these cores are all relatively irregular in form and the debitage is homogeneous, it is clear that they are part of the same reduction strategy and are simply developments according to the nodule or core shape. The high number of change of orientation flake cores suggests a similar level of formalization in the reduction methodology as in the type 1 and 16 flake cores at Ghwair.

At WFA the dedicated flake cores are also in the wadi raw materials (fine, medium and rough) and, as at Ghwair, there are a range of core types from single and opposed platform to change of orientation flake cores. Unlike Ghwair, 50% of these cores are change of orientation, which is a significant proportion, but we do not see such a clear preference for this reduction method as we do at Ghwair. However, as at Ghwair, the irregularity of core shape and the homogeneous debitage indicates that all these different core types were part of the same strategy.

At Baja there are two separate strategies apparent in the dedicated flake core assemblage. The first is in type 1 material and consists of a wide range of core types (Baja list of tables 1), which makes up 63.9% of the total core assemblage. However, the dimensions and raw material puts all these type 1 cores into the same category. These particular cores are unusual, they are very small and so did not produce much debitage as can be seen in the type 1 flake debitage. The opposed platform and bipolar type 1 flake cores show piece esquillée crushing and so it is possible that at least some of these cores were used as 'wedge-like' tools. However, it remains unclear whether their main purpose was as cores or as tools. Certainly this is an informal strategy whether it was used to produce flake debitage or core tools. This is a distinct core reduction strategy, the like of which cannot be found on any of the other sites, much like the opposed platform blade strategy at Ghwair.

The other dedicated flake cores at Baja are irregular and change of orientation cores in medium and rough wadi material. Only 26.9% of the dedicated flake cores (including those in type 1) are change of orientation, indicating that this reduction strategy was not as important as it was at Ghwair and WFA. However, those cores in raw materials are probably part of the same reduction sequence because the cores are so irregular in form, dimensionally similar and the related debitage is homogeneous. These particular cores are more closely comparable to the dedicated flake cores on Ghwair and WFA. Though, fine wadi is not included because at Baja it is the raw material associated with naviform production.

Goals of the reduction strategies

At Ghwair, very few formal tools have been produced on flake blanks and so the dedicated flake core strategies are clearly most important for the production of non-formal tools, 81% of the flake assemblage in wadi materials has been retouched. In fact, the majority of the Ghwair assemblage as a whole (including the blades) has been retouched. Like the exhausted naviform flake core strategy in type 1 and 16, there is no specialisation at the final tool production stages of the reduction sequence of the dedicated flake core strategy, despite the fact that there is some formalization at the other end of the sequence in the core reduction. Again, like Ghwair, there are very few formal tools produced on flake blanks at WFA and so this dedicated flake core strategy is more important for the production of non-formal tools, though not on the same scale as at Ghwair. Up to 42% of the fine, medium and rough wadi flakes have been retouched, which is a little more than 32% of the type 1 flakes. However, unlike Ghwair, the main goal of this reduction strategy was either to produce flake debitage that was not to be retouched, or the knappers were willing to expend a lot of debitage in the selection of each tool. What is most comparable to Ghwair is the lack of specialisation at this end of the reduction sequence.

There are also very few formal tools on flake blanks at Baja, this is possibly due to Gebel removing tools from the assemblage, tools being removed by the knappers in antiquity or the choices the Baja knappers made in selecting blanks for the production of tools. The type 1 flake debitage is relatively important for the production of non-formal tools, 50% of the type 1 flakes have been retouched, which could be even higher if some of the tools removed by Gebel are produced on type 1 flake blanks. It is also possible that the type 1 'wedge-like' cores were also used as tools themselves for very specific purposes. Therefore, though the form of the cores is generally irregular and the tool production of type 1 debitage is unspecialised, this reduction strategy may have been used to fulfil a specific purpose. The medium and rough wadi flake production strategies are not important for the production of non-formal tools; only 22% have been retouched (but this is marginally more than the 18.8% of the baja fine flake debitage). It appears that the main goal of the medium and rough wadi flake production strategy is to produce debitage that will not be retouched, or a lot of expendable debitage was produced for every tool selected, much like the dedicated flake core strategies in wadi raw materials at WFA.

Reduction sequences

The reduction sequence of the dedicated flake core assemblage at Ghwair is generally complete, including cortical debitage, though it is difficult to relate crested and rejuvenation elements to these cores because their shape is so irregular.

At WFA the low number of dedicated flake cores and the dimensions of the debitage suggests the possibility that some cores, but not all, are missing from the assemblage. Otherwise the reduction sequence is complete. It is a possibility that the missing cores will be found close to this trench because the early stages of the reduction sequence is present including some of the cores. Therefore, this situation is similar to that at Ghwair.

The reduction sequence of the dedicated flake cores in type 1 material at Baja is incomplete; the early stages are under represented in the assemblage. The preforms are prepared elsewhere, possibly at source if they are comparable to the only other dedicated type 1 cores (the naviforms at Ghwair and WFA). The reduction sequence of the dedicated flake cores in medium and rough wadi is complete, much like the equivalent industries at WFA and Ghwair.

Technique

On a general level, there are broad similarities of common platform types on dedicated flake cores across all three PPNB sites. As with the exhausted naviform flake cores, plain platforms are common at Ghwair, WFA and Baja. However, the specific proportions of plain platforms are similar at Ghwair and WFA, but slightly lower at Baja (table 13). There is also a greater use of punctiform and filiform platforms at Baja on type 1, medium and rough wadi flakes (all the dedicated flake core strategies at Baja), which is not seen on the flake debitage produced by dedicated flake core strategies (that are in wadi materials table 13). The high level of smaller platform use is a feature of all the blade and flake reduction strategies at Baja. Crushed platforms are most commonly found on dedicated flake core debitage at Ghwair and Baja, but crushing is related to strike factors and is not a part of any decisions made on platform choice. Therefore, Ghwair and WFA clearly have a closer relationship on platform type preferences in dedicated flake production strategies.

Overall, across the three PPNB sites, the levels of preparation are high and the level of grinding is low, this can be seen in the other flake production strategies. However, at Ghwair and WFA the levels of preparation and grinding reduce gradually from the highest on fine wadi flakes, through medium wadi, to the lowest on rough wadi flakes (table 14). At Baja, this simple pattern cannot be seen on type 1 flakes, though it can on the medium and rough wadi flakes with punctiform platforms (tables 10 and 15). The pattern reverses on medium and rough wadi flakes with plain platforms (there is higher levels of preparation on rough wadi flakes). The overall levels of preparation on plain platforms at Ghwair and WFA are similar (quantifying preparation on crushed platforms does not work because the crushing obscures previous preparation), though there are higher levels of grinding on fine and medium wadi flakes at WFA. At Baja, the levels of preparation on medium and rough wadi flakes are also similar to Ghwair and WFA but there is a more extensive use of grinding on both the smaller (punctiform and filiform) platforms and plain platforms (table 14). Therefore, the relationships between the three sites displayed in the choices made on platform type in the dedicated flake core strategies, is reflected in the use of platform preparation. Ghwair and WFA have greater similarities with each other than with Baja.

The platform and bulb combinations at Ghwair and WFA and the high level of crushing at Baja, found on the flake debitage relating to the dedicated flake core strategies, would, conventionally, suggest that harder hammer was used at all three sites. However, the specific percentages of strike factors do not suggest such a simple pattern. Baja immediately stands out, there are no platform features on flakes in rough and medium wadi, and very low levels of clear cones (table 4). There are similar levels of platform features at Ghwair and WFA, but not of clear cones. The levels of clear cones at Ghwair are comparable to the other flake and blade reduction strategies at Ghwair and the blade reduction strategies at WFA (around 30% tables 3 and 4). However, as is seen in the WFA exhausted naviform flake core strategies, the levels of clear cones on debitage from WFA dedicated flake core strategies are higher than Ghwair and Baja (though in this case significantly higher at 60.7%). This data (on dedicated flake core strategies) shows that there is a closer relationship between Ghwair and WFA than with Baja, as is reflected in the data on platform type and preparation.

Importance of the reduction strategies.

The medium wadi flake debitage is most common at Ghwair and, together, the wadi materials make up 59.2% of the flake assemblage. As the effort put into platform preparation is consistent throughout the flake assemblage, this leaves only debitage quantity to assess the relative importance of a strategy. Therefore, the dedicated flake core strategy is possibly more important than the strategy that produced the type 1 and 16 flake debitage, especially as some of the type 1 and 16 flakes will be by-products of the naviform production. However, raw material availability may also be having an impact on this data. The dedicated flake core strategies utilize raw materials from the immediate locality of the site and so the higher quantity of wadi material flake debitage may simply be a reflection of this rather than any concept of value.

At WFA the wadi flake debitage is less common than the type 1 flake debitage, it only makes up 41.1% of the flake assemblage (as opposed to the 50.6% in type 1 material). This is possibly a reflection of the greater relative importance of the naviform and exhausted naviform flake strategies in type 1 material at WFA than at Ghwair. Raw materials accessibility may also be affecting use of dedicated flake core strategies at WFA; the wadi raw materials found at WFA come from the locality of Ghwair, not WFA.

The small type 1 cores at Baja do not produce much debitage and this is reflected in the flake assemblage, only 15.5% is in type 1 material. The platform preparation does not single this strategy out from the other flake production strategies and it is not clear whether it is the flakes or the cores that are important. The relative importance of the medium and rough wadi dedicated flake core strategy is possibly comparable to the wadi material flake production strategy at WFA. Medium and rough wadi flakes make up only 35% of the Baja flake assemblage and so the flake production strategy in the naviform related raw material (baja fine) is possibly more important. Again suggesting the potential importance of naviform by-products.

Raw material at Wadi Fidan C (WFC)

There is a continuation of raw material use from PPNB Ghwair and WFA to the later PPNC/6th mbc WFC. The wadi type raw materials (fine, medium and rough wadi) all come from the vicinity of Ghwair in the wadi Dana which is about a days walk away. This is much the same scenario as at WFA, because the flint raw materials in the Wadi Fidan are low quality conglomerates. However, the knappers at WFC are also using the same exotic flint raw materials (type 1 and 16) as they are at Ghwair and WFA.

Blade core strategies at WFC

Reduction strategies

There are three blade core reduction strategies at WFC and, unlike the PPNB sites, they are not necessarily as closely related to raw material types.

The single platform blade cores in medium wadi and the single platform pyramidal blade cores in type 16 and medium wadi are probably part of the same strategy as indicated by the similarity of the debitage. This is the most common and formalized of all the blade core reduction strategies.

There is one single platform, reused bi-directional blade core produced in type 1 material. The rejuvenation and crested elements and the only overshot all suggest that there was a significant bi-directional blade core strategy in type 1 raw material. This partially relates it to the Ghwair and WFC naviform strategies because they are using the same raw material to produce cores that have two platforms that are reduced at the same time, thus maximizing the use of this type 1 raw material.

The opposed platform blade core in fine wadi is a separate strategy from the bi-directional cores but it also has two platforms being reduced at the same time. However, it differs from the naviform cores on the three PPNB sites because it is not a carefully prepared core. One of the platforms, on the WFC fine wadi opposed platform blade core, has not been prepared at all and remains fully cortical. The back of this core is also fully cortical. It is difficult to compare this core to the opposed platform strategies at Ghwair and Baja because these particular cores are not present in either strategy. However, the very low degree of core preform preparation on the WFC opposed platform blade core suggests that this is a rather an ad hoc strategy and unlikely to be often repeated either at WFC or on the PPNB sites.
There are some blades produced in rough wadi, suggesting that the rough wadi blade cores are missing from this assemblage. However, the dimensions of the blade and flake debitage are

similar indicating that the debitage was possibly removed from the same or similar rough wadi flake cores.

There is much more variety in the blade core reduction strategies at the PPNC/6th mbc site of WFC than there is at the PPNB sites of Ghwair, WFA and Baja. The WFC strategies are also not as closely tied to the raw material (exotic type 16 and medium wadi materials are used in the same reduction strategy). However, the importance of the type 1 raw material has been inherited from Ghwair and WFA (using a strategy that maximizes production in this raw material).

Goals of the reduction strategies

The formal tool assemblage is too small to provide much meaningful information. However, two out of the four formal tools have been produced on type 16 and medium wadi blade blanks which relate to the single platform/pyramidal blade core strategy. Therefore, this strategy is at least used for the production of formal tools. Non-formal tools make up 43.8% of the blade and indeterminate assemblages in type 16 and medium wadi indicating that these tools are relatively important. However, in terms of quantity, the main goal of the single platform/pyramidal blade production strategy appears to be the production of blade debitage that was not to be retouched and either produced as by-products of tool selection or to be used as unretouched tools. This differs from Ghwair, WFA and Baja where the main goal of all blade production is to produce blanks for formal and non-formal tools.

The other two formal tools have been produced on type 1 blade blanks and these are associated with the bi-directional blade core strategy. One is a burin and the other a piercing tool similar to those found in abundance at Ghwair and WFA. Though formal tool production may not be the main goal of this reduction strategy, 64.6% of the type 1 blade and indeterminate assemblages have been retouched. This suggests that the main goal of the bi-directional blade reduction strategy was to produce non-formal tools with a significant role for debitage without retouch.

The goals of the opposed platform fine wadi blade production strategy are similar to the single platform/pyramidal cores. Though no formal tools have been produced in this raw material, 40% of the fine wadi blades and indeterminates have been retouched, a significant proportion. However, this suggests that the main goal is to produce blade debitage that will not be retouched, or the knappers were producing a lot of by-products for every blade tool.

The tool production at WFC generally reflects the type 1 raw material use from the PPNB sites of Ghwair and WFA and the baja fine material use at Baja, in the sense that it is the type 1 and 16 raw materials that were the main raw materials for formal tool production and the majority of formal tools were produced on blade blanks. However, the proportions of non-formal tool production on all blade production strategies at WFC are specifically comparable to WFA, which is the closest site. The knappers at WFC also appear to be much more selective in the choice of blade blanks that are to be retouched than is apparent at the three PPNB sites. Overall there is much less production and use of formal tools at WFC than there is at WFA, Ghwair and Baja, suggesting that this is a feature of the PPNC/6th mbc date of WFC.

Reduction sequence

The single platform and pyramidal blade core reduction sequence in type 16 and medium wadi materials are not complete in this assemblage. Both the early stages of reduction and some aspects of later reduction stages are not present. It is difficult to compare this reduction strategy with the single platform strategies seen at Ghwair, WFA and Baja because it is more formal in nature. However, the absence of the early stages of the blade reduction strategy in type 16 material at WFC is comparable to the absence of the early reduction stages of naviform blade cores in type 16 material at Ghwair, WFA and Baja. The only other blade production strategy in medium wadi is found at Ghwair and the initial reduction, stages including the cores, are also not present.

The very early stages of the type 1 bi-directional blade core reduction sequence are also not present in this assemblage. Otherwise this is the most extensive reduction sequence represented in the assemblage. This is comparable to the type1 naviform strategies at Ghwair and WFA where there is a possibility that the naviform preforms were prepared close to the raw material source.

The reduction sequence of the fine wadi opposed platform blade production strategy is complete in this assemblage, making it distinct from the pyramidal blade core and bi-directional strategies in type 1 and medium wadi. Again it is difficult to compare this reduction strategy to blade strategies on the PPNB sites, as the only other possible opposed platform reduction strategies are in medium wadi at Ghwair and in type 1 and 16 at Baja.

These opposed platform blade reduction sequences at Ghwair and Baja are not as complete as the fine wadi opposed platform blade production strategy at WFC.

The early sites of Ghwair and WFA show a certain consistency as at both sites core preforming occurred off site, a factor closely linked to the raw materials used and the relative procurement distances involved. There is also a consistency in the fact that the final reduction sequences were carried out on site. It is only at Baja where a lack of consistency appears throughout the reduction strategy, a factor probably due to the dump context from which the assemblage was recovered. At WFC, the aspects of the reduction sequences represented in the assemblage is neither consistent (in the way it is at Ghwair and WFA) in relation to where the preform in wadi materials were prepared nor to the reduction sequence of the single platform/pyramidal cores in type 16 and medium wadi. The only clear relationship with the blade production strategies on the older sites can be seen in the use of type 1 raw material.

Technique

Plain platforms are the most common type of platforms used in the production of blades in all blade production strategies at WFC (table 15), and plain platforms are certainly an important platform type in the production of blades on the three PPNB sites. The proportions of plain platforms on WFC blades are comparable to the proportions of plain platforms on blades from the three PPNB sites. However, punctiform and filiform platforms are only common on type 1 blades. It is these blades that are associated with the bi-directional reduction strategy, which is comparable to the naviform strategies on Ghwair and WFA, and to a lesser extent, Baja. The proportions of punctiform and filiform platforms on type 1 blades at WFC (18.8% punctiform and 21.9% filiform table 15) are closest to some of the proportions of smaller platforms on naviform related blades at Ghwair and WFA (which range between 10.6% - 46.5%) rather than with those at Baja (which range between 30.0% - 46.3% (table 7)). The level of preparation is generally high on WFC blades, and the levels of grinding on these plain platforms is generally similar to the levels of grinding on plain platforms on naviform related blades at the PPNB sites, with the exception of plain platforms on type 1 WFC blades. Here, the majority of grinding has occurred on the punctiform and filiform platforms. Though 33.3% of grinding on type 1 punctiform platforms is relatively low and comparable to the grinding on medium wadi plain platforms, type 1 filiform platforms have been prepared at high levels (71.4%) comparable to the grinding on naviform related punctiform and filiform blade platforms from the PPNB sites. These results hint at a similar intensive preparation of small platforms, relating to the bi-directional blade production strategy, as is seen in the naviform industries from the three PPNB sites.

The features relating to strike factors on WFC blades indicates that, again, there is a distinction between the type 1 blades and the rest of the blade assemblage. The platform and bulb features also single out type 1 blades, it is only in this raw material that there are platform features. It is difficult to compare the exact proportions of platform and bulb features between WFC and the PPNB sites because we are dealing with very low percentages. However, the percentage of lips on the WFC type 1 blades is probably more comparable to the proportions of lips on the naviform associated raw materials, than with the proportion of lips on non-naviform associated raw materials, which are generally lower (tables 18, 3 and 4) on the three PPNB sites. The percentage of type 1 WFC clear cones is also generally similar to the percentages of clear cones on naviform related debitage. Therefore, there may be some similarities in the combination of strike factors utilized in the production of bi-directional and naviform blade debitage. This again, indicates a relationship between the type 1 bi-directional blade production strategy at WFC and the naviform blade production strategy on the PPNB sites.

The percentage of clear cones ranges significantly between the blades in different raw materials, suggesting that some aspects of technique relating to strike factors differs between all the different raw materials, but the absence of platform features on type 16, fine, medium and rough wadi blades suggests that other aspects of technique are similar when using these raw materials (which includes all blade production strategies except the type 1 bi-directional strategy). The absence of platform features could possibly be comparable to the production of non-naviform associated blades at Baja, but here there is an absence of clear cones as well. It is difficult to establish any relationships relating to strike factors between the PPNB sites and WFC, both because we are dealing with the passage of time and because it is not yet fully understood which strike factors produce which features.

Importance of the strategies

The type 16 and medium wadi debitage from the single platform/pyramidal blade core strategy makes up only 27.7% of the blade and indeterminate assemblages [5] and the effort put into platform preparation is not as extensive as seen on the type 1 bi-directional blade core debitage. Therefore, this is not the most significant strategy for the production of blades. The debitage from the bi-directional blade core strategy makes up 42.9% of the blade and indeterminate assemblages. This, coupled with the fact that most effort has been put into

[5] The majority of the indeterminates are probably blades. (chapter 8 pg. 284)

preparing these particular platforms, indicate that this is the most important strategy for the production of blades. The relative importance of this strategy, along with other aspects of the strategy previously discussed, are comparable to the naviform production on the PPNB sites (particularly naviform production in type 1 material at Ghwair and WFA).

Opposed platform in fine wadi is the least important blade production strategy in terms of debitage quantity (only 13.4% of the blade and indeterminate assemblages are in fine wadi) and effort put into platform preparation is no greater than that applied to the single platform/pyramidal cores. The relative importance of the opposed platform blade production strategies on the PPNB sites is comparable, however, the strategies themselves clearly differ and so cannot really be related to the WFC strategy. The medium wadi opposed platform strategy at Ghwair is only expediently opposed platform and those at Baja could possibly be naviform.

Flake core strategies at WFC

Reduction strategies

There are possibly four flake reduction strategies on this site, one reuses an exhausted blade core, two are dedicated flake production strategies, and there is only debitage to indicate the presence of the fourth flake reduction strategy. It is also important to consider that some of the flake assemblage will have been produced as part of the blade core reduction strategies, though it is not possible to quantify what proportion of the flake assemblage will have been produced in this way.

There are no flake cores in type 16 material present in this assemblage. Type 16 flakes are very low in number and the technique applied to this debitage is closely related to the type 16 blade assemblage, suggesting that these flakes were produced as part of the blade reduction strategy.

The irregular flake core with bi-directional elements in type 1 material is possibly a reused exhausted bi-directional blade core (chapter 8, 269-271), suggesting that this strategy is part of the intensive use of the type 1 raw material. This can also be seen at the three PPNB sites where some naviforms have been reused as flake cores. At Ghwair and WFA it is seen specifically in type 1 raw material.

The single platform flake core in fine wadi is a dedicated flake core strategy. Dedicated single platform flake cores at Ghwair and WFA are related to the irregular change of orientation reduction strategies and at Baja are related to the distinctive 'wedge like' cores. At WFC the single platform flake core is almost pyramidal in form though the removals do not continue 360 degrees around the platform (it is not a reused single platform blade core because it is not completely reduced and shows no evidence of previous blade removals), therefore, this reduction strategy can not be related to the predominantly change of orientation reduction strategy at Ghwair and WFA or to the 'wedge-like' cores at Baja.

Only the medium wadi flake debitage indicates that there is a medium wadi flake reduction strategy present in this assemblage, the flake cores themselves are missing. I do not think that all of the medium wadi flake debitage could have been produced as part of a blade production strategy because the medium wadi flake debitage is comparable to the rough wadi flake debitage.

The change of orientation and change of orientation/bi-directional (appendix 4) flake cores in rough wadi are possibly part of the same or a similar reduction strategy to that which produced the medium wadi flake debitage.

Goals of the reduction sequence

The goals of the type 1 irregular flake core strategy are probably to produce both non-formal tools and flake debitage that will not be retouched (52.5% of the type 1 flake debitage has been retouched). Certainly this is the most important strategy for the production of non-formal tools on flake blanks. The relative importance of this strategy for non-formal tool production (in relation to the other flake production strategy) can also be seen in the exhausted naviform flake cores on all three PPNB sites. However, the specific percentage of retouched type 1 flakes at Ghwair is 86.4%, at WFA is 34% and retouched baja fine flakes is 19%, suggesting that WFC is possibly closer to WFA than to Ghwair and Baja in this matter. No formal tools have been made on any flake blanks at WFC.

The main goal of the single platform fine wadi, medium wadi flake production and the rough wadi change of orientation strategies was to produce flake debitage that would not be retouched or alternatively produced large numbers of by-products for each tool selected. Non-formal tools make up a significant proportion, 34.2% flake assemblage in wadi materials, and again this percentage is most comparable to the proportion of retouched flakes in wadi materials at WFA (at Ghwair, 77%, WFA 40% and Baja 25.3% of the flake debitage in wadi materials have been retouched).

Reduction sequences

The early reduction stages of the type 16 flake assemblage are not present in this assemblage; there are no primary flakes, in stark contrast to the rest of the flake assemblage. In combination with the absence of flake cores and the low quantity of flake debitage, this further suggests that these flakes in type 16 are part of a blade reduction strategy.
The type 1 flake assemblage indicates that the reduction sequences from the irregular flake core strategy are all present. Again this is comparable to the exhausted naviform flake core strategy on the PPNB sites.

The reduction sequence in fine wadi is fully present, including primary cortical flakes, and some platform rejuvenations (which could relate to both the blade and flake production strategies in fine wadi).

The medium wadi flake reduction sequence is fully present apart from the cores. This either means that the cores were removed from this assemblage after knapping was completed, the complete sequence in the debitage was added to this assemblage, or the excavation processes have affected the collection of this assemblage. It is unlikely that the reduction sequence was added to this assemblage because it is unusual to move and deposit an entire reduction sequence excluding only the cores in these wadi raw materials (where the cores are not heavily conserved and tend not to be used as tools).

The reduction sequence from the rough wadi change of orientation cores is also complete and present in this assemblage. The presence of relatively complete flake core reduction sequences in fine and rough wadi is comparable to the assemblages at Ghwair and WFA. However, at WFA some of the medium wadi flake cores are not present in the assemblage; this could be comparable to the missing medium wadi flake cores at WFC, however, we do not know the form of these WFC flake cores and, therefore, cannot directly relate them to the medium wadi change of orientation flake core strategy at WFA.

Technique

Plain platforms are consistently the most common platform types throughout the flake assemblage at WFC; this can also be seen on the three PPNB sites. However, surprisingly, punctiform platforms are proportionally relatively common as well, across all flakes except those in type 16 raw material (table 18). This is not seen in the blade assemblage where punctiform platforms are only common on type 1 blades. We do see some punctiform platforms on the PPNB flakes, but they are most common in naviform associated raw materials, (though not at Ghwair and at Baja where they are common on medium and rough wadi flakes as well). However, with the exception of WFC type 1 flakes, the proportions of punctiform platforms are significantly lower at WFC than they are on flakes at Ghwair, WFA and Baja. At WFC, 13% of the type 1 flakes have punctiform platforms and this is comparable to 15.9% at WFA and 13.9% at Baja (punctiform platforms are not common on any types of flake at Ghwair). Again, the WFC data hints that not only is the bi-directional blade strategy comparable to the PPNB naviform strategy, but also that the flake cores that reuse these types of blade cores are also comparable between WFC and particularly the late PPNB sites of WFA and Baja.

There are high levels of preparation in the total flake assemblage at WFC, as is seen on the PPNB sites. The level of preparation on flake platforms may well be a practical feature necessary in developing flake platforms rather than a feature influenced by choice. However, the use of grinding has been demonstrated to be influenced by choice on the debitage platforms from the PPNB sites. On the WFC flakes, the level of grinding is consistently highest on the punctiform platforms, but it is especially high on the punctiform platforms on type 1 flakes, 65.5% (table 19). Levels of grinding are relatively high on smaller platforms on flakes at the three PPNB sites, however, the percentages are much more comparable to the WFC percentages of grinding on fine and medium wadi flakes with punctiform platforms. The very high level of grinding on WFC type 1 flakes with punctiform platforms is much more comparable to the levels of grinding on WFC blades associated with the bi-directional blade cores (in type 1) and with blades associated with naviform production on the PPNB sites (tables 20, 17 and 9). This is possibly an indication that the technology once associated with naviform production on the PPNB sites has now become associated with the type 1 raw material on the PPNC/6th mbc site.

The platform and bulb features would conventionally suggest that a combination of harder and softer hammer was used to produce type 1 flakes, harder hammer was used to produce fine and medium wadi flakes and hammer type is unclear for rough wadi flakes. Though it is not really clear which strike factors lead to which features, it can be deduced from the data that the combinations of strike factors that produced the type 1 flakes are distinct from the other flake production strategies, because there is an almost equal number of lips and ring cracks, and the number of platform features is also higher than any other flake production strategy (table 20). The quantity of platform and bulb features on WFC flakes is generally higher than is seen on the blades suggesting that the strike factors also differ between flakes and blades. The percentages of clear cones on WFC flakes are generally similar to those found on flakes at Ghwair and WFA, however, at WFC the overall numbers of platform features is significantly higher than both the blade and flake debitage on the PPNB sites. It is clear that combinations of strike factors in flake production at WFC differ to those on the PPNB sites, but type 1 flake production remains distinct from other flake production strategies at both the PPNC/6th mbc site and the PPNB sites of Ghwair and WFA.

Importance of the strategies

The overall flake assemblage at WFC is larger than the blades (including the indeterminates that are mainly broken blades). This is the major difference between the PPNB sites and WFC. However, at WFC there clearly remains an important role for the blades especially those in type 1 material.

The debitage from the irregular flake core strategy (in type 1) is the second largest group of flakes after those in medium wadi and it is clear that the majority of these flakes are not simply by-products of the bi-directional blade core strategy. More effort is put into preparation than in any of the other flake reduction strategies and these flakes are also the most important category for non-formal tool production, so this is possibly the most important strategy for flake production.

The single platform flake production strategy in fine wadi is the least significant, effort put into preparation does not distinguish it from the other strategies that use wadi materials and it produces the lowest quantity of flake debitage.

The largest group of flake debitage is produced in medium wadi, indicating that these flakes were probably not only produced as part of a blade production strategy. However, the effort put into preparation, as well as the production of non-formal tools, is not as extensive as type 1 and so the importance of this strategy is possibly secondary to the production of flakes in type 1.

The importance of the change of orientation flake production strategy in rough wadi possibly falls in-between the medium and fine wadi reduction strategies.

It is interesting to note that type 1 and medium wadi materials are the most widely utilized raw materials at Ghwair and WFA both in the blade and flake production strategies. At WFC, type 1 is the most important raw material for the production of blades and type 1 and medium wadi materials are most important for the production of flakes.

Summary

I have drawn up two tables listing the flake and blade strategies and describing the most important aspects of these strategies.

Site	Reduction sequence	Raw material	Main goals	Presence/ absence in assemblage	Technique
Ghwair blade strategies	Naviform variant	Type 1	Non-formal and formal tools, low by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
	Naviform classic	Type 16	Non-formal and formal tools, low by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
	Opposed platform (expedient)	Medium wadi	Non-formal and formal tools (unspecialised selection), low by-product/tool ratio	Absence of cores, and early reduction stages, later stages present.	Most common platforms = plain
WFA blade strategies	Naviform variant	Type 1	Formal and non-formal tools (specialised selection), low by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
	Naviform classic	Type 16	Formal and non-formal tools (specialised selection), low by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
Baja blade strategies	Naviform variant	baja fine	Non-formal and formal tool production, high by-product/tool ratio	Incomplete reduction sequence, absent at many stages	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
	Opposed platform (poss. navi)	Type 1 Type 16	Non-formal and formal tool production, high by-product/tool ratio	Incomplete reduction sequence, absent at many stages	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to other navi's
WFC blade strategies	Single platform pyramidal	Type 16 Medium wadi	Non-formal and formal tool production, high by-product/tool ratio	Incomplete reduction sequence, early and some later stages absent	Most common plat = plain
	Bi-directional	Type 1	Non-formal and formal tool production, low by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = plain, punctiform and filiform. Highest levels of grin on smaller plat. Distinct combinations of strike factors
	Opposed platform	Fine wadi	Non-formal and formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain

Site	Reduction sequence	Raw material	Main goals	Presence/ absence in assemblage	Technique
Ghwair flake strategies	Exhausted navi flake	Type 1 Type 16	Non-formal tool production, low by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain
	Dedicated flake core	Fine, medium and rough wadi	Non-formal tool production, low by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, crushed
WFA flake strategies	Exhausted navi flake	Type 1	Non-formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, punctiform, filiform. Highest levels of grin on smaller platforms. Distinct combinations of strike factors, similar to navi's
	Dedicated flake core	Fine, medium and rough wadi	Non-formal tool production, high by-product/tool ratio	Some cores absent, otherwise a complete and present reduction sequence	Most common plat = plain
Baja flake strategies	Exhausted navi flake	Baja fine	Non-formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, punctiform, filiform. Highest levels of grin on smaller platforms
	Dedicated flake core	Medium and rough wadi	Non-formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, punctiform, crushed. Highest levels of grin on plain and punc.
	'wedge like' dedicated flake core	Type 1	Non-formal tool or core tool production, <u>equal</u> by-product/tool ratio	Early reduction stages absent, later stages present and complete	Most common plat = plain, punctiform. Highest levels of grin on smaller plat.
WFC flake strategies	Reused exhausted bi-directional bld core	Type 1	Non-formal tool production, <u>equal</u> by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, punctiform, crushed. Highest levels of grin on smaller plat. Distinct combinations of strike factors, similar to bidirec. bld strat.
	Single plat flake	Fine wadi	Non-formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, punctiform, crushed. Highest levels of grin on smaller plat.
	Flake core (unclear type)	Med wadi	Non-formal tool production, high by-product/tool ratio	Cores absent, later reduction stages complete and present	Most common plat = plain, punctiform, dihedral, crushed. Highest levels of grin on smaller plat.
	Change of orientation	Rough wadi	Non-formal tool production, high by-product/tool ratio	Complete and present reduction sequence	Most common plat = plain, faceted.

PPNB naviform reduction strategies

Both variant and classic naviform strategies are similar on each of the PPNB sites (though classic naviforms are not found at Baja, but it is entirely possible that the classic naviforms have been removed by the excavator). However, the variant naviforms at WFA are smaller than the average classic and variant naviforms at Ghwair, though the classic WFA naviforms are a similar size to Ghwair. This size differentiation is a result of the goals of the naviform production strategies, which differs at all three PPNB sites. There is much more specialisation in the production of formal tools at WFA; significant quantities of piercing tools were produced on small blade and bladelet blanks (hence the smaller naviforms). At Baja, there is a high by-product to tool ratio in the baja fine naviform strategy which is not seen at either Ghwair or WFA. Only the early stages of the naviform reduction sequence at Ghwair and WFA are not present in the assemblages and, as the naviforms at both sites are produced in the same type 1 and 16 raw materials, it is possible that the preforming and early reduction sequences were knapped at source. At Baja, the naviform cores are produced in baja fine raw material and the early reduction stages, as well as aspects of later reduction stages, are not present in the assemblage. However, this is possibly due to the nature of the dump context (from which the Baja assemblage came) rather than knapping practices. Technique, on a general level, is similar on all three PPNB sites. The importance of smaller platforms and intensive grinding preparation on these smaller platforms is consistent at Ghwair, WFA and Baja. However, at WFA there is a more extensive use of specifically punctiform platforms and at Baja of both punctiform and filiform platforms. These are the two late PPNB sites and the increasing use of punctiform platforms at WFA and both types of smaller platforms at Baja could be a possible development in technique that happened over time from the early

PPNB (Ghwair) to the later PPNB. The relative importance of punctiform platforms at WFA is possibly a reflection of the specialisation seen in the goals of the naviform industry, and the more extensive use of both the smaller platform types at Baja could indicate that certain aspects of the knapping process at Baja is distinct from Ghwair, WFA and WFC. The levels of grinding used in the naviform strategies are similar across all three sites. The combinations of strike factors on naviform blades distinguish them from all other blade and dedicated flake strategies at all three PPNB sites. On a more specific level, the proportion of clear cones single WFA blades out from the other two sites, suggesting that though there are some similarities in aspects of technique (relating to the strike factors) between the three sites, something slightly different is occurring at WFA. Blade production is more important at Ghwair and WFA both in terms of debitage quantity and effort put into production. At Baja, there are more flakes (221) than blades (104), but this may be due to the fact that many blades were removed from this assemblage before deposition in a dump context. The effort put into producing the Baja blades is greater than the flakes suggesting that blades are the more important debitage type. Naviform production is the most important blade production strategy at all three PPNB sites, however, WFA is again singled out because the high proportion of naviform cores and debitage indicates that naviform production was the main knapping activity.

PPNC/6th mbc WFC bi-directional blade core strategy

This is the blade production strategy from WFC that is most comparable to PPNB naviform production. The similarities can be seen in type 1 raw material use (comparable specifically to Ghwair and WFA), in the nature of the core type (it has two platforms being utilized at the same time, maximizing production) and in the absence of early reduction stages (possibly preforms are being knapped at the raw material source much like the Ghwair and WFA naviform cores). Similarities can also be seen in the technique, platform type and platform preparation, particularly on the smaller platforms that are comparable to those seen on the naviform debitage. The combination of strike factors separates the WFC bi-directional blade cores from other blade and dedicated flake production strategies in much the same way as the naviform strike factors do. The percentages of bi-directional blade platform and bulb features are more comparable to naviform production than to the PPNB flake industries and to other WFC blade production strategies. The goals of the bi-directional blade core strategy is comparable to naviform strategies in some ways, blade blanks are used for formal tools and there is a relatively low by-product to tool ratio (in comparison to other blade production strategies at WFC). However, the levels of non-formal tool production at WFC is significantly lower than in the naviform industries at Ghwair and WFA, but interestingly, higher than in the naviform production at Baja. Formal tool production has also significantly reduced in comparison to all three PPNB sites. The relative importance of the bi-directional blade production strategy is similar to the naviform production in the sense that it is the most important strategy for the production of blades. However, flake production has now become the most common knapping activity at the PPNC/6th mbc site of WFC.

PPNB non-naviform blade reduction strategies

All of the non-naviform blade cores on all three PPNB site are related to the naviform production, they are responses to limitations imposed by the raw material or previous removal sequences and not separate strategies. The only exception is the opposed platform blade production strategy in medium wadi from Ghwair, which is one of only two unique knapping strategies from the three PPNB sites. This strategy differs from the opposed platform blade production strategy at Baja because the debitage and technique are distinct from the naviform production. The goals of this opposed platform reduction sequence also differs a little from naviform production. Formal tool production is less specialised than naviform formal tool production at Ghwair, concentrating less on tool types like points and piercers. However, the by-product to tool ratio remains low as it does in all of the Ghwair reduction strategies (blade and flake).

PPNC/6th mbc WFC non-bi-directional reduction strategies

There is a greater role for varied blade reduction strategies at WFC than there is on the PPNB sites. There is also a greater use of different raw materials for blade production. A single platform pyramidal blade production strategy in type 16 and medium wadi and an opposed platform blade production strategy in fine wadi are present at the WFC site. The single platform pyramidal blade core is only found on WFC (out of the four sites analysed in this thesis), and the irregular nature of the opposed platform blade core indicates that this is not related to earlier PPNB opposed platform blade cores. The goals of these blade production strategies also differ to earlier blade production strategies (though some formal tools have been produced on medium wadi blades), both strategies have high by-product to tool ratio's, suggesting that the knappers at WFC were more selective in their choice of blade blanks to be retouched than is evident at any of the PPNB sites (particularly in these non-bi-directional blade production strategies). The opposed platform blade reduction strategy is complete in the assemblage, unlike the bi-directional blade production strategy at WFC and the naviform strategies at Ghwair and WFA, and also unlike the opposed platform blade production strategies at Ghwair and Baja. The single platform pyramidal blade core reduction strategy is incomplete and absent from the assemblages at different stages throughout the sequence, which again differs to the bi-directional blade production strategy. Technique applied to these two blade production strategies is generally homogeneous and very different to what is occurring in the bi-directional blade production strategy and PPNB naviform and opposed platform blade production strategies The most common platform types are plain and there is little use made of grinding, which along with the complete absence of platform features separate these two strategies (single platform pyramidal and opposed platform blade production) from the bi-directional and naviform blade production.

PPNB exhausted naviform flake core strategies

This is a strategy that is present on all three PPNB sites, but at Ghwair they occur in type 1 and 16 and at WFA only in type 1 (at Baja they occur in baja fine). Despite the fact that these cores are somewhat related to the naviform industries, the close relationship of reduction processes, seen in the naviform industries cannot be seen as clearly in this flake production strategy. This strategy encompasses several irregular core types, and this varies between the three sites, it is a much less formalized strategy than naviform production (though change of orientation are slightly more common at Ghwair). The goals of this reduction strategy are similar between the three sites (producing non-formal tools), however, at Ghwair the by-product to tool ratio is low, unlike WFA and Baja where it is high. The reduction sequences are all complete and present in their relevant assemblages, however, this may be due to the fact that this strategy comes at the end of another strategy that is also present (at least in the later stages), they are not preforming these flake cores. The techniques used in this exhausted naviform flake strategy differs between Ghwair, WFA and Baja. At Ghwair, technique is not distinct from the other flake production strategies, both in platform and platform preparation and in platform and bulb features. At WFA not only is technique distinct from the other flake production strategies but it is also more akin to the naviform techniques. There is relatively extensive use of smaller platforms and grinding but the combination of lips and ring cracks reflects that seen in naviform production. At Baja, there is also a relatively extensive use of smaller platforms and grinding, but there are far fewer platform and bulb features than at Ghwair and Baja. Though some aspects of technique suggest a closer relationship between WFA and Baja in this reduction strategy, other aspects relating to strike factors suggest differences between all three sites.

PPNC/6th mbc WFC exhausted bi-directional blade cores, reused as flake cores

This flake reduction strategy reuses exhausted bi-directional blade cores in much the same way that exhausted naviform cores are reused as flake cores. The distinction in reduction processes of this flake strategy from other flake strategies at WFC is comparable to the treatment of exhausted naviform flake cores at WFA and Baja. The irregular, less formalized, nature of this reduction strategy is comparable to the equivalent PPNB cores, production strategy goals are also comparable (producing non-formal tools). However, there is an equal by-product to tool ratio which is relatively higher than at WFA and Baja. The reduction sequence is complete and present, as it is on the PPNB sites, though this may simply be due to the way in which this strategy relates to the bi-directional blade production strategy. The extensive use of smaller platforms and grinding, and the distinct combination of strike factors (in relation to the other flake production strategies) are comparable to the techniques applied to exhausted naviform flake cores at WFA and Baja. However, there are more platform features overall than on the PPNB flakes and the significant levels of grinding on these WFC flake are more akin to levels of grinding on naviform blades (and are higher than on the WFC bi-directional blade debitage). This data indicates that not only can the PPNB naviform and the WFC bi-directional blade production strategies be related, but the reuse of these cores is also comparable. However, the technique applied to naviform core production during the PPNB has become associated with type 1 raw material (rather than a production strategy) by the PPNC/6th mbc at WFC, because certain aspects of this naviform technique are now also applied to type 1 flake production in a way that is not seen on the PPNB exhausted naviform flake debitage.

PPNB dedicated flake core strategies

This strategy is similar at Ghwair, WFA and Baja and is associated with wadi materials (though at Baja it does not include fine wadi, which is reserved for naviform production). However, there is another distinct dedicated flake core strategy at Baja that is associated with type 1 material. The dedicated flake core strategy in wadi materials is also an irregular strategy encompassing several different core types. It is most important at Ghwair where flake production makes up a greater portion of the assemblage than at WFA and Baja. The goals are similar across all three sites where the strategy is used for the production of non-formal tools. However, at Ghwair there is a low by-product to tool ratio (as is seen in the entire Ghwair assemblage) and at WFA and Baja the by-product to tool ratio is high. The strategy is complete and present at all three sites, possibly because the wadi raw material source is the closest raw material source to all three sites. Technique applied to the strategies on each raw material is similar at each site. Though there is more use of punctiform platforms and grinding at Baja (possibly a reflection of the greater use of smaller platforms generally at Baja). There are no platform features on the debitage from medium and rough wadi strategies at Baja, suggesting that there is a closer relationship between Ghwair and WFA in aspects of technique relating to strike factors. However, the high percentage of clear cones at WFA indicated that the technique occurring at WFA differs slightly to Ghwair.

PPNB Baja 'wedge-like' dedicated flake cores

The only other unique PPNB reduction strategy (other than the opposed platform blade production at Ghwair) are dedicated flake cores produced in type 1 material at Baja. These are small cores that range extensively in type (some of which display bipolar piece esquillée crushing, possibly used as a form of wedge) and are related by dimensions, raw material and general shape of the core. It is unclear whether the goals of the reduction sequence are to produce debitage, cores or both, for tool production. The main product in the debitage is non-formal tools and there is an equal by-product to tool ratio (not counting the cores). The early stages of the reduction sequence are not present in the Baja assemblage, but later stages are complete and present, this is possibly comparable to the type 1 naviform cores which may be preformed at the raw material source. The relatively high use of punctiform platforms and grinding is reflected in the complete Baja assemblage. However, there are more platform features found on type 1 flake debitage than on the debitage from other dedicated flake core strategies, suggesting that the aspects of technique that relate to these strike factors is more comparable to blade production at Baja.

PPNC/6th mbc WFC dedicated flake core strategies

As in the blade production, there are a wider variety of flake production strategies at WFC than on the PPNB sites (consisting of single platform and change of orientation flake cores and an unclear flake core type in medium wadi). The single platform flake core in fine wadi differs from single platform flake cores at Ghwair and Baja because this core is partially pyramidal in form (though it is not an exhausted pyramidal blade core) Furthermore, it cannot be related to the change of orientation flake core at WFC in the same way that the single platform flake cores at Ghwair are related to the change of orientation flake cores and single platform flake cores are related to the 'wedge-like' cores at Baja.

Only the flake debitage from the medium wadi flake production strategy are present in this assemblage and so the core type is unclear. The change of orientation flake core in rough wadi at WFC could possibly be comparable to the PPNB change of orientation flake cores, however, it has bi-directional elements and some aspects of technique also differ. With the exception of the medium wadi flake cores, the reduction sequences of these three flake strategies are complete and present in the WFC assemblage, which is comparable to the PPNB dedicated flake core strategies (with the exception of the 'wedge-like' cores at Baja). The goals of these strategies are also similar to the equivalent strategies at WFA and Baja, they are used largely for the production of non-formal tools and have a high by-product to tool ratio. The use of punctiform platforms and grinding on the single platform flake core can be compared to the exhausted bi-directional (blade) flake core strategy. We see the widest range of common platforms and, surprisingly, high levels of grinding on the change of orientation and unclear medium wadi flake production strategies; this differs significantly from the PPNB change of orientation flake production strategies. The proportions of platform features in all three dedicated flake core strategies are significantly higher than those in all other strategies at WFC and PPNB strategies. However, the levels of clear cones on wadi flakes at WFC is comparable to those found at Ghwair and WFA. This suggests that the aspects of technique relating to strike factors have a closer relationship with Ghwair and WFA than with Baja, nevertheless, there are significant differences.

The data from all four assemblages show that though blade production is relatively homogeneous across all three PPNB sites, there is a closer relationship between WFA and Baja, probably because these two sites are contemporary during the late PPNB. This indicates that though strategies did not change during the middle and late PPNB, some aspects of technique did develop around the use and preparation of smaller punctiform and filiform platforms. Despite this homogeneity in the naviform production, the goals of this reduction strategy differ significantly between Ghwair, WFA and Baja, and this does subtly influence the reduction processes within naviform production. There are general similarities in flake production, particularly in the treatment of exhausted naviform flake cores, but local knapping traditions are also clearest in the flake production. Unique knapping strategies are present at Ghwair and Baja, but not at WFA. The knapping strategies and techniques show a closer relationship between WFC, Ghwair and WFA than with Baja. This can also be seen in the use of raw materials, especially in blade and flake production in type 1. The close relationship between WFC, Ghwair and WFA suggests the continuation of local knapping traditions through to the PPNC/6thmbc particularly relating to the use of type 1 raw material. However, we also see the introduction of distinct knapping traditions at PPNC/6th mbc WFC that far exceeded the changes seen between middle and late PPNB.

Conclusion

The nature of flint knapping means that it is predisposed to increasing levels of variation. This results from the relatively individualistic nature of the process (only one or a limited number of individuals can be involved in the same part of a knapping process at the same time). Flint knapping is also influenced by an infinite variety in raw material and it is affected by the hammer technology used by the knapper. Therefore, degrees of similarity in any given assemblage will indicate levels of information sharing between knappers and in turn this will have implications on the social context of this information sharing.

By comparing the assemblages from the PPNB sites I have been able to show that there are different levels of similarity in the lithic technology, beginning with the general similarities of blade and flake reduction strategies. This establishes that there is a basic level of technological information sharing occurring during the PPNB both horizontally between contemporary sites and vertically over time. This level of information sharing is the least complicated, describing and understanding a general reduction strategy can be done via instruction without demonstration (because it does not involve aspects of technique that relate to body movement). However, it does require a suitable technological language that is distinct from language relating to other aspects of daily life. The development of a shared technological language would require regular contact between individual artisans within, and between villages.

The comparison of the PPNB assemblages on a more specific level has shown that there are clear similarities in technique, especially in the naviform production strategies. Passing on technological information relating to technique is complex and requires both instruction and demonstration as it involves the way in which tools are used for knapping as well as including the body itself. The sharing of this information, at a basic level involves two individuals, pupil and teacher involved in instruction and demonstration (this does not necessarily mean that one knapper is less proficient than the other, but that each will bring to bear their own experience to the sharing of information). However, anthropological studies have shown that skilled craft production is often carried out in groups, specifically for the purpose of information sharing. A good example is a study on the adze makers from the village of Langda, in Indonesian Irain Jaya, (Stout 2002) who knap in groups whilst continuously discussing the knapping process. Knapping in groups will also speed up the transmission of technological information and learning. The result of this social context to the knapping process will be social constraints on technological variation and also the possible development of power structures within the knapping community surrounding the control of information sharing. The level of similarity in technique between the PPNB sites, particularly in relation to naviform production, indicates extensive networks of information sharing that involved group knapping activities within communities. However, it is important to bear in mind that only WFA and Baja were contemporary, but the similarities to Ghwair do indicate that it was involved in earlier networks that later developed into those that involved the knapping communities at WFA and Baja. Whether this encompassed direct contact between villages or travelling groups of artisans is not made clear by the lithic assemblages alone. However, the similarity in other aspects of the material culture suggests that there was direct contact between villages (though not necessarily by all social groups within the village context).

Though the knappers at the three PPNB sites are sharing very detailed levels of information, it does not necessarily follow that the purposes of the comparable reduction strategies are also similar. The naviform production is similar at all three PPNB sites, but the purposes for the final products of these industries differ. Tools are often produced for use in other types of activity, for example craft production or food procurement. The tool proportions show that certain aspects of the economy differ at each site. At WFA there is a specialised craft production that requires intensive production of piercing tools, which differs significantly to Baja where apparently, very little production of retouched tools is required (this is not to say that they are not using unretouched debitage as tools); this suggests that there are slightly different slants or aspects to the economies at Ghwair, WFA and Baja. However, the Baja assemblage is from a dump context and therefore significant proportions of tools may have been removed from the assemblage; consequently the dump assemblage does not necessarily represent what is occurring on the rest of the site. For this reason it is difficult to make an assessment of the site economy from the lithic assemblage, whereas it is possible to do this at Ghwair and WFA.

The formalized nature of the naviform production across the three PPNB sites clearly requires certain levels of proficiency in knapping. This appears to be in stark contrast to the informal nature of the flake production strategies on the three sites, especially as they are produced using simpler techniques. This raises the question whether the naviform producers are the same people who are involved in flake production. However, we do see evidence of information sharing involved in flake production, particularly in the treatment of the exhausted naviform flake strategies relating to some aspects of technique and tool production. There are also similarities in some aspects of technique applied to non-naviform related, dedicated flake cores. The generally high level of platform preparation on the flake cores also suggests that a certain level of proficiency in knapping techniques, similar to that seen in the naviform production, is required for flake production at the three PPNB sites. As a consequence, this kind of evidence points to the fact that the artisans producing the naviforms were the same people as involved in all of the flake production.

Despite these networks of information sharing, it is in the flake production that we see the clearest indications of local knapping traditions (including the exhausted naviform flake cores). This is possibly a reflection of the informal nature of the flake strategies, the reduction sequences are possibly not as extensively controlled by these networks of information sharing, as were the naviform production. A lower level of instruction has been involved in the flake reduction strategies because each site has its own combination of flake core types (though they are using some similar aspects of technique), and this potentially gave more room for personal expression and the development of local traditions.

The comparison of Ghwair, a middle PPNB site, with WFA and Baja, both late PPNB sites, and with WFC which is a PPNC/6th mbc site, gives insight into the development of the networks of technological information sharing and also into the developments of local knapping traditions. The data on technique identifies a generally closer relationship between

WFA and Baja than with Ghwair, suggesting that this is evidence for the development of shared techniques from the middle to late PPNB. This change is centred around the increasing use of smaller platforms and high levels of grinding preparation on these small platforms, in both the blade and flake industries, suggesting that skill levels increase from Ghwair (mid PPNB) to WFA and Baja (late PPNB). Consistently knapping smaller platforms is a reflection of the knappers skill; it is difficult to strike an accurate blow so close to the edge of the core platform. The evidence, overall, indicates that there was relatively little change during this period. If local traditions were strong you would possibly expect to see a closer relationship between Ghwair and WFA (which are the two closest sites) in some aspects of the assemblages, as local traditions might be passed down through time. However, this does not happen, in fact it is WFA that often stands out in the proportional use of different production strategies, and in some aspects of technique and tool production. There are also unique knapping strategies at Ghwair and Baja. Therefore, local knapping traditions can be seen on each site but they are not necessarily passed on through time to other sites in the locality. Ghwair and WFA do share raw material sources and this does influence the makeup of both assemblages.

The PPNC/6th mbc site of WFC also shares the same raw material sources as Ghwair and WFA and similar raw material uses can be seen in the assemblage. The data also indicates a closer relationship between WFC, Ghwair and WFA than between WFC and Baja, particularly in its approach to type 1 raw material. The WFC bi-directional blade strategy in type 1 and the consequent type 1 flake strategy (that reuses the blade cores) are comparable to the PPNB naviform and exhausted naviform flake strategies. The techniques, once applied to naviform blade strategies, are now possibly applied to the type 1 raw material (because levels of grinding preparation on the type 1 flake cores at WFC are more comparable to PPNB naviform blade production than to exhausted naviform flake core production). Therefore, the WFC knappers have inherited some aspects of the PPNB information sharing networks but they have become distilled into local traditions (because WFC is not as closely related to Baja which is farther away than WFA and Ghwair).

There is also rapid change in the reduction strategies between the late PPNB and the PPNC/6th mbc. A greater variety in the reduction sequences and techniques possibly implies that the social control on variation has reduced and is no longer on a regional scale as it was during the PPNB. However, to establish clearly whether information-sharing networks have truly become more localized, it would be necessary to conduct a similar study on other PPNC/6th mbc sites in the locality and further a field.

In the next (chapter 10) I shall relate the conclusions made in this chapter to other areas in the Levant where similar studies have been conducted.

List of tables: Chapter 9 (Site comparison)

Table 1

all cores	navi	non-navi
Ghwair total 67	19/28.4%	48/71.6%
WFA total 32	20/62.5%	12/37.5%
Baja total 35	4/11.4%	31/88.6%

Table 2

navi cores	type 1	type 16
Ghwair total 19	14/73.7%	5/26.3%
WFA total 20	18/90%	2/10%

Table 3

navi associated raw mat	Ghw. bld total 570	Ghw. flk total 283	WFA bld total 449	WFA flk total 217	Baj. bld total 80	Baj. flk total 139
lips	18/3.6%	5/1.8%	6/1.3%	10/4.6%	1/1.3%	1/0.7%
ring cracks	10/1.8%	19/6.7%	9/2%	8/3.7%		1/0.7%
clear cones	59/10.4%	85/30%	87/19.4%	82/37.8%	5/6.3%	24/17.3%
total % of features	15.3%	38.5%	22.7%	46.1%	7.5%	18.7%

Table 4

non-navi associated raw mat	Ghw. bld total 570	Ghw. flk total 283	WFA bld total 449	WFA flk total 217	Baj. bld total 80	Baj. flk total 139
lips	2/1.1%	1/0.3%	1/1.8%	2/1.3%		
ring cracks	3/1.7%	21/5.4%	1/1.8%	12/8%		
clear cones	48/26.5%	127/32.5%	10/17.9%	91/60.7%		6/7.9%
total % of features	29.5%	38.1%	21.4%	70.0%	0.0%	7.9%

Table 5

formal/non-formal tools	Ghwair total assem. 4875	WFA total assem. 3967	Baja total assem. 1423
bld tools	13.2%	5.6%	1.6%
flk tools	11.6%	3.5%	3.7%
indeterm tools	52.5%	22.2%	21.4%
crest elem tools	1.2%	1.0%	0.4%
rejuv elem tools	0.8%	0.6%	0.7%
spall tools	0.2%	0.1%	0.1%
formal tools	2.1%	24.3%	0.8%
total %	**81.6%**	**57.3%**	**28.7%**

Table 6

Navi. dim.	Ghwair		WFA		Baja
in mm	**type 16**	**type 1**	**type 16**	**type 1**	**baja fine**
Length	55.8-79.2	43.7-90.7	62.7-82.1	27.9-37.7	52.7-77.9
Width	32.1-54.1	19.8-55.9	34.4-35.8	18.8-46.5	22.6-64.9

Table 7 (Navi associated raw materials.)

most common platform types	Ghwair		WFA		Baja	
blades	**type 16**	**type 1**	**type 16**	**type 1**	**type 1/16**	**baja fine**
plain	17.5%	27.7%	No plain plat	20.0%	30.0%	7.3%
punc	27.1%	20.5%	28.6%	46.5%	30.0%	41.5%
fil	20.3%	18.1%	28.6%	10.6%	30.0%	46.3%

Table 8 (Navi associated raw materials.)

most common plat types	Ghwair		WFA		Baja	
flakes	**type 16**	**type 1**	**type 16**	**type 1**	**type 16/1**	**baja fine**
plain	52.5%	41.5%	57.1%	31.2%	50.0%	26.7%
punc				15.9%	20.0%	13.9%
fil					13.3%	11.9%
faceted		8.7%		11.1%		
crushed		14.5%		1.0%	36.7%	21.8%

Table 9 (Navi associated raw materials.)

Levels of prep on most common plat						
Blades	**type 16**		**type 1**			
Ghwair	level of prep	level of grin	level of prep	level of grin		
plain	39.1%	21.7%	50.6%	42.4%		
punc	100.0%	94.1%	88.1%	68.1%		
fil	93.4%	86.7%	93.9%	81.6%		
other	58.3%	8.3%	64.1%	20.3%		
WFA						
plain	100.0%	0.0%	67.3%	42.9%		
punc	83.4%	83.4%	95.6%	84.2%		
fil	100.0%	83.3%	98.7%	85.5%		
other	100.0%	20.0%	73.2%	17.9%	baja fine	
Baja					level of prep	level of grin
plain	no plain		33.3%	0.0%	66.0%	66.0%
punc	100.0%	100.0%	100.0%	100.0%	94.1%	88.2%
fil	100.0%	100.0%	100.0%	50.0%	100.0%	68.4%
other	no other		0.0%	0.0%	50.0%	0.0%

Table 10 (Navi associated raw materials.)

Levels of prep on most common plat						
Flakes	**type 16**		**type 1**			
Ghwair	level of prep	level of grin	level of prep	level of grin		
plain	66.7%	9.5%	68.4%	7.0%		
faceted			76.0%	4.0%		
crushed			77.8%	0.0%		
other	60.0%	0.0%	51.5%	6.1%		
WFA						
plain	81.2%	6.2%	67.8%	13.6%		
punc			86.6%	48.4%		
faceted			81.0%	27.3%		
crushed			50.0%	0.0%		
other	76.9%	15.4%	76.5%	15.7%	baja fine	
Baja					level of prep	level of grin
plain	50.0%	0.0%	64.3%	0.0%	51.7%	6.9%
punc			40.0%	20.0%	53.3%	20.0%
fil	50.0%	0.0%			76.9%	30.8%
crushed			88.9%	0.0%	81.8%	4.5%

Table 11

	reused bld cores	dedicated flk cores
Ghwair	20.9%	47.8%
WFA	6.3%	18.6%
Baja	13.9%	72.2%

Table 12

	blade cores	flake cores
Ghwair	31.0%	68.7%
WFA	75.0%	25.0%
Baja	13.9%	86.1%

Table 13 (Non-navi associated raw materials.)

most common plat	Ghwair			WFA			Baja	
flakes	**fine wadi**	**med wadi**	**rough rough**	**fine wadi**	**med wadi**	**rough wadi**	**med wadi**	**rough wadi**
plain	48.9%	60.5%	65.7%	55.2%	58.0%	65.6%	26.4%	39.1%
punc							22.6%	30.4%
crushed	17.0%	9.1%					20.8%	

Table 14 (Non-navi associated raw materials.)

Levels of prep on most common plat						
flakes	**fine wadi**		**med wadi**		**rough wadi**	
Ghwair	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin
plain	71.4%	7.1%	50.8%	5.1%	44.0%	0.0%
crushed	25.0%	12.5%	76.7%	6.7%	25.0%	0.0%
other	80.0%	30.0%	66.7%	5.1%	28.6%	14.3%
WFA						
plain	82.4%	11.8%	59.6%	1.9%	47.8%	0.0%
other	75.0%	25.0%	97.1%	5.7%	66.7%	0.0%
Baja						
plain	/	/	26.7%	0.0%	40.0%	20.0%
punc	/	/	50.1%	16.7%	25.0%	12.5%
crushed	/	/	81.8%	18.2%	/	/
other	/	/	60.0%	6.7%	33.3%	16.7%

Table 15

WFC most common plat type					
Blades	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
plain		31.2%	25.0%	27.3%	33.3%
punc		18.8%			
fil		21.9%			
crushed	33.3%	12.5%		36.4%	

Table 16

levels of prep on most common plat										
WFC	**type 16**		**type 1**		**fine wadi**		**med wadi**		**rough wadi**	
Blades	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin
plain			100.0%	10%	25.0%	25.0%	66.7%	33.3%	33.3%	0.0%
punc			83.3%	33.3%						
fil			100.0%	71.4%						
crushed	100.0%	0.0%					75.0%	0.0%		
other	100.0%	0.0%	88.9%	33.3%	100.0%	50.0%	33.3%	0.0%	100.0%	0.0%

Table 17

WFC plat and bulb features					
blades total 75	type 16	type 1	fine wadi	med wadi	rough wadi
lips		1/2.8%			
ring cracks		1/2.8%			
clear cones	1/16.7%	9/25%	4/33.3%	2/16.7%	5/55.6%
total % of features	16.7%	30.6%	33.3%	16.7%	55.6%

Table 18

WFC most common plat					
Flakes	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
plain	64.0%	36.0%	3.6%	52.8%	60.0%
punc		13.0%	6.6%	6.9%	
dih				11.1%	
faceted					13.3%
crushed		15.0%	6.6%	11.1%	

Table 19

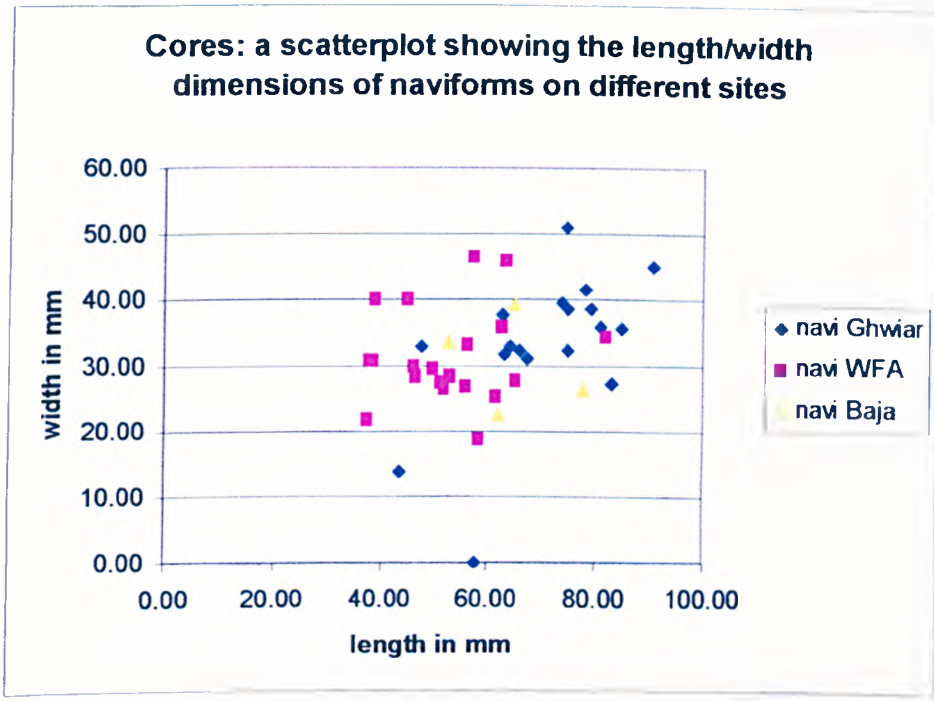
levels of prep on most common plat										
WFC	**type 16**		**type 1**		**fine wadi**		**med wadi**		**rough wadi**	
flakes	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin	level of prep	level of grin
plain	77.8%	0.0%	86.4%	9.1%	63.6%	0.0%	71.0%	5.3%	44.0%	0.0%
punc			87.5%	62.5%	75.0%	25.0%	60.0%	20.0%		
dih							75.0%	0.0%		
facted									33.3%	0.0%
crushed			88.9%	0.0%	100.0%	0.0%	75.0%	12.5%		

Table 20

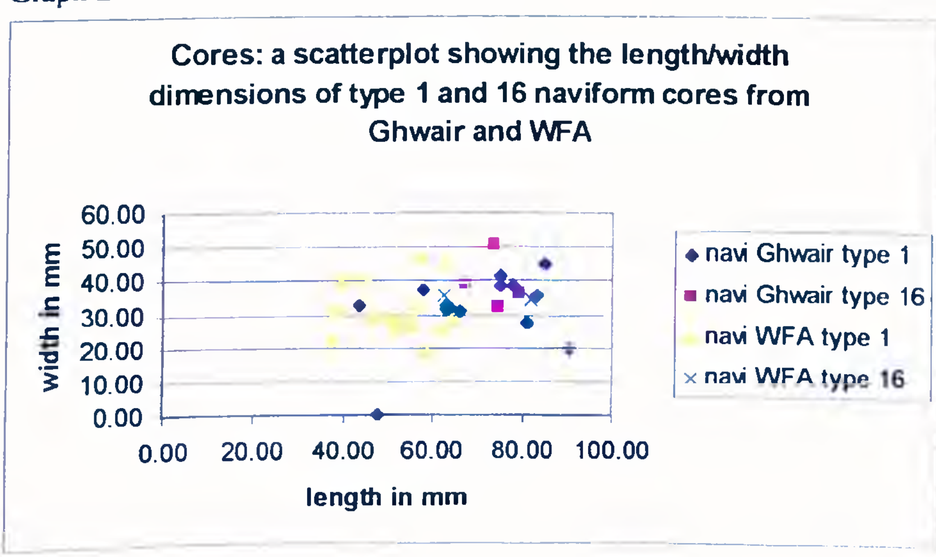
WFC platform and bulb features					
flakes total 230	**type 16**	**type 1**	**fine wadi**	**med wadi**	**rough wadi**
lips	1/7.1%	6/9.8%		1/1.3%	3/6.4%
ring cracks		5/8.2%	4/11.1%	3/4%	3/6.4%
lips/ring cracks on same flk	2/14.3%				
clear cones	4/28.6%	25/41%	12/33.3%	45/60%	26/55.3%
total % of features	**50.0%**	**59.0%**	**44.4%**	**65.3%**	**68.1%**

List of graphs: Chapter 9 (Site comparison)

Graph 1



Graph 2



Chapter 10

Conclusion

This chapter will discuss how my conclusions on the nature of the networks of technological information sharing, occurring in the locality of Ghwair, WFA, Baja and WFC, compares with what is happening during the PPNB and early 6th mbc, in other regions of the Levant. There are three published studies from which it is possible to make direct comparisons with my research: the analysis of chipped stone assemblages from the Azraq Project by D. Baird (Baird 1993, 1994), the analysis of the chopped stone assemblage from Dhuweila by C. McCartney and A. Betts (McCartney in Betts 1998), and the analysis of various chipped stone assemblages from Syria by Y. Nishiaki (Nishiaki 2000). The chapter is divided into four sections, Description of other sites, Core reduction strategies, Technique, and a Summary. The small number of similar studies illustrates how little research has been done on this subject. My thesis will significantly add to this body of work, by producing very detailed and interesting results on the nature of social interaction in the area of stone tool production.

Description of other sites

Azraq - Baird

There are 6 sites, relevant to this thesis, investigated by the Azraq project; one in the Azraq basin and five in the Wadi Jilat (table 1). These sites are in the desert area of eastern Jordan; Jilat being located *c.*160km and Azraq being located *c.*212km northeast of the four sites in my study (fig. 1). Azraq and Jilat themselves are *c.*68km apart. The Azraq project sites are seasonal settlements with semi permanent structures made up of low walls that often partially line a pit, presumably forming the base of a temporary superstructure. The dates of these sites cover the PPNB and the transition to the 6th mbc; and, Wadi el-Jilat 7, Wadi el-Jilat 13 and Azraq 31 all show evidence for long periods of continuous occupation.

Dhuweila - Betts, McCartney

Dhuweila is also a seasonal site situated in the desert of eastern Jordan *c.*276 km northeast of the Wadi Fidan area (*c.*60km northeast of Azraq fig.1). The structure on this site is semi permanent with low thick walls providing a windbreak and base for a temporary superstructure, similar to those found at Azraq and Jilat. This site shows evidence for two main periods of occupation covering the latter part of the PPNB and the 6th mbc (table 1).

Douara Cave II – Nishiaki

Douara Cave II is a rock shelter site (table 1) situated northeast of Palmyra in Syria (*c.*392km north-east of Jericho fig.1). The excavators found no evidence of structures and consider the deposit, which may have been moved by water action and erosion, not to be *in-situ*. However, the assemblage is PPNB in character and is not mixed with other periods.

Abu Hureyra – Nishiaki

Abu Hureyra is a tell site on the middle Euphrates in Syria (*c.*504km north-east of Jericho) and shows evidence for long periods of permanent occupation. The assemblages analysed by Nishiaki come from trenches D and C (table 1).

Jericho - Nishiaki

Jericho is also a tell site with long periods of continuous occupation, situated in the southern Levant *c.*160km north of Fidan. Nishiaki analysed assemblages from area M of the Kenyon excavation during the 1950's (table 1).

Tell Damishliya – Nishiaki

Tell Damishliya is a tell site situated in the Balikh valley in Syria, again showing evidence for long periods of continuous occupation.

It is clear that the majority of the arid zone sites were intermittently occupied, and many of the other Mediterranean zone sites were continuously occupied, over longer periods than Ghwair, WFA, Baja and WFC. This will have an effect on the nature of the lithic assemblages particularly during the transition period from the PPNB to the 6th mbc (Early Late Neolithic).

Core reduction strategies

It is possible to make detailed comparisons of strategy where the strategies are similar, and naviform blade production is present on all sites with the exception of Damishliya and WFC. The flake reduction strategies appear to differ except in the case of change of orientation flake cores, which are described by McCartney as a 'core turning' reduction method (McCartney in Betts 1998). However, this is such a simple and logical method (in comparison to prepared core strategies like naviform cores) that it could have been arrived at independently by different knapping communities.

Proportions of naviform cores

The proportions of naviform cores are highest at Douara cave II and Abu Hureyra, and then at WFA (table 2). However, it is clear that naviforms form the main group of core types at all sites until the PPNC/6thmbc, where they become less common or are completely absent (in the case of Damishliya and WFC, table 2).

Naviform core type

At all the sites looked at, there are several different sub-types of naviform core, which are related to the reduction sequence methodology and/or to the raw material type.

Douara cv. II Abu Hureyra	Classic naviforms Flat backed naviform Naviforms with partial cortex across the back (incomplete biface preform)
Damishliya	No naviform cores, but the blade debitage indicates opposed platform reduction.
Jericho	Naviforms with cortex across the back Naviforms with two ridges down the back (both types are possibly related to the use of tabular flint).
Jilat/Azraq	(Classic) naviforms sub- (classic) naviforms Tabular naviforms Sub- tabular naviforms
Dhuweila	Classic naviforms Tabular naviforms (both produced from tabular raw material)
Ghwair/WFA	Classic naviforms Variant naviforms with partial or completely cortical backs (incomplete biface preforms, the two naviform types are produced from different raw materials)
Baja	Variant naviforms (classic naviforms may have been removed by the excavator)
WFC	No naviform cores

Nishiaki identifies what he describes as the 'Douara method' (Nishiaki 2000) of naviform reduction. This involves a twisted axis on the main removal surface, which makes the removal surface partially include the sides of the naviform core. He finds this type of naviform core at Douara Cave II, at Abu Hureyra and at Qdeir I (Nishiaki 2000 following Calley 1986), which are all Syrian sites; but not at Jericho, a southern Levantine site. Both Baird and Nishiaki attribute the 'Douara method' to be a typical knapping tradition of Syria (Nishiaki 2000, Baird 1994), and Baird attributes the tabular naviform core to be a method typical of the southern Levant (Baird 1994). However, the 'Douara method' can be found at Ghwair, WFA and at Baja (all southern Levantine sites) on the variant type of naviform core though the tabular method is absent from these three sites. These two distinct methods of naviform core reduction are not necessarily or simply a result of regional knapping traditions but of the 'evolution' of an intensively reduced core (Nishiaki 2000 following Calley 1986) and the access, or lack of access, to tabular flint sources.

Naviform core dimensions

The intensive reduction of the naviform cores at the sites in my study can be attested to in the naviform core dimensions. Baird argues that one of the differences between arid and mediterranean zone sites is in the length of the naviform cores; he lists a number of mediterranean zone sites, Palmyra, Abu Gosh and Beisamoun as having long naviform cores, 85-185mm in length (Baird 1994). The naviform cores at Ghwair, WFA and Baja are all between 35-90mm long, which are generally similar, if a little shorter, than the naviform cores from Azraq and Jilat. The bulk of the naviform blade debitage from the sites in my study indicate that the initial naviform biface preforms would not have been significantly larger than the naviform cores themselves, suggesting that the goal of the naviform production was to produce smaller blades and bladelets at Ghwair, WFA, and Baja. This is comparable to the naviform blade debitage from the arid zone sites in Baird's study. However, though Ghwair, WFA, WFC and Baja are considered to be in the southern arid zone, I do not think that their local environment is as marginal as that at Azraq and Jilat. Though the knappers from these different communities may have been aiming for similar sized blade blanks, the use they made of them differed significantly. Ghwair, WFA, Baja and, to a certain extent, WFC are all distinct from the sites in Nishiaki's, Baird's and Betts' research because of the low proportions of burins, and the high proportions of piercing tools on blade and bladelet blanks. The piercing tools at Azraq and Jilat were produced on burin spalls (Baird 2001b).

Strategy and the PPNB/6th mbc transition

A high degree of continuation can be seen in reduction strategy during the PPNB/6th mbc transition period at Jilat, Azraq and Dhuweila (table 2) because the use of naviform cores continues though it does become less common, particularly in the Jilat area (it is difficult to identify changes in strategy and technique during the transition in Nishiaki's study because of the way in which he has published his data). Such a high degree of continuation in strategy cannot be seen at WFC; naviforms are absent from the WFC assemblage and have been replaced with a wider variety of different blade production strategies (this is not seen at the three PPNB sites in my study).

Technique

Only data on blades and bladelets from most of the sites in the three studies have been published (with the exception of Dhuweila and Damishliya). For this reason and because I am particularly interested in the relationship between groups of sites rather than of individual sites, it has been necessary to concentrate on a comparison of blade debitage, rather than on flake debitage, from my sites with those published in the studies of Nishiaki and Baird (Nishiaki 2000 and Baird 1994).

Platform type

There is a greater production of smaller platform types (punctiform and filiform) at the sites in my study, Ghwair, Wadi Fidan A/C, Baja and Azraq 31, Wadi el-Jilat 26 and Jericho (table 3). The highest proportions are found at Baja and Jericho. There is a clear distinction between Azraq and Jilat in the proportions of common platform type, and between the sites in my study and all other sites (despite Baja standing out slightly from Ghwair, WFA and WFC). These patterns of platform type proportions could be evidence for separate local knapping traditions, however, only if these patterns persist through other aspects of technique. Over time, the proportions of smaller platforms reduce at Jilat, Azraq and at my sites (it is not possible to identify specific change over time in Nishiaki's published data). However, the reduction is most significant at Jilat. The proportions of common platform types at Dhuweila are similar to Azraq 31, possibly including Dhuweila in the Azraq knapping traditions. The proportion of smaller platforms on blades at Dhuweila also reduces over time (McCartney in Betts 1998).

Platform preparation

I have had to compare the data on platform preparation from Baird and Nishiaki's studies (Nishiaki 2000 and Baird 1994) separately because they are slightly different forms of data (tables 4 and 5). There is a greater level of preparation on the blades at my four sites than there is at Azraq, Jilat and Dhuweila (table 4). The data from Dhuweila is not included in table 4 because it is not suitable for this format of presentation. Again, Azraq is clearly distinct from Jilat in the proportions of platform preparation (Baird 1994), and my sites are also distinct from the desert sites. This adds to the picture of distinct local knapping traditions emerging from the data. The proportion of platform preparation generally decreases over time at the desert sites, possibly relating to the decrease of naviform core production. However, the overall level of preparation does not decrease on blades at WFC, though the level of grinding preparation (most associated with naviform production at my sites) does reduce (Chapter 9 list of tables 17). Nishiaki's data distinguishes between the types of platform preparation (table 5, Nishiaki 2000). There are generally higher levels of grinding (abrasion) preparation at Nishiaki's sites, particularly at Jericho. Tell Damishliya has lower levels of preparation on the blade debitage possibly because there are fewer smaller platforms produced at this site, which in turn is possibly related to the absence of naviform cores at this site.

Platform and Bulb features

Difficulties arise here as Nishiaki (Nishiaki 2000) has not published the complete data on proportions of platform and bulb features and McCartney (McCartney in Betts 1998) has not published data on bulb features. However, from the data that is published, my sites clearly stand out because of the significantly lower proportions of lips and the slightly lower proportions of ring cracks (table 6). Azraq is also distinct from Jilat in the proportions of lips, ring cracks and clear cones. The proportions of lips at Dhuweila are similar to Azraq 31, though not the proportions of ring cracks, suggesting that at least some aspects of technique (including platform type and preparation) are similar at these two sites. It is interesting to note that there is a clear dominance of lips over ring cracks on blades at all of the desert sites (with the exception of Dhuweila stage 2 blades), unlike at my sites, suggesting that the aspects of technique that relate to combinations of strike factors is very different at my four sites. Where there is the pattern of lips and ring cracks at the desert sites it makes it easier to apply the theory developed by Ohnuma and Bergman relating to softer hammer type (Ohnuma and Bergman 1982). The proportions of platform and bulb features at Ghwair, WFA, Baja and WFC clearly demonstrate that the relationship between hammer type and debitage features (that relate to technique) is more complex than that indicated by Ohnuma and Bergman. As Nishiaki only lists the hammer type in his published data, this makes it very difficult to compare to my data on platform and bulb features. I can only assume that as he has been able to clearly identify hammer type from the platform and bulb features (using Ohnuma and Bergman's system), the proportions of features cannot be similar to those on the blade debitage from my sites. Flaking mode is the one aspect of technique that will vary most, as it involves extensive combinations of factors, including those that are directly related to the knapper's personal level of skill and other factors which the knapper may not even be conscious of. However, we are still able to see very general regional distinctions in knapping traditions, Ghwair, WFA, Baja and WFC form one group, Azraq and (to a certain extent) Dhuweila form another, and the Jilat sites form a third group.

Summary

At this point that we need to consider what all this data indicates regarding the level and the nature of the interaction between these distinct communities.

Strategy

Strategy has not been that useful for identifying specific community affinity. Certainly as far as naviform blade production is concerned, it is seen throughout the Levant. This requires a basic level of interaction between knapping communities across a vast super-region. However, this interaction does not necessarily involve community based group knapping activities in order to share technological information on reduction strategy. It also does not necessarily involve a shared technological language across the entire super-region because the information could have been passed on through many intermediaries rather like the game 'Chinese Whispers'. The distinctions in naviform reduction sequences (the 'Douara and Tabular methods') have been used by Baird and Nishiaki to suggest regional knapping traditions in Syria and the southern Levant. However, the similarity of the variant naviform cores at the southern Levantine sites of Ghwair, WFA and Baja to the 'Douara method' of Syria and the apparent absence of the 'Tabular method' on these sites in my study suggests that these two methods do not necessarily represent specific knapping traditions but rather relate to the intensive reduction of naviform cores and to the degree of access to particular raw material sources. Access to raw material sources may not simply be dictated by site/source propinquity but also by social control of the raw material sources.

Strategy goals

It is certainly clear that the ultimate goal of the reduction strategy influences certain aspects of the knapping sequence. Baird suggests that one of the distinctions between the arid and Mediterranean zones is in the size of the naviform cores and in turn, in the size of the desired blade blanks. The purpose of the arid zone naviform production being to produce smaller blade and bladelet blanks. The sites in my study, do not lie within the mediterranean zone, but in a less marginal environment than Azraq and Jilt, and also appear to be aiming for smaller naviform blade and bladelet blanks though for very different reasons. Therefore, the extensive production of retouched blades, points and particularly, piercing tools distinguishes my group of sites from those looked at in the three studies by Baird, Betts and Nishiaki.

Strategy and the PPNB/6th mbc transition

The analysis on Dhuweila and the Azraq/Jilat sites have been able to demonstrate a relatively high level of continuation in knapping traditions between the PPNB and the 6thmbc. Naviform blade production (particularly the tabular method) continues though it becomes less common and blade production is no longer more important than flake production. At WFC naviforms are no longer produced and have been substituted for a variety of different blade production strategies. However, as at the desert sites, blade production is no longer more important than flake production.

Technique

The data relating to technique has provided the most useful information relating to the degree of community affinity. There is a higher degree of smaller platform production at the sites in my study, than at all other sites detailed in the three studies (Baird 1993 and 1994, McCartney in Betts 1998, Nishiaki 2000), with the exception of Jericho. This might suggest that there was greater intention for developing higher levels of skill at Jericho and my sites, as it is difficult to consistently strike a core platform so close to the edge. The high levels of platform at my sites and Jericho probably relate to the desire to create smaller platforms. However, the high levels of preparation do not necessarily relate to similar desires at Douara cave II and Abu Hureyra. Whatever the intentions and desires of the knappers, there are clear regional differences in all aspects of technique; tentatively demarking Douara cave II and Abu Hureyra as one group and clearly demarking my sites, the Jilat sites and the sites of Azraq and Dhuweila as three separate groups. Jericho and Damishliya appear to be unique, certainly as far as can be ascertained by the scope of the analysis undertaken in this chapter. However, they may share similarities with sites not covered in the studies by Baird (1993 and 1994), Betts (1998) and Nishiaki (2000). These groupings of sites create distinct regions of knapping traditions, though they may not be the only sites involved in each knapping tradition.

Technique and the PPNB/6th mbc transition

As with strategy, Baird's and Betts' analysis of chipped stone assemblages has been able to demonstrate a high level of continuation in technique from the PPNB to the 6th mbc. The technological distinction between Azraq/Dhuweila and Jilat continues through into the 6th mbc. However, there is a decrease in the use of smaller platforms, and platform preparation, attributed to the decrease in the opposed platform blade production. At WFC we see similar changes in technique though they are less significant despite the complete change in reduction strategy. Therefore, evidence for a certain levels of continuation during this transition period at WFC can be seen in the technique rather than strategy. Overall, there is greater change, particularly in knapping practices, in the Wadi Fidan area than in the Desert areas and at the sites Nishiaki looked at, not least in the fact that my sites generally do not have as long periods of continuous occupation.

Networks of information sharing

We do see extensive networks of information sharing, centred on group knapping activities particularly in naviform blade production, and this lead to the development of distinct knapping traditions located in four, possibly six, regions (of community affinity) mentioned in this chapter.

Azraq Dhuweila	Jilat	Ghwair WFA Baja WFC	Jericho	Douara cave II Abu Hureyra (?)	Tell Damishliya (?)

During the transition from the PPNB to 6^{th} mbc, these networks continue in the desert area though they change a little in form, possibly as the result of less frequent community interaction and group knapping activities. However, the networks do not decrease or change the geographical area they originally covered during the PPNB. This is possibly related to the degree of seasonal community movement in this arid zone, which does not change in size and scope during the transition period (many of the same sites are continually re-occupied across the transition). Some aspects of the local knapping tradition of the PPNB endure in the region of WFC but in a much-changed form. Less social control, in the form of group knapping activities, is exerted over the production of blades, as attributed to by the complete change in blade reduction strategies and the relative increase of variation in blade production strategies (in the arid zone all of the reduction strategies endure through the transition period though they change in proportion). Therefore, the information-sharing networks have changed significantly in the region of Ghwair, Wadi Fidan and Baja; reducing much more significantly in size and scope than in the Azraq/Jilat arid zone. Given the changes in the lithic assemblages on my sites it is, therefore, unsurprising that there are also greater changes in settlement patterns over the PPNB and through to the PPNC/6th mbc than in the arid zone of Azraq/Dhuweila and Jilat.

Looking at other aspects of material culture, we see a reflection of the dual nature of the lithic technology. During the PPNB, the general umbrella of naviform blade technology seen across the vast area of the Levant as a whole, sat alongside more local knapping traditions, manifested in technique. A similar scenario can be seen in aspects of material culture as diverse as architecture and burial or ritual practices. This points to a very basic level of social interaction across the Levant, though not all sections of each community were necessarily involved. This certainly changes to different extents in different localities across the Levant; we see a greater degree of change in the locality of the Wadi Faynan/Fidan than we do in the arid areas of Jilat and Azraq. However, it is difficult to assess the exact nature of social interaction and information sharing networks, apart from in those areas where the relevant research has been conducted (i.e. in the area of this thesis and that of Baird's thesis, Baird 1993/4). The material culture and lifestyle of the arid zones are distinct due to the effect of environmental conditions. The sites in my research are also relatively distinct from other areas of the Levant as they are a collection of small permanent sites. Other extremely large sites like 'Ain Ghazal and Jericho may have interacted with their surrounding localities in a different manner. This illustrates the need for further research into the nature of social interaction between communities, using the medium of technology. This would greatly increase our understanding of the important period of the Pre-Pottery Neolithic and the transitional phases that began and ended this period.

List of tables: Chapter 10 (Conclusion)

Table 1

Site		Period
Wadi el-Jilat 7 (WJ7)	II	Middle PPNB
	III	Middle/late PPNB
Wadi el-Jilat 26 (WJ26)		Middle PPNB
Wadi el-Jilat 32 (WJ32)		Middle/late PPNB
Wadi el-Jilat 25 (WJ25)		PPNC/Early Late Neolithic
Wadi el-Jilat 13 (WJ13)	I	Early Late Neolithic
	II	Early Late Neolithic
Azraq 31 (Az31)	I	Middle/late PPNB
	II	Early Late Neolithic
Dhuweila	Stage 1	Late PPNB
	Stage 2	6th mbc (early late Neolithic)
Douara Cave II		PPNB (no radiocarbon dates)
Abu Hureyra (relevant levels)	Trench D	Middle PPNB
	Trench C	Late PPNB/PN (early late Neolithic)
Jericho (relevant levels)		*c.* Middle PPNB
Tell Damishliya	Strata 1-2	PPNB
	Strata 3-7	PN (early late Neolithic)
Ghwair		Middle PPNB
Wadi Fidan A (WFA)		Late PPNB
Baja		Late PPNB
Wadi Fidan C (WFC)		PPNC/6th mbc (early late Neolithic)

Table 2 (Yellow demarks the periods the assemblages cover.)

Total % of naviforms	Middle PPNB	Middle/late PPNB	Late PPNB	PPNC	Early Late Neolithic (6^{th} mbc)
WJ7 II	44%				
WJ7 III		36.1%			
WJ26	48.6%				
WJ32		44.4%			
WJ13 I					16.7%
WJ13 II					6.4%
WJ25					2.9%
Az31 I		28.57%			
Az31 II					20%
Dhuweila			20%		2.6%
Douara cv. II	81.9%				
Abu Hureyra	70.3%				
Jericho	?				
Damishliya	0%				
Ghwair	28.4%				
WFA			62.5%		
Baja			11.4%(?)		
WFC				0%	

Table 3

Total % plat type	plain	thinn (fil)	small (punc)	IDB*	cortical	faceted	dih	winged	crushed	total smaller plat
WJ7 II	41.7%	10.5%								16.2%
WJ7 III	47.0%	12.8%								20.1%
WJ26	34.1%	19.6%								27.1%
WJ32	14.8%	16.4%								21.3%
WJ13 I	47.0%							10.1%		14.9%
WJ13 II	50.5%	11.3%								14.6%
WJ25	46.7%						6.7%			1.7%
Az31 I	47.6%	25.4%	14.3%							39.7%
Az31 II	42.9%	21.4%	12.5%							33.9%
Doura Cave II	29.0%	24.5%		41.3%						27.5%
Abu Hureyra	49.2%	29.1%		10.4%						34.7%
Jericho	31.7%	43.6%	21.0%							64.6%
Damishliya fine**	73.7%				10.5%					5.3%
Damishliya course*	41.9%	11.6%								11.6%
Ghwair	26.6%	16.4%	13.0%							39.4%
WFA	13.1%	7.9%	25.1%							33.0%
Baja	13.4%	35.8%	43.3%							79.1%
WFC	28.0%	16.0%	13.3%						17.3%	29.3%

* IDB imitation dihedral burin

** fine and course grained raw materials

Dhuweila has not been included because the data is not suitable for this table format.

Table 4

site	total prep on bld/bldlets
WJ7 II	20.0%
WJ7 III	20.7%
WJ26	14.5%
WJ32	13.1%
WJ13 I	16.1%
WJ13 II	15.6%
WJ25	1.7%
Az31 I	34.9%
Az31 II	26.8%
Ghwair	65.6%
WFA	86.2%
Baja	58.2%
WFC	81.0%

Table 5

Plat prep blds	abrasion(grin)	faceted (plat edge flk)	absent
Doura Cave II	77.4%	7.3%	15.3%
Abu Hureyra	53.7%	13.1%	33.2%
Jericho	91.1%	1.1%	7.8%
Damishliya fine*	42.1%	26.3%	25.3%
coarse*	15.4%	11.5%	73.1%
Ghwair	44.9%	15.8%	32.3%
WFA	62.4%	14.9%	12.6%
Baja	37.3%	13.4%	32.8%
WFC	22.2%	31.7%	17.5%

* fine and coarse grained raw materials

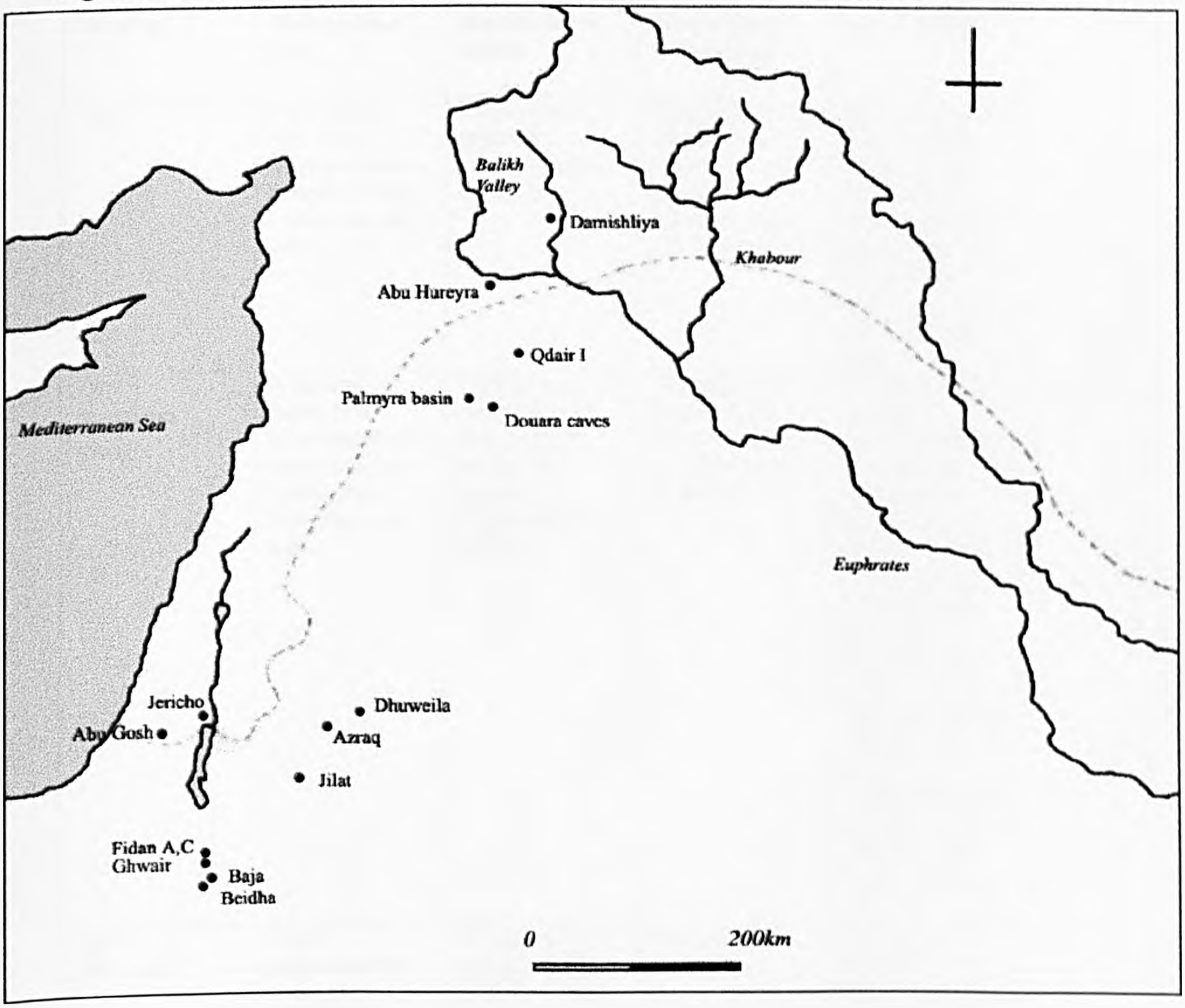
Table 6

Total % plat/bulb features	lip	ring crack	clear cone
WJ7 II	25.5%	4.1%	16.2%
WJ7 III	24.4%	2.4%	15.2%
WJ26	28.2%	4.3%	14.9%
WJ32	42.6%	0.0%	19.7%
WJ13 I	23.8%	6.0%	16.1%
WJ13 II	23.1%	1.9%	18.4%
WJ25	20.0%	5.0%	16.7%
Az31 I	61.9%	0.0%	0.0%
Az31 II	42.9%	0.0%	7.1%
Dhuwaila stage 1	52-60%	40.0%	(not pub)
stage 2	21.1-23.8%	47.6-57.9%	(not pub)
Ghwair	2.4%	1.6%	16.4%
WFA	4.8%	3.4%	28.7%
Baja	3.0%	0.0%	6.1%
WFC	1.3%	1.3%	28.0%

(The data on platform and bulb features is not published in Nishiaki's study)

List of Figures: Chapter 10 (Conclusion)

Fig. 1 Map showing the sites in Betts', Nishiaki's, Baird's and my studies.



Appendix 1

Raw material types:

Number	Description of flint	Description of cortex	Description of nodule shape	Source of flint
Type 1	A fine glossy flint, which ranges in colour between cream, brown and pale grey.	Chalky cortex, relatively unweathered or battered.	The nodule have rounded edges (I do not know the general, complete shape of these nodules)	Unknown, not in the immediate locality of the wadi beds of Ghwair, Faynan and Fidan (I do not have this kind of information for Baja)
Type 3 (medium wadi)	A medium-coarse flint, which ranges in colour between brown, light brown/grey and grey.	Cortex can be either cream or an orange/red colour; both types are weathered and battered.	The nodules are large with flat surfaces. Edges are angular and weathered.	This flint can be found in abundance in the Ghwair wadi bed. (I later renamed this medium wadi for the sake of convenience as so much was used) I do not have source information from Baja though some of the assemblage flint types looked similar to those in this category.
Type 4 (fine wadi)	A fine translucent flint with a matt surface, which ranges in colour between grey/cream and grey.	The cortex ranges in colour between a white to a very dark grey/brown. It is weathered and battered.	The nodule shape is a relatively irregular rounded cobble.	This flint is found in the Ghwair wadi bed (and a lighter conglomerate version can be found down steam in the Fidan wadi bed, see *type 7*)
Type 16	A fine flint with a matt surface and brown in colour.	Not enough cortex remaining to clearly describe it.	Unidentifiable nodule shape, though it is possibly more tabular in shape	Unknown source

			than *type 1* due to the way in which it was used to produce Naviform cores	
Type 7 (rough wadi)	This category includes several type of rough flint found in the wadi beds, including the conglomerates found in Wadi Fidan.	Battered cortex much like the flint itself.	The nodules are angular wadi cobbles.	Common to the wadi beds of Ghwair, Faynan and Fidan.
Baja fine	The same in appearance to type 4 *(fine wadi)*	The cortex is the same as type 4 *(fine wadi)*, however, it is not wadi rolled or weathered in the same way.	Nodule shape is a relatively irregular rounded cobble	Unknown original source, probably not from a wadi bed.

Appendix 2

Flake and blade categories:

Primary (1) flake (6)	Primary blade (3)	Primary Bladelet (4)	Primary blade/bladelet (5)	Primary Indeterminate (7)
Primary flake retouched (8)	Primary blade retouched	Primary Bladelet retouched	Primary blade/bladelet retouched	Primary indeterminate retouched
Secondary (2) flake	Secondary blade	Secondary bladelet	Secondary blade/bladelet	Secondary indeterminate
Secondary flake retouched	Secondary blade retouched	Secondary Bladelet retouched	Secondary blade/bladelet retouched	Secondary indeterminate retouched
Flake	Blade	bladelet	blade/bladelet	Indeterminate
Flake retouched	Blade retouched	Bladelet retouched	blade/bladelet retouched	Indeterminate retouched

Overshot categories:

Secondary overshot (flk) (9)	Secondary overshot (bld) (10)	Secondary (indeterminate) overshot (11)
Secondary overshot (flk) retouched	Secondary overshot (bld) retouched	Secondary (indeterminate) overshot retouched
Overshot (flk)	Overshot (bld)	Overshot (indeterminate)
Overshot (flk) retouched	Overshot (bld) retouched	Overshot (indeterminate) retouched

Core and core associated categories:

Core (12)	Core with cortex (13)
Indeterminate flake core/tool (14)	Core tool (15)
Core chunk (16)	Chunks and shatter (17)
Wadi pebble (18)	Hammer stone (19)

Cresting and rejuvenates categories:

Secondary crested piece (20)	Secondary crested blade (21)	Secondary crested blade/bladelet (22)
Secondary crested piece retouched	Secondary crested blade retouched	Secondary crested blade/bladelet retouched
Crested piece	Crested blade	Crested blade/bladelet
Crested piece retouched	Crested blade retouched	Crested blade/bladelet retouched
Secondary rejuvenation (23)		
Secondary rejuvenation retouched		
Rejuvenation		
Rejuvenation retouched		

(1)(2) Primary and secondary refer to the remaining amount of cortex on the artefact. Primary, means that the cortex covers the entire dorsal surface. Secondary includes every piece with any other amount of cortex remaining.

(3) A blade is a complete blank, which is twice as long as it is wide.

(4) A bladelet is a blade, which is under 50mm in length and 12mm in width.

(5) Blade/bladelet refers to all broken pieces that are twice as long as they are wide, which fall within the standard bladelet measurements (50mm length, 12mm width).

(6) A flake is a complete blank, which is not a blade.

(7) Indeterminate refers to broken pieces which cannot be proved to be either a blade or a flake.

(8) Retouch is the removal or series of removals, which intentionally modify a blank in order to produce a tool. Anything with retouch on is considered a tool; though for the purposes of this thesis I only use the term tool when it has a formal shape, see *(30)*.

(9)(10)(11) Overshot (or plunging blank) describes a flake, blade or indeterminate piece which has removed the entire base of the core (on single platform cores) or part, or the entire opposite platform (on opposed platform cores). The lower part of the ventral surface is concave with a general distal thickening.

(12) A nodule or block of raw material from which blanks (flakes and blades) have been removed.

(13) A core on which some of the cortex (or external surface of the flint) remains.

(14) Indeterminate flake core/tool refers flaked with large irregular removals, which could either be used as a core or as a tool and cannot be proven to be one or the other.

(15) Core tool is a tool made from a core rather than a blank e.g. an axe or an adze.

(16) Core chunks are the remains of exhausted cores; no complete ventral surface remains.

(17) Chunks and shatter are small irregular pieces of flint which break off when any blank or core is hit hard enough. They are identified by the fact that they have no clear ventral surface.

(18) Wadi pebble is unmodified.

*(19)*A hammer stone shows signs of crushing where it has been used to hit something e.g. flint to produce blanks.

(20) Crested piece refers to a flake, which shows signs of cresting on its dorsal side. Cresting is the reshaping of a core in order to create a ridge, which will guide the force of a blow in the direction required in order to later remove blanks of a desired shape.

(21) Crested blade is a blade with cresting on its dorsal surface.

(22) Crested blade/bladelet is a broken piece, twice as long as it is wide, which falls within the bladelet dimensions (50mm long/12mm wide). It also has cresting on its dorsal side.

(23) Rejuvenation is a general term describing a piece of debitage which has removed a damaged or exhausted core platform, platform edge or removal surface. It also refers to a similar piece, which refreshes or reshapes a tool edge.

Appendix 3

Platform type	**Plat-form prepara tion**	**Plat-form features**	**Bulb type**	**Bulb features**	**Raw material**	**Dimen-sions**	**Opposed platform features**
Plain *(1)*	Bash-ing *(9)*	Lip *(12)*	Promin ent bulb *(14)*	Clear cone *(17)*	See *Appen-dix 1*	Length *(20)*	Opposed platform scar *(21)*
Winged *(2)*	Plat-form edge flaking *(10)*	Ring crack *(13)*	Diffuse bulb *(15)*	Siret fracture *(18)*		Width	Remains of opposite platform *(22)*
Punct-iform *(3)*	Grindi ng *(11)*		Conica l *(16)*	Large eraill-ure *(19)*		Thickness	
Filiform *(4)*							
Faceted *(5)*							
Dihedral *(6)*							
Cortical *(7)*							
Crushed *(8)*							

(1) A plain platform is when a single removal has created the platform, no further preparation has been done.

(2) A winged platform is created by the scar of a previous blank removal on the dorsal side. The position of the bulb negative is exactly opposite the bulb on the ventral side of the blank (which makes the platform look as if has wings).

(3) A punctiform platform is a tiny platform

(4) A filiform platform is a tiny linear platform

(5) A faceted platform is prepared by retouch which faceted the surface of the platform.

(6) A dihedral platform is prepared by making only two removals, the scars of which create a ridge, which crosses the platform roughly in the centre.

(7) A cortical platform is either an unprepared cortical surface or it has been prepared but the retouch has not penetrated the cortex (this category can be used in conjunction with other platform categories).

(8) Crushed, means that the blow from the hammer has crushed the platform so that its original form is no longer visible.

(9) Bashing refers to the preparation of the platform edge. Careful bashing was used to remove any jagged imperfections, which might take the force of percussion in the wrong direction. Bashing preparation could also be evidence of several fruitless strikes and so it is a fine line between intentional bashing preparation and accidental crushing. The best way to distinguish intentional bashing preparation is if it is associated with any other types of preparation.

(10) Platform edge flaking is also applied to the platform edge, for the same reason as bashing only it is a little more controlled and harder to perform. It is also used to isolate the platform of the intended removal from the core platform

(11) Grinding serves a similar purpose to bashing and pressure flaking. The edges of the core platform were occasionally ground down into a smooth rounded shape in order to strengthen and consolidate an isolated platform, or to correct any mistakes or damage caused by bashing and platform edge flaking. This is the hardest and most detailed of all the preparation and was usually applied to cores that required the most precision when removing blanks. Each method of platform edge preparation can be used in conjunction with one or both of the other methods, though they are usually applied in a sequence. Bashing first, then pressure flaking and/or grinding (grinding is always the final stage).

(12) A lip is a slight projection of the edge of the platform at the point where the bulb meets the platform. This morphology is thought to be characteristic of soft hammer percussion (Inizan, Roche and Tixier 1992).

(13) A ring crack is a tiny fracture in the shape of a ring visible on the platform, this is the striking point and the ring is the very tip of the cone of percussion, which sometimes can be visible further down in the bulb. The ring crack is thought to be characteristic of hard hammer percussion.

(14) A prominent bulb is a roughly conchoidal shape, which radiates from the striking point on the platform.

(15) A diffuse bulb is when the conchoidal shape is not visible on the ventral surface.

(16) Conical refers to when the blow from the hammer has left only the cone of percussion (see *13*), all the flint around this feature has broken away on both the ventral and dorsal sides.

(17) Clear cone is when the cone of percussion is visible on the ventral surface just below the striking point on the

platform.

(18) Siret fracture is when the blow of the hammer has split the entire blank in half. The fracture runs through the center of the cone of percussion.

(19) A large eraillure (or bulb scar) is created when a flake or parasite has separated off the bulb at the point of percussion. It is recorded when it is significant in size relative to the size of the bulb. It can be linked to hammer technique in relation to other bulb features.

(20) I record the dimensions of every piece except when the piece is broken, here I omit the dimension (length or width) which is incomplete from the break.

(21) Opposed platform scar refers to any remains of a scar on the dorsal surface, which clearly indicate (with waves of percussion) that the previous removal was taken from an opposite platform.

(22) Remains of opposite platform describes when the blank has removed part of an opposite platform but is not an overshot, see *appendix 2 (9),(10)* and *(11)*.

Appendix 4

Cores		Rejuvenation pieces	Crested Pieces	
Core type	**Angle of platform**	**Rejuvenation type**	**Cresting**	**Initial/non-initial**
Single platform flake core *(1)*	For up to 7 platforms *(16)*	Ski spall *(17)*	Large cresting removals *(21)*	Initial *(28)*
Single platform blade core *(2)*		Platform correction *(18)*	Small cresting removals *(22)*	Non-initial *(29)*
Single platform pyramidal blade core *(3)*		Removal surface correction *(19)*	Regular removals *(23)*	
Single platform bladelet core *(4)*		Platform edge /removal surf correction *(20)*	Irregular removals *(24)*	
Double platform flake core *(5)*			crested *(25)*	
Double platform blade core *(6)*			Ridge refreshing cresting*(26)*	
Opposed platform flake core *(7)*			Unclear cresting *(27)*	
Opposed platform blade core *(8)*				
Bipolar flake core (using esquillée technique) *(9)*				
Bidirectional flake or blade core *(10)*				
Naviform core 'classic' and 'variant' *(11)*				
Change of orientation flake core *(12)*				
Change of orientation/bi-directional flake core *(13)*				
Multiple orientation flake core *(14)*				
Irregular flake core *(15)*				

(1) A single platform flake core is a block of flint from which flake blanks have been removed from the same platform.

(2) A single platform blade core is a block of flint from which blade blanks have been removed from the same platform.

(3) A single platform pyramidal blade core is a block of flint from which blade blanks have been removed from a single platform and the removal surface tapers to a point opposite the platform creating a pyramidal shape (with the platform as its base).

(4) A single platform bladelet core is a block of flint from which bladelet blanks have been removed from a single platform.

(5) A double platform flake core is a block of flint from which flake blanks have been removed from two platforms.

(6) A double platform blade core is a block of flint from which blade blanks have been removed from two platforms.

(7) An opposed platform flake core is a block of flint from which flake blanks have been removed from two platforms that are opposite each other.

(8) An opposed platform blade core is a block of flint from which blade blanks have been removed from two platforms that are opposite each other.

(9) A bipolar flake core (using esquillée technique) is a block of flint from which flake blanks have been removed from opposite platforms. Pressure has been applied by striking one platform while the other is resting on a hard flat surface (hammer and anvil), so that the force of the blow runs from both platforms and meets in the middle. This can be identified by crushing features on the end of the core that has been placed on the anvil (crushing appears on both the tip of removal surface and the platform itself).

(10) A bi-directional flake core is where flake removals have been taken from two separate platforms on opposite ends, and opposite sites of the core.

(11) A naviform core is a block of flint from which blade or bladelet blanks have been removed from two opposite platforms. The two platforms and crested ridge along the back of the core give it a boat shape. The shape of this core is a formal one, which appears throughout the PPNB of the Levant. The 'classic' naviform core follows this description and has a fully crested ridge along its back, the nature of the 'classic' naviform preform is a complete biface. The 'variant' naviform has a fully cortical back (no cresting), partially crested back or occasionally, a large flake removal on its back, the nature of the 'variant' naviform preform is a partial biface with some cortical edges.

(12) A change of orientation flake core is a block of flint from which flake blanks have been removed from platforms that are the negative scar of the previous flake removal. This technique can only be applied to flake cores.

(13) A change of orientation flake core where two sequences of flake removals has been started at either ends of the

core on opposite sides.

(14) A multiple orientation flake core is similar to a change of orientation flake core. Flakes are removed in the same way but there are more than one distinct areas on the block of flint where flake removal has occurred. The chain of flaking does not join up in these distinct areas.

(15) An irregular flake core is a block of flint from which flake blanks have been removed in no particular order, using no particular technique.

(16) Angle of platform refers to the angle between the platform and the removal surface.

(17) 'Ski spalls', a formal term described by Quintero and Wilke, is part of the naviform core reduction strategy (Wilke and Quintero 1994). They are removed in order to either rejuvenate a platform or to enlarge it. They are identifiable by their tabular shape with a partially faceted edge.

(18) A platform correction is an irregular removal used to correct part or all of a platform on any core (it does not have the formality of shape that the ski spall does). It is identified by a partially faceted edge.

(19) A removal surface correction is used to remove any mistakes on a removal surface, which is preventing any subsequent blank production. It can be identified by the fact that it usually is taken off from a new, different platform (for example, from the side of the removal surface) and/or removes an obvious mistake like an overhang.

(20) A platform edge/removal surface correction refers to a rejuvenation that takes off a damaged platform edge and some of the removal surface. This is used when the edge can no longer be simply prepared in order to continue with blank removal.

(21)(22) Large/small cresting removals describe the removals that crest the ridge.

(23)(24) Regular/irregular removals indicate whether the cresting was carefully produced running down the entire piece. Or it was irregular and *ad hoc*, taking advantage of the shape of the flint and cresting only where needed to guide the ridge in a particular direction.

(25) Crested means bifacial cresting down the dorsal ridge. Used to create a new ridge where previously there was none. Often applied to the initial stages of core reduction or when a removal surface has been rejuvenated.

(26) Ridge refreshing cresting is where only one side of the dorsal ridge is crested. Used to refresh and consolidate a ridge as part of core removal surface maintenance.

(27) Unclear cresting is when cresting travels down one side of the ridge and then down the other, it is not bifacial. Therefore, it is not clear whether this is the creation of a new ridge or the refreshing an old one.

(28) Initial refers to the removal of the first crested element; it is identified by the fact that some cortex is visible along both edges roughly running parallel to the crested ridge.

(29) Non-initial means that there is no cortex visible and sometimes the negative scar of a previous blank removal can

be seen along its edge.

Appendix 5

Formal tool categories:

Large tools	Small tools	Burins
Primary core tool *(1)*	Secondary scraper *(9)*	Secondary burin *(19)*
Secondary core tool *(2)*	Secondary borer *(10)*	Secondary burin/ retouched *(20)*
Core tool *(3)*	Borer *(11)*	Burin *(21)*
Secondary indeterminate flake/core/tool *(4)*	Secondary piercing tool *(12)*	Burin /retouched *(22)*
Indeterminate flake/core/tool *(5)*	Piercing tool *(13)*	Secondary transverse burin/retouched *(23)*
Broken cobble retouched *(6)*	Broken point *(14)*	Transverse burin/retouched *(24)*
Adze *(7)*	Broken Byblos point *(15)*	
Secondary pick *(8)*	Byblos point *(16)*	
	Secondary sickle blade *(17)*	
	Sickle blade *(18)*	

(1) A tool that is produced on a nodule of flint. It is fully cortical except for removals which retouch the edge.

(2) A tool that has been produced on a core that retains some cortex.

(3) A tool produced on a core and does not retain any cortex.

(4) A large secondary flake (appendix 2), with regular removals. It is unclear whether the removals are retouching the edge of a large tool or that this is a core on a flake.

(5) A large flake, similar to previous number 4 (appendix 5) but without cortex.

(6) A retouched and broken wadi cobble.

(7) A core tool produced with rough bifacial retouch. It is similar to an axe but both ends are angular forming a roughly rectangular shape. It is used for chopping.

(8) A secondary pick is a core tool that retains cortex, produced with rough bifacial retouch. It has a bulbous end (or handle) and a heavy-duty robust point.

(9) A secondary scraper is a tool on a flake that retains cortex. It has one straight retouched edge used for scraping.

(10) A borer is the same as a secondary borer but it does not retain cortex.

(11) A borer is a large (usually broken) piercer. It has semi abrupt bifacial retouch around the point creating a triangle in cross section

(12) A secondary piercing tool is the same as a piercing tool but it retains some cortex.

(13) A piercing tool is a broken blade or bladelet that has had a relatively long point made on one or both ends (the point forms two shoulders on either side). The point is created with fine, semi abrupt bifacial retouch, which is triangular in cross section.

(14) Broken point refers to when the diagnostic features are missing.

(15) A broken Byblos point still retains the diagnostic shoulders.

(16) A Byblos point is a point that has been produced using fine bifacial retouch, and has two distinctive shoulders at its base.

(17) A secondary blade (appendix 2) or broken blade with regular retouch and evidence of sickle gloss along the edge.

(18) A blade or broken blade similar to the above number 16 (appendix 5) but without cortex.

(19) Secondary burin is the same as a burin, but it retains cortex.

(20) Secondary burin/ *retouched is the same as a burin retouch, but retains cortex.*

(21) A burin is a tool or blank, which has had one or more burin spalls removed from its edge or end. It can be identified by the presence of a burin facet (Inizan, Roche and Tixier 1992), which is a negative scar of a bladelet.

(22) Burin/retouched is a burin that has received retouch other than the burination.

(23) Transverse burins/retouch are blade blanks that have been truncated across its width by a burination spall removal and have subsequently been retouched further.

(24) A secondary transverse burin/ retouched are transverse burins *(23)* that retain some cortex and have been further retouched.

Burin spall categories:

Secondary spall *(1)*		
Secondary spall retouched	Secondary spall with retouch *(2)*	Secondary spall with retouch/retouched *(3)*
Spall		
Spall retouched	Spall with retouched	Spall with retouch/retouched

(1) A burin spall is what is removed from a burin, it is a bladelet in shape and is distinguished by the fact that it has two ventral surfaces (one from the spall removal itself and the other from the original ventral surface of tool or blank).

(2) A spall with retouch refers to the fact that the spall has removed some retouch that was on the original tool. This is identified because the edges of the spall sometimes cut the retouch scars, also that the retouch is along what is effectively the dorsal ridge of the spall.

(3) With retouch/retouched means that the spall not only removes retouch from the original tool, but also was later retouched itself. This can be identified because the retouching of the spall is along its edges and it sometimes cuts the earlier retouch from the original tool.

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